Shaping India’s Tech Future

This editorial is based on “India's tech startup boom: Are policy tweaks needed to drive growth?” which was published in Business Standard on 09/03/2025. The article brings into picture the transformative role of technology in economic and social growth while highlighting India's challenges, such as regulatory hurdles and adoption barriers.

For Prelims: Digital Public Infrastructure, UPI, Aadhaar, IndiaAI Mission, BharatGen, PLI (Production-Linked Incentive) schemes, Make in India, Green Hydrogen Mission, Faster Adoption and Manufacturing of Electric Vehicles (FAME), Prime Minister Electric Drive Revolution in Innovative Vehicle Enhancement, Digital Personal Data Protection Act (2023), Competition Commission of India

For Mains: Key Drivers of India's Tech Revolution, Key Issues Associated with India's Tech Revolution.

As the world accelerates into the digital age, **technology** is no longer just an enabler—it is the backbone of **economic growth, governance, and social transformation**. India, with over 120,000 startups and **pioneering digital infrastructure** like **UPI**, stands at the forefront of this transformation. However, barriers such as regulatory complexities and low adoption rates threaten sustainable growth. To navigate this, India must craft a **strategic policy framework t**hat fosters innovation while ensuring scalability and **resilience of India’s Tech Revolution.**

What are the Key Drivers of India's Tech Revolution?

- **Digital Public Infrastructure (DPI) as a Catalyst:** India’s robust **Digital Public Infrastructure (DPI),** including **UPI**, **Aadhaar**, and ONDC, is driving financial inclusion, e-commerce expansion, and digital payments at an unprecedented scale.
    - These platforms lower transaction costs, enhance accessibility, and create a foundation for innovation in **fintech, health tech, and e-governance.**
        - The DPI model is now globally recognized, with India advocating its adoption at the **G20.**
    - For instance, in **January, 2025**, UPI transactions in India reached a record high of 16.99 billion, with a value exceeding Rs 23.48 lakh crore.
- **Startup Ecosystem & Deep Tech Advancements:** India's startup ecosystem, the world’s **third-largest**, is diversifying beyond IT services to **AI, semiconductor design, space tech, and quantum computing**.
    - Increased investments, government incentives, and a culture of innovation are pushing India toward self-reliance in critical technologies.
    - The rise of **Deep Tech Startups** is evident in sectors like **defense, AI-driven healthcare, and blockchain applications**.
    - In the last 10 years, over 120,000 startups have been registered in India. Also, — deep tech start-ups in India raised about **10 billion U.S. dollars in funding in 2023.**

