YOJANA

MAY 2023 A DEVELOPMENT MONTHLY ₹ 22

TECHADE

LEAD ARTICLE

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FOCUS

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Dr Sameer Patil

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NATIONAL QUANTUM MISSION

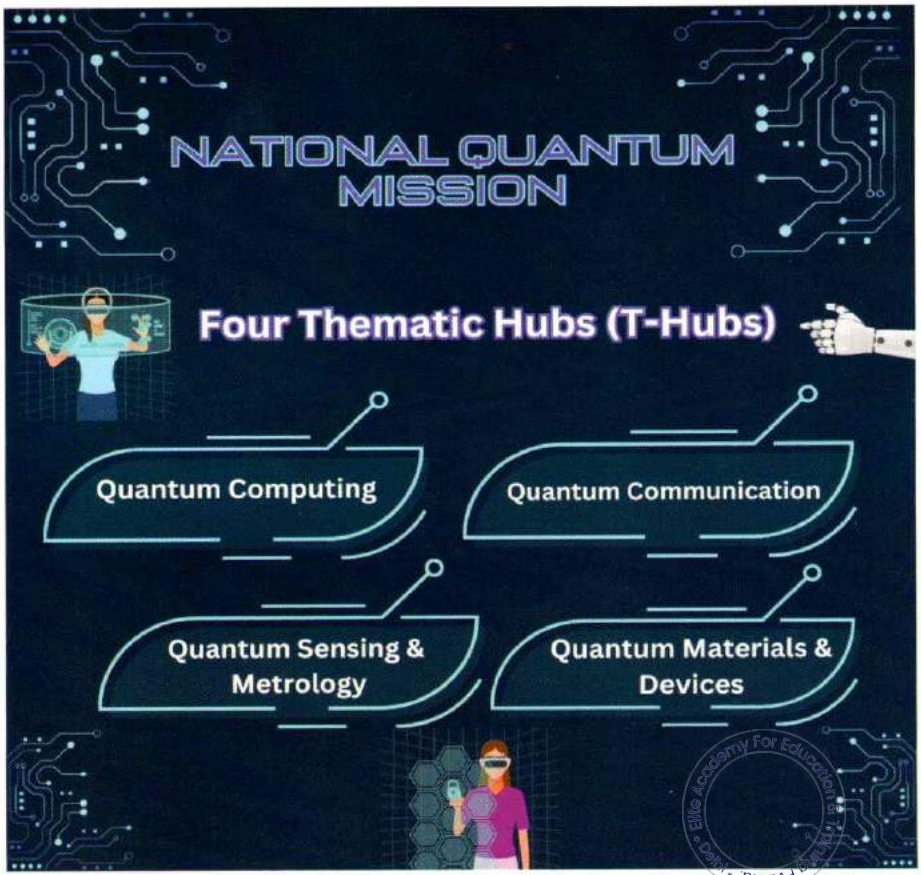
SCALING-UP SCIENTIFIC & INDUSTRIAL R&D FOR QUANTUM TECHNOLOGIES

Aiming to seed, nurture, and scale up scientific and industrial Research and Development (R&D), and create a vibrant & innovative ecosystem in Quantum Technology (QT), the Union Cabinet has recently approved the National Quantum Mission (NQM) at a total cost of Rs 6003.65 crore from 2023-24 to 2030-31. This will accelerate QT-led economic growth, nurture the ecosystem in the country, and make India one of the leading nations in the development of Quantum Technologies & Applications (QTA).

The new Mission targets developing intermediate scale quantum computers with 50-1000 physical qubits in 8 years in various platforms like superconducting and photonic technology. Satellite-based secure quantum communications between ground stations over a range of 2000 kilometres within India, long distance secure quantum communications with other countries, inter-city quantum key distribution over 2000 km as well as multi-node Quantum network with quantum memories are also some of the deliverables of the mission.

It will help develop magnetometers with high sensitivity in atomic systems and atomic clocks for precision timing, communications, and navigation. It will also support design and synthesis of quantum materials such as superconductors, novel semiconductor structures and topological materials for fabrication of quantum devices. Single photon sources/detectors, entangled photon sources will also be developed for quantum communications, sensing, and metrological applications.

Four Thematic Hubs (T-Hubs) will be set up in top academic and National R&D institutes on the domains - Quantum Computing, Quantum Communication, Quantum Sensing & Metrology, and Quantum Materials & Devices. The hubs which will focus on generation of new knowledge through basic and applied research as well as promote R&D in areas that are mandated to them.



NQM can take the technology development ecosystem in the country to a globally competitive level. The mission would greatly benefit communication, health, financial and energy sectors as well as drug design, and space applications. It will provide a huge boost to National priorities like Digital India, Make in India, Skill India, and Standup India, Startup India, Self-reliant India, and Sustainable Development Goals. ❑

Source: PIB

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YOJANA

Since 1957 A DEVELOPMENT MONTHLY

Let noble thoughts come to us from all sides.
Rig Veda

Yojana (English): Room No. 647, Soochna Bhawan, CGO Complex, Lodhi Road, New Delhi-110 003.
E-mail (Editorial): sec-yojanaeng-moib@gov.in

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sec-yojanaeng-moib@gov.in

Promote Local Startups Globally

The April 2023 issue of Yojana on Startup India has shed light on the ecosystem of startups and how, by leveraging information technology and creative ideas, new enterprises attract investors for a successful and sustainable business. It also envisages the role of the Government in imbibing and encouraging new entrepreneurs to come forward in order to substantially contribute to the Indian economy. The Government should be vocal for local startups in order to make them global.

– Debasis Das
Odisha

Story of Amrit Kaal

The Yojana issue of Startup India was very informative and illuminating. It was like learning about the inner workings of a complex machine – the Indian economy. While the coverage was broad, a few more topics could have enhanced it. All in all, the issue was an enjoyable read and a peek behind the curtain at India's growth story in the Amrit Kaal.

– Anjali Singh
Delhi

Fulcrum of Change

Although I never miss reading any of your monthly editions of Yojana, I personally want to appreciate your efforts to extensively cover the important topic of the Startup India programme. A dedicated magazine edition on the Government policies and efforts for startups for the reader section is the need of the hour. India being home to a demographic dividend, it is necessary that our youth have an idea, how to go for startups as a career. Despite the April 2023 edition, the March special edition on Union Budget had a chapter that had dedicated points on how the Government is focusing on human resource development - the fulcrum of change. This magazine is very special as it always comes up with quality content and rich information on every topic. Team Yojana must be congratulated for their efforts. I just wanted to request Team Yojana to please bring a dedicated edition on India's relevance in geo-politics after securing the presidency of the G20 and SCO as well.

– Kirti Wadhawan
Uttar Pradesh

Collector's Issue

'Yojana' March 2023 special issue on the Union Budget, is a collector's issue as it contains important articles on the Union Budget 2023-24. The write-ups, well supported by graphical data, enable readers, young and old, to know the nitty-gritty of budgeting. The editorial 'Saptarishi for Amrit Kaal' has lucidly described the vision for Amrit Kaal, the seven priorities of the Union Budget, and the importance of MSMEs as growth engines of our economy. Kudos to Team Yojana for bringing out such a beautiful issue.

– Pratap Nayak
Odisha

The Last Mile

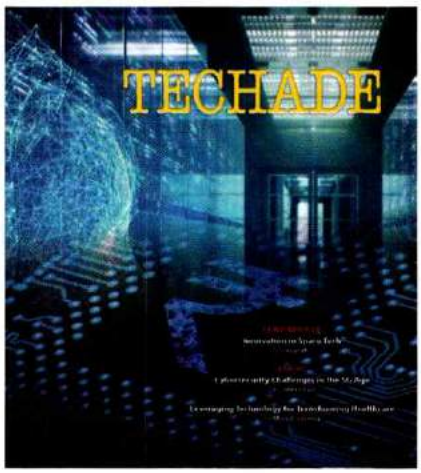
Yojana is not only for UPSC aspirants, but also for anyone in every field of education who is interested and can read this magazine and grasp the knowledge from it. It has been on my reading list for two years. The April 2023 section on 'Antyodaya and Mass Media' is truly amazing. The way he describes the upgrading of mass media like mobile applications, shows how truly it needs to update and benefit the last person in the society.

– Bhagyashree Moharana

Techade

"We all know that knowledge is paramount in the global economy of the 21st century. I believe that the dream of India's Techade will definitely be fulfilled on the strength of our innovators and their patents. With this, we will all be able to take full advantage of world-class technology and products prepared in our own country."

– Narendra Modi, Prime Minister of India



For the Millennials and the early Gen Zs, one of the most prevalent essay or debate topics in examinations was, 'Technology: Boon or Bane'. Those were the days when technology was an option, a choice, and a value addition to otherwise non-tech lives. The access and use of technology were limited to certain sections of society. Those were the times when people used to go to standard PCO booths to make a mere phone call; there were no personal phones, just a single-corded landline for an entire family, and just a computer with a giant-domed monitor, which was the same as the televisions. Nearly a decade ago, we all had the opportunity to witness what life might be like without today's cutting-edge technology. Sharing a document meant sending it through *dak* or, if the then-modern means permitted, via fax. When transferring money meant sending a money order that would take days to arrive; when we had to wait in queue for everything, from rail ticket booking to banking, from the movie to paying bills; when written communication meant postcards and inland, and one-liner telegrams were used for urgent communication, this was India just three to four decades ago. It was a time when the world could not even imagine life with smartphones, digital payments, podcasts, social media, and so on.

Since then, things have changed dramatically. The swift pace and phenomenal expansion of technology have drastically altered human existence during the past 25 years. The youth of the country are driving this transformation. Nobody could have predicted a decade ago that we would call this period, 'The Techade'. Everything is becoming possible, scalable, and accessible, thanks to technological advancements. The beauty of this technological era lies in its inclusiveness, where digital India is taking shape in every nook and corner of the country, and beyond.

With the goal of providing affordable access to digital services for all citizens, India has pioneered distinctively creative digital projects, launched population-scale transformational initiatives, and ensured digital inclusion. India's digital transformation trajectory has left an indelible impression on all facets of life, ensuring digital access, digital service delivery, and digital inclusion for all, based on technology that is sustainable, economical, and transformative. Digital India is dedicated to exposing India's technological capability to the world, facilitating collaboration and economic prospects for tech entrepreneurs, and encouraging citizens by presenting them with an abundance of opportunities.

Today, India is joining hands with other democratic nations to take this technology to the next level. These are interesting times when we are at the intersection of tech development and innovation that are bringing solutions to the complex and day-to-day problems of our lives. This 'Techade' is clearly here to stay. ❑

LEAD ARTICLE

INNOVATION IN SPACE TECH

The exploration of space has always been a driving force for technological innovation, pushing the boundaries of what is possible and opening up a myriad of opportunities for research and development. From the early days of the space race to the present day, the pace of innovation in space technology has been rapid and transformative. Space applications, transportation systems, and infrastructure are a few verticals of the ISRO programme that have witnessed many technological innovations. It is actively pursuing the maiden human spaceflight mission - Gaganyaan to send astronauts to space and safely return to Earth.

S SOMANATH

The author is the Chairman, Indian Space Research Organisation (ISRO), Space Commission, and the Secretary, Department of Space, GoI. Email: isropr@isro.gov.in

In our country, the Indian Space Research Organisation (ISRO) has been at the forefront of space technology and exploration since its inception. On 21 November 1963, the first rocket took off from Thumba, a fishing hamlet near Thiruvananthapuram, announcing the birth of India's space programme. The then rocket, payload, radar, and computer all that was required for the first launch, came from outside the country.

Over the years, leveraging its key resources, the organisation has made several strides in space technologies, making India a major player in the global space arena. In ISRO, the evolution of space technology and innovation had taken place in various technological frontiers. It is beyond the scope of the present article to touch upon every innovation in space technology that has taken birth at ISRO in the journey of 53+ years.

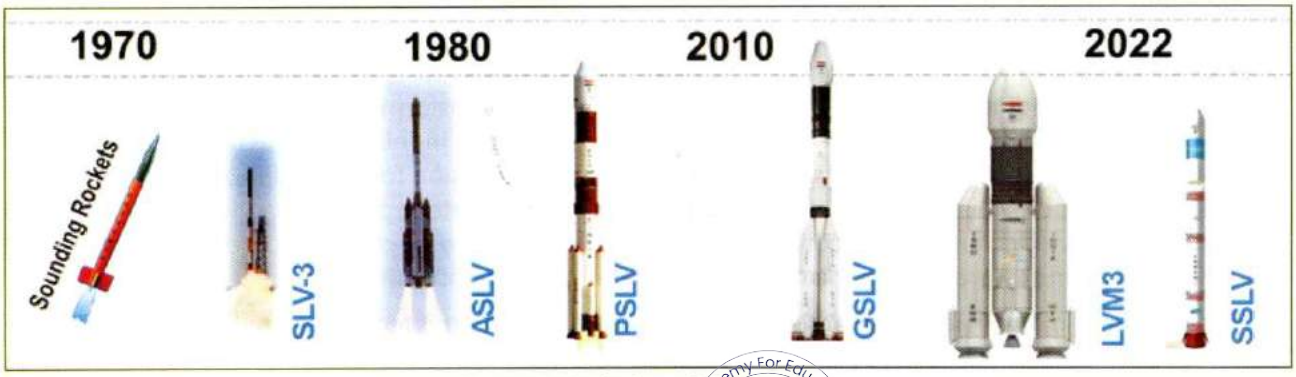


Figure 1: Evolution of ISRO rockets

Nevertheless, the spectrum of technological innovations, in this article, will cover the major verticals of Space Transportation System, Space Infrastructure, Space Science and Inter-Planetary Missions, Space Applications, Human Space Exploration, Space Robotics, Artificial Intelligence, Quantum Technologies, among others.

SPACE TRANSPORTATION SYSTEM

The 1970s marked the beginning of space transportation system with the development of solid-propulsion-based Sounding Rockets, which are capable of putting 30 kg of payload in 120 km of altitude, soon followed by the subsequent development of first generation launch vehicles, i.e., Satellite Launch Vehicles (SLV) and Augmented SLV (ASLV) with the induction of liquid-propulsion technology. The integration of solid and liquid propulsion and the development of various key technologies in the areas of Aerodynamics, Manufacturing, Composites, Mission Simulation, Avionics, Pyros, Mechanisms, Materials, Structural Engineering, Payload Integration, and System Reliability have resulted in the development of the second generation workhorse launch vehicle, which is none other than the Polar Satellite Launch Vehicle (PSLV), with the capability of placing a 1700 kg payload into polar orbit.

The indigenous development of a Cryogenic propulsive engine was the major technology leap in the development of third generation rockets i.e., GSLV launch vehicles, which have the capability of placing a 2000 kg payload in Geo-Synchronous Transfer Orbit (GTO).

Launching of high-throughput communication satellites necessitated the development of a further advanced launch vehicle, i.e., Launch Vehicle MK3 (LVM3). Powered by the world's 3rd largest solid boosters, high-capacity liquid and cryogenic engines, LVM3 has the capability of putting 4000 kg payload in GTO.

The latest member of ISRO's rocket family is the Small Satellite Launch Vehicle (SSLV), a three stage launch vehicle. Solid stages and a liquid propulsion based velocity trimming module made SSLV capable of launching a 500 kg satellite into a 500 km planar orbit in a quick turn-around time. Figure 1 shows the generations of ISRO rockets, from the sounding rocket era to the latest SSLV timeline.

Successful findings of water on the Moon was the scientific breakthrough achieved by Chandrayaan-1. Then, Rover and Landercraft technologies were developed, leading to the conception of a second mission to our nearest celestial neighbour. Chandrayaan-2 mission was altogether a highly complex mission, consisting of an Orbiter, Lunar Rover and Lunar Landercraft, as compared to its predecessor.

SPACE INFRASTRUCTURE

Like the space transportation system, the early 1970s were the formative years of the Space Infrastructure of ISRO, which led to the foundations for design, building and operation of spacecraft. Soon, the first satellite of the country, 'Aryabhata' was realised and launched on 19 April 1975. Subsequently, experimental missions like Bhaskara and APPLE were executed and geared towards remote sensing, meteorology, and communications technologies.

Further momentum was gained with the indigenous development of key technologies for spacecrafts such as Advanced Propulsion, Power Systems, Thermal Systems, Deployable Structures, Space Bus Systems, Communication Systems, Ground Infrastructure, Optical, Microwave, Scientific & Communication Payloads, Unfurlable Antennas, High Throughput Satellite Systems, Multi-Spectral Optical Satellite Systems, High Resolution Cameras, Multi-Wavelength observations of the Universe, Stationary Plasma Thruster etc., for the self-reliance in spacecraft technology.

Capability in the remote sensing has grown from the coarse resolution of 1 km to the fine resolution of 28 cm with day & night and all-weather capability. The communication transponders have also proportionally grown from a mere single unit to 317 numbers. Altogether, ISRO has mastered the capability of making satellites of 2000 kg with 1 kW power to 6000 kg with 14 kW power, operating in various frequency bands and with wide, shaped, and highly focused spot capability for communications, sub-metre resolution, optical, multi-spectral, and microwave imaging for earth observations, and progressing from payload-based navigation solutions to a satellite constellation - NavIC (Navigation with Indian Constellation). The present space infrastructure includes 25 Earth observation satellites, 22 communication satellites, 7 navigation satellites, 2 space science satellites and experimental, small and student satellites. The evolution of satellites in ISRO is outlined in Figure 2.

