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**TECHADE****A. Innovation in Space Technology**

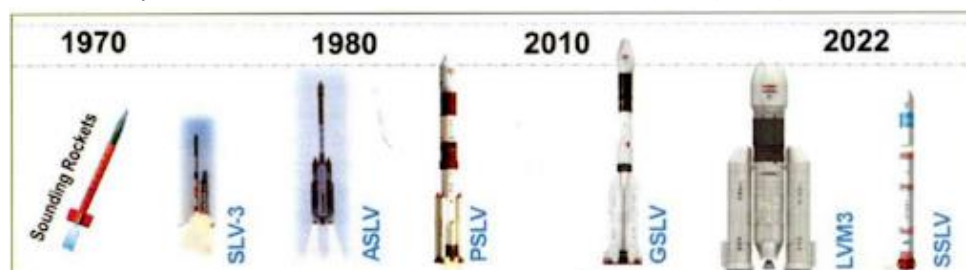
Space technology has been one of the defining forces of the 20th and 21st century. The Soviet launch of Sputnik in October 1957 and the ensuing space race to the moon came to symbolize countries demonstration of their prowess and global influence. These bright moments, including the Apollo moon landing, were evidence of space technologies lighting a clear path to the future and in recent times, it is on the cusp of a great technological revolution.

- Since the days of its heroic endeavours, space engineering has matured into a series of interconnected technologies that deliver exciting new space science missions which in the present times are rendering great technological advancement in space as well as use on earth.
- By democratizing access to space-based resources, we can create a more humane and just world. But realizing these benefits requires overcoming complex technical, legal, political and regulatory challenges.
- Present times is seeing a wave of start-ups driving dramatic and ongoing reductions in launch costs with innovations such as reusable boosters. The second is the development of nano sats that are dramatically smaller, lighter and less expensive to build and launch than those typically used by governments or industry.
- Space is stepping up to the connectivity challenge posed by the fourth industrial revolution. One of the driving forces of this change has been the introduction of next-generation high-throughput satellite (HTS) systems. HTS will enhance the end user experience much like the terrestrial move from dial-up to broadband access.
- Space is quickly becoming a place where the industries that power our global economy will conduct business. Like any major change, this sharing economy in space faces major legal, regulatory and technical hurdles.
- Further, this change is being led by private enterprises unlike earlier governmental efforts, which makes it conducive to exponential growth in light of unlimited resources that the space economy provides.
- Space industry leading the technological revolution is evident from earlier precedents when technologies developed for Apollo and other missions had a spillover effect on various industries in the world. In present times, reusable rockets help in revolutionising transportation on earth is one such example
- At the same time, there will also be need for mechanisms to track and control satellites to prevent their being used for criminal or terrorist purposes, as well as finding ways to safely destroy failed satellites so they don't cause damage to other satellites or space vehicles.

**Space Transportation System:**

- The 1970s marked the beginning of the 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.

- 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 have resulted in the development of the **Polar Satellite Launch Vehicle (PSLV)**, which can place a 1700 kg payload into polar orbit.
- The indigenous development of a Cryogenic propulsive engine was the major technological leap in the development of third-generation rockets i.e., GSLV launch vehicles, which can place a 2000 kg payload in **Geo-Synchronous Transfer Orbit (GTO)**.
- Then the 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** can put 4000 kg payload in GTO.
- ISRO recently introduced the **Small Satellite Launch Vehicle (SSLV)**.



*Image Source: Yojana*

#### India's recent achievements on the space technology front

The Indian Space Research Organization (ISRO) is one of the largest and most successful space agencies in the world. Since its inception back in 1969, the Indian space agency has achieved a number of milestones, from successfully launching Chandrayaan-2 to testing a critical technology for human spaceflight. Indian Space Research Organisation (ISRO) has come a long way since its formation from launching small rockets of just 30-70 kg payloads to carrying 4,000 kg payloads to outer space. In this regard, some of India's recent achievements on space technology front include –

##### **Launch Vehicles –**

- **Polar Satellite Launch Vehicle (PSLV):** PSLV upper stage (PS4) restart capability has also been demonstrated which enables PSLV to inject multiple satellites in different orbits in same mission thereby making PSLV more versatile launcher.
- **GSLV-Mark III:** The first developmental flight was successfully launched, in which a 3136 kg communication satellite (GSAT19) was injected into the Geosynchronous Transfer Orbit. GSAT-19 is the heaviest satellite launched with Indian launch vehicle.
- **Technology demonstration:** The first experimental mission of ISRO's Scramjet engine towards the realization of an Air Breathing Propulsion System, was successfully conducted. With this test, India became the fourth country to demonstrate the flight-testing of a Scramjet engine.
- Towards developing essential technologies for a fully reusable launch vehicle to enable low cost access to space, ISRO successfully flight tested India's first winged body Reusable Launch Vehicle - Technology Demonstrator (RLV-TD) demonstrating Autonomous navigation, guidance and control & re-entry mission management.

**Communication, Navigation and Earth Observation Satellites –**

- The Indian space agency, scripted history by successfully launching RISAT-2B, a super surveillance satellite, from the Satish Dhawan Space Center. The radar imaging satellite can take high-resolution images even in cloudy conditions.
- Further, South Asia Satellite was realized with the objective of providing communication services over South Asian countries.
- Recently, ISRO's PSLV-C43 lifted off with India's Hyper-Spectral Imaging Satellite (HysIS), the country's best high-resolution satellite ever, which can study the earth's surface in visible, near-infrared, and shortwave infrared regions of the electromagnetic spectrum.
- Seven more satellites of the Indian Regional Navigation Satellite System (IRNSS) constellation were successfully launched. The constellation is named as 'NavIC', and was dedicated to the nation by the PM.
- Recently, the Indian Space Research Organisation (ISRO) declared that it has successfully demonstrated free-space Quantum Communication over a distance of 300 metres, for the first time in the country.

**Space Science Missions –**

- **ASTROSAT:** India's first multi wavelength observatory capable of simultaneously viewing the Universe in the visible, Ultra-Violet and X-ray regions of the electromagnetic spectrum, with its 5 payloads, was successfully launched into its planned orbit.
- **Mars Orbiter Mission (MOM):** India's first inter-planetary mission MOM, far outliving its originally planned life, completed three years in its orbit, in September 2017. The Mars Colour Camera has, so far, produced around 940 images.
- **Chandrayaan 1:** It changed the course of India's space exploration. It was launched in October 2008 and was the first lunar probe under the Chandrayaan program. The mission had a lunar impactor and orbiter. It was launched to collect scientific information about the moon's mineralogy, geology and topography.

**Human Space Flight –**

- ISRO successfully carried flight test of the indigenous **Crew Escape System**, a crucial technology for launching astronauts into space. The Crew Escape System is an emergency escape measure that is designed to quickly pull the crew module and the astronauts away from the launch vehicle, to a safe distance, in case of a malfunction in the initial launch stage.
- Further, **ISRO's Vyommitra** will ride to space in the first test flight of the human space mission, Gaganyaan. She is being called a half-humanoid since she will only have a head, two hands and will not have lower limbs. She will simulate human functions before real astronauts take off. She can detect and warn if environmental changes within the cabin get uncomfortable to astronauts and change the air condition.

**Ongoing Efforts**

- In an effort to develop technologies for low-cost access to space and space travel, ISRO is working on a Reusable Launch Vehicle (RLV) programme.
- ISRO is also working on Air breathing propulsion with reusable capability for a cost-effective futuristic space transportation system.
- 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).

- For the first time in India, 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.
- ISRO has been actively pursuing several R&D programmes related to Space Robotics Vyom Mitra (Humanoid robot), Lander and Rover for Chandrayaan-3 mission, On-orbit Satellite refuelling, Planetary Rock Sampler, Space-based robotic manipulator, Robotic arm-based umbilical systems, 3D printing in Space among others.

### What are the structural changes that are reshaping the global space activity?

- Through the second half of the 20th century, outer space was the sole preserve of national space programmes driven by government-funding, direction, and management
- As military uses of space and prestige projects like Moon-landing emerged, major private sector entities already in the aviation industry won space contracts in the US but under overall guidance & control of NASA & Pentagon
- The last decades of the 20th century saw significant expansion of satellite-based telecommunication, navigation, broadcasting and mapping, and lent a significant commercial dimension to the space sector.
- As a result, private sector companies (Ex: Space X) started playing major role in the sector like independent Space launches. Hired for a resupply mission for the space station, Space X now launches more rockets every year than NASA
- The entry of private sector has begun to drive down the cost-per-launch through innovations such as reusable rockets.
- As the digital revolution in the 21st century transformed the world economy, the commercial space sector has begun to grow in leaps and bounds.
- The global space business is now estimated to be around \$ 400 billion and is expected easily rise to at least trillion dollars by 2040. This has made private sector participation attractive and inevitable.