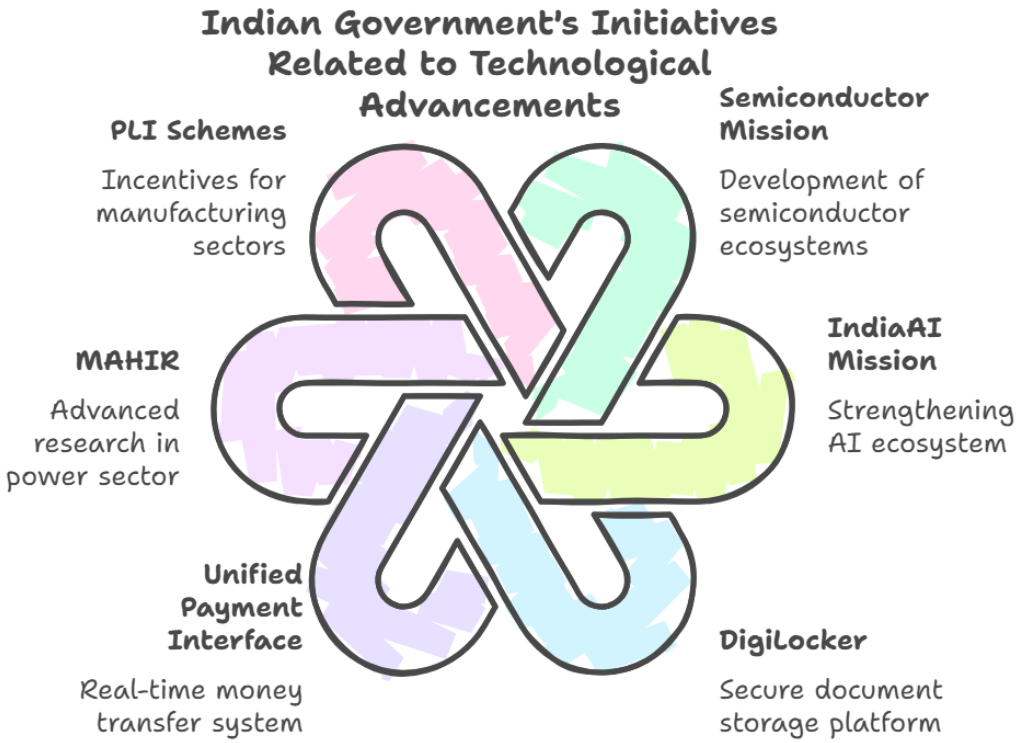
- **AI and Automation Driving Industrial Growth:** AI adoption in **manufacturing, banking, governance, and healthcare** is reshaping productivity and decision-making.
    - With India's IT giants heavily investing in AI, domestic businesses are leveraging automation to optimize costs and improve efficiency.
    - The government's **IndiaAI Mission** aims to democratize AI access, positioning India as a global leader in ethical AI development.
    - Also, the **world's first government-funded multimodal LLM initiative, BharatGen** was launched in 2024.
        - It aims to **enhance public service delivery** and citizen engagement through foundational models in language, speech, and computer vision.
- **5G & Future Telecom Infrastructure:** India's **rapid 5G rollout** is unlocking new frontiers in IoT, smart cities, and high-speed internet penetration, particularly in rural areas.
    - With **6G research** underway and the government pushing for **domestic telecom manufacturing**, India is set to lead in next-gen connectivity.
    - Telecom giants like **Reliance Jio and Bharti Airtel** are aggressively expanding fiber-optic networks to boost digital access.
    - The country's 5G adoption is gaining momentum, with projections indicating 330 million 5G subscribers by 2026.
        - **Bharat 6G Vision document** envisages India to be a frontline contributor in design, development and deployment of 6G technology by 2030.
- **Policy Reforms & Government Push for Self-Reliance:** India's policy ecosystem, through initiatives like **PLI (Production-Linked Incentive) schemes, Make in India, and the Digital India Act (tabled)**, is fostering an innovation-driven economy.
    - Strategic trade policies aim to reduce dependency on Chinese imports while incentivizing domestic high-tech production.
    - The **simplification of regulations for deep tech startups and EV manufacturing** is attracting global investors.
    - For instance, **Apple** may move up to 18% of global iPhone production to India by FY2025 under the government's production-linked incentive scheme.
- **Green Technology & Sustainable Digital Growth:** India's **tech revolution is increasingly integrating sustainability**, with a push for **green data centers, renewable-powered AI, and eco-friendly digital solutions**.
    - The government and private sector are investing in **energy-efficient chip manufacturing, sustainable cloud computing, and AI-driven climate solutions** to align tech growth with environmental goals.
        - For instance, Airtel's data centre arm Nxtra, one of India's leading data centre companies, has joined the RE100 initiative and committed to sourcing 100 per cent renewable electricity.
    - With India's **commitment to net-zero by 2070**, digital expansion must also be energy-efficient.
    - The **PLI scheme for selected solar PV module manufacturers and Green Hydrogen Mission** supports clean energy adoption in the tech sector.

What are the Key Issues Associated with India's Tech Revolution?

- **Regulatory Uncertainty & Compliance Burden:** Frequent policy shifts, delays in approvals, and compliance complexities hinder innovation and investments in India's tech ecosystem.
    - For instance**, the Faster Adoption and Manufacturing of Electric Vehicles (FAME)** scheme was replaced by the **Prime Minister Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE)** scheme in 2024.
    - The **Digital Personal Data Protection Act (2023)** provides a legal framework but **lacks clarity on cross-border data flows** and regulatory overlaps.
    - India ranks 63rd in the World Bank's Doing Business Report (DBR), 2020, highlighting regulatory bottlenecks.
        - Also, SEBI's recent crackdown on unregistered financial influencers has led to a sharp **40-60% decline in brand deals.**
- **Digital Divide & Uneven Internet Penetration:** Despite digital expansion, **rural internet penetration remains low**, leading to an unequal tech revolution.
    - High costs of digital infrastructure and device affordability gaps prevent uniform access,