SPACE SCIENCE AND INTER-PLANETARY MISSIONS

Entrusted by confidence and technical expertise gained from satellites and launch vehicle technologies, ISRO has sailed successfully to the reach of the Moon and Mars, opening the era of planetary explorations and beyond. Chandrayaan-1, the first lunar orbiter mission has brought new experiences in hosting international payloads, calibration, data interpretation, adopting global standards in science data formats, etc. The science outcomes of the maiden mission have provided

Figure 2: Evolution of ISRO satellites

new perspectives about the Moon. Successful findings of water on the Moon was the scientific breakthrough achieved by Chandrayaan-1. Then, Rover and Landercraft technologies were developed, leading to the conception of a second mission to our nearest celestial neighbour. Chandrayaan-2 mission was altogether a highly complex mission, consisting of an Orbiter, Lunar Rover and Lunar Landercraft, as compared to its predecessor.

ISRO continues to explore Mars with the first ever interplanetary mission to the red planet, called Mars Orbiter Mission (MOM), aka Mangalyaan. It made India the first Asian nation to reach the Martian orbit and the first nation in the world to do so on its maiden attempt. MOM explored Mars' surface features, morphology, mineralogy, and Martian atmosphere with five onboard scientific instruments. The key technologies required for designing, planning, management and operations of an interplanetary mission were developed during MOM, which comprised - Orbit raising Manoeuvres, Trans-Mars Injection, Trajectory Correction Maneuvers, Mars Orbit Insertion, Development of Force Models and Algorithms for Orbit and Attitude (Orientation) Computations and Analysis, Navigation in all phases, etc. The spacecraft was monitored from ISTRAC, ISRO-Bengaluru with support from the Indian Deep Space Network (IDSN) antennae in Karnataka. MOM has yielded unprecedented technical insights into the Martian atmospheric composition and many other aspects of the planet.

The multi-wavelength space astronomy mission, AstroSat has served astronomers from nearly 50 countries. One of the breakthrough findings of the mission is the detection of UV emission from star formation in a galaxy that is 9.4 billion years away, providing the first measurements in the redshift range, near to the peak of the cosmic star-formation history of the Universe. Figure 3 shows a few glimpses of ISRO's space science and planetary mission.

Figure 3: Glimpses of ISRO's space science and planetary missions

SPACE APPLICATIONS

Space Applications is yet another vertical of the ISRO programme, which has witnessed many technological innovations. Earth Observation (EO) applications are institutionalised across many user Ministries/Departments, towards National security, Agriculture, Agro-forestry, Disaster management, Fishery, Land Use Land Cover (LULC), Resource Mapping, Planning, Monitoring & Evaluation and decision support for major Flagship Programmes of the Government.

In order to meet the gamut of aforementioned requirements for remote sensing/EO applications, a great deal of development had taken place in ground infrastructure and imaging technologies.

Ground technologies for tracking multiple objects in space, including the establishment of multi-object tracking radar, an integrated multi-mission ground segment for earth observation satellites, Polarimeteric Doppler Weather Radar, state-of-the-art advanced ground station for Earth Observation satellites at Bharti station, Antarctica Multi-Frequency Earth Stations, and a Distress Alert Transmitter have facilitated the uninterrupted

Figure 4: PAD Abort Test (PAT-01) for Gaganyaan

usage of satellite services.

The revolution in imaging technologies such as Pushbroom, 3-Tier Imaging, Step-Stare, Stereo Imaging, Scatterometer, Synthetic Aperture Radar (SAR), Ground Penetrating Radar (GPR) Altimeter, TDI imaging, VHR imaging, etc., in the domain of Earth Observation served to accomplish 47 missions with capabilities of spatial resolution from 1 km to 28 cm, temporal resolution of 24 days to 2.5 days, and spectral resolution of 7 bits to 14 bits.

HUMAN SPACE EXPLORATION

Human Space Exploration is the latest entrant to programmatic verticals of ISRO. At present, ISRO is actively pursuing the maiden human spaceflight mission - Gaganyaan to send astronauts to space and safely return to Earth. Gaganyaan is yet another very complex mission, involving development of major technology elements such as human-rated launch vehicle, Crew escape systems, Habitable orbital module, Life support system, Crew management activities for the safety of humans onboard, to name a few. Demonstration of re-entry flight of Crew Module i.e., Crew Module Atmospheric Re-entry Experiment (CARE) mission and Pad abort test for crew escape systems, and testing of human-rated launch vehicle propulsive stages i.e. solid boosters, liquid and cryo engines have been successfully accomplished. A new vehicle i.e., Test Vehicle (TV) has been developed to test critical crew associated systems. ISRO conducted a major development test, 'Integrated Main Parachute Airdrop Test (IMAT)' of the crew module deceleration system to simulate different failure conditions of the parachute system before it is deemed qualified to be used in the first human spaceflight mission. Gaganyaan is at an advanced stage of its mission realisation.

ISRO has been actively pursuing several R&D programmes related to Space Robotics -Vyommitra (Humanoid robot), Lander and Rover for Chandrayaan-3 mission, On-orbit Satellite Refueling, Planetary Rock Sampler, Space based robotic manipulator, Robotic arm based umbilical systems, 3D printing in Space, to name a few.

TECHNOLOGY INNOVATION CONTINUES...

Apart from the aforementioned five major programmatic verticals of ISRO, strides in space technology innovation continue in the thrust areas of Reusable Launch Vehicles, Stage Recovery and Reuse, Vertical Take-off Vertical landing (VTVL), LOX-Methane Engine, Air breathing/ Hybrid Propulsion, 3D printing, Artificial Intelligence, Space Robotics,

Humanoid robots, On-orbit servicing, Advanced Materials & Manufacturing, Chemicals and Energy Systems, miniaturised Avionics system, Advanced Inertial systems, Low Cost Spacecrafts, Inter Satellite Link (ISL) Networks, Space Based Solar Power, Quantum Communication, Quantum Radar, Electric Propulsion, Advanced Scientific Payloads, Space Based Surveillance, Advanced Data processing, Atomic Clock, Travelling Wave Tube Amplifiers, In-Situ Resource Utilisation, Flexible Satellite Payloads, Inter-planetary Space Exploration, Space Tourism, Low-temperature Energy Systems, Intelligent Satellite, Self-destructing Satellite, Space Bio-mimetic, Technologies for sustained Human space missions namely, Regenerative Life support systems, Rendezvous and Docking, Inflatable habitats, Human factor and Engineering studies, etc.

In an effort to develop technologies for low-cost access to space and space travel, ISRO conceived a Reusable Launch Vehicle (RLV) programme to develop space planes and shuttles that can ascent to orbit, stay there, re-enter, and land on a runway like an aeroplane. Having accomplished suborbital flight and sea landing in 2016, recently, ISRO made a significant development in RLV technologies with RLV landing experiment (RLV-LEX) demonstrating autonomous landing of a winged vehicle on a runway. The experiment was demonstrated at ATR-Chitradurga, Karnataka, on 02 April 2023. Currently, ISRO is working on the Orbital Re-entry Experiment (ORE) which will be carried out with RLV flown atop an updated version of GSLV.

"Space data economy, aided by new data churning, artificial intelligence, machine learning tools, is new oil for the service of advanced livelihood requirements like smart city, smart manufacturing, and supply chain, among others."

Air breathing propulsion with reusable capability is yet another key technological elements for a cost-effective futuristic space transportation system. ISRO is actively pursuing the development of technologies for an Air Breathing Two Stage to Orbit (AB TSTO) vehicle under the Air Breathing Propulsion Project (ABPP). The successful demonstration of 'scramjet operation' in flight conditions in the ATV-D02 Scramjet demonstration flight, in 2016, was a major technological boost in this regard. The ISRO's current focus is on the development of critical technologies towards the realisation of a vehicle-integrated scramjet engine called the Hypersonic Air Breathing Vehicle with Airframe integrated system (HAVA). Successful testing of the engine was accomplished in December 2022.

It is worth noting that for the first time in the country, ISRO achieved a breakthrough demonstration of free-space Quantum Communication over a distance of 300 m using the Prepare & Measure Protocol and Quantum Entanglement protocols. A number of key technologies were developed indigenously to accomplish these feats, including Entangled-photon source, Polarization compensation technique, gimbal mechanism systems, cryptographic software suite.

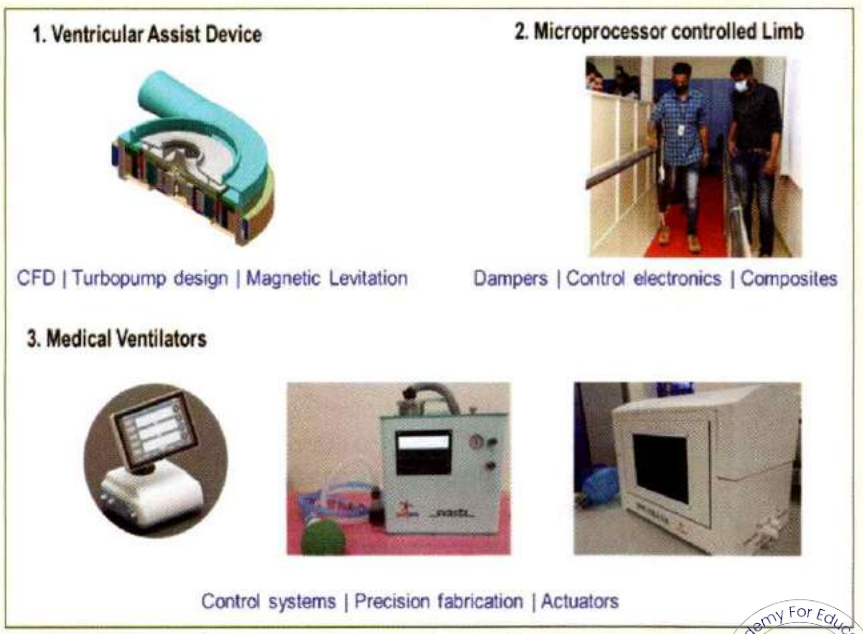
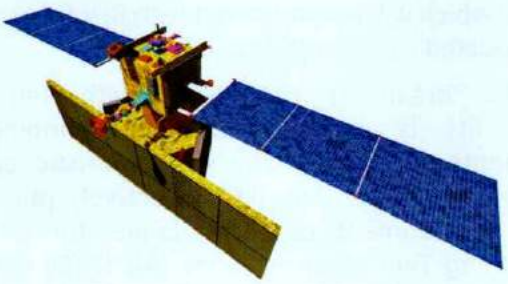


Figure 5: Spin-Off/ Societal Applications

There is a requirement for the close integration of IT and space-based data for providing digital solutions in the future. Big data analytics in decision-making and human-machine symbiosis will play a key role in providing a governance solution.



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ISRO has innovatively used the spent 4th stage of PSLV for carrying out scientific experiments under a nick name called POEM (PSLV Orbital Experimental Module). It provides a microgravity platform for conducting various scientific experiments in space. The opportunities are open for academic institutions and industries.

Space data economy, aided by new data churning, artificial intelligence, machine learning tools, is the new oil for the service of advanced livelihood requirements like smart city, smart manufacturing and supply chain, among others. Every day, 100s of Terabytes of satellite data volume are downloaded from EO satellites, communication satellites and navigation satellites for the service of mankind on earth. Even the advent of electrified and autonomous cars demands very high data usage. It is estimated that one autonomous car consumes 4000 gb data per day which is roughly the amout of data used by 2666 internet users.

The applications of satellite data in Smart cities are increasingly high, and data consumption becomes extremely enormous in connected cities. The applications include monitoring critical infrastructure, weather, location, navigation, etc. There is a requirement for the integration of satellite telecommunication, EO and navigation platforms. Today's smart manufacturing involves end-to-end digitally connected supply chain, which enables prediction, raw material forecasting and selecting optimised routes to deliver product in less time while integrating all the stakeholders.

There is a requirement for the close integration of IT and space-based data for providing digital solutions in the future. Big data analytics in decision-making and human-machine symbiosis will play a key role in providing a governance solution. India has a flourishing software industry and a self-reliance space industry with deep internet penetration, which form the three pillars of technology enabled governments.

The technology developments in the space sector have also reaped the benefits directly to Societal Applications as spin-offs. In this genre, mention can be made of Ventricular Assist Devices, Microprocesser-Controlled Limbs, and Medical Ventilators.

With the advent of space sector reforms, the participation of Non-Governmental Entities (NGEs) in space activities is encouraged to foster the space ecosystem and make space a driver for the country's scientific temperament and overall development.

As can be seen, in the country, the field of space technology has witnessed an unprecedented amount of innovation over the past few decades, and ISRO has played the role of a gravity organisation to unlocking the secrets of the cosmos and advancing human knowledge. As we look towards the future, innovations in space technology will undoubtedly pave the way for new discoveries and advancements, opening up new frontiers for exploration and expanding our understanding of the universe. Ultimately, innovation in space technology is not just about pushing the boundaries of science and technology, but also about expanding the horizons of our understanding of the universe and the world we live in. ❑

NEW-AGE BUSINESS

STARTUPS REVOLUTIONISING INDIA'S GROWTH STORY

Today, entrepreneurship in India is an inevitable pillar of Atmanirbhar Bharat. It is embedded in India's ecosystem in a way that traces its roots in history and is heading towards building a brighter future. As we progress, India is becoming a hub for startups, especially over the last few years, due to phenomenal disruptions in innovation, technological advancements, and supportive government policies. At this pivotal stage, it is crucial to study how the Indian startup ecosystem has evolved and accomplished its current position on both the national and international levels, leaving its footprints globally.

MANMEET K NANDA

The author is Joint Secretary of the Department for Promotion of Industry and Internal Trade, Ministry of Commerce & Industry, GoI.
Email: manmeet.nanda@ias.nic.in

As India completed its 75th year of Independence on 15 August 2022, Prime Minister Narendra Modi laid the goal of Amrit Kaal, i.e., the next 25 years, is to ascend to new heights of prosperity for India and Indians. The rise of the Indian startup ecosystem is unarguably igniting innovation among the entrepreneurs of the nation, leading it to fulfil the Vision@2047 for the country.

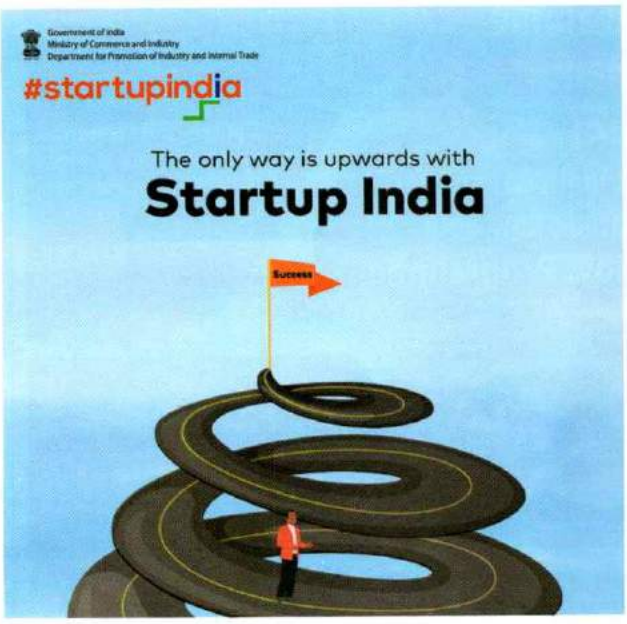
To facilitate this growing, promising, yet scattered ecosystem, the Government of India realised the need for a platform for inclusive innovation and entrepreneurship in India. Therefore, in 2016, the government launched the Startup India initiative to promote, transform, and nurture the ecosystem and empower startups, along with budding and aspiring entrepreneurs.

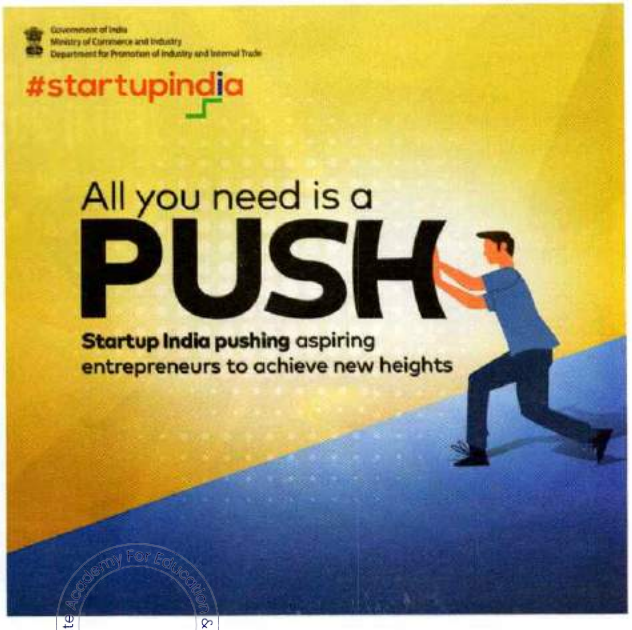
The Department for Promotion of Industry and Internal Trade (DPIIT) is the nodal department for the Startup ecosystem. The Indian startup ecosystem is constantly evolving, expanding, and innovating in tandem with the rapidly changing world. The country's entrepreneurial ecosystem has also seen an exponential spurt in funding activities over the past few years. Indian startups raised over $25 billion in 2022 alone. Indian Unicorns are also flourishing in the fast-paced, dynamic ecosystem while developing innovative solutions and generating large-scale employment. Untill FY 2016-17, approximately one unicorn was being added every year. Over the past four years (since FY 2017-18), this number has increased exponentially, with a whopping 66% Year-on-Year growth in the number of additional unicorns being added every

year. India is home to over 108 unicorns today – becoming the second-largest unicorn nation in the world.