### What does the commercialisation/privatisation of the space sector mean in practical terms?

- **Space Sector Revolutionized:** With its reusable rockets, large capsules to carry payloads and crew and competitive pricing, SpaceX has revolutionised the space sector.
- **Technology has brought down the Cost:** The price tag for reaching low Earth orbit has declined by a factor of 20 in a decade. NASA's space shuttle cost about \$54,500 per kg; now, SpaceX's Falcon 9 advertises a cost of \$2,720 per kg.
- **Increased Market:** According to a Bank of America Report, the \$350 billion space market today will touch \$2.7 trillion by 2050. In a decade, 80,000 such satellites could be in space compared to less than 3,000 at present
- **Telecom Revolution:** The aim of Starlink exercise is to provide Internet services that link any point on Earth to any other point. Targeting coverage in northern U.S. and Canada by end of 2020, the aim is to have the globe covered by 2021. This will be the new telecom revolution then, in the context of India, reaching out to rural areas as never before.

### What is the significance of development of Space Sector?

- **Better Weather Prediction:** Satellites provide more accurate information on weather forecasts and assess long-term trends in the climate and habitability of a region. As a result,

governments would be able to devise more pragmatic and combative plans of action for farmers and dependent industries.

- **Real-time Tracking:** With more accurate data collected through satellites can also serve as real-time monitoring and early-warning solutions against natural disasters such as earthquakes, tsunamis, floods, wildfires, mining etc. Real-time tracking can also serve multiple purposes in defence.
- **Bolsters Connectivity:** Satellite communication can reach more remote areas where conventional networks would require a heavy complimenting infrastructure.
- **Space Debris Management:** As space becomes more congested with satellites, advanced space technology is required to help in managing 'space junk' (debris of old spacecraft and satellites).
- **Spillover effect on multiple sectors:** What essentially needs to be remembered is that the space avenue is an integration of the aerospace, IT hardware and telecom sectors. It is thus argued that investment in this arena would foster positive carryover effects to other sectors as well.

#### What are the challenges to fulfilling the potential of space?

- **Multilateral framework for Space governance is becoming outdated for present context**
  - **The Outer Space Treaty of 1967** enshrines the idea that space should be "the province of all mankind" and "not subject to national appropriation by claims of sovereignty".
  - The Rescue Agreement, Space Liability Convention, and the Space Registration Convention expanded provisions of the Outer Space Treaty.
  - **Gaps in the Space laws include**
    - The Moon Treaty of 1979 was not ratified by major space-faring nations.
    - Space law does not have a dispute settlement mechanism
    - Space law is silent on collisions and debris
    - They offer insufficient guidance on interference with others' space assets.
  - **The legal framework of Space laws is state-centric, placing responsibility on states alone**
    - However, non-state entities are now in the fray for commercial space exploration and utilisation.
    - Some states like US are providing frameworks for resource recovery through private enterprises based on the notion that this is not expressly forbidden for non-state actors.
    - Some scholars and governments view this as skirting the principle of national non-appropriation, violating the spirit if not the letter of the existing space law.
    - The lack of alignment of domestic and international normative frameworks risks a damaging free-for-all competition for celestial resources involving actors outside the space framework.
  - **Space Arms race and Growing Militarisation**

- States are investing in military space systems for communications, navigation, and reconnaissance purposes, so as to ensure operability of a range of capabilities.
- Reliance of militaries on satellite systems means that space assets become potential targets. So investment in technologies that can disrupt or destroy space-based capabilities is under way.
- The space arms race is difficult to curb, especially since almost all space technologies have military applications

### Where does India stand in the global space market?

- As per SpaceTech Analytics, India is the sixth-largest player in the industry internationally having 3.6% of the world's space-tech companies (as of 2021).
  - S. holds the leader's spot housing 56.4% of all companies in the space-tech ecosystem. Other major players include U.K. (6.5%), Canada (5.3%), China (4.7%) and Germany (4.1%).
- The Indian Space Industry was valued at \$7 billion in 2019 and aspires to grow to \$50 billion by 2024.
- The country's standout feature is its cost-effectiveness. India holds the distinction of being the first country to have reached the Mars' orbit in its first attempt and at \$75 million — way cheaper than Western standards.
- Most companies in the sector, globally, are involved in the manufacture of spacecraft equipment and satellite communications.
- S. and Canada were the highest receivers of space-related investment in 2021.
  - A scrutiny of SpaceTech data puts forth that U.S. alone has more companies in the sector than the next 15 countries combined. Forbes pointed out in May 2021 that.
- India's total budgetary allocation for FY2022-23 towards the Department of Space was ₹13,700 crore. Further, funding into the sector's start-ups (in India) nearly tripled to \$67.2 million on a year-over-year basis in 2021.
  - USA's space budget was \$41 billion in 2021, \$23.3 billion of which was focused on NASA. The spur in research and innovation driven by government-led spending could also be attributed to the global concentration of considerable number of private investors in the country.
- It is not that there is no private industry involvement in India's space sector. In fact, a large part of manufacturing and fabrication of rockets and satellites now happens in the private sector
- However, Indian industries' role has been mainly that of suppliers of components and sub-systems while there is huge scope for participation in satellite-based services, and ground-based systems.
- There were several Indian companies waiting for make use of these opportunities but the policy environment in India was supportive of private players
  - Additionally, the demand for space-based applications and services is growing even within India, and ISRO is unable to cater to this.



**How is the space scenario changing in India?**

- **Shift in Focus of ISRO:** There has also been a shift from a mandated focus on utilitarian projects to those focused on exploring space and our planetary neighbours, the Moon, the Sun and so on.
- **Increasing role of Private Players:** As a result of shift in ISRO's focus, we have seen the yielding of governmental control over the space industry bit by bit, starting from hiring of vendors and active outsourcing of rocket components to the present idea of allowing external agencies to use ISRO facilities.
- **NewSpace India Ltd (NSIL)**
  - Additionally, constituted in March 2019, NewSpace India Ltd (NSIL), is mandated to transfer the matured technologies developed by the ISRO to Indian industries. All of them are under the purview of the Ministry of Defence.
  - Antrix Corporation Limited is an Indian government-owned company under the administrative control of the Department of Space. It was incorporated in September 1992, as a commercial and marketing arm of ISRO by prompting, commercially delivering and marketing products and services emanating from ISRO
- **Indian National Space Promotion and Authorisation Centre (IN-SPACe)**
  - IN-SPACe was mandated the task of promoting, authorising and licensing private players to carry out space activities. As an oversight and regulatory body, it is responsible for devising mechanisms to offer sharing of technology, expertise, and facilities free of cost (if feasible) to promote non-government private entities (NGPEs).
  - ISRO shares its expertise in matters pertaining to quality and reliability protocols, documentations **and testing procedure through IN-SPACe's 'interface mechanism'.**

***What is the significance of the creation of IN-SPACe?***

- **Facilitator and regulator:** IN-SPACe will act as an interface between ISRO and private parties, and assess how best to utilise India's space resources and increase space-based activities.
- **Fair Competition:** IN-SPACe will provide a level playing field for private companies to use Indian space infrastructure.
- **Better utilisation of space resources:** Existing ISRO infrastructure, both ground- and space-based, scientific and technical resources, and even data are planned to be made accessible to interested parties to enable them to carry out their space-related activities.
- **Strategic benefits:** ISRO, like NASA, is essentially a scientific organisation whose main objective is exploration of space and carrying out scientific missions. The private industry will also free up ISRO to concentrate on science, R&D, interplanetary exploration and strategic launches.
- **Widening the horizon of Private participation:** IN-SPACe will promote private players in end-to-end space services, including building and launching rockets and satellites and providing space-based services commercially.
- **Reorients space activities:** IN-SPACe will reorient the space sector from a 'supply-driven' model to a 'demand-driven' one, thereby ensuring optimum utilization of the nation's space assets.

- **Leveraging the potential of Young Country:** So far only ISRO was doing all space-related activities. Opening up of the space sector means the potential of the entire country can be leveraged
- **Boost to Space Start-ups:** This will not only result in the accelerated growth of the sector but also enable India to generate large-scale employment in the technology sector.
- **Additional revenue:** ISRO can earn some money by making its facilities and data available to private players.

### Sustainability in Space Tech – Issues

- The earth's orbital environment has more than tripled in the past decade.
- One of the hot issues when it comes to space sustainability is orbital crowding.
- It poses a direct threat to the operations and safety of a mission and is likely to cause legal and insurance-related conflicts.
- Space debris is another prominent issue. After the completion of a mission, an 'end-of-life protocol' requires space objects to be moved to the graveyard orbit or to a low altitude.
- Space weather threats – other causes of concern are solar and magnetic storms which potentially damage communication systems.

### Where does India stand on space sustainability?

- With the establishment of Indian National Space Promotion and Authorisation Centre (In-SPaCe) – One can expect an increased role of the private sector in India's space activities.
- India is well on its way to create a subsystem that addresses global sustainability questions.
- The Indian Space Research Organisation (ISRO) has initiated 'Project NETRA' to monitor space debris, this would aid further planning on protecting space assets.
- In April 2022, India and the U.S. signed a new pact for monitoring space objects at the 2+2 dialogue.
- To provide in-orbit servicing, ISRO is developing a docking experiment called 'SPADEX'.
- It looks at docking a satellite on an existing satellite, offering support in re-fuelling and other in-orbit services while enhancing the capability of a satellite.
- This would not only ensure the longevity of a mission but would also provide a futuristic option to combine missions/experiments.