The spike in funding was majorly led by the increased adoption of digitisation and the easy availability of capital at the early stages of growth for startups. Startup India has introduced various schemes to simplify and facilitate the process of raising funds at both early and mature stages. One such scheme, supporting early-stage funding from angel investors and venture capital firms, is the Startup India Seed Fund Scheme (SIFSS) with an outlay of Rs 945 crore, which provides financial assistance to early-stage startups for proof of concept, prototype development, product trials, market entry, and commercialisation. It will support an estimated 3,600 entrepreneurs through 300 incubators in the upcoming 4 years (till 2024). Another government scheme committed to assisting startups financially is the Fund of Funds scheme launched in 2016. Under FFS, support is extended to Securities and Exchange Board of India (SEBI) registered Alternative Investment Funds (AIFs), which in turn invest in startups. FFS was announced with a corpus of Rs. 10,000 crores and is aimed at supporting and handholding startups at mature stages.

Apart from the several managerial and regulatory challenges, one of the biggest problems faced by startups is easy access to early-stage debt to finance their capital requirements. Traditional lending





The spike in funding was majorly led by the increased adoption of digitisation and the easy availability of capital at the early stages of growth for startups. Startup India has introduced various schemes to simplify and facilitate the process of raising funds at both early and mature stages.

institutions, such as commercial banks, rely on the same old mandate. The Government has established the Credit Guarantee Scheme for startups for providing credit guarantees to loans extended to DPIIT-recognised startups by Scheduled Commercial Banks, Non-Banking Financial Companies (NBFCs), and Venture Debt Funds (VDFs) under SEBI registered Alternative Investment Funds. CGSS is aimed at providing credit guarantees up to a specified limit against loans extended by Member Institutions (MIs) to finance eligible borrowers, namely DPIIT-recognised startups.

Today, India is inevitably one of the fastest-growing economies in the world. It has come a long way with the government's support and the collective efforts of our innovators. However, this is just the beginning of the Golden Era of India as we have just entered the Amrit Kaal. This is India's time to shine in the world. We can transcend the nation to unprecedented heights and build the India of our dreams inclusively and sustainably – only if we join forces, let go of any and every barrier and come together as one united nation. ❑

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TECH FOR DEVELOPMENT

POTENTIAL OF INDIA'S EDTECH SECTOR

The emergence and rapid adoption of EdTech can be attributed to the fast-paced digitalisation of India, the expansion of Information and Communication Technology (ICT) infrastructure, and the accessibility of gadgets and data over the last two decades. India's EdTech sector is one of the largest in the world with about 400 startups operating across its various sub-sectors. These startups have cumulatively raised more than US$10 billion over the last decade. EdTech will continue to play a complementary role to enhance the teaching-learning experience for students, and equip them with knowledge and future skills that are vital for success in the 21st century.

ROHIT GUPTA	The author is Programme Director, Atal Innovation Mission (AIM). Email: rohit.aim@nic.in
DR SHASHANK SHAH	The co-author is Senior Specialist (Higher Education), NITI Aayog. Email: shashank.shah@gov.in

Since a decade, Education Technology or EdTech, as it is popularly known, and its potential to provide affordable learning at scale have been a matter of discussion in academic and policy circles. In recent years, news about EdTech startups raising billions has hit the headlines. Hence, it is topical to understand its nuances, potential, challenges, and impact in nurturing the largest student base in the world during the Amrit Kaal.

What is EdTech?

EdTech is the usage of technology – software and/or hardware, to enhance teaching and learning. Smartphones loaded with EdTech apps have now become synonymous with education. Classrooms have now moved beyond bricks and mortar to clicks and portals. The potential for EdTech to reach underprivileged students in areas far and wide has played and will continue to play a big role in the sector's growth in the coming years. The needs of

each student are different, as are the pace and style with which they learn. EdTech enables everyone to get a consistent quality of education, no matter their age or learning abilities.

Given these advantages, why has EdTech not been embraced in all these years? The answer to this question lies in the fact that for EdTech to flourish, there is a need for the availability of and access to a robust Information and Communication Technology (ICT) ecosystem. Let us see the growth of this system in India over the last two decades.

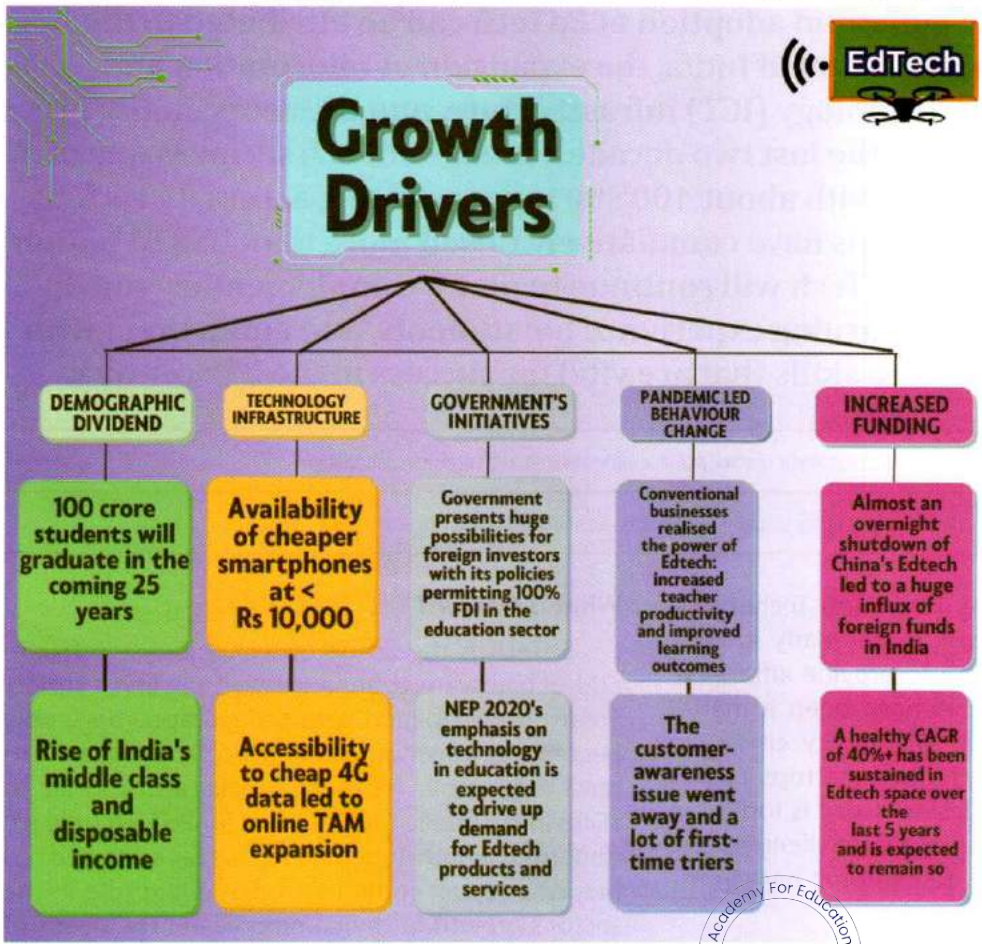
India's ICT Revolution

The Indian ICT industry has been growing rapidly over the last quarter century. In FY 2022, the industry crossed US$200 billion in total revenue and 5 million in total workforce. By the end of 2023, it is predicted to spend US$144 billion on ICT. The services segment is expected to make up about 52% of this spending. EdTech is an important sector in the industry's transition from enterprise servicing to enterprise solution provision.

The emergence and rapid adoption of EdTech can also be attributed to the fast-paced digitalisation of India, the expansion of ICT infrastructure, and the accessibility of gadgets and data over the last two decades. Between 2010 and 2022, the number of internet users in India has increased by 10X, from 92.5 million to 932.2 million. This is expected to rise to 1.53 billion by 2040. This could also be attributed to the fact that India has one of the cheapest mobile data rates globally, with 1 GB costing only Rs 14, a 90% reduction from 2013.

There has also been a 27X increase in the number of smartphone users in India, from 34 million in 2010 to 931 million in 2022. This is expected to rise to 1.53 billion by 2040. This could also be attributed to the fact that over the last 10 years, there has been a significant drop in smartphone prices in India, with the average selling price decreasing by around 12%.

The development of these factors and the tangible benefits that EdTech provides in the teaching-learning process have presented a significant opportunity for the EdTech sector and its diverse players to expand their presence and adaptability.



How does EdTech help students?

Technology has made education inclusive and affordable for all strata of students and learners. Catalysed by India's digital revolution, EdTech has enabled accessibility by reaching the remotest parts of India. Three major benefits of EdTech for students include:

i. Learning while playing: Gamified techniques used in EdTech, especially K-6, make concepts easier for students to

understand and make learning a fun activity.

ii. Classes anywhere and anytime: EdTech makes learning inclusive by reaching the remotest parts of India. Students can access these classes at their convenience and pace. Working professionals can devote their free time to learning a new skill.

iii. Access to quality teachers: According to the Annual Status of Education Report (ASER) 2019, around 30% of all schools in India are privately managed. In urban areas, the percentage of private schools is higher, and in some cities, it is nearly 70%. Most good-quality teachers are available in these schools, but they charge fees ranging from several thousand rupees to a few lakhs per year, depending on the school and the grade level, making them unaffordable for the masses. EdTech facilitates access to quality teachers in every town and village in India, at the push of a few buttons in a mobile app.

How does EdTech help teachers?

EdTech not only benefits students but also teachers by providing engaging pedagogical practices to complement their teaching. This can include interactive whiteboards, educational videos, VR/AR simulations, and other digital resources that can help engage students and enhance their learning experience. EdTech can also help in the process of academic administration through automated grading, classroom management tools, paperless classrooms, and eliminating guesswork. Automated grading through AI tools saves teachers' time in grading objective assignments. Classroom management tools help create a less chaotic, more collaborative environment. Paperless classrooms reduce printing budgets and promote greener policies. EdTech can assess student skills and needs in real time, leading to proactive plans to help struggling students, thereby eliminating guesswork.

Offline vs Online Education

In a traditional offline classroom setting, the cost structure includes rentals, utilities, and maintenance on the property, as well as the cost of the teacher's time. Several inefficiencies are apparent: the accessibility factor with the classroom being physically accessible to students living in the vicinity; the quality and time factor, with the best teachers not being available to all students all the time. The brunt of these costs and inefficiencies are eventually borne by students (and parents).

> **The government's initiatives to expand digital infrastructure, such as the National Broadband Mission, Digital India, and BharatNet, along with the telco-led digital revolution, have made it easier for EdTech to reach out to remote areas.**

EdTech theoretically takes away all of that. Lower infrastructure costs and a larger student base help leverage economies of scale. This ultimately leads to lower costs for the end user. Moreover, the best teachers can be made available to students living in the remotest parts of India. The primary requirements are a simple smartphone or a tablet and a data connection that can be accessed at their convenience. When compared with traditional textbooks, EdTech provides a more engaging learning experience for students with interactive elements built into the curriculum and easier navigation through graphic tools for easier understanding.

Key Growth Drivers

The growth of EdTech in India has been driven by five key factors that are essential for its expansion and success. These include:

i. Demographic Dividend: There is a huge room for EdTech to grow in India. There are about 300 million kids in K-12, out of whom 85-90 million have internet access. The current penetration of EdTech among kids with internet access stands at just 5%. The population aged between 15 and 34 years in India is around 463 million, which is almost 35% of the country's total population. Currently, nearly 40 million students are part of the Indian higher education system. As envisaged in the National Education Policy (NEP) 2020, when the Gross Enrollment Ratio (GER) increases to 50% in 2035, this number will double to 80 million. Hence,

at school and higher education levels, the numbers are very promising for EdTech to create impact at scale. Moreover, according to NSO estimates, India's per capita net national income (at current prices) has doubled from Rs 86,647 in 2014-15, to Rs 172,000 in 2022-23, with a consequent rise in disposable income across strata. This creates a further demand for mid-career education, and lifelong learning, which can be effectively met by EdTech through online platforms.

ii. Technology Infrastructure: The government's initiatives to expand digital infrastructure, such as the National Broadband Mission, Digital India, and BharatNet, along with the telco-led digital revolution, have made it easier for EdTech to reach out to remote areas.

iii. Government Initiatives: The government has launched various programmes and initiatives to promote digital education, such as SWAYAM, DIKSHA, and ePathshala. The latest announcement by the Finance Minister in the Union Budget 2022 is of the National Digital University (NDU), a virtual university that will offer a wide range of courses across disciplines using digital technology. NDU will offer regular degrees and mid-career certificate courses that will be recognised by employers and other universities.

iv. Pandemic-led Behavioural Changes: The pandemic accelerated the adoption of online education in India and across the world. With schools and colleges shut down for several months, students and teachers turned to online platforms. This led to a massive surge in demand for EdTech.

v. Increased Funding: The sector has attracted significant investments from venture capitalists and private equity firms, which have enabled EdTech companies to expand their offerings and reach a larger user base. With the government's focus on promoting digital education, it is expected that this sector will continue to attract significant investments in the years ahead.

Financial Potential

EdTech in India can be classified into six categories based on the target user it serves. Most users fall within the student demographic, ranging from preschoolers to college graduates and professionals. However, teachers, schools, and universities also make up a significant user segment for EdTech B2B platforms.

The Indian EdTech sector was valued at US$750 million in 2020 and has grown to reach US$ 5.8 billion by early 2023, at a CAGR of 43%. Furthermore, the market size is estimated to grow 3.7X over the next five years, from the current levels to $10.4 billion. By 2027, the sector is expected to grow to US$10.1 billion. This growth is driven by rising demand for non-academic courses from Tier II and III cities and the need for personalisation in the EdTech space. Out of the projected market value of US$4 billion, US$1.5 billion will focus on K–12, after-school foundational, and pre-preparational courses.

Funding Scenario

The EdTech sector witnessed unprecedented growth and funding during the Covid-induced lockdown, when online education became a necessity instead of a luxury. Before Covid, technology was used to supplement education. Post-Covid, EdTech has become central to the education process. The forecast for EdTech spending worldwide in 2019 was estimated to be US$163 billion, growing at 13% CAGR. The number may seem large in isolation, but it was only about 3% of the total spent on education worldwide. This was forecasted to grow to US$340 billion by 2025. Again, the number may seem large in isolation but is only about 4% of the total spent on education globally. Post-Covid, a significant uplift has been seen in EdTech spending across countries, and the estimated CAGR now stands at upwards of 16%. This will lead to overall EdTech spending globally reaching US$400 billion by 2025. However, this will still be only 5% of the overall money spent on education worldwide.

India's EdTech sector is one of the largest in the world, with about 400 startups operating across its various sub-sectors. These startups have cumulatively raised more than US$10 billion over the last decade. As of March 2023, 7 out of 30 global EdTech unicorns were from India. However, the funding in India slowed down considerably in 2022. Venture funding in India's EdTech sector went down to US$2.6 billion from a peak of US$4.7 billion in 2021. This was a 44% YoY drop. While most of the media headlines are referring to it as a 'Fall of EdTech', it is also believed to be a return to normalcy. The year 2021 needs to be looked at as an exception with the sudden rise of EdTech

because of the lockdown. Another lesser known yet extremely powerful catalyst was the sudden and overnight shutdown of the private EdTech sector in China, which lead to a huge influx of venture capital to India's EdTech sector. Despite all the doom and gloom reports of the fall in EdTech, the funding to the sector doubled in 2022 when compared to 2020.

Challenges

While EdTech conveys high potential, massive opportunities, and the ability to transform education at various levels, it also presents several challenges that need to be considered as we embrace EdTech products, platforms, and services. Three major challenges include:

i. Psychological and Social Effects of Online Digital Education: Online digital education can have psychological and social effects on students. Lack of face-to-face interaction and socialisation opportunities can affect their mental health and social skills. It is important to consider these effects when designing online education programmes and to provide students with opportunities for social interaction and emotional support.

ii. Perception of Parents: Parents may have reservations about the effectiveness of EdTech and may prefer traditional classroom-based education for their wards. It is important to address the concerns of parents and provide them with information about the benefits and effectiveness of online education to increase acceptance.

iii. Pupil-teacher Ratio: It is important to maintain a low pupil-teacher ratio in online education programmes to ensure that students receive personalised attention, support, and mentorship from teachers.

To ensure the holistic impact of EdTech, it is important to strike a balance between technology and traditional education methods. The use of technology should not compromise the quality of education, but rather enhance it.

Critical Success Factors

The use of Education Technology in India can be traced back to the 1980s when computer-aided learning was introduced in some schools. During the pandemic, the importance of using digital tools such as networks, platforms, and apps for education was accentuated. While students are gradually returning to face-to-face learning, these elements of EdTech will continue to be used in education as complementary approaches. The focus is now on the supply side of EdTech to provide useful tools for students, as their demand has already been established. As long as the digital aids are deemed useful by students, the supply of EdTech will continue to create its own demand.

However, to ensure the holistic impact of EdTech, it is important to strike a balance between technology and traditional education methods. The use of technology should not compromise the quality of education, but rather enhance it. Three critical success factors that can enhance this impact of EdTech include:

i. Integrate Practical Work: EdTech programmes must integrate internships/ apprenticeships as part of the curriculum design. This will help students develop group dynamics, team building, and interpersonal skills that are vital at the workplace. This will also enable them to test the knowledge and technical skills gained online on the field and thereby enhance their confidence and self-esteem when they enter the workforce.

ii. Create Multilingual Content: According to the last Census, only 10% of the Indian population speaks English and 45% speaks Hindi. This means that nearly 45% of the Indian population is not conversant with Hindi and/or English. Hence, EdTech platforms need to focus on content creation in regional languages to ensure wider reach, usage, and relevance.

iii. Focus on Holistic Education: Providing holistic education is one of the key objectives of NEP 2020. EdTech programmes must ensure that the core elements of holistic education that include environmental responsibility and sustainable development at the planet level, self-reliance and patriotism at the national level, community

wellbeing at the societal level, and cultivation of human values along with empathy at the individual level, are integrated into the curriculum and overall design of the programmes.

What does the future hold?

Over the past few years, we have witnessed explosive growth and widespread acceptance of Generative AI technology. It is not far-fetched to imagine a future where AI will provide individualised learning experiences for students. This could involve tasks such as creating assessments, providing feedback, adjusting to student's learning pace, and organising routine tasks. The AI would also be able to curate and recommend learning activities based on the student's progress, preferences, and learning goals, with continuous improvement over time. Essentially, AI has the potential to revolutionise the way we learn, making education more efficient and effective for students.

While the above scenario may seem scary at first, the teacher's role is indispensable in the process of education – with or without technology. In the era of Industry 5.0 and Society 5.0, teachers need to act as facilitators and take on the role of helping students develop skills beyond acquisition of knowledge. These would include complex problem-solving skills that would involve critical thinking and innovation; self-management skills that would involve stress, tolerance, and resilience; and people management skills that would involve leadership through conflict resolution, and communication. Essentially, teachers will be responsible for nurturing students to become well-rounded individuals with a high emotional quotient (EQ), social quotient (SQ), and intelligence quotient (IQ). The role of educational institutions will be to provide an environment that promotes peer-to-peer learning, facilitating hands-on experiences, social interactions, and on-demand practical opportunities. Thus, EdTech will play a complementary role through techniques, products, platforms, and services that will support, enrich, and enhance the teaching-learning experience for students, and equip them with knowledge and future skills that are vital for success in the 21st century. ❑

Other contributing author is Ashish Pandey, Young Professional, Atal Innovation Mission.
Email: ashishpandey.aim@nic.in

Views expressed are personal.

DIGITAL HEALTH

LEVERAGING TECHNOLOGY FOR TRANSFORMING HEALTHCARE

Digital health captures a wide spectrum of technology-supported and operated health innovations and solutions. It aims to provide healthcare services and interventions in an increasingly technologically sophisticated world. Advancements in digital applications have led to greater use of technology in the provisioning of healthcare services to a larger cohort of the population. In recent times, the Internet of Medical Things (IoMT) has combined medical devices and applications connecting to health IT systems that use diverse networking technologies.

DR MANISHA VERMA | The author is Additional Director General (Media & Communication), Union Ministry of Health, GoI. Email: pibhealth@gmail.com

A comparatively recent addition to the repository of health-related terminology is 'Digital Health'. It is often used in the same context as artificial intelligence and machine learning, which are also components of digital health. Let us understand the landscape of digital health, a fast growing area in the health sector globally.

What is digital health?

How would one define 'Digital Health'? Instead of a linear or more structured definition of the term,

it is rather a broad multidisciplinary framework and comprises a concept requiring a more precise definition. It encompasses software, hardware, and services in an integrated platform. In some literature on the subject (Mesko et al., 2023), this new 'phenomenon' is defined as 'the cultural transformation of how disruptive technologies that provide digital and objective data accessible to both caregivers and patients lead to an equal level doctor-patient relationship with shared decision-making and the democratisation of care.' Digital health would also refer to the use of technology interventions for providing healthcare solutions and empowering healthcare seekers and providers (including individuals, the community or professional caregivers, doctors, the paramedical workforce, and the pharmaceutical and medical device industries), with a focus on better quality, higher efficiency, and easy access to healthcare services.

Various terms being used are e-health, telehealth, telemedicine, tele-consultations, health apps, etc. The Telemedicine Practice Guidelines issued by the Union Ministry of Health (March 2020) define Telemedicine as- 'The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.'

The Guidelines also define Telehealth as - 'The delivery and facilitation of health and health-related services, including medical care, provider and patient education, health information services, and self-care via telecommunications and digital communication technologies.'

A dominant concept appears to be mobileHealth (or mHealth, as it is popularly termed). Handheld devices such as tablets with pre-loaded customised software applications are being used by field-level healthcare functionaries in several countries, including India, where ASHAs have been using these for several field level services. These are also used for awareness building, skilling, capturing of data, etc., Digitisation of data (including patient data), data stacks, e-registries, electronic medical records (EMR), health informatics and analytics platforms, self- health trackers, wearable health devices with sensors are all included in the large ambit of what comprises digital health. Newer realms of biotechnology, genomics, and AI-assisted healthcare are also being discussed in the same breath. The wide field of digital health applications includes training, education, skill development, and enhancement of the capacities of healthcare providers. In one of the simplest applications of digital health, patient satisfaction feedback platforms for improving services at private and public healthcare institutions have been implemented in several countries.

Additionally, in recent times, the *Internet of Medical Things* (IoMT) has combined medical devices and applications connecting to health IT systems that use diverse networking technologies. The Internet of Things (IoT) uses range from telemedicine technology to improve communication between doctors and patients, to decreasing the potential for exposure to contagious diseases, along with various smart sensor technologies that can collect data at the user level.

Growth of digital health interventions

As per the Precedence Research report (May 2022), the global market size of digital health was estimated at USD 332.53 billion in 2022. It is

Digital health, in a broad multidisciplinary framework is defined as the cultural transformation of how disruptive technologies that provide digital and objective data accessible to both caregivers and patients lead to an equal level doctor-patient relationship with shared decision-making and the democratisation of care.

anticipated to peak around USD 1,694.21 billion by 2032, showing a CAGR of 19.4%.

It would be valuable to understand what has caused or accelerated the growth of digital innovations in the healthcare and health services sectors. While the use of mobile-aided health interventions has been around for some time now, it is widely believed that the global pandemic gave a major push to the quick adoption of digital health innovations and mainstreamed them. At a time when healthcare received the highest priority and attention both from the healthcare seekers and providers, technology not only facilitated solutions to scale up services but also broadened them to cover a large number of beneficiaries who could access quality services often from the confines of their homes. The use of telemedicine platforms and remote monitoring solutions increased significantly, thereby enabling healthcare providers to remotely monitor patient health and provide care.

It is noted that increasing smartphone penetration along with several applications related to health and fitness across the globe are expected to be key factors driving the digital health market's presence and growth. Furthermore, rapid investments in the healthcare IT infrastructure, particularly in developing and developed nations, is also estimated to be conducive to scaling up market growth.

From the viewpoint of healthcare seekers, easy access and quick availability of medical counseling, specialist care from the confines of their homes during lockdown, and periods of social distancing gave a strong impetus to recognising and valuing the numerous benefits brought about by telecounseling and telemedicine. This aspect favors the market's growth positively in the upcoming years.

One of the major advantages of telemedicine is that it can save time and efforts especially of rural patients, who need not travel long distances for obtaining consultation and treatment. The population cohort, including children, older adults, and individuals with disabilities, also stands to benefit from e-health services. This is also accompanied by reduced financial costs associated with travel as travel for seeking healthcare by marginalised and disadvantaged communities is often accompanied by loss of work hours, loss of wages, and lower productivity. As per a recent impact study by an NGO, each tele-consultation at an Ayushman Bharat Health & Wellness centre saves an average of a journey of up to 21.58 km, and more than Rs 941 as Out-of-Pocket- Expenditure (OOPE) on healthcare. Women caregivers in families especially expecting and feeding mothers, have been known to be burdened with travel related to health services. WHO underlines that digital health could contribute to achieving targets of the Sustainable Development Goals (SDG) by 2030 by providing assured access to quality healthcare services to a wider cohort of population. Improved health outcomes through better accessibility have been seen in various telehealth interventions. Telehealth platforms and solutions have led to an enhanced level of equity with increased reach and inclusion of marginalised and hard-to-reach populations and regions. With innovative interventions such as the Government of India's telemedicine and telecounseling platform- eSanjeevani, specialist doctors are roped in to provide specialised support for delivering quality healthcare services to rural and hard-to-reach areas. This has elevated the quality of healthcare being provided to meet the goals of Antyodaya-last mile delivery of quality services.

One of the major advantages of telemedicine is that it can save time and efforts especially of rural patients, who need not travel long distances for obtaining consultation and treatment. The population cohort, including children, older adults, and individuals with disabilities, also stands to benefit from e-health services.

Prime Minister Narendra Modi in his 98th edition of 'Mann ki Baat' address in February 2023 lauded the 'eSanjeevani App' for its extensive medical services via teleconsultation. "At the time of the

Covid-19 pandemic, the eSanjeevani App has proved to be a great boon for the people," Prime Minister said in his monthly radio programme.

Another significant driver of the digital health market is the increasing prevalence of chronic diseases such as diabetes, cardiovascular diseases, and cancer. Digital health solutions can help manage these diseases more effectively by providing personalized care plans, monitoring patient health remotely, and improving patient engagement. Health apps have helped in monitoring of health parameters, thereby aiding in preventive and curative health. This would eventually help to reduce out-of-pocket expenditure for treatment and also reduce the burden on the country's health care infrastructure.

Studies have also depicted enhanced efficiency of health institutions and health services through the adoption of technology by way of a reduction in the time needed to access patient information while improving data quality and interoperability. Interoperability between varied systems brings benefits from cross-cutting platforms through information exchange, often in real time. Digital healthcare services have added to the level of standardisation and uniformity of care, by minimising ambiguity in protocols and reducing the gaps between expected and actual services provided. There is higher and more efficient analyses of outcomes based on data with the aid of digital tools.

Digital health records and health stacks are gaining fast recognition and implementation as they are helpful in useful repository of data. With telemedicine, there would be higher maintenance of records and documentation. This reduces the likelihood of missing out on advice from the doctor and other health care staff. Additionally, it is argued that written documentation would help to increase the legal protection of both parties.

India leads the way– Digital health initiatives driving change

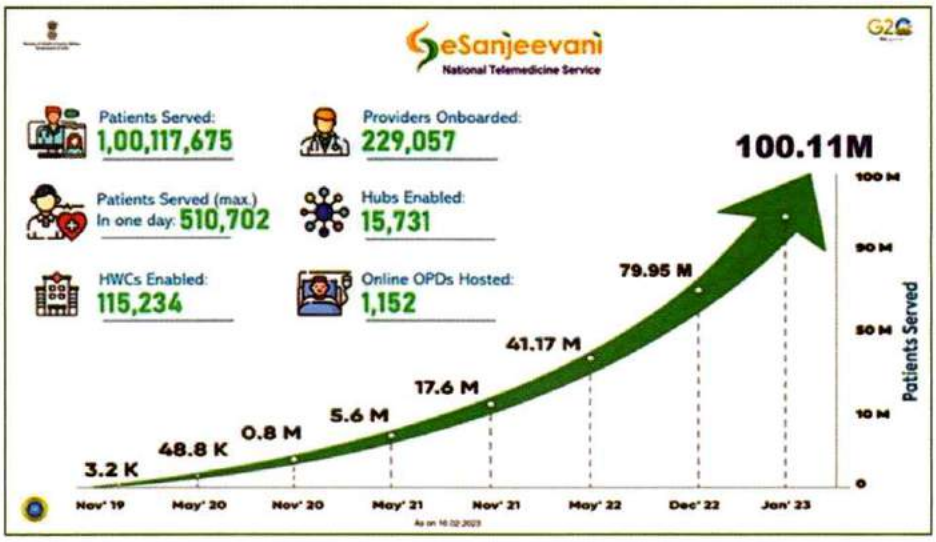
Digital health solutions are proving to be fundamental building blocks of a more sturdy and resilient healthcare infrastructure of the country. Increased use of digital tools is seen to result in the transformation of India's healthcare sector, adding to an enhanced citizen servicing, health seeker satisfaction, better levels of quality and efficiency, and higher transparency and accountability. Some of the key features of the digital interventions launched by the Government of India are inclusiveness, multilingual platforms, scalability, and interoperability. These have helped serve a population of over a billion people. The following are some of the initiatives that have seen a vast acceptance among people, accompanied by innumerable advantages.

Ayushman Bharat Digital Mission (ABDM)

Ayushman Bharat Digital Mission envisions an integrated digital health infrastructure for the country and aims to develop the backbone that is necessary to support it. These digital highways will bridge the existing gap among different stakeholders of healthcare ecosystem. The Prime Minister launched ABDM in September 2021.

ABDM proposes to create a seamless online

platform through the provision of a wide-range of data, information and infrastructure services, duly leveraging open, interoperable, standards-based digital systems while ensuring the security, confidentiality and privacy of health-related personal information. The ABDM will eventually connect the digital health solutions of hospitals across the country. This will not only make the processes of hospitals simplified but also will increase ease of living. The digital ecosystem will also enable a host of other facilities, like digital consultation, consent of patients to letting medical practitioners access their records, etc.



An important part of ABDM is ABHA (Ayushman Bharat Health Account). The ABHA is a 14-digit number that will uniquely identify a beneficiary as a participant in India's digital healthcare ecosystem. It will allow the users, insurance companies, and hospitals to access and share the health records digitally. It is envisaged to be used for uniquely identifying persons, authenticating them, and threading their health records (only with their informed consent) across multiple systems and stakeholders.

So far, over 33.18 crore ABHA IDs have been created, and 23.56 crore health records have been digitally linked under the ABDM.

Another new feature introduced recently is the Scan & Share service. Introduced in October 2022, this service provides faster OPD registrations. This helps to reduce the time taken at the OPD registration counter, provides accurate data in the hospital record, and most importantly, avoids the wait in the long queues. This service allows old as well as new patients to simply scan a QR code and share their demographic details with the hospital. Once the profile is shared, the hospital provides a token number (queue number). The token generated is sent as a notification to the patient's selected app and is also displayed on the screens placed at the OPD registration counters for the patient's ease. As per their token number, the patient can go to the registration counter and directly collect their outpatient slip (OP slip) for doctor consultation, as their details are already present at the registration counter. Within five months of its launch, the service has been adopted by 365 hospitals and helped over 5 lakh patients save time. The service is currently live in 125 districts across 25 States/ UTs in the country.

CoWIN

The Covid Vaccine Intelligence Network (CoWIN) system was launched on 16 January 2021. It has provided the technological backbone to India's Covid-19 vaccination programme, which has administered more than 220 crore doses, so far. CoWIN was developed in record time with consideration given to scalability, modularity, and interoperability to connect various stakeholders, including vaccine manufacturers, administrators, and verifiers, public and private vaccination facilities, and vaccine recipients, etc. The platform has been made available in English and 11 regional languages to allow citizens across multiple states to access it with ease. With CoWIN, beneficiaries could book for Covid vaccination from any part of the country through a seamless network. To circumvent the lack of digital access, the platform provided for up to six members to be registered under one mobile-number linked account.

The key features of the CoWIN platform are: (i) Blended registration- Beneficiaries can register online or on-site (walk-in) to Vaccination Centre. (ii) Beneficiaries can book online appointment based on convenience of time and choice of location

(iii) Track Vaccination Schedule (iv) Instant Digital vaccination Certificate with certificate correction utility (v) Multilingual portal with 12 languages (vi) Mobile application for their ease of use for vaccinator (vii) Vaccine Stock Management (viii) Publishing of Vaccine Schedules in advance (ix) Real Time Dashboards (x) tracking of Adverse Event Following Immunization (AEFI) (xi) Digital Covid-19 vaccination Certificate tracking, and (xii) Facility wise coverage.

CoWIN platform was developed at record speed with ample consideration given to its scalability, modularity, and interoperability. India has offered CoWIN platform as a digital public good to the world to combat Covid-19.

As of February 2023, more than 10 crore tele-consultations have benefitted patients (more than 9 crore at AB-HWCs; and nearly 97 lakh through eSanjeevani OPD) through medical specialists and super-specialists trained in telemedicine. It is reassuring to note that over 57% of the beneficiaries are women and around 12% are senior citizens.