### India should...

- Sustainable practices in outer space would directly help reduce orbital crowding and collision risk while nurturing future technologies.
- The Plan for Space Sustainability, which includes private industries, is a timely move.
- Collective effort by all space players, with the active role of the UN COPUOS (United Nations Committee on the Peaceful Uses of Outer Space) or the United Nations Office for Outer Space Affairs (UNOOSA), is needed to set equitable standards for the ease of activities.
- India has always emphasised cost-effective and efficient missions with problem-solving applications. Its debris footprint is minuscule; it has 114 debris among the 25,182 pieces, of sizes larger than 10 cm, in the lower earth orbits.
- The UK's Astro Carta idea throws light on the need for addressing the principles and rules that guide the activities of entities in outer space.

### What is the way Ahead?

- Need for new navigation policies: India has the SatCom policy and Remote Sensing Data Policy (RSDP) but they need suitable modifications for the purpose of IN-SPACE to perform its duty in an effective manner
- Changes needed in New Space India Limited (NSIL): It needs to be recalibrated to transform its approach of a supply-driven model to being a demand-driven model for space-based services
- Enhancing ease of doing space business: Space activities are multi-layered projects which involve a lot of intricacies across domains, such as gaining access to frequencies, licensing of satellites for operation, ability to export products, imagery
- Updation of Space Regulation: Space legislation is needed for enabling coherence across technical, legal, commercial, diplomatic and defence goals.
- India's space vision also needs to address global governance, regulatory and arms control issues.

## B. Potential of India's Edtech sector

### Some key Statistics:

- 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-preparation courses.
- The EdTech sector witnessed unprecedented growth and funding during the Covid-induced lockdown, when online education became a necessity instead of a luxury.
- 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.
- 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.

### What exactly is 'edtech'?

- Edtech is essentially a combination of 'education' and 'technology'.
- Before the pandemic hit, edtech was mostly about using technological tools to improve learning outcomes and enhancing access. It was a sector that was already growing fairly steadily.

- A major push came as Covid-19 shut down schools, colleges, and universities. From being a 'modern' choice, remote learning suddenly became the only alternative as institutions, students, guardians, and authorities switched to the digital mode.
- Four out of the six Indian edtech startups with valuations of \$1 billion and above have come up in recent years, which captures the way the industry has grown of late.

***Technology must play a significant part in the field of primary and secondary education for further reach and better learning outcomes.***

- **Primary (elementary) level:** 6-14 years of age. The elementary-level education is guaranteed by our constitution under **Article 21 A**. For this level, the government has introduced Sarva Shiksha Abhiyan (SSA) under the Right To Education (RTE) Act.
- **Secondary level:** Age group between 14-18. For this level, the government has extended SSA to secondary education in the form of the Rashtriya Madhyamik Shiksha Abhiyan.

Technology has changed the education scenario in the last few decades by emerging as one of the most efficient tools used in the learning process, both by tutors and learners.

### Significance of Technology

Technology plays an important role in:

- Improving the classroom process of teaching, learning and evaluation
- Aiding teacher training.
- Improving access to education.
- Improving the overall planning, administration and management of the entire education system.
- Looking for matter beyond the textbooks is no longer a challenge with respect to time and resources anymore.
- **Classroom-based learning**  
Nowadays technology has become integral part of classroom-based teachings. Today in many schools, colleges and universities in India instead of blackboard projector screens are used for teachings. Hand writings of teachers are replaced by powerpoint presentations. Students experience a different kind of setup in today's technology-based classroom. Gadgets like tablets and laptops are used to take down notes. Animated content are created on various subjects and in different languages so that students can have better understanding of a complex subject in a simple way.
- **Online learning management system**  
Many schools and universities in India are integrating online Learning Management System or LMS platform into their web portal. Students can remotely login to access course material and also attend live classes with teachers. Pre-recorded lectures, videos can be uploaded on the LMS platform making it easy for students to go through it multiple times.
- **Learning through mobile Apps**  
According to a report released by Counterpoint Research, India has become the second biggest smart phone market in the world after China with more than 220 million active users. This presents a huge opportunity for delivering e-learning content through mobile apps. Today educational mobile apps are available on popular platforms like Android and iOS. Developers are creating educational apps based on particular subjects. They are simplifying complex concepts with easy to understand illustrations and animations, puzzles



games etc. There are apps available for grammar, physics, chemistry, mathematics and so on. With the prices of tablets and smart phone coming down people from villages and remote areas can also make use of this apps to learn and update their skills.

#### Challenges:

- **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.
- **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.
- **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.

#### Govt interventions:

The concept of ICT in schools was initially introduced in December 2004. The Central Government later revised it in 2010 to ensure opportunities for students enrolled at the secondary level of education.

- Presently, the Central Government has subsumed ICT in schools under Rashtriya Madhyamik Shiksha Abhiyan, a national drive for secondary education.
- **National Mission on Education through ICT:** An autonomous body, National Education Technology Forum, set up under the Mission, will facilitate decision making on the use of technology.
- **National Repository on Educational Data:** maintain all records related to institutions, teachers, and students in digital form.
- Single online digital repository to make available copyright-free educational resources in multiple languages.
- **Diksha** has the potential to re-engineer the in-service teacher training in India. It is important to create good content and also to ensure technology consumption by teachers, the role of headmasters in promoting teachers' professional development etc.

#### The Road Ahead:

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:

- **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.
- **Create Multilingual Content:** According to the last Census, only 10% of the Indian population speaks English and 45% speaks Hindi. Hence, EdTech platforms need to focus on content creation in regional languages to ensure wider reach, usage, and relevance.
- **Focus on Holistic Education:** EdTech programmes must ensure that the core elements of holistic education that include environmental responsibility and sustainable development at the planet level, self-reliance 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.

### C. Leveraging Technology for Transforming Healthcare

*According to WHO “Universal health coverage (UHC) is the single most powerful concept that public health has to offer. It is a powerful social equalizer and the ultimate expression of fairness.”*

#### About India's healthcare sector at a glance:

- In the **Economic Survey of 2022**, India's public expenditure on healthcare stood at **1% of GDP in 2021-22** against **1.8% in 2020-21** and **1.3% in 2019-20**.
- India had **7 physicians per 1,00,000 people in 2017** (in contrast to 98 in Pakistan, 100 in Sri Lanka and 241 in Japan).
- **53 beds per 1,00,000 people**(in contrast to 63 in Pakistan, 79.5 in Bangladesh, 415 in Sri Lanka and 1,298 in Japan).
- **7 nurses and midwives per 1,00,000 people**(in contrast to 220 in Sri Lanka, 40 in Bangladesh, 70 in Pakistan, and 1,220 in Japan).
- India has among the **highest out-of-pocket (OOP)** expenditures of all countries in the world- **62% of the total health expenditure in India is OOP**.
- According to the **World Health Organization (WHO)**, India ranks 184 out of 191 countries in health spending.
- The **US spends over 16% of its total GDP on healthcare**, while Japan, Canada, Germany etc. spend over 10% of their GDP on healthcare.

## Health Index for states developed by Niti Aayog:

**The performance report**

In 2019, Kerala was the top performer followed by AP and Maharashtra. The best incremental change was seen in Haryana, Rajasthan, Jharkhand, AP and Assam.

**State-wise health index score - 2019****How states improved their scores on healthcare**

Change in scores between 2015-16 and 2017-18

**► Not improved\*\***

Madhya Pradesh, Odisha, Uttarakhand, Uttar Pradesh, Bihar, West Bengal, Kerala, Punjab, Tamil Nadu

**► Least/moderately improved\*\***

Chhattisgarh, Gujarat, Himachal Pradesh, Maharashtra, Jammu & Kashmir, Karnataka, Telangana

**► Most improved**

Rajasthan, Haryana, Jharkhand, Assam, Andhra Pradesh

\*\* Some states may not have shown much improvement but were already in the NITI Aayog's "front runners" list (high scores).

- The Health Index for States developed by **Niti Aayog in consultation with the health ministry and the World Bank** has rankings for large states, smaller states and Union territories.
- It is based on **23 health parameters** ranging from mortality rate and sex ratio to functioning cardiac care units.
- In 2019, **Kerala was the top performer followed by Andhra Pradesh and Maharashtra.**
- The index results indicated that states even with a lower economic output are performing better on health and well-being.