Tele-MANAS: Tele Mental Health Assistance and Networking Across States

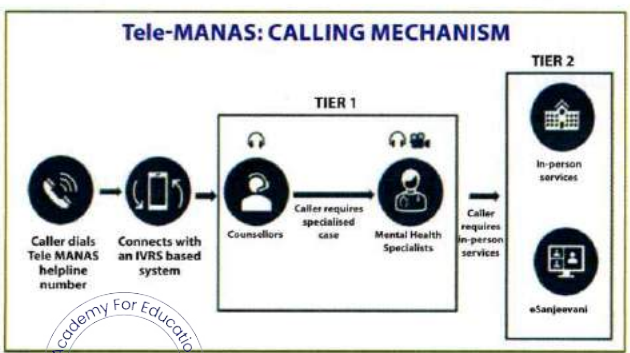
Telemental Health Assistance and Networking Across States (Tele-MANAS) initiative was launched on 10 October 2022. It aims to provide free telemental health services, including counseling, integrated medical and psychosocial interventions through video consultations with mental health specialists, e-prescriptions, follow-up services, and linkages to in-person services, particularly to the remote areas and vulnerable groups of the population.

The programme includes a network of 23 telemental health centers of excellence, with NIMHANS being the nodal centres and International Institute of Information Technology-Bangalore (IIITB) providing technology support. The Indian Institute of Technology (IIT)-Bengaluru and National Health Systems Resource Centre (NHRSC) will provide the technical support. A toll-free, 24/7 helpline number (14416) has been set up across the country allowing callers to select their language of choice for availing services. Service is also accessible with 1-800-91-4416. The calls would be routed to Tele-MANAS cells in the respective states and union territories.

Specialised care is being envisioned through the programme by linking Tele-MANAS with other services like the national tele-consultation service, e-Sanjeevani, Ayushman Bharat Digital Mission, mental health professionals, Ayushman Bharat Health and Wellness Centres, and emergency psychiatric facilities. Eventually, this will include the entire spectrum of mental wellness and illness, and integrate all systems that provide mental health care. NIMHANS has conducted training for 900 Tele MANAS counselors from majority of States/UTs, so far.

Ni-kshay 2.0 Portal

The President of India launched the 'Pradhan Mantri TB Mukt Bharat Abhiyan – Ni-kshay 2.0', a digital platform for community support for the persons diagnosed with tuberculosis, in September 2022. The purpose of this portal is to provide technology backup for the Ni-kshay Scheme, which aims to mobilise communities, stakeholders, elected representatives, corporates, NGOs, and individuals to come forward as donors to help the patients through additional diagnostic, nutritional, and vocational support. This digital health tool has enabled the community across the country to register as Ni-kshay Mitra and helped them in adopting TB patients in their preferred geography by providing the option of viewing the list of consented patients on this platform. It has also empowered the implementors on the ground



to manage and monitor the actual provision of support to TB patients.

As of 3 March 2023, around 13.25 lakh TB patients were on TB treatment in the Ni-kshay portal, out of whom 9.69 lakh TB patients had given their consent for adoption. More than 69,000 Ni-kshay Mitras had registered on the portal, of whom 61,144 had agreed to support almost 95% of the consented TB patients. This has helped to accelerate the response against TB to complement government efforts. More than 4 lakh food kits had been distributed to date.

Health Technology Assessment (HTA)

In a world teeming with an array of technologies, how would health professionals and policymakers decide about the choices that would offer the most cost-effective solution for different healthcare needs, age groups, diseases, etc. With resources being finite and coupled with competing demands, health technology assessment provides evidence to decide the choice of technology for the best possible healthcare to address public health challenges at different levels; it provides the rationale for decisions in a systematic way. It is also argued that it acts as a tool to promote equity. The Government of India has created an institutional arrangement called the Health Technology Assessment in India (HTAIn) under the Department of Health Research (DHR) to facilitate the process of transparent and evidence informed decision-making in the field of health. It provides evaluation of the appropriateness and cost effectiveness of available and new health technologies in the country. HTA aims to inform formulation of safe and cost-effective health policies that are patient focused and seek to ensure most optimum value for money. HTAIn will collate and generate evidences related to the clinical effectiveness, cost-effectiveness, safety of medicines, devices, and health programmes. Established in 2017, it has supported the Union Health Ministry, Ayushman Bharat-PMJAY, and various states with evidence-based decision-making.

Summary

As has been presented, technology-aided health interventions and digital solutions in healthcare have revolutionised the healthscape globally by bringing in unprecedented change. It has been widely acknowledged that digital health has the potential to bring about rapid, radical, and vast changes in not only healthcare services but also research and development in pharma, medical devices, drugs, and vaccination cold chain management, supply chain, and logistics, etc. Digital health forms one of the key priorities of the G20 India Health Track. It will serve countries to collaborate and pool of knowledge and experience in developing and using innovative technologies aimed at serving people with enhanced care, efficiency, and quality. ❑

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Transforming the Quality of Living for

The middle class plays a critical role in the Indian economy, serving as the backbone of society and driving economic growth and stability. The middle class has gained immensely from incisive yet simple remedies introduced by Prime Minister Narendra Modi during the last nine years. This is primarily attributable to the Prime Minister's emphasis on the middle class and his vision for "ease of living". The Modi led government introduced initiatives to support the middle class, including increasing access to affordable medicines and devices, cheaper loans to make education more accessible, low-interest personal loans, expanding metros and airways for convenient and affordable travel, and providing low-cost internet services.

The Modi administration has therefore aimed to reduce the tax burden on the middle class, resulting in more disposable income in their hands. As a direct result of these reforms, the enormous potential of the Indian middle class has been unleashed, with a myriad of opportunities knocking on the door.

Building Healthy Lives for a Fit Middle Class

Prime Minister Modi's government has introduced various initiatives to improve the accessibility and affordability of healthcare for the middle class. In line with Prime Minister Modi's mission of affordable and quality healthcare for all, **A ceiling was placed on the price of coronary stents and knee implants in 2017.**

Low-Cost Pharma: Pradhan Mantri Bhartiya Janaushadhi Pariyojana (PMBJP)

- **90 Fold Increase** in Jan Aushadhi Kendras between 2014-15 and January 2023
- PMBJP medications cost **50% to 90% less** than medicines available in the market
- Savings of around **Rs. 18,000 crores** over last eight years

World's Largest Health Insurance Programme: Ayushman Bharat Pradhan Mantri Jan Arogya Yojana

- **Nearly 18 crore** Households given Compensation
- **Rs. 50,400 crores** Monetary Benefits in cases of Hospital Admissions
- **4.3 crore** Authorised Hospital Admissions
- **26,000+** Empanelled Hospitals

Ayushman Bharat and Jan Aushadhi together helped poor & middle-class patients save around Rs. 1 lakh crores in healthcare expenditure

Investing in Education for Enhanced Opportunities

The Modi government has implemented various policies to make education more affordable by increasing funding for public schools and colleges, expanding financial aid programs, and providing low interest-rate loans for students who want to pursue higher education. The **National Education Policy** (NEP) announced in July 2020 gave a new direction to India's massive education system. It set new standards for the education sector, shifting the focus of the government from setting up schools to improving the quality of education that prepares students for the future.

Making Education Accessible: Financing through Low Cost Loans

Cost Savings more than Rs. 1.84 lakh

- Rate of Interest for Rs. 10 Lakh Loan for 5 yrs
- Loan Amount Payable (In Rs.)

May 2014	May 2022	Savings to Students
₹14,19,540	₹12,35,340	₹1,84,200
14.75%	8.65%	6.10%

PM Modi flagging off the Vande Bharat Express from Una, Himachal Pradesh to Delhi.

> "The middle class is a huge force to fulfill the dreams of a prosperous and developed India. Just as the youth power of India is the special strength of India, similarly the growing middle class of India is also its great strength. In order to empower the middle class, our government has taken several decisions in the past years and has ensured Ease of Living."
> - Prime Minister Narendra Modi

Socially Securing the Middle Class

Schemes introduced by the Modi government such as **Credit Linked Subsidy Scheme** (CLSS) under **Pradhan Mantri Awas Yojana-Urban** (PMAY-U) and **Special Window for Affordable and Mid-Income Housing Projects** (SWAMIH) have made it easier for the middle class to achieve their dream of owning a home.

the Middle Class

Middle Class: From Renters to Owners

Pradhan Mantri Awas Yojana-Urban: CLSS

Home Loan Burden Reduced by **Rs. 48,000 crores**

6.15 Lakh beneficiaries from the middle-income group availed subsidy

Special Window for Affordable & Mid-Income Housing Projects

20,500+ Homes Completed in 30 tier 1 and 2 cities since 2019

Further Target **81,000 homes in next three years**

The Modi administration has implemented policies aimed at reducing interest rates across the board, thus stimulating economic growth by making borrowing more affordable.

Great Drop in Interest Rates: A Win for Consumers

Home Loans: Savings of Approx. Rs. 82,990 pa on every loan due to **3.65% drop in RoI**

3% Reduction in Car Loan Interest Rates between 2014 and 2022

More Money in the Hands of the Middle Class

Union Budget 2023-24 Increases Concessions for Middle Class

Full Tax Rebate Total Income up to Rs. 7 Lakhs

Standard Deduction of Rs. 50,000 Salaried Individuals

Surcharge rate reduced from 37% to 25% Income above Rs. 2 crore

Drop in RoI Boosts Auto & Home Loan (Personal) Uptake

% Loan Availed

4%+ Decline in Effective Income Tax Rate between 2013 and 2022

The Middle Class Entrepreneurial Boom

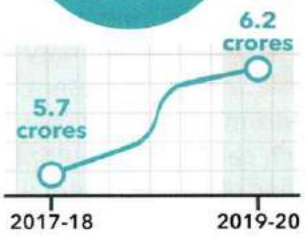
Make in India and Aatmanirbhar Bharat, the twin mantras of the Modi government, have supported employment generation. The government is pushing India's entrepreneurial environment to generate more jobs, which has had a multiplier impact. The middle class has now shifted from being a job seeker to a job provider.

Aatmanirbhar Bharat: Making India Self-Reliant

1.3+ crore MSMEs benefited from the Emergency Credit Line Guarantee Scheme.

Guarantee cover increased by Rs. 50,000 crore

Rise of Jobs in the Manufacturing Sector



Tech-Powered Middle Class

The Modi administration's focus on making India digital ready is evident in both supply and demand side interventions. This is reflective in the increased coverage of mobile phones and network connectivity to the hinterland and reduced prices of mobile data. Measures to bring down the cost of component parts of digital devices such as mobile phones, laptops and tablets have allowed for cheaper prices and improved accessibility.

Connectivity on a Budget: The Cheaper, Better Internet Solution

Cheapest Internet Data in the World: Cost of internet data reduced 25 times in the last 9 nine years

232% Increase in Internet Connections

1,238% Increase in Broadband Connections

266 Fold Increase in Average Monthly Data Consumption per Wireless Data Subscriber

*All data refers to increase between 2014 & 2022

Evidently, the Modi government has implemented various policies and initiatives aimed at supporting and empowering the middle class. These efforts have focused on increasing money in the hands of the middle class directly and indirectly. **In the last nine years, the government has endeavoured to provide greater access to healthcare, education, housing, and financial resources, as well as promoting entrepreneurship, innovation, and economic growth.** Middle-class people have saved massively and increased their discretionary income due to lower taxes and borrowing rates. After the GST, domestic goods and restaurant meals are cheaper.

Since 2014, Prime Minister Modi's infrastructure push has reduced middle class household spending. The UDAN scheme has made air travel cheaper and middle class households no longer prefer trains as a result of this. People are therefore switching to public transportation and saving money without sacrificing comfort. Thus, by investing in the middle class, Prime Minister Modi has helped build stronger and more prosperous communities, with greater opportunities for individual growth and success.

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QUANTUM COMPUTING

TRANSFORMING TECHNOLOGY

PROF YOGESH K DWIVEDI | The author is a Professor of Digital Marketing and Innovation and Director of Digital Futures for Sustainable Business & Society Research Group at the School of Management, Swansea University, UK. Email: y.k.dwivedi@swansea.ac.uk

PROF ARPAN KUMAR KAR | The author is a Chair Professor at the Department of Management Studies, Indian Institute of Technology Delhi, India. Email: arpankar@iitd.ac.in

Quantum computing differs from traditional computing, which uses 'bits'—binary digits of 0s and 1s — to represent information. However, quantum computing uses quantum bits, or 'qubits', which can exist in multiple states simultaneously, instead of just two states (i.e., 0 and 1). This property of qubits, known as 'superposition' allows quantum computers to perform many computational calculations orders of magnitude faster than classical computing. Further, quantum computing also borrows inspiration from another property of quantum mechanics called entanglement, wherein two qubits could be connected in such a way that the state of one qubit intrinsically affects the state of the other qubit. As quantum computing moves steadily towards real-world applications, it continues to be a thriving area for interdisciplinary research and booming scholarly outputs, as well as new fundamental discoveries in physics. In 2012, Serge Haroche and David Wineland were awarded the Nobel Prize in Physics for their ground-breaking experimental methods that enable the measurement and manipulation of individual quantum systems. Their work has profound implications for quantum information and quantum computing.

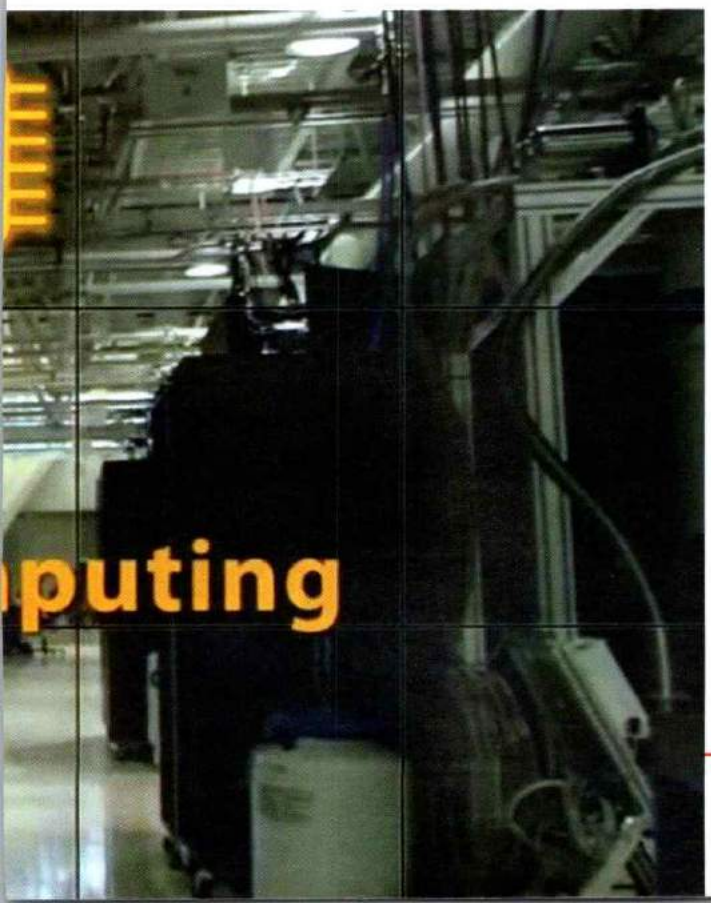
Nations and industries are slowly and steadily gearing up to leverage the quantum computing wave through strategic collaborations and investments in research and innovation. This wave may transform the entire technology ecosystem; indeed, one that may fundamentally transform society, culture, and the economy.

Quantum computing is an advanced area where research and development are still at a nascent stage. However, this presents an opportunity for India to establish well-funded research Centres of Excellence in the leading technological institutions. Long-term schemes of the Department of Science and Technology could possibly be introduced whereby strategic infrastructure and manpower training projects can be funded in the established technology engineering institutions. This would need to cover both hardware and software to further develop a homegrown quantum technology industry.

Quantum computing is still a relatively young domain, and while practical quantum computers are now commercially available, they are currently limited to performing very specific types of calculations. However, researchers believe that quantum computers have the potential to revolutionise fields such as data sciences, artificial intelligence, and decision sciences. We attempt to deliberate on the following important elements of quantum computing evolution:

1. How would the evolution of quantum computing impact the nation and society?
2. How can policy interventions be planned now to ride the wave of quantum computing as the field matures?

The subsequent sections would attempt to address these questions stage-wise. First, we discuss the impact of quantum computing; then, we discuss the implications for policymakers, and finally, we conclude the article.

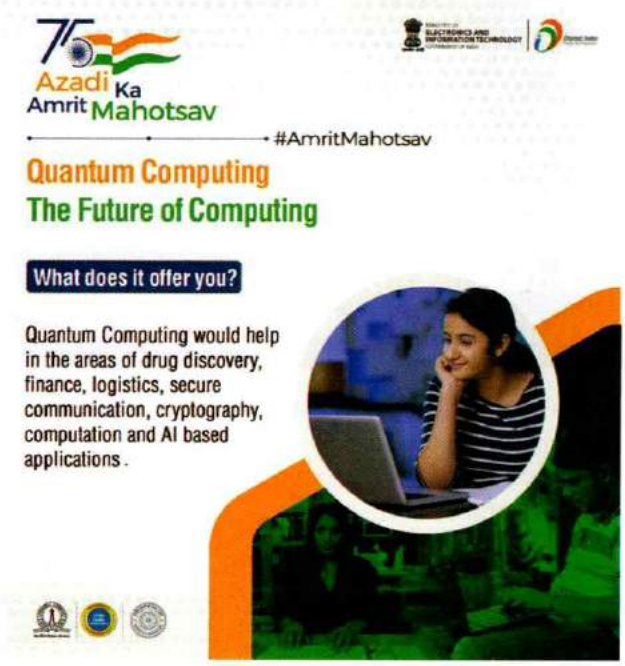


Impact of Quantum Computing

Given India's growing capabilities in the space of information technology (IT) and IT-enabled services, including technology consulting capabilities, we foresee that the future of quantum computing is going to drastically revolutionise the skill needs and capabilities of the emerging skill force, which is gradually gearing up in the space of data science, artificial intelligence, machine learning, and decision sciences. Here are a few areas where the impact of quantum computing is likely to be felt:

Faster data analysis in industrial data science applications: Quantum computers can perform certain types of calculations significantly faster than classical computing logic. As these types of computations increase in scope and scale, this could enable faster data analysis for business problems in the era of big data, particularly for large datasets created with high velocity.