**Challenges associated with India's healthcare sector:**

- **Low Budget Spending:** India's public expenditure on healthcare is only 2.1% of GDP in 2021-22 while Japan, Canada and France spend about 10% of their GDP on public healthcare.
- **Unequal distribution:** India's health care system is concentrated in urban areas with very little presence in the rural areas where majority of the population lives.
- **Lack of Medical Research:** In India, R&D and cutting-edge technology-led new projects receive little attention.
- **Low doctor-patient ratio:** The doctor patient ratio in India is about 1:1500 much higher than **the WHO norm of one doctor for every 1,000 people.**
- **Lack of Affordability:** The contribution of private sector in healthcare expenditure in India is around **80 percent while the rest 20 percent is contributed by Public Sector.**
  - The private sector also provides for 58 percent of the hospitals and 81 percent of the doctors in India.

**Emerging technologies can be leveraged to move towards the goalpost of UHC, some of these are**

- **Robots:** Hospitals can use robots to deliver medicines and food to COVID-19 patients. This helps to reduce the chances of hospital staff contracting the infection.
- **Blockchain technology:** The health blockchain would contain a complete indexed history of all medical data, including formal medical records and health data from mobile applications

& wearable sensors. This can help in addressing the interoperability challenges that health information and technology systems face.

- **AI and the Internet of Medical Things:** IoMT is defined as a connected infrastructure of medical devices, software applications, and health systems and services.
  - IoMT can be utilized to provide health-care applications that can help in quick diagnosis of illness.
  - AI can help by addressing issues of high barriers particularly in rural areas that lack poor communication and a professional healthcare system.
  - Some of the emerging application includes AI-driven diagnostics, personalized treatment, early identification of potential pandemics, and imaging diagnostics.
  - Atomwise, a drug development company used AI to analyze if existing medicines could be redesigned to target the Ebola virus in 2016.
- **Cloud computing** is another application that can facilitate collaboration and data exchanges between doctors, departments, and even institutions and medical providers to enable best treatment.
- **Application of nanotechnology in health sector:**
  - **Health monitoring:** With increasing life style disease and diabetic patients in India nanotubes and nanoparticles can be used as glucose, carbon dioxide and cholesterol sensors and for in-situ monitoring of homeostasis, the process by which the body maintains metabolic equilibrium.
  - **Nanofibers:** With high number of disable population in India nanofibers can be used in wound dressings and surgical textiles, as well as in implants, tissue engineering, and artificial organ components.
  - **Disease diagnosis:** It can be done using quantum dots nanosized semiconductors that can be used as biosensors to find disease and which can be made to fluoresce. For example, nanotechnology-based tuberculosis diagnostic kit would cut both the cost and time required for most prevalent TB tests in India.
  - **Targeted Drug Delivery System:** Researchers are working on a number of different therapeutics where a nanoparticle can encapsulate or otherwise help to deliver medication directly to cancer cells and minimize the risk of damage to healthy tissue.
  - *Concerns of using nanotechnology:*
    - Lack of proper knowledge about the effect of nanoparticles on biochemical pathways and processes of the human body.
    - Expensive processes and treatments make them less desirable.
    - Toxicity: Scientists are primarily concerned about the toxicity, characterization, and exposure.
  - *Policies and infrastructure to promote:*
    - Institute like IISC, IITs can work on Nanotech detectors for heart attack and nanochips to check plaque in arteries.
    - National Centers for Nanofabrication and Nanoelectronics can be established.



- Much larger funding and efficient policies for capacity building in fields of basic research in nanotechnology, infrastructure development, human resources development, and global collaboration can be done.

#### The growing need to introduce electronic health records

- In the current form, ABDM lays little emphasis on the use of this health data by the public health research community.
- Electronic health records are most useful to public health research. In the absence of electronic health records, data for public health research studies is usually collected by public health agencies or research institutes as part of an ongoing or new study.
- This requires time to plan the study, recruit participants, and train field staff before the actual data collection.
- To facilitate longitudinal analysis, such data collection also needs to be carried out at pre-decided future intervals that could be months or years apart.
- The limitations to this include **high cost and lengthy durations of time**. Having access to pre-collected data will address both these limitations. Most importantly, data from the health ID is likely to be more complete as compared to most hospital records in India, which comprise of paper prescriptions or manual register entries.
- The **COVID-19 pandemic** has made it clear that to obtain evidence-based findings real-world data needs to be available. While there is no doubt that with prior health records, a doctor or physician can flag the severity of COVID-19 for someone who has a history of diabetes or blood pressure, the reverse of this is also true.
- Using medical history and disease end-point data, **unknown risk factors of the disease can also be identified**. This would require that electronic health records be made available and supplemented with additional information of the patient such as lifestyle.
- For western countries, electronic health records are maintained at the hospital level, and they commonly store responses to basic lifestyle questions as part of the patient's health record.

#### Unique Health ID

One of ABDM's objectives is to develop a repository of verified hospitals, clinics, doctors, physicians, nurses, and pharmacies. As claimed by the ABDM, this will help filter out all the unscrupulous medical entities to avoid fraud. The ABDM relies on the premise of **creating a unique health ID (identifier)** for Indians.

The idea is to allow an individual **to integrate all their health records** onto one platform. Subject to the consent of the participating individual/patient, their health data will be made available for use by the treating doctor or physician, and more parties such as health insurance companies. This health ID is different from the Aadhaar ID; multiple health IDs can be generated for the same individual.

- ABDM claims that this will allow individuals to keep **certain medical records private** such as those relating to sexual history.
- Armed with a retrospective medical history of the patient, a physician can make better diagnoses. This will improve quality of treatment and overall healthcare, and bring down financial costs for the patient.

- Subject to the consent of the participating individual/patient, their health data will be made available for use by the treating doctor or physician, and more parties such as health insurance companies.

#### **Technological Infrastructure**

The involved digital infrastructure for storage and accessing this data will be built on the **National Health Stack**.

- The stack is a collection of pre-written code (or commonly referred to as APIs) specific to interface with the ABDM system.
- This will be one platform where those interested (and approved) file for insurance claims, can perform analytics in addition to storing individual health data and hosting the repository of various medical agencies.
- This health stack will also integrate with payment gateways.

Currently, **around 14 crore users have enrolled for a health ID** with the ABDM and the programme has been piloted for a year in six union territories in India.

#### **What are the possible challenges to the above technologies?**

The possible constraints in this effort are

- Standardisation of health data
- Public Trust
- Internet Connectivity Problems
- Developing a template for sharing data
- Training Personnel in Rural Areas
- Informed Consent
- Reengineering many of the institutional and structural arrangements in the medical sector
- Organisational silos in bureaucracy
- Data security and Data privacy
- High investments

#### **Initiatives by the Government**

The following are some of the initiatives that have seen vast acceptance among people, accompanied by innumerable advantages.

**1. Ayushman Bharat Digital Mission:** Based on the foundations laid down in the form of Jan Dhan, Aadhaar and Mobile (JAM) trinity and other digital initiatives of the government, Ayushman Bharat Digital Mission will

- 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 Mission will enable access and exchange of longitudinal health records of citizens with their consent.
- Create interoperability within the digital health ecosystem, similar to the role played by the Unified Payments Interface in revolutionizing payments. Citizens will only be a click-away from accessing healthcare facilities.

*The key components of Ayushman Bharat Digital Mission include*

- A health ID for every citizen that will also work as their health account, to which personal health records can be linked and viewed with the help of a mobile application;
- A Healthcare Professionals Registry (HPR) and Healthcare Facilities Registries (HFR) that will act as a repository of all healthcare providers across both modern and traditional systems of medicine.
- This will ensure ease of doing business for doctors/hospitals and healthcare service providers.

**2. CoWIN:** CoWIN stands for Covid Vaccine Intelligent Network. The platform was unveiled by the union government in January 2021 to launch a vaccine drive across the country.

### **3. Pradhan Mantri Digital Health Mission**

- Under this, a **unique digital health ID** will be provided to the people, which will contain all the health records of the person.
  - Every time one visits a doctor or a pharmacy, everything will be logged in this card. From the doctor's appointment to the medication, everything will be available in the health profile
- It will not only digitise health records but also provides a registry of doctors and health facilities.
- The mission is being rolled out on a pilot basis in six union territories including Puducherry, Chandigarh, Ladakh, Lakshadweep, Andaman and Nicobar Islands, Daman, Diu, Dadra and Nagar Haveli.
- **Implementing agency:** The National Health Authority (NHA)
- The NDHM is part of the Centre's National Digital Health Blueprint, which aims to enhance healthcare delivery by setting up a core e-health database of international standards and, on paper, allowing patients to have control over their health data.
- With its key building blocks or applications, HealthID, DigiDoctor, Health Facility Registry, Personal Health Records, Telemedicine, and e-Pharmacy, the mission will bring together disparate stakeholders and radically strengthen — and, thus change — India's healthcare delivery landscape.

### **4. Tele-MANAS**

- It's an initiative of Union Ministry of Health & Family Welfare
- NIMHANS will be the nodal centre while National Health Systems Resource Centre (NHRSC), IIT Bengaluru and IITB will provide technology support.
- The services will be available 24x7 on Toll Free Number— 14416, allowing callers to select the language of choice for availing services.
- Tele-MANAS will be organised in two tier system; Tier 1 comprises of state Tele-MANAS cells which include trained counsellors and mental health specialists. Tier 2 will comprise of specialists at District Mental Health Programme (DMHP)/Medical College resources for physical consultation and/or e-Sanjeevani for audio visual consultation.
- The initial rollout providing basic support and counselling through centralized Interactive Voice Response system (IVRS) is being customized for use across all States and UTs.
- Specialised care is being envisioned through the programme by linking Tele-MANAS with other services like 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.