Improved machine learning outcomes: Machine learning algorithms are increasingly being used for predictive capabilities and enhanced data-driven decision-making. In the era of cognitive computing, these algorithms may focus on complex data types like images and videos for solving business and social problems through areas like computer vision. Quantum computers could potentially improve machine learning by enabling more efficient optimisation of these algorithms so that computer vision capabilities become more efficient, accurate, and fast. Further, in applications of generative artificial intelligence, quantum computing could potentially have better recommendations since it



would be possible to create architectures that analyse real-time additions to the web of knowledge in the digital world to create advice. The outcome of these capabilities would translate to the development of areas like driverless cars, automated management of smart city infrastructure, and digital public services.

Improved optimisation for complex problems: Many analytics problems involve finding the optimal solution to a complex problem. Quantum computers can potentially solve these problems much faster than classical computers, enabling more efficient optimisation of complex systems. This may create faster optimisation of very large-scale problems involving complex network structures, computational biological sciences, and physical sciences. Local optimisation can be avoided, and quantum computing may enable the achievement of global optimal solutions in problems that typically demonstrate high multi-dimensional computational complexity, or indeed NP-hard problems.

Improved industrialisation: Realisation of industrial maturity levels such as Industry 4.0 and beyond, through platforms like digital twins would be enabled through quantum computing. The Distributed computing networks, federated learning, 'Internet of Everything', blockchain, and related technologies can be envisioned to become more efficient in terms of achieving their desired objectives computationally as well as in terms of quality of outcome.

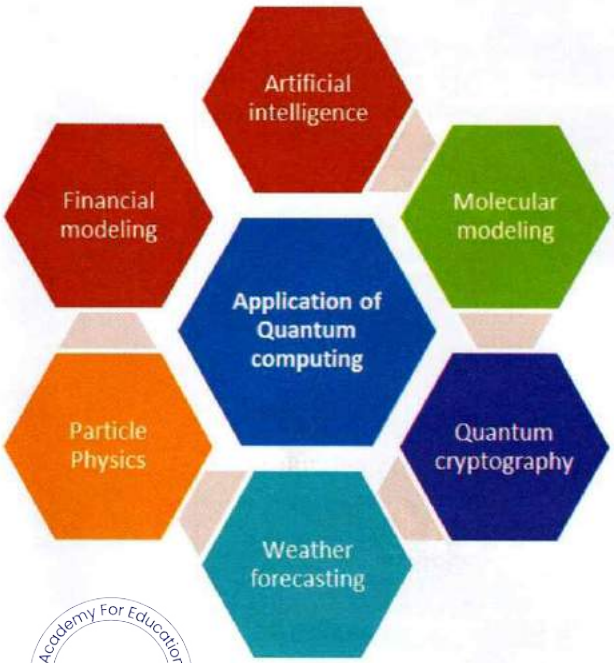
Improved process efficiencies in digital transformation: Quantum computing may result in faster process automation by analysing real-time data generated in the organisation processes. This may make the organisations nimbler to change in the information ecosystems within which they operate. Further, these platforms may enable organisations to connect with multiple stakeholders through open network architectures to make information flow and processing seamless and real-time.

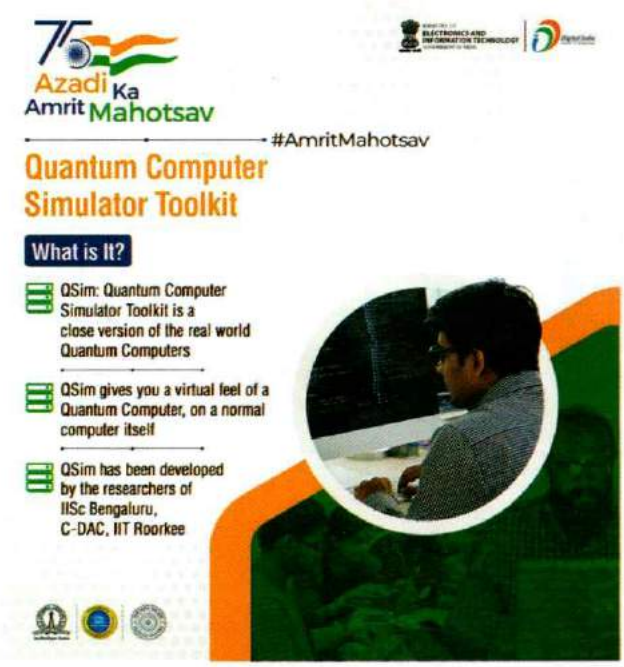
Implications for practice and policy

The possibilities that quantum computing can open up are immense, and there are serious deliberations that are needed from a public policy viewpoint. We list some of these deliberations below:

Quantum computing is an advanced area where research and development are still at a nascent stage. However, this presents an opportunity for India to establish well-funded Research Centres of Excellence in the leading technological institutions. Long-term schemes of the Department of Science and Technology could possibly be introduced whereby strategic infrastructure and manpower training projects can be funded in the established technology engineering institutions. This would need to cover both hardware and software to further develop a homegrown quantum technology industry.

Furthermore, quantum computing also needs clear and sustained policy and governance since it





deals with new levels of data and computation. The legal frameworks surrounding data management, data sharing, data privacy, information assurance, algorithmic governance, and transparency need to evolve. This is where sponsored projects need to be created to form a knowledge repository surrounding how data governance and policy frameworks should evolve. Similarly, frameworks surrounding security, transparency, accountability, fairness, and ethical use of quantum computing systems also need to evolve. This is where social scientists would be needed to explore and develop inputs for policy making, and co-creating these outcomes from the start of the interventions and projects. Frameworks surrounding information governance, information access, and information dissemination may need to be revisited given these emerging computational capabilities.

Skill areas of data science, decision science, and machine learning are going to be intensely impacted in the near future by quantum computing. This is where policymaking at the national level needs to create consolidated efforts towards the future talent and skill development of the large young population that India boasts of, to make them future- ready. So, the skills of the existing workforce need to be geared towards better understanding data science and decision science, so that they can take advantage of the wider quantum computing domain over the coming years. Manpower skilling is an important component for the employability of the future workforce of India, and this may require policy intervention since most private organisations focus on exploiting immediate skill availability and project needs by compromising future skilling needs. However, these employees who do not develop future skills suddenly become irrelevant when the technology ecosystems evolve, resulting in job losses.

Realisation of digital healthcare and biomedical research would be strongly facilitated using quantum computing. Quantum computing is a global field, and collaboration is crucial for making progress. International funding agencies could develop joint project funding schemes whereby collaborations can be fostered to enable faster development in this space. Mobility grants need to be augmented by infrastructure and manpower hiring grants for these projects to be really impactful.

Startups can generate huge opportunities that disperse the burden of economic welfare and employment from metro cities. Startups focusing on quantum computing can be encouraged using government support through organisations like the Technology Development Board, where grants can be given to startup ventures in non-metropolitan cities in the space of quantum computing product development. These initiatives can also facilitate the full realisation of national missions such as Make in India over the coming years.

Conclusion

The quantum computing domain is an area that the government must focus on because it will be heavily dependent on exploiting information assets within and outside the organisations in the long-term. There is a significant opportunity for India; for moving towards that direction as it is envisioned that strategic investments in research, development, and training mechanisms should be created. This may enable improved capability for leveraging and exploiting this domain for the benefit of citizens and the nation going forward.

Acknowledgement

Professor Tom Crick and Dr Laurie Hughes have also made important contributions to this article. *Dr Tom Crick is Professor of Digital & Policy and Deputy Pro-Vice Chancellor (Civic Mission) at Swansea University, Wales, UK. Email: thomas.crick@swansea.ac.uk; and Dr Laurie Hughes is a Senior Lecturer at the School of Management, Swansea University, UK; Email: d.l.hughes@swansea.ac.uk.* ❑

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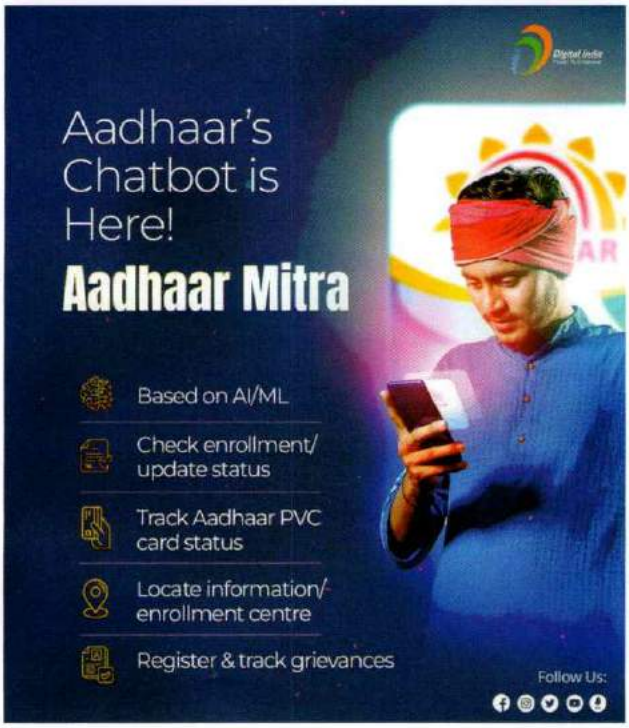
AI CHATBOTS FUTURE AND CHALLENGES

The recent emergence of chatbots is a clear indication of the incredible transformation that artificial intelligence is currently undergoing. This is facilitating the new-age chatbots utilise Artificial Intelligence and Natural Language Processing to simulate human-like conversations and automate responses to customer queries, making it easier for users to find information without human intervention. Consequently, they are enhancing their ability to predict user requirements and provide accurate responses over time.

BALENDU SHARMA DADHICH | The author is the Director- Localization & Accessibility at Microsoft India. He is a nationally-awarded senior technology professional, author, and speaker. Email: balendudadhich@gmail.com

Chatbots are not an entirely new phenomenon. Even before the recent disruption in the market, you may have encountered them, say, while exploring a website. You may remember that tiny window that suddenly appears at the bottom right of the webpage and inquires, 'May I help you?' That is a bot. Chatbot, to be more precise. Though this one may have been a conventional chatbot with limited capabilities to converse with humans, understand user input and provide accurate information. Moreover, it could only understand text-based input.

In simple terms, a bot is a piece of code, a programme, or an application that can conduct pre-defined tasks using a database of pre-existing responses or a limited knowledge base. They are unable to give appropriate answers to complex queries or questions that the developers did not know might be asked.



The recent emergence of chatbots is a clear indication of the incredible transformation that artificial intelligence is currently undergoing and creating. The new-age chatbots utilise AI and Natural Language Processing (NLP) to simulate human-like conversations and automate responses to customer queries, making it easier for users to find information without human intervention. They have progressed into more sophisticated, context-aware, and self-learning programmes that rely on machine learning and deep learning to create a detailed knowledge base of questions and responses. Consequently, they are enhancing their ability to predict user requirements and provide accurate responses over time. They are not limited to understanding text-only queries, as audio input has emerged as another popular mode of interaction with AI. Voice-based chatbots are interacting with millions of users worldwide almost in a manner that mimics human interactions.

Even though chatbots can be useful for each one of us, they are making a profound impact in areas such as healthcare, finance and banking, education, customer service, e-commerce, human resources, marketing, and social media. With the success of generative AI, these chatbots have also started showing their creative, analytical, and conversational sides and they are poised to play a vital role in the world of media, the arts, literature, and day-to-day productivity.

Future of Work

The way we work and create content is being revolutionised by chatbots. Recently, a tech giant has announced the integration of a powerful generative AI technology to its various applications. This chatbot can automate a range of tasks across multiple Apps. For instance, it can generate a first draft for a user to edit and iterate on, saving considerable time in the writing, sourcing, and editing processes. It can also summarise chat conversations, extract key highlights and talking points, and add recent contacts to emails. It can also assist in creating presentations by incorporating relevant content from a user's past documents, analyse trends and generate professional-looking data visualisations in seconds. This demonstrates the potential of a future where digital and human intelligence work together to achieve outcomes that are currently beyond our imagination.

One area that is facing huge change thanks to generative AI is Internet search. New capabilities are being introduced to search applications, including those of handling queries in natural language. We have used keyword-based Internet search so far, but an era of conversational Internet search has started where we can just talk to the search using queries like, 'Name the most popular tourist spot around Delhi and suggest a fast, convenient, and cost-effective way to explore it.'

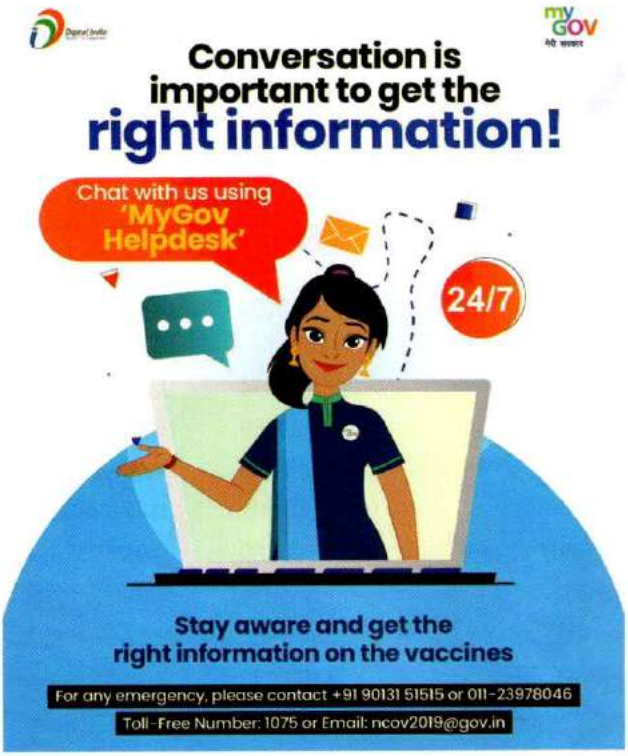
The race of AI chatbots is not limited to the big tech companies, as hundreds of AI chatbots have been launched by companies of all sizes in the recent past. However, it is one of the most happening spaces in the technology world today, and we will continue to witness exciting developments and innovations that will transform the future of work in the years to come.

Use-Cases of Chatbots

When applying for a job, candidates may not be aware of the significant role technology plays in the screening process. It can assist in interacting with the candidates, scheduling interviews, and even conducting initial job interviews. When a company receives a large volume of resumes, it becomes challenging to determine which applicants are most suitable for the job. Artificial intelligence,

and now AI-based chatbots, can analyse resumes and score them based on the job requirements, shortlisting the most suitable candidates. If a highly qualified candidate's skills do not precisely match a particular role, AI chatbots can identify other job openings within the company and recommend the candidate for those positions. In fact, AI technology is involved in almost every aspect of the recruitment process, from job creation and advertisement to candidate selection, enabling HR departments to identify a diverse pool of qualified candidates. Even after the candidates are hired, the chatbots can help in answering employee queries around internal processes, payroll, facilities and benefits, compliance requirements, policies, and so on.

AI chatbots can transform the healthcare sector by offering numerous services to both healthcare providers and patients. They can function as virtual aides, offering assistance to patients with their healthcare inquiries. Their 24x7 availability makes basic healthcare accessible to people at all times and all places, and reduces the workload faced by the healthcare system. The substantial number of patients they can interact with at the same time signifies a phenomenal capability which cannot be matched by professionals. Patients can seek answers from the chatbot about their symptoms, medications, and treatment plans and receive primary medical guidance. Chatbots can also help in scheduling appointments, monitoring and following up on patient's health, educating the patients on health topics, offering mental health support, and providing emergency responses in critical situations.



AI chatbots are playing a dominant role in handling customer queries and requests across sectors and industries. Customer service chatbots can be integrated into various digital channels, such as websites, mobile apps, social media platforms, and messaging applications to help people with their inquiries and provide support. Often, they are the first customer care representatives to attend to a customer's call or respond to a chat message. Once their job is over, they hand over the call to a human professional or forward the text message to the right people for further action. The new, AI-enabled chatbots, however, are equipped with newer skills and capabilities. Many times, they can have efficient, intelligent, and informed conversations with the customers, and the interaction may not need any kind of human intervention.