**5. Nikshay 2.0:** President Draupadi Murmu launched the 'Pradhan Mantri TB Mukh Bharat Abhiyan' and the Nikshay 2.0 portal to eliminate TB by 2025.

- Nikshay 2.0 is a digital platform for community support for the persons diagnosed with tuberculosis.
- 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.

#### **6. Health Technology Assessment (HTA):**

- The Government of India has created an institutional arrangement called the Health Technology Assessment in India (HTAI) 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 the formulation of safe and cost-effective health policies that are patient focused and seek to ensure the most optimum value for money.

#### **The Way Ahead**

- **Digital Strategy:** India needs to own its digital health strategy that works and leads towards universal health coverage and person-centred care. Such a strategy should emphasise the ethical appropriateness of digital technologies, cross the digital divide, and ensure inclusion across the economy.
- **Using Local Knowledge:** In addition to robust health systems, an effective national response must also draw upon local knowledge. Primary health centres in India could examine local/traditional knowledge and experience and then use it along with modern technology.

### **D. Quantum Computing-Transforming Technology**

The allure of quantum computers (QC) is their ability to take advantage of quantum physics to solve problems too complex for computers that use classical physics.

- The 2022 Nobel Prize for physics was awarded for work that rigorously tested one such 'experience' and paved the way for its applications in computing – which speaks to the contemporary importance of QCs
- In 2021 alone, the Indian government launched a National Mission to study quantum technologies with an allocation of ₹8,000 crore; the army opened a quantum research facility in Madhya Pradesh; and the Department of Science and Technology co-launched another facility in Pune.



- Given the wide range of applications, understanding what QCs really is crucial to sidestep the misinformation surrounding it and develop expectations that are closer to reality.

#### How does a computer use physics?

- A macroscopic object – like a ball, a chair or a person – can be at **only one location at a time**; this location **can be predicted accurately**; and the object's effects on its surroundings can't be transmitted faster than at the speed of light. This is the classical 'experience' of reality.
- For example, you can observe a ball flying through the air and plot its trajectory according to Newton's laws. You can predict exactly where the ball will be at a given time. If the ball strikes the ground, you will see it doing so in the time it takes light to travel through the atmosphere to you.
- Quantum physics describes **reality at the subatomic scale**, where the objects are particles like electrons. In this realm, **you can't pinpoint the location of an electron**.
- You can only know that it will be present in a given volume of space, with a probability attached to each point in the volume – like 10% at point A and 5% at point B. When you probe this volume in a stronger way, you might find the electron at point B. If you repeatedly probe this volume, you will find the electron at point B 5% of the time.
- There are many interpretations of the laws of quantum physics. One is the '**Copenhagen interpretation**', which Erwin Schrödinger popularised using a thought-experiment he devised in 1935.
  - There is a cat in a closed box with a bowl of poison. There is no way to know whether the cat is alive or dead without opening the box. In this time, the cat is said to exist in a **superposition of two states: alive and dead**.
  - When you open the box, you force the superposition to collapse to a single state. The state to which it collapses depends on the probability of each state.
  - Similarly, when you probe the volume, you **force the superposition of the electrons' states to collapse to one** depending on the probability of each state.
- The other 'experience' relevant to quantum-computing is **entanglement**. When two particles are entangled and then separated by an arbitrary distance (even more than 1,000 km), making an observation on one particle, and thus causing its superposition to collapse, will instantaneously cause the superposition of the other particle to collapse as well.
  - This phenomenon seems to violate the notion that the speed of light is the universe's ultimate speed limit.
  - That is, the second particle's superposition will collapse to a single state in **less than three hundredths of a second**, which is the time light takes to travel 1,000 km.

#### How would a computer use superposition?

- The bit is the fundamental unit of a classical computer. Its value is 1 if a corresponding transistor is on and 0 if the transistor is off.
- The transistor can be in one of two states at a time – on or off – so a bit can have one of two values at a time, 0 or 1.
- The **qubit** is the fundamental unit of a Quantum Computing. It's typically a particle like an electron.
  - Google and IBM have been known to use transmons, where pairs of bound electrons oscillate between two superconductors to designate the two states.

- Some information is directly encoded on the qubit: if the spin of an electron is pointing up, it means 1; when the spin is pointing down, it means 0.
- But instead of being either 1 or 0, the **information is encoded in a superposition**: say, 45% 0 plus 55% 1. This is entirely unlike the two separate states of 0 and 1 and is a third kind of state.
- The **qubits are entangled** to ensure they work together. If one qubit is probed to reveal its state, so will some of or all the other qubits, depending on the calculation being performed. The computer's final output is the state to which all the qubits have collapsed.
- One qubit can encode two states. Five qubits can encode 32 states. A computer with N qubits can encode  $2^N$  states – whereas a computer with N transistors can only encode  $2 \times N$  states.
- So a qubit-based computer can access more states than a transistor-based computer, and thus access **more computational pathways** and solutions to more complex problems.

#### How has Quantum Mechanics evolved over a period of time?

- It was developed in the early 20th century to **describe nature in the small** — at the scale of atoms and elementary particles.
- It helped in understanding of the physical world, including the interaction of light and matter and on subjects such as gravity and black holes.
- It led to ubiquitous **inventions such as lasers and semiconductor transistors**
- A **second revolution** is currently under way with the goal of controlling and harnessing the properties of quantum mechanics.
- **Recent Developments:**
  - Google's [Sycamore demonstrated the quantum supremacy](#)
  - China demonstrated secure quantum communication links between terrestrial stations and satellites.

#### Impact of Quantum Computing:

Given India's growing capabilities in the space of information technology (IT) and IT-enabled services, 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.

- **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 optimization of these algorithms so that computer vision capabilities become more efficient, accurate, and fast.

- **Further, in applications of generative artificial -intelligence,** quantum computing could provide better recommendations since it is 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 optimization 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 optimization of complex systems.
- **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.

#### Implications for practice and policy:

- 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.

#### How come we're not using Quantum Computers?

- A practical QC needs at least 1,000 qubits. The current biggest quantum processor has 433 qubits. There are no theoretical limits on larger processors; the **barrier is engineering-related**.
- **Technical Difficulties:** The challenge lies in harnessing the properties of quantum superposition and entanglement in a highly controlled manner by building a system composed of carefully designed building blocks called quantum bits or qubits.
  - Qubits exist in superposition in specific conditions, including very low temperature (~0.01 K), with radiation-shielding and protection against physical shock.
- **Fragility of Qubits:** The qubits tend to be very fragile and lose their "quantumness" if not controlled properly, and a careful choice of materials, design and engineering is required to get them to work.
  - Tap your finger on the table and the states of the qubit sitting on it could collapse.
  - Material or electromagnetic defects in the circuitry between qubits could also 'corrupt' their states and bias the eventual result.

- Researchers are yet to build QCs that completely **eliminate these disturbances in systems** with a few dozen qubits.
- **Theoretical Challenges** of creating the algorithms and applications for quantum computers
  - Researchers are also yet to build **QCs that don't amplify errors** when more qubits are added. This challenge is related to a fundamental problem: unless the rate of errors is kept under a certain threshold, more qubits will only increase the informational noise.
  - Practical QCs will require at least lakhs of qubits, operating with superconducting circuits that we're yet to build – apart from other components like the firmware, circuit optimisation, compilers and algorithms that make use of quantum-physics possibilities.
- Quantum supremacy itself – a QC doing something a classical computer can't – is thus at least decades away.
- The billions being invested in this technology today are based on speculative profits, while companies that promise developers access to quantum circuits on the cloud often offer physical qubits with noticeable error rates.

#### What is India's National Mission on Quantum Technologies & Applications (NM-QTA)?

- The mission will oversee the development of quantum technologies for communications, computing, materials development and cryptography.
- The mission addresses the constraints (listed above) that led to slow progression of country in quantum field, through adoption of holistic approach.
- Announced in Budget 2020
- Period: Five years (2020-25)
- Total Funds: Rs 8000 years
- Implementing Body: Department of Science & Technology (DST)

#### Significance of the mission:

- The mission may eventually lead to the creation of a **super-secure communication network**
- It will help prepare next generation **skilled manpower**, boost translational research and also encourage entrepreneurship and start-up ecosystem development.
- It will find utility in finding **solution for complex problems** in fields of computing, communications, sensing, chemistry, cryptography, imaging and mechanic
- The mission will enable **India to emerge as Global leader** in the field through increased investment & focus in Quantum Technologies

### Use of Technology in Urban Planning

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 that help in the urban design process and assist to generate areas that the population of a city needs.

**GIS:** With open-source data, many open-source Various GIS software have come up as a free and open-source cross-platform.



- 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.

**Cloud computing technologies** can also aid in the planning of bigger infrastructure projects.

**Internet of Things and Urban Planning:** Several fundamental IoT tools such as intelligent street lights that automatically turn off to conserve energy are already in use in India.

- Urban planners can create ideas that improve the infrastructure of cities by employing technology to establish self-management strategies to create smarter cities and put more emphasis on growing communities and neighbourhoods.
- 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.
- Technology will also enable urban planners to concentrate more on creating communities, leading to a higher level of municipal self-sufficiency.
- Citizens may participate more actively in the creation of sustainable and environmentally friendly cities in this way.

**With all its given potential, the use of technology faces some significant challenges –**

- Maintenance and upkeep of a complex system for all the services
- Privacy of the citizens
- Security of the system & authenticity of information
- Crossing the language barrier

**However, upon addressing these issues, E-governance can bring about transformation by –**

- Empowering citizens by bridging the knowledge gap
- Enabling data driven and evidence-based planning
- By bringing about large-scale impact with incremental small scale, and
- System reform, through transparency, efficiency and accountability.

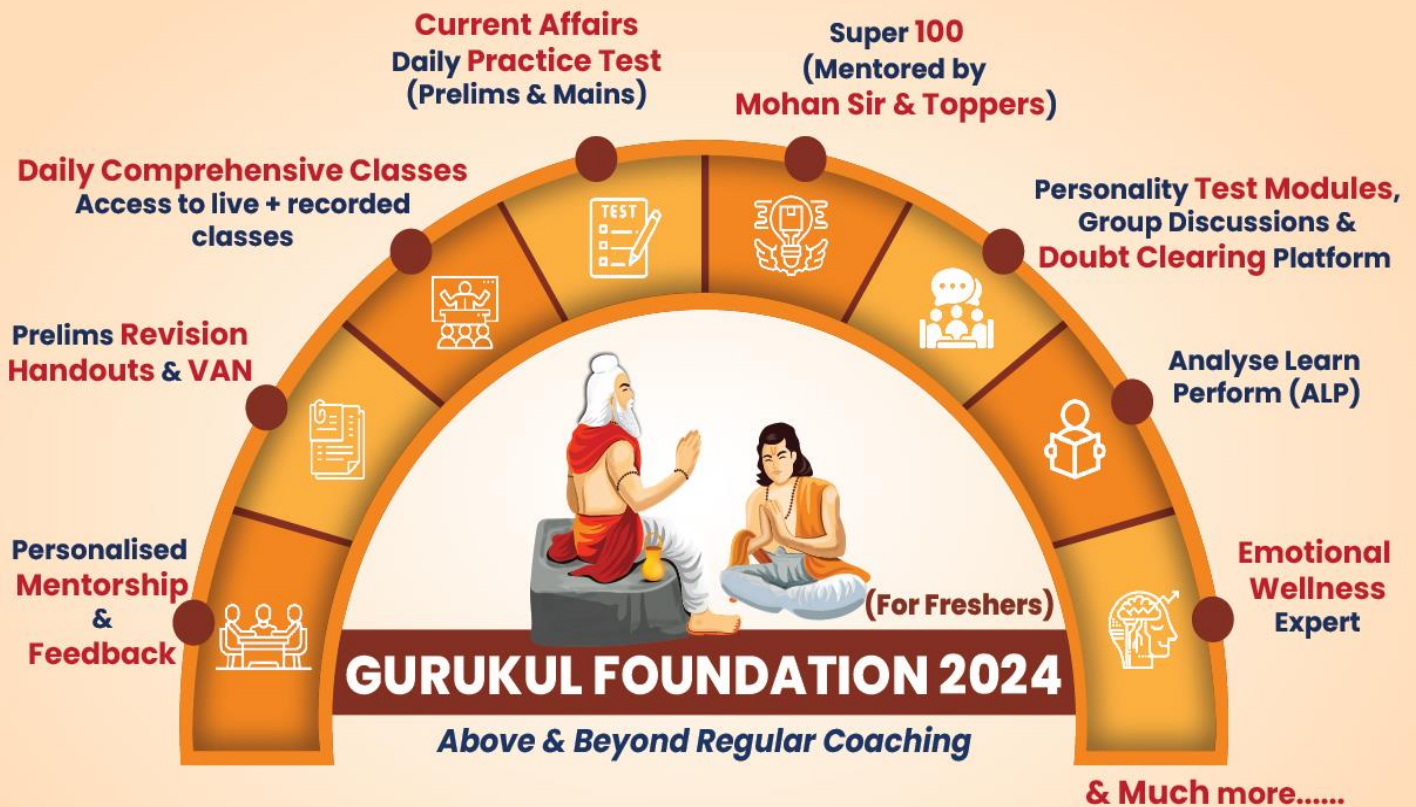
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## RURAL CRAFTS

*India's abundant rural crafts and traditions are passed down through generations and they present significant potential for the nation's rural tourism sector. These crafts, the livelihood of numerous rural communities, offer unique attractions for tourists, contributing to the local economy, employment, and skill development.*

*The government's role in promoting these crafts, conservation efforts, ecotourism, and infrastructure development enhances this potential. Thus, rural tourism in India holds the promise of not only preserving the rich cultural and natural heritage but also boosting local incomes and job opportunities, making it a vital sector for India's overall growth.*

### Rural Tourism

#### **Potential in India:**

- Cultural wealth- Numerous local traditions like plays, art forms, dances etc. enhance the cultural wealth of rural areas, making these attractive for the tourists.
- Natural wealth- Lush green forests in south Indian villages, sacred groves etc. make them an ideal site to promote tourism.
- Peace and serenity in the countryside can offer a relaxing experience.
- The stresses of Urban lifestyles have led to a "counter-urbanization" syndrome, which has led to growing interest in the rural areas.
- Improved infrastructure and connectivity of rural India can improve tourist footfall.
- Growing trend of short-break holidays, rural areas being near to cities can easily provide for great tourism destinations.

#### **Measures to promote tourism:**

- Identification of strength's of villages in different states and introduction of customised trips like Cultural and Heritage walk in Rajasthan, Tribal tours in North-East India.
- Promoting Farm and home stays to provide local and humane touch to tourists.
- Development of infrastructure and convergence among various government initiatives.
- Train villagers to address foreign tourists.
- Exposing tourists to basic works in village like milking cows, making pottery and handicrafts etc.
- Adoption each potential site by a Member of Parliament.
- Involvement of NGOs for promotion of culture.
- Marketing of clusters of villages.
- FDI or Private investment to introduces latest technology
- Government initiatives to support the young entrepreneurs by providing loans.

#### **Precautions:**

- Safety of tourists, especially females should be ensured.

- Adequate finances must be devolved to the gram sabha for maintenance of basic infrastructure.
- Training of villagers to avoid any kind of hostility towards tourists.
- Adequate healthcare facilities must be provided.
- Environment impact of increased number of tourists must be assessed.

Rural Tourism models of States like Kerala (Back water Spots), Karnataka (Forest Tourism spots), Tamil Nadu (Temple Tourism of villages) etc. must be replicated in other areas. Government initiatives of Swadesh Darshan and PRASAD will help develop tourist circuits on principles of high tourist value, competitiveness and sustainability in an integrated manner.

### SHADOW PUPPETRY

India has the richest variety of types and styles of shadow puppets.

- Shadow puppets are flat figures.
- They are cut out of leather, which has been treated to make it translucent.
- Shadow puppets are pressed against the screen with a strong source of light behind it.
- The manipulation between the light and the screen makes silhouettes or colourful shadows, as the case may be, for the viewers who sit in front of the screen.
- This tradition of shadow puppets survives in Orissa. Kerala, Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu
  - Examples: Togalu Gombeyatta-Karnataka, Tholu Bommalata- Andhra Pradesh, Ravanachhaya- Orissa
- **Tholpavakoothu:** For the first time, Tholpavakkoothu, the famous shadow leather puppets will tell stories of the epic Ramayana with the help of robots.
  - Tholpavakoothu is a form of shadow puppetry.
  - **Practiced in:** Kerala, India.
  - It is performed using leather puppets as a ritual dedicated to **Bhadrakali**.
  - It is performed in Devi temples in specially built theatres called **Koothumadams**.
  - It is believed to have originated in the ninth century AD.
  - It uses **Kamba Ramayana** as its basic text.

### Initiatives by the Government

**A. One District One Product (ODOP):** One District One Product Scheme is an initiative that is seen as a transformational step forward towards realizing the true potential of a district, fuel economic growth, and generate employment and rural entrepreneurship, taking us to the goal of AtmaNirbhar Bharat.

- This scheme is basically a Japanese business development concept, which gained prominence in 1979.

- It is aimed at promoting a competitive and staple product from a specific area to push sales and improve the standard of living of the local population.
- Over time, it has been replicated in other Asian countries as well.
- In India, Uttar Pradesh government was the first state of India to launch the concept of One District One Product in 2018.