Making Services Accessible

E-commerce companies are using AI chatbots to help their customers locate products that match their needs by asking questions about preferences and showing relevant products. They can also help them navigate through processes such as placing orders and making payments. In the post-sales scenario, they can manage automated tasks such as collecting customer feedback and processing product returns, replacements, or refunds. All of this can lead to an improved customer experience and increased sales for the companies.

Education is a key area where AI chatbots are becoming increasingly relevant. Generative AI can help in the digital transformation of our education system and make it more efficient and accessible. It can help with content creation, the translation of educational material into multiple languages, and even play the role of a tutor or instructor where there is a lack of teaching resources. Conventionally, chatbots have been helping students with basic tasks such as sharing personalised learning recommendations and dealing with academic and administrative queries. They have also been helping the institutions and educators manage

administrative tasks such as fee collections and automated reminders.

The banking sector uses AI chatbots as a way of reducing costs and enhancing customer satisfaction. The primary reason for their popularity is that they can minimise the expenses of providing initial support. Chatbots can address basic customer queries, while complex ones can be forwarded to human agents for further assistance. Currently, banks are adopting a hybrid approach, utilising both chatbots and human agents to manage customer support. Enabled with AI, the chatbots are becoming more advanced and competent in handling complex customer queries. We can assume that in the not-so-distant future, they will handle a larger proportion of challenging customer inquiries, which will further decrease the need for human agents and their associated costs. Chatbots will also be helping banking professionals in their internal administrative tasks, such as summarising a customer's profile, analysing eligibility for banking services such as loans, and flagging potential security and privacy breaches.

Challenges

The biggest concern about AI chatbots is that their increasing use can result in a considerable number of people losing their jobs since AI is gaining capabilities to match human output and intelligence. Only time will tell how we as a civilisation will adapt to the emerging trends in the technology space: whether we will use AI and its agents as our assistants, tools, or actual replacements for human labour.

We have two schools of thought with differing views. One of them thinks that once the hype around it subsides, AI will be seen as the result of a natural process of development and innovation. When the Internet and computers first arrived, many people had similar fears, but with the passage of time, we learned to use them as tools for human empowerment and productivity. The same may happen with AI.

The second school of thought feels that the power and capabilities that AI can acquire over time are beyond what we can visualise, especially considering the speed with which things are happening. If we do not put a break on its uncontrolled development, AI can become a challenge for its creator itself. However, both schools of thought realise that its continued development in a controlled and planned manner under reasonable human supervision, limitations, and guidelines may be the safest bet.

Other challenges that AI chatbots are associated with include their improper responses due to misunderstandings, their lack of emotional intelligence, which may result in biases and a lack of empathy, and their compromises on privacy. There are also some ethical issues, and over-dependence on technology is another concern as it can impact our emotional, intellectual, and physical health. In a nutshell, we must take advantage of the emerging technology revolution, without forgetting the limits we are not supposed to cross. ❑

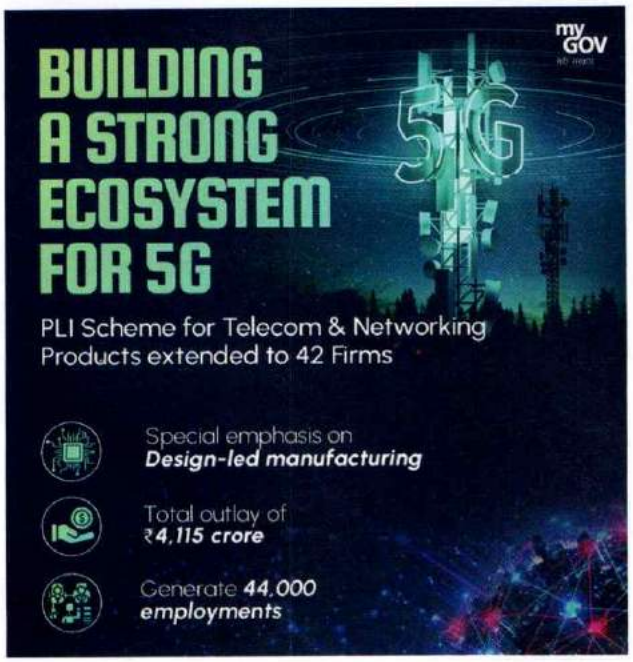
5G CYBERSECURITY CHALLENGES

The ultra-fast speed of 5G indeed holds the promise of revolutionary changes in how we communicate and consume content on the internet. In India, 5G services were launched in October 2022, with telecom companies presently offering services in select cities. The country is estimated to have over 150 million 5G users by the end of 2024 – a tiny fraction of the current 1.2 billion mobile phone users. The fundamental drivers including geopolitical rivalries, commercial motives, and data harvesting behind the recently increased cyberattacks and data breaches from adversarial states and other threat actors remain intact.

DR SAMEER PATIL | The author is a Senior Fellow at the Observer Research Foundation think-tank. He works at the intersection of technology and national security. Email: sameer.patil@orfonline.org

The 5th Generation of the mobile network, or 5G is the latest global standard for wireless communications. Every few years, a new generation of mobile communications takes shape and is described as 1G, 2G, 3G, 4G networks, and so on. Each of these brings higher data transfer speeds and lower latency rates – the time it takes for data to transfer or download. 5G is expected to bring in an average data rate of 100 megabits per second and promises to go up to 20 gigabits per second. These higher speeds will potentially ensure lower latency rates and, thus, more reliability in mobile data communications.

The ultra-fast speed of 5G indeed holds the promise of revolutionary changes in how we communicate and consume content on the internet. Upgraded mobile service is among the most noticeable impacts of initial 5G network rollouts.[1] However, it will subsequently impact edtech, autonomous and robotic systems, telemedicine, and precision agriculture. Besides, 5G will unleash



the benefits of Internet of Things (IoT) technologies and connected devices. High speed and low latency will enable the connected devices to communicate in real-time, offering better and more reliable performance. This will benefit household purposes (such as IoT-enabled smart homes) and the industrial sector (for example, smart factories and automated manufacturing). According to one study, by 2035, 5G will enable US$ 13.2 trillion of global economic output and support 22.3 million jobs.[2]

In India, 5G services were launched in October 2022, with telecom companies services in select cities, including Delhi, Mumbai, Bengaluru, and Kolkata. The country is estimated to have over 150 million 5G users by the end of 2024 – a tiny fraction of the current 1.2 billion mobile phone users. However, this number will expand significantly once the 5G network is progressively deployed in tier-2 and tier-3 geographies.

Geopolitics of 5G

Given its potential to influence our digital future and bring economic transformation, it is not surprising that leading tech powers have strived to attain the 'first mover' advantage in 5G technology. While major world telecom leaders may have taken the lead in developing 5G technology, yet, the real thrust has come from the Chinese telecom companies, which have been aggressively penetrating new markets by commercialising the technology and offering it at cheaper rates than their competitors. This has sparked concerns that China may be strategically pushing these companies to capture global markets and, therefore, may establish a vast eavesdropping network.

There are apprehensions that China might weaponise 5G technology by coercing the Chinese telecom companies to share their consumer data with the government or even force them to shut down 5G networks in times of geopolitical tumult.[3] Various instances and allegations of Chinese telecom companies engaging in cyber espionage in many countries have only reinforced these concerns.[4] For example, in August 2020, a report from the Australian government and Papua New Guinea's National Cyber Security Centre noted that the latter's National Data Centre, built by a Chinese telecom company, had multiple cybersecurity issues, which exposed confidential government data. Likewise, in 2019, vulnerabilities were found with equipment deployed by the same Chinese company for Italian telecom network. These instances have cast doubts on the security, availability, and integrity of Chinese telecom companies' equipment – concerns many experts perceive will only exacerbate in the 5G domain.

Consequently, in the last few years, the United States has spearheaded a campaign to counter the Chinese telecom companies' dominance in the 5G market. The US government has designated Huawei and ZTE as national security threats[5], banned American companies from using government subsidies to buy their equipment, and barred sales

> **Considering the potential role that 5G will play in national development and economic growth, it can undoubtedly be regarded as a critical infrastructure. Hence, 5G communication networks will represent a valuable target for cyberattacks, including sabotage.**

of semiconductor chips without a specific licence. Most recently, in November 2022, in another wider crackdown, the United States banned the sale and import of new communications equipment from five Chinese companies. In addition, the US has persuaded its allies not to use Chinese equipment in their domestic 5G networks.[6]

Naturally, these developments have shaped not only the trade dynamics between China and the United States but also the broader tech competition between democratic states and authoritarian regimes. As a result, there have been efforts to bring together like-minded and leading democratic states to jointly tackle the tech challenge posed by authoritarian regimes such as China and Russia.[7] For instance, former UK Prime Minister Boris Johnson floated the idea of D-10, a coalition of ten democracies, to create an alternative supply chain for 5G and other emerging technologies. The Quadrilateral Security Dialogue, or the Quad (which brings together India, Japan, Australia, and the United States) too has pledged to advance interoperability and security and work on 5G supplier diversification and Open RAN, which uses software to replicate signal-processing functions.[8] As authoritarian regimes pursue emerging technologies beyond 5G, this trend is only expected to crystallise further.

5G and Cyber Threat Landscape

However, 5G's cyber threat landscape extends beyond the risks of Chinese telecom companies'

> **Due to the higher speeds and enhanced capacity, 5G requires more access points and network edges, where the local network or device connects with the internet. This shifts much of the core network functions to the edges, closer to the end-user, making it challenging to enforce the requisite security compliance and ensure trusted third-party vendors.**

dominance and hardware. The fundamental drivers (geopolitical rivalries, commercial motives, and data harvesting) behind the recently increased cyberattacks and data breaches from adversarial states and other threat actors remain intact. Therefore, they will pose threats to even 5G networks. Among these is the increased tendency among threat actors to target critical national infrastructure. Considering the potential role that 5G will play in national development and economic growth, it can undoubtedly be regarded as a critical infrastructure. Hence, 5G communication networks will represent a valuable target for cyberattacks, including sabotage.

In doing so, threat actors will exploit several vulnerabilities of the 5G network and ecosystem. Due to the complexity of technology, there are many moving parts in the 5G ecosystem, which raises uncertainty about the resilience of each of those parts. This uncertainty dramatically expands the threat landscape. For instance, if some systems in the network are not fully patched, they can potentially act as the weakest link in cyber defence. Therefore, 5G will require an enhanced focus on the security of the connections, devices, and applications.[9]

Due to the higher speeds and enhanced capacity, 5G requires more access points and

network edges, where the local network or device connects with the internet.[10] This shifts much of the core network functions to the edges, closer to the end-user, making it challenging to enforce the requisite security compliance and ensure trusted third-party vendors. These conditions thus expand the attack surface for threat actors. Besides, the mixed types of networks – 5G with legacy systems such as 4G – also expose the 5G network to the vulnerabilities of previous generation networks.[11]

In addition, as mentioned earlier, the 5G network will bring about a wider proliferation of IoT-enabled devices. According to one estimate, by 2025, there will be approximately 27 billion connected IoT devices.[12] This magnifies the threat canvas, as these devices will offer new malware and botnet distribution vectors. These will bring increased avenues for attacks such as Distributed Denial-of-Service attacks or Man-in-the-Middle attacks. There have already been such incidents. For instance, in 2016, the Mirai botnet exploited unsecured IoT devices' vulnerabilities to disrupt the functioning of thousands of routers, security cameras, and digital video recorders.[13]

Another important dimension in the context of 5G is privacy risks. Unlike 4G, networks running on 5G have a much smaller area of coverage. Hence, they require several smaller antennas and base stations. This can allow precise location tracking of mobile phone or internet users inside and outside, potentially compromising their privacy.[14] Besides, 5G inherits the vulnerability from previous generation protocols, i.e., threat actors can get hold of the International Mobile Subscriber Identity (IMSI) – the number used to identify and authenticate subscribers on the mobile network. By seizing the IMSI, threat actors can intercept mobile traffic in a defined area to monitor an individual user's activity, including tracking location and intercepting calls.

These cybersecurity challenges and privacy risks will not remain restricted to only 5G. Even as 5G networks are progressively rolled out worldwide, leading tech companies have already begun to explore next-generation technologies. The Quad countries, for instance, have announced plans to collaborate on space-based 6G to ensure that security-by-design and best cybersecurity practices are incorporated as the technology takes shape.[15] Likewise, China too is formulating plans to advance research and innovation in 6G technologies.[16]

Conclusion

To sum up, 5G offers new opportunities for digitalisation and development, but the technology and network are not secure by design. Therefore, countries, like India, adopting 5G must have a cyber resilience plan in place. Much depends on the cyber and information-security policies of the ecosystem's various elements. Organisations connecting to the 5G network must be cognisant of the evolving threat landscape, adopt security protocols accordingly, determine their threat posture, and secure their digital infrastructure. This will need constant updating and upgrading since threat actors continue exploiting emerging vulnerabilities. A critical element of this resilience will also be the awareness of end-users. Their cyber hygiene – their understanding of safe practices in cyberspace – can help them better tackle the threats and protect themselves. ❑

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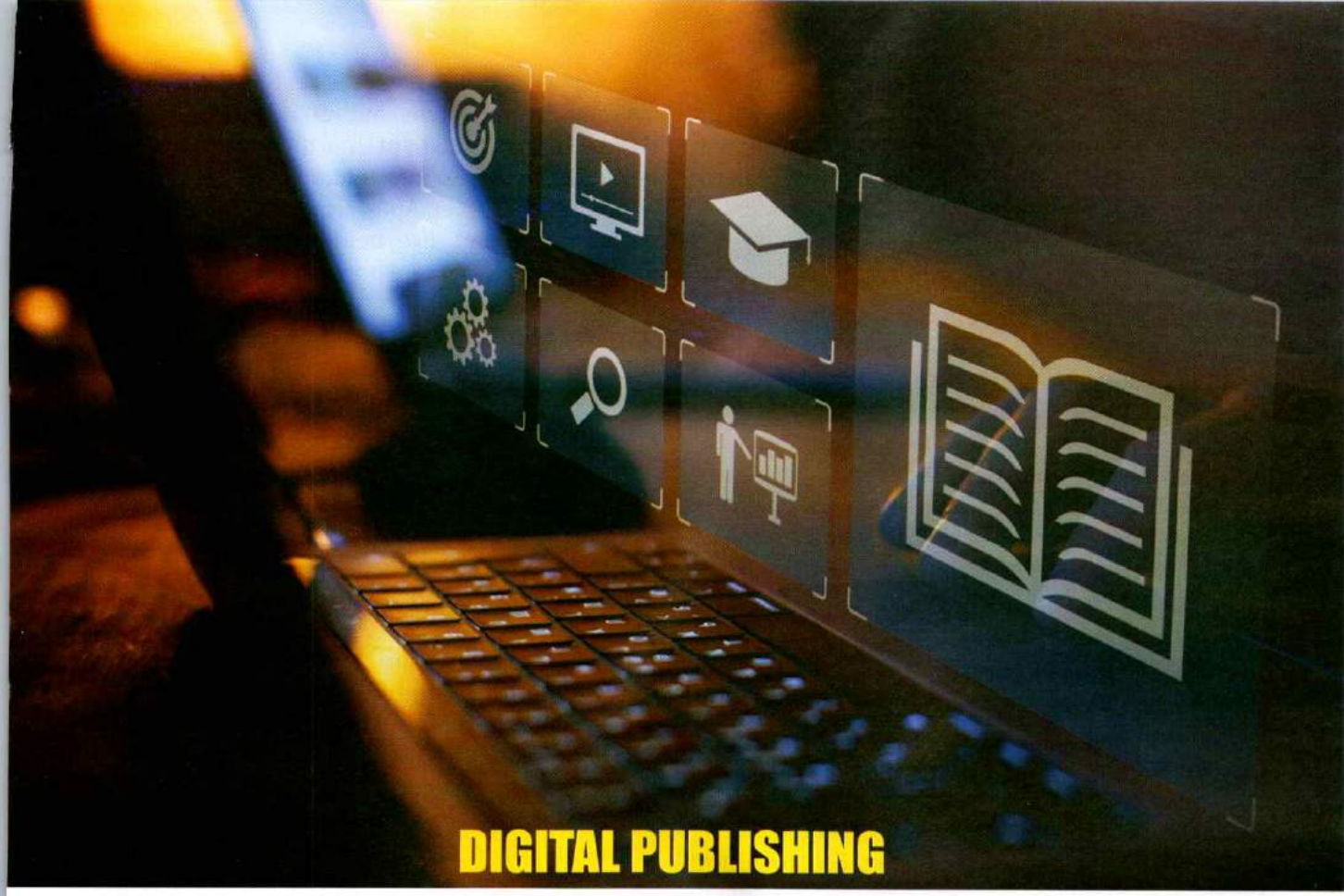

DIGITAL PUBLISHING

EXPANDING THE HORIZON

In recent years, digital publishing has gained immense popularity in India and paved new avenues for publishers, authors, and readers. With the rise of big data and artificial intelligence, publishers can collect data on their readers' preferences and tailor content according to their needs and interests. Digital content has made reading more accessible to people who may not have had access to traditional books. However, digital publishing still has a long way to go before it becomes a mainstream publishing mode in India.