**Components of the Scheme:**

- Identify one product per district based on the potential and strength of a district and national priorities
- Develop a cluster for that product in the district which is capable of producing a world-class product with quality, scalability, and a brand
- Provide market linkages
- Address bottlenecks for exporting these products
- Support local exporters/manufacturers to scale up manufacturing
- Find potential buyers outside India with the aim of promoting exports
- Promoting manufacturing & services industry in the District
- Generate employment in the District

**GIS One District One Product (ODOP) Digital Map of India:**

- By The Ministry of Food Processing
- The digital ODOP map provides detailed information about ODOP products to all states and facilitates the stakeholders.
- The digital map also has indicators for tribal, SC, ST, and aspirational districts.
- It will enable stakeholders to make concerted efforts for its value chain development.

**Few products identified include:**
**Uttar Pradesh**

- The ancient and nutritious 'Kala namak' rice of Siddharthanagar
- The rare technique of wheat-stalk craft, handicraft in Bahraich
- The famous chikankari and zari-zardozi work garments
- Banana fibre of Kushinagar,
- Banana of Kaushambi,
- Jaggery of Ayodhya,
- Amla of Pratapgarh,
- Pulses of Balrampur and Gonda,
- Desi ghee of Auraiya,
- Wooden toys of Chitrakoot
- Wooden artifacts of Saharanpur, Basti, Bijnor, Rae Bareilly
- The horn and bone work that uses the remains of dead animals rather than living ones, making it a nature-friendly replacement for ivory.
- **Sunahri Kand:** To support the production of horticultural items under the "One District One Product (ODOP)" scheme and provide better nutrition to school children

**Rajasthan:** Blue Pottery (Jaipur) and MarkhamaMarbels (Nagaur)

**Maharashtra:** Wine from the Nashik valley

**Karnataka:**



- The hilly district in Malnad region of Karnataka is known for its coffee production and accounts for 30-40% of the total coffee production in India. It is also nicknamed the 'coffee cup' of India.
- In Chikkamagaluru, spices were earmarked, while pineapples were chosen in Shivamogga district.
- Other products included are Kalaburagi (red gram), Mandya (jaggery), Vijayapura (lemon), Haveri (mango), Gadag (Byadagi chillies), Bidar (ginger), Ballari (fig), Mysuru (bananas), and Koppal (guava).

Art and Crafts (Products)	Main Places of Production (City / District / State)
<b>Zari (Zardozi Embroidery)</b>	Surat, Bareilly, Varanasi, Agra, Hyderabad, Lucknow, Vadodara, Lathur, Jaipur, Barmer
<b>Carpet</b>	Bhadohi, Varanasi, Mirzapur, Agra, Jaipur, Bikaner, Kashmir, Panipat, Gwalior, Elluru. In states like West Bengal, Uttarakhand, Karnataka, Andhra Pradesh
<b>Rugs and Durries</b>	Agra, Bhadohi, Mirzapur, Jaipur, Panipat, Kashmir, Bhavani, Navalgund, Warangal, Jaisalmer, Barmer. In states Uttar Pradesh, Rajasthan, Haryana, Tamil Nadu, Karnataka, Andhra Pradesh
<b>Textile (Handloom)</b>	Bahraich, Bhuj, Karimnagar, Patan, Varanasi, Nawan, Shaheer, Boudh
<b>Textile (Hand Embroidery)</b>	Lucknow, Barabanki, Unnao, Sitapur, Rae Bareilly, Hardoi, Amethi
<b>Textile (Hand Printing)</b>	Hyderabad, Machilipattanam, Varanasi, Farrukabad, Bagh, Behroragarh, Indore, Mandas, Burhanpur, Ahmedabad, Rajkot, Kutch, Bagru, Chittroli, Sangner, Jaipur, Jodhpur. In states like Andhra Pradesh, Uttar Pradesh, Odisha, Madhya Pradesh, Gujarat, Maharashtra, Rajasthan
<b>Wood (Carving)</b>	Bhopal, Nagpur, Chennai, Madurai, Mysore, Kashmir. State like Manipur
<b>Wood Inlay</b>	Mysore, Bengaluru, Bijnor, Saharanpur. In states like Punjab, Uttar Pradesh, Karnataka
<b>Wood (Turning &amp; Lacquer Ware)</b>	Etikoppaka, Ernakulam, Chennapatna, Chitrakoot, Davangere, Medak, Sankheda, Varanasi
<b>Stone Carvings</b>	Agra, Bhubaneswar, Puri, Jaisalmer, Cuttack, Cuddapah, Bankura, Kanchipuram, Patna, Mysore, Rajkot, Gwalior, Puducherry, Mahanandi
<b>Stone Inlay</b>	Jodhpur, Jaisalmer, Agra. State like Rajasthan
<b>Cane and Bamboo Crafts</b>	Lakhimpur, Bongaigaon, Guwahati, Agartala, Nalagarh. In states like Assam, West Bengal, Odisha, Arunachal Pradesh, Manipur, Arunachal Pradesh, Tripura
<b>Pottery and Clay Objects</b>	Asharikandi, Bulandshahar, Bhadravati, Nizamabad, Pune, Chandrapur. State like Assam
<b>Terracotta</b>	Several parts of India like Pottery
<b>Horn and Bone Work</b>	Lucknow, Moradabad, Sambhal, Sarai Tarin, Honawar, Gajapati, Jodhpur, Thiruvananthapuram. In states like Uttar Pradesh, Odisha, Rajasthan, Kerala
<b>Folk Paintings</b>	In states like Odisha, West Bengal, Madhya Pradesh, Rajasthan, Bihar, Gujarat, Andhra Pradesh
<b>Conch-Shell Crafts</b>	In states like West Bengal, Tamil Nadu
<b>Theatre, Costumes and Puppet</b>	In states like Odisha, Karnataka, Andhra Pradesh, Tamil Nadu, Bihar, Kerala

Source: Kurukshetra (List of Art and Craft and Places of Production)

**B. Linking Textile with Tourism:** Under the programme, major tourist places are being linked with handicraft clusters and infrastructure supports combined with soft interventions.

- Craft village will develop handicrafts as a sustainable and remunerative livelihood option for artisans in the clusters and thus protecting the rich artisanal heritage of the country.

**C. Ek Bharat Shreshtha Bharat:**

- Announced by Indian Prime Minister on 31st October 2015 on the occasion of the 140th birth anniversary of [Sardar Vallabhbhai Patel](#).
- It is implemented under the overall guidance of Ministry of Education.
- The scheme was launched to celebrate the cultural vibrancy of India while establishing a strong mechanism to inculcate nationalism and cultural awareness among the citizens of our nation
- It aims to enhance interaction & promote mutual understanding between people of different states/UTs through the concept of state/UT pairing.
  - Under it rich culture, heritage, customs and traditions of paired states will be showcased in each other's states
  - This cultural exchange amongst states enables people to learn about the culture of different states and regions, promoting the spirit of national integration.
- Multiple initiatives have been taken up under the Ek Bharat, Shreshtha Bharat program some of which are:
  - Award-winning books and poetry, popular folk songs have been translated from one language to the language of the partner state
  - Culinary events have been organised to learn culinary practices of partner states
  - Homestay for visitors coming from partner states
  - Rajya Darshan for Tourists
  - Accepting the traditional attire of other states and Union Territories
  - Exchange of information like traditional agricultural practices with partner states
- The scheme thus bolsters sentimental bonds among the people of different states and build the feeling of 'One Nation' among all the citizens of the country

**D. Some of the examples of events organized by the government to promote rural crafts are:**

- **Saras Aajeevika Mela:** An annual event to promote rural livelihoods and products.
- **Surajkund Crafts Mela:** Provides a platform for artisans, craftsmen, and performers to display their skills and creations.
- **Aadi Mahotsav:**
- A celebration of the spirit of Tribal Culture, Craft, Cuisine and Commerce, was successfully conducted by the tribal ministry in Delhi. It has been organised in the memory of legendary tribal leader Birsa Munda.
- The Festival showed exquisite craftsmanship of tribal artisans. This included beautiful sarees, dress materials, jewellery, bamboo & cane products, paintings and hundreds of other items.

**E. Swadesh Darshan Scheme Tribal circuit**

- Union Ministry of Tourism has inaugurated India's first tribal circuit project connecting 13 tourism sites in Chhattisgarh under Swadesh Darshan Scheme Tribal circuit project
- Major components sanctioned under tribal circuit project in Chhattisgarh includes developing eco log huts, craft haats, souvenir shops, open amphitheatre, tribal interpretation centres, workshop centres, tourist amenities centres, viewpoints, nature trails, solar illuminations etc.

- These components will improve the existing tourist facilities, enhance the overall tourist experience and help in getting more visitors which in return will increase promotion of tribal culture and job opportunities in the area.
- Construction of Museums for Tribal Freedom Fighters.