PROF SANJAY DWIVEDI | The author is Director General, Indian Institute of Mass Communication, New Delhi, Email: dgiimc1965@gmail.com

DR PAWAN KOUNDAL | The author is Associate Professor, Indian Institute of Mass Communication, New Delhi, Email:pawankoundal@gmail.com

The culture of any country can be ascertained by the literature it has published. The publishing industry in India is the cornerstone of Indian culture, values, and transcendence. India's publishing industry contributes to India's economic growth by promoting learning and education, and it also creates employment for crores of people. The publishing industry in India reached the US$ 33.2 billion mark in 2022. According to a report, the market will reach US$ 41.6 billion by 2028 and is expected to show a compound annual growth

rate (CAGR) of 3.4% from 2023-2028[1]. An increase in the overall education expenditure in National Education Policy 2020 has also helped in the growth of the Indian publishing industry.

Today, digital technology has given us a variety of mediums to obtain information. The same information can be obtained through different mediums. There is an onslaught of information from various electronic devices. Today, the media and its tools have become so commonplace that we learn from them and also get spoiled. They can both benefit and ruin us. So much information is available that it becomes difficult to differentiate between right and wrong information. Books and other published materials have always been considered important sources of information.

With the advent of technology, there has been a significant transformation in the publishing industry. Traditional print media has given way to digital publishing, making it easier for publishers to reach a wider audience. Digital publishing is still in its nascent stages in India. It accounts for about 8-10% of the country's publishing sector. However, the digital publishing sector in India has witnessed significant growth in recent years. According to a report, digital and regional content will drive the growth of Indian media. The digital sector is expected to grow at a rate of 29.1% between FY 2019 and FY 2024. Driven by the strength of regional content, it would reach INR 621 billion by 2024[2]. This development will certainly impact digital publishing.

In recent years, digital publishing has gained immense popularity in India and paved new avenues for publishers, authors, and readers. With the substantial growth of smartphones, tablets, and e-readers, access to information has become more accessible than ever. Apart from the key features of digital publishing, like being accessible anytime, anywhere, e-readers are now available with options like authentic page feel, page flipping mode, etc., to make the reading experience more interesting. Another advantage of digital publishing is its cost-effectiveness. Unlike traditional publishing, digital publishing does not require printing, shipping, or storage expenditures. Publishers can save on production and distribution costs, which can be passed on to consumers through lower prices.

Accessibility is one of the main advantages of digital publishing. People can access digital content from any corner of the world. It means publishers are reaching a wider readership than ever before. Digital publishing also allows for more interactive content, such as video, animations, and interactive graphics. The podcasting market in India is fast growing in terms of audio content. India recorded a 29.3 per cent increase in podcast consumption in the first year of the pandemic[3]. According to a report, India is the third largest consumer of podcasts (after the US and China), with 57.6 million monthly listeners, and is expected to reach 17.61 million by 2023[4].

E-books have played a significant role in the growth of digital publishing in India. According to a Nielsen report, e-books accounted for 20% of book sales in India in 2018. E-books offer several advantages over traditional books, including cost and convenience. Besides, e-books are more environment- friendly than traditional books, as they eliminate the need for paper production. On the other hand, audiobooks are becoming one of the most important forms of digital publishing and consumption. In some countries, the growth of audiobooks is faster than the growth of e-books. India is also witnessing a similar trend in this format. Some of our established audiobook providers expect the interest in and revenue from digital formats to grow in India as well.

Stakeholder Opportunities

The major stakeholders in the publishing industry include readers, authors, and publishers. Digital publishing has opened up new opportunities for publishers in India. It allows them to publish

Apart from the key features of digital publishing, like being accessible anytime, anywhere, e-readers are now available with options like authentic page feel, page flipping mode, etc., to make the reading experience more interesting.

content in regional languages, which would not have been possible to that extent with traditional publication. The translation is aided by digital technology, which has made publishing in Indian languages more accessible. It has increased the availability of Indian language content, thereby preserving and enhancing the rich cultural heritage of India. Secondly, it has enabled publishers to reach a global readership, which was impossible earlier. Thus, it has also opened up new avenues of income for the publishers.

Digital publishing has created new opportunities for writers in India. First, it allows them to self-publish their work without the support of a traditional publisher. Authors can self-publish their books with digital publishing platforms. With digital content so easily accessible, authors can reach readers worldwide. It enhances exposure and sales. Digital publishing has made it easy for readers to access a wide range of content from anywhere. Second, it has made reading more affordable, as e-books are generally cheaper than their print counterparts. Third, the growth of digital publishing has significantly impacted reading habits in India. With the increasing availability of digital content, people are reading more now than ever. The revenue of the e-publishing segment in India is projected to reach US$ 890.00 million in 2023. Also, the readership of e-publishing is expected to reach 165.70 million by 2027[5].

The Challenges

Digital publishing presents the opportunities as well as challenges. One of the main challenges is piracy. With digital content being easily accessible, it becomes easier for people to illegally download and distribute copyrighted material. Therefore, the publishers must take additional measures to protect their content from unauthorised distribution. Another challenge of digital publishing is constant updates and maintenance. Digital content should be updated regularly to ensure it remains relevant and up-to-date. It requires a significant investment in time and resources. In the world of digital publishing, quality content is the ultimate parameter. With so much content available online, publishers need to make sure their content is engaging and eye-catching. This means creating high-quality content that is distinct and informative.

Future

Despite the challenges, the future of digital publishing is bright. We expect to see more interactive and immersive content as technology advances. Virtual reality and augmented reality are already being used in some digital publishing and we may see more personalised content in the future. With the rise of big data and artificial intelligence, publishers can collect data on their readers' preferences and tailor content according to their needs and interests. Digital content has made reading more accessible to people who may not have had access to traditional books. However, digital publishing still has a long way to go before it becomes a mainstream publishing mode in India.

Digital publishing has revolutionised how content is created, distributed, and consumed in India. It has opened up new opportunities for publishers, authors, and readers alike. However, some challenges still need to be addressed before it becomes a mainstream publishing mode in India. With the right infrastructure and awareness campaigns, digital publishing can become a game-changer for the Indian publishing industry. ❑

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USE OF TECHNOLOGY IN URBAN PLANNING

Urban planning has always been a difficult and complex job due to the multi-faceted nature of cities as dynamic, active, and vibrant living organisms. Nevertheless, in the modern era, the rapid boom of Information Technology and Artificial Intelligence has more significant potential to incorporate diverse issues of city planning to a general platform, as well as lead to deal with the challenges of complexity. Technology may be used by urban planners to enhance their processes and build better urban areas where people can live and work.

DR RAWAL SINGH AULAKH | The author is Assistant Professor, Department of Architecture, Guru Nanak Dev University, Amritsar, Punjab. Email: rawal.arch@gndu.ac.in

DR SAKSHI SAHNI | The co-author is Assistant Professor, Guru Ram Das school of Planning, Guru Nanak Dev University, Amritsar, Punjab. Email: sakshi.plan@gndu.ac.in

Urban planning is the process of both developing and designing open land, urban areas, and the built environment. Urban Planning dated back its history since the town and cities have existed. Early city planning revolved around some essential and significant elements like building structures and bastions with fortification, and has experienced a huge change throughout the centuries. Urban planning is a many-sided process involving infrastructure like physical and social, utility systems, communication networks, distribution chains, and more. Urban planners, also known as city planners, design cities and create plans for future improvements and growth. The plans are in the form of a land use plan. These plans comprise things in an urban environment like streets, parks, public spaces, and more.

It has never been easy to make plans that address various city challenges holistically. Nevertheless, in the modern era, the rapid boom of Information Technology and Artificial Intelligence has more

> **Urban planners may employ technology to establish self management strategies to create smarter cities and put more emphasis on growing communities and neighborhoods.**

significant potential to incorporate diverse issues of city planning into a general platform, as well as leading to a better way to deal with the challenges of complexity. The use of Information Technology has helped urban planners in many aspects, especially with softwares based on GIS (Geographic Information System).

There are various urban planning apps that can be used by urban planners, and that use contemporary technologies as well as open data to build up comprehensive and lively spaces for inhabitants and commercial businesses. There are various planning tools which help in the urban design process and assist to generate areas that the population of a city needs. GIS in urban planning is becoming gradually more helpful over time. Initially, it had a huge cost, but now in today's world with open source data, many open source Various GIS softwares have come up as a free and open-source cross-platform desktop GIS application that supports the viewing, editing, printing, and analysis of various data and is freely available for all to use. With the help of GIS improved mapping along with locational attributes, this has been possible, which was missing in the earlier drawing and mapping software. GIS is being used in all the Government offices for record keeping, such as property mapping, utility services like water supply and sewerage networks for seeing the coverage of water supply and sanitation system; it is also used in Municipal Solid Waste Management to identify the zones in order to manage the MSW Management system. GIS is also used in network analysis by transport planners in order to analyse the road network, to identify the conflict points at various junctions, to identify the various road hierarchies, etc. Various predictive models, like 3D models can be made with the help of GIS through its tools, where 3D analysts help in assessing the topography of the town or city by making virtual models. These points help the city planners to analyse the various situations in the city and identify the problems, thus GIS helps in decision-making and policymaking decisions.

Urban planners, decision-makers, policymakers and the general public now have the means to envisage unconventional futures for their cities and regions. In contemporary time, we have moved away from complex and complicated computer architecture, or less important memory or storage devices in the 1950s and 1960s, where huge processor computers were used to process data, with punched cards or magnetic tapes serving as input and output, and at that time, the primary concern was a lack of hard disks. There were no developed operating systems like we have today. In today's time, there are considerable developments in 3D visualisations software as well as the ongoing evolution of analytical capacity of GIS.

There has been a great development and expansion in the accessibility of data and information resources. The speedy development of an information system has fed on hardware and software developments. These topologically correct line files, first used in the 1990 US Census, have proven invaluable to planners and analysts, representing a broad depiction of communities from the viewpoint of their roads and railways. There has been an unbelievable development in satellite imaging, with resolution as fine as one meter now available, thereby meaning that individual vehicles can be counted in a parking lot. The internet has shown immense potential for group interactions. The new technology involves all the stakeholders, ranging from communities, local residents, shopkeepers, and NGOs in the development of a town or city. The Information Technology will help in analysing the perception of each stakeholder and providing solutions accordingly through the analysis of databases and their decisions.

Various apps, open source as well, are handy for maps to be used offline, site design-level apps which allow creating and editing the drawings on the phone, presenting 3D models on mobile phone. There are certain apps that allow collecting data in the field, analysing various aspects of the problem.

There are certain apps to perform these functions as well, like collecting and accessing data wherever you are through photographs, videos, location and is available to the network of other team easily. There are apps which help planners to provide specific templates like transportation, sustainability, as well as accessibility on mobile and helps to make field reports and punch lists for planners, engineers, and architects with the help of onsite inspections, checklists, and photos. Reports are available on the tap of your mobile phone.

Technology may be used by urban planners to enhance their processes and build better urban areas where people can live and work. Urban planners can establish a database to get information about specific metropolitan regions using cloud technologies. Cloud computing technologies can also aid in the planning of bigger infrastructure projects. Internet: Urban planners may use the internet to create cities that are accommodating to distant workers. As a result, urban designs have better transportation alternatives and reduced traffic congestion.

Internet of Things (IoT)

Several fundamental IoT tools are already in use. They include intelligent streetlights that automatically turn off to conserve energy. On top of those answers, urban planners can create ideas that improve the infrastructure of cities. Urban planners may employ technology to establish self-management strategies to create smarter cities and put more emphasis on growing communities and neighborhoods. Cities achieve more financial stability, independence, and provision of green space this way. These instances demonstrate how technology may be utilised to develop smarter city plans and foster more community participation. Urban design requires the use of technology. Urban planners can handle and resolve the present urban difficulties if they are used properly. Technology will also enable urban planners to concentrate more on creating communities, leading to a higher level of municipal self-sufficiency. Finally, technology is effectively applied when it prioritises local citizens and residents. Citizens may participate more actively in the creation of sustainable and environmentally friendly cities in this way. Therefore, technology has become the saviour in all fields, and with globalisation, its effects have reached to far flung as well as remote areas. Hence, technology has become the key for planners to do planning efficiently and effectively. ❑

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FROM LOCAL TO GLOBAL

HOW INDIA'S DIGITAL PAYMENT REVOLUTION IS INSPIRING THE WORLD

A quiet revolution is underway, attracting little attention but with deep implications for the Indian economy. In January this year, about eight billion transactions worth nearly $200 billion were carried out on the Unified Payment Interface (UPI).

Digital payments are being made for even the smallest of transactions, with nearly 50 per cent classified as small or micropayments: Rs 10 for a cup of milk chai or Rs 200 for a bag of fresh vegetables. That is a significant behavioural shift in what has long been a cash-driven economy.

India has built a homegrown instant payment system that has remade commerce and pulled millions into the formal economy. The foundation of the digital public infrastructure was laid by the government and built upon by a robust Public-Private Partnership. The value of instant digital transactions in India last year was far higher than in the United States, Britain, Germany, and France. It has made daily life more convenient, expanded banking services like credit and savings to millions more Indians, and extended the reach of government programmes and tax collection. The Prime Minister has described the digital payment ecosystem to the G20 Finance Ministers as a free public good that has radically transformed governance, financial inclusion, and ease of living in India. The digital infrastructure is seen as a set of 'rail tracks' laid by the government, on top of which innovation can happen at a low cost.

With this network, India has shown, on a previously unseen scale, how rapid technological innovation can have a leapfrog effect for developing nations, spurring economic growth. It is a public-private model India wants to export as it fashions itself as an incubator of ideas that can lift the world's poorer nations. At the heart of this initiative is the famed JAM trinity – Jan Dhan Accounts, Aadhaar and Mobile – the three pillars that revolutionised the entire economic ecosystem of India. The first pillar, PM Jan Dhan Yojana was started with the aim of financial inclusion to ensure access to a bank account for every adult Indian. As of 2022, 46.25 crore bank accounts have been opened, with 56% belonging to women and 67%

UPI
UNIFIED PAYMENTS INTERFACE

opening in rural and semi-urban areas, amounting to Rs. 1,73,954 crore. The second pillar of Aadhaar transformed identity services. Aadhaar ID can be used for digital authentication through two-factor authentication or biometric IDs. Aadhaar-led authentication has become an enabler for institutions like banks and telcos. Today, 99 per cent of adults have a biometric identification number, with more than 1.3 billion IDs issued. The IDs facilitated the creation of bank accounts and became the foundation of the instant payment system. The third pillar is that of Mobile, which showcases the core digital innovation in India's telecom sector. After the disruptive entrance of one private company in 2016, the cost of data dropped by 95%. It led to every Indian having low-priced and easy access to the internet. This catapulted verticals such as e-commerce, food delivery, and OTT content to take-off in India. Most importantly, it made the digital payment system accessible to the last and the least in the remotest regions of India.

India and Singapore have launched cross-border linkage using their respective Fast Payment Systems, namely Unified Payments Interface (UPI) and PayNow. The UPI-PayNow linkage enables users of the two fast payment systems in either country to make convenient, safe, instant, and cost-effective cross-border funds transfers. Funds can be transferred to / from India using just the UPI ID, mobile number, or Virtual Payment Address (VPA). This interlinkage aligns with the G20's financial inclusion priorities of driving faster, cheaper and more transparent cross-border payments and will be a significant milestone in the development of infrastructure for cross-border payments between India and Singapore. ❑

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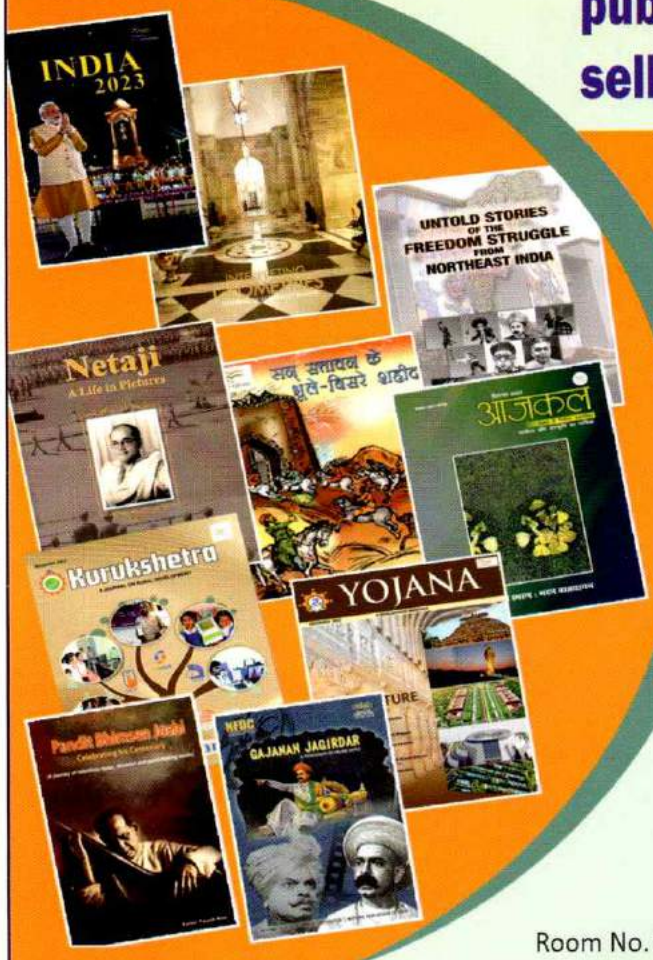

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