#### F. Interventions to Boost Handicraft Industry

- The Office of Development Commissioner (Handicrafts), Ministry of Textiles implements schemes like National Handicraft Development Programme and Comprehensive Handicrafts Cluster Development Scheme.
- Artisans are mobilized under **Ambedkar Hastshilp Vikas Yojana** to provide direct benefits, technology and infrastructure support, marketing support, etc.
- '**Shilp Guru**' awards and **National Awards** are given by the Ministry of Textiles to give recognition to legendary craftsmen for their excellence.
- TRIFED is a national apex body under the Ministry of Tribal Affairs. Its main aim is retail marketing development of tribal handicrafts and handloom products.
- Several NGOs like **Indian National Trust for Art and Culture Heritage (INTACH)** work with craft clusters to develop community-based enterprise



Source: Kurukshetra

#### KONDAPALLI TOYS

- **State:** Andhra Pradesh
- 'Tella Poniki' wood: Gives the toys a unique character - malleable and can be easily chiseled into the desired shape.
- **Dolls:** Made piece by piece and are stuck together using an adhesive paste made of tamarind seeds, followed with a coating of lime glue.
- Traditional craft that is protected as a **geographical indication (GI)** under the World Trade Organisation.

## Empowering India's Artisan Economy

### Artisan Economy of India

- Over 200 million livelihoods are directly or indirectly linked to the artisan economy.
- This sector is a primarily rural, informal and creativity-led landscape.
- It also has a very high concentration of micro, small and medium enterprises (MSMEs) that drive labour-intensive and skill-intensive employment.
- Has an all-pervasive reach, thereby making it **India's second largest source of employment and livelihood after agriculture**.

**Holds immense significance:** Because more than 50% of artisans in India are women and marginalised groups, whose mobility is greatly restricted due to cultural and social norms.

- From a gender-lens perspective, this makes the artisan economy crucial for inclusion, addressing a vital challenge for a young economy like India—the declining labour participation of rural women.
- Advances 12 out of the 17 Sustainable Development Goals (SDGs): Formal craft-led businesses/MSMEs in India have a unique growth trajectory.
  - They become key nodes for greater financial and social inclusion by employing informal rural communities and deploying necessary social protections (i.e., access to bank accounts, government schemes, government-issued ID proofs, etc.), thereby formalising them.
  - They also serve as models that demonstrate how environmentally sustainable and socially inclusive businesses can drive profitability.

*With 90 million new non-farm jobs needed in India by 2030, the creative/social enterprises in the country's artisan sector should be lauded as the next frontier of impact. But they are not. Instead, these businesses continue to face systemic bias across the cultural, social, policy and investment spectrums.*

### How does the 'New Normal' look like?

The New Formal, as seen in India's artisan economy, is an emergent hybrid approach that combines the benefits and best practices of the informal space (e.g., cultural networks, labour relationships, and behaviours rooted in social, familial, ethnic and caste dynamics) and the formal space (e.g., social protections, data, and economic and social mobility).

- Combines the flexibility and complexity of cultural interactions from the informal economy with metrics from the formal economy, such as literacy, compliance and finance.
- Has the potential to facilitate a more equitable and inclusive dialogue between diverse stakeholders across the policy and investment landscapes.

### Characteristics

- **Differently organised:** Modes of production and engagement are rooted in familial and sociocultural relations and formalities.

- **Decentralised:** Decision-making is redistributed across geographies and communities, and within organisations.
- **Trust-led:** Various approaches, like co-creation and co-ownership, aim to lower trust deficits across the public-private-community landscape.
- **Localised innovation:** Indigenous models (structural, material and environmental) and local initiatives are used to address global and local challenges.
- **Social protections:** The participation gap in informal cultures is reduced via labour rights, financial access, digital inclusion, etc.
- **Aspirational mobility:** The potential of informal communities as active consumers and producers in future economies is catalysed.

Formal craft-based enterprises like Industree, rangSutra, Jaipur Rugs, Xuta, Kadam and others are adopting these New Formal approaches, and what makes them exciting is how informality and inclusion are the bedrock of their business models. These enterprises have adapted to local needs and contexts, and they also navigate labour relationships differently—i.e., by recognising that an artisan could be a wage-worker and a home-worker, a self-employed entrepreneur, or a part-time job-seeker.

### Rethinking business approaches for sustainable development

We can no longer ignore the importance and role of the “New Formal” and craft-led enterprises/MSMEs in driving long-term employment creation and economic growth in countries like India. But for these businesses to achieve their potential, they’ll need support.

- **Bridging information gaps:** Asymmetric data inhibits artisan and MSME access to global-local networks, marketplaces, service providers and investors, thus impacting their growth and scalability. This also impairs engagement by institutional actors such as banks, government bodies, etc. in critical areas such as infrastructure, credit, education and market access. As a result, craft-based work—which is pro-people and pro-nature—remains underrepresented as a priority focus area in policy and investment.
- **Making policy responsive:** The absence of reliable figures on how many artisans or craft-based enterprises operate in this sector only fuels state and institutional apathy—a missed opportunity on all counts. Policy cannot be created without context-specific mapping—both qualitative and quantitative.
- **Reimagining access to capital:** While India is fast becoming a focal point for impact investing, much like in other parts of the world, the pool of investors remains limited to sectors such as education and financial inclusion. Catalytic capital can step in to unlock the potential of craft-based MSMEs and level the playing field for these entrepreneurs. This means employing mixed strategies—grants, concessional debt and equity—to address working capital requirements. But this can only happen if investment meets the enterprises in India’s artisan sector where they are. The right kind of capital access can drive aspirational mobility at the bottom of the pyramid, enabling informal, rural communities to become the empowered producers and consumers of the future.



- **Redefining scale for the artisan sector:** Social and creative enterprises in the artisan sector are differently motivated, prioritising creativity, purpose and impact over market-rate returns. Scale is achieved via decentralised collectivisation anchored in the New Formal. The decentralised approach significantly lowers entry barriers for differently skilled communities, especially women. Innovation ecosystems thrive when they recognise that what is right for the artisan communities influences the right size for the enterprise.
- **Supporting the ecosystem for innovation:** It is evident that context-specific entrepreneurial action in the handmade sector can catalyse the inclusion of informal and traditionally marginalised creative communities, in order to achieve the SDGs by 2030. In the handmade sector, this entrepreneurial action can contribute to building the collaborative and equitable supply chains of the future. To that end, IKEA's partnerships with enterprises like RangSutra and Industree are now informing the company's global approach. Such partnerships create two-way learning, and enable many more informal communities to be integrated into formal ecosystems. However, the development sector need to support and incentivise these bottom-up, rights-based solutions rooted in co-ownership, co-creation and shared values

### Culture – The Driving Force in the New Economy

In any cultural economy, “culture”—any individual or group’s unique social behaviours and norms—carries tangible value.

- Cultural practices are the core drivers of many goods and services that also influence non-cultural industries.
- For example, a tribal terracotta tile maker will make a roof for a neighbouring farmer who gives him grain, in the age-old practice of bartering that is still prevalent among many rural communities across India.
- Cultural factors also affect the interactions between businesses and their customers, competitors and supporters.
- The influence of culture drives the intertwined nature of formal-informal economic activities, which means that enterprises operating in this sector need to take a more holistic approach to value creation.

A new approach to business is now needed, and India’s artisan economy can point the way toward a more effective roadmap.

Investment should focus on building the four cornerstones of artisan sustainability:

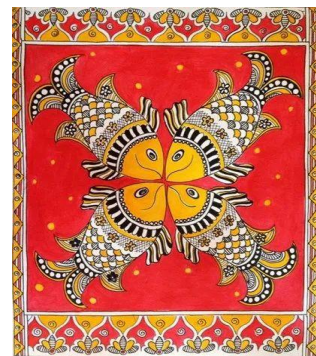


## ROLE OF G20 IN PROMOTING INDIAN RURAL HANDICRAFTS AND RURAL TOURISM

- **Improving international market access:** By reducing trade barriers and simplifying customs procedures
- **Financial assistance:** In the form of loans, grants, or subsidies, assisting Indian artisans with capital to expand their businesses.
- **Investment in skill development:** Contribute to skill development programs for Indian artisans, improving the quality and range of their products.
- **Strengthen intellectual property laws:** Help strengthen intellectual property laws to protect the designs and techniques of Indian artisans.
- **Global promotion:** By leveraging its influence, the G20 can help promote Indian handicrafts globally, increasing their recognition and marketability.

## MADHUBANI PAINTINGS

- Madhubani literally means “forests of honey”. It is a traditional Indian painting.
- Madhubani belongs to Mithila region in the areas of Indo-Nepal border across Bihar.
- Madhubani paintings include both mythology and natural objects like sun, moon, plants etc. Mostly done by women.
- In Madhubani paintings, a cotton wrapped around bamboo stick is used as brush.
- In Madhubani paintings, the work is done on freshly plastered mud walls. Now a days, for commercial purposes, it is done on cloth and paper also.
- In Madhubani, different colours are obtained in different ways. For e.g. black from mixture of soot and cow dung, white from mixture of rice powder etc.
- It has got **GI tag**.



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