limiting fintech, e-learning, and e-governance adoption in **Tier-3 and rural areas**.
    - The **urban-rural internet divide** exacerbates economic disparity and slows digital financial inclusion.
    - 45% of the Indian population, or about 665 million citizens, do not access the internet as of 2023.
        - The **PM WANI Wi-Fi scheme** has seen slow implementation.
- **Lack of Research Push and Skilled Workforce in Emerging Tech: India spent only 0.65% of its GDP on R&D in 2022.**
    - Also, India stands 14th in AI research with a global share of just 1.4% (2018-2023) in terms of paper contribution.
    - India also faces a **talent crunch in AI, cybersecurity, quantum computing, and semiconductor design**, affecting tech-driven economic expansion.
        - While **STEM education is strong**, industry demand for skilled workers in **deep tech and R&D roles** far exceeds supply.
- **Cybersecurity Threats & Data Privacy Challenges:** As India's digital footprint grows, **cyberattacks, data breaches, and lack of cybersecurity awareness** pose severe risks to businesses and governance.
    - **Fintech, banking, and Aadhaar-linked databases** remain primary targets **(e.g, rise of digital arrests)**, with rising concerns over data localization and citizen privacy.
        - Weak encryption standards in small businesses and startups further expose vulnerabilities in the digital economy.
    - In 2023 alone, India saw more than 79 million cyber attacks, with the **AIIMS ransomware attack (2022)** exposing **millions of patient records**.
        - In 2024, India faced significant losses from digital arrest scams, with **₹1,777 crore** lost in the first four months alone.
- **Over-Reliance on Foreign Tech & Semiconductor Imports:** India's digital boom is largely dependent on **imported semiconductors, cloud infrastructure, and foreign AI models**, leading to vulnerability in global supply chains.
    - Delayed progress in domestic chip fabrication and lack of indigenous alternatives to **Nvidia AI chips, Google Cloud, and AWS** limit India's **tech self-reliance**.
        - Geopolitical tensions further raise concerns over supply disruptions.
    - For instance, according to the recent government data, the semiconductor imports in India rose 18.5% to Rs 1.71 lakh crore in 2023-24.
        - The **Micron semiconductor plant** aims to start local production, but gaps in fabrication remain.
- **Ethical & Social Implications of AI & Automation:** Unregulated AI adoption in governance, recruitment, and law enforcement risks **bias, job losses, and mass surveillance concerns**.
    - McKinsey Global Institute projections suggest automation could displace between **400 and 800 million jobs globally by 2030**
    - **Deepfake technology, misinformation, and algorithmic discrimination** threaten **public trust in AI-driven decision-making**.
        - For instance, several **deep fake political scandals** misled voters during General elections 2024, highlighting risks in AI governance.
- **Digital Monopolies & Lack of Platform Competition:** India's **digital economy is increasingly dominated by a few large corporations**, stifling competition and innovation among smaller tech players.
    - The rapid expansion of **Big Tech firms in cloud computing, e-commerce, and AI services** has led to concerns over data monopolization and anti-competitive practices.
    - Despite policies like **ONDC (Open Network for Digital Commerce)**, barriers remain for startups to challenge entrenched tech giants.
        - **Amazon and Flipkart control more than half of India's e-commerce market**, making small retailers struggle.
        - The **Competition Commission of India (CCI) fined Google ₹1,337 crore in 2023** for monopolizing the Android app ecosystem.

//



What Measures can India Implement to further Strengthen its Technological Capabilities?

- **Strengthening Digital Public Infrastructure (DPI) Beyond Finance:** Expand the **DPI model beyond UPI and Aadhaar** to sectors like **health, education, and agriculture**, ensuring seamless digital access to essential services.
    - Develop **AI-driven governance frameworks** to optimize welfare distribution, reduce leakages, and improve real-time policy implementation.
    - Encourage interoperability between **health records, education credentials, and digital identity systems** to create an integrated ecosystem.
        - Establish **public-private partnerships (PPPs)** to co-develop scalable DPI solutions.
- **Boosting Indigenous Semiconductor & Electronics Manufacturing:** Accelerate domestic chip production under the **₹76,000 crore Semiconductor PLI scheme**, ensuring faster establishment of fabs and ecosystem development.
    - Incentivize **chip design startups and R&D in high-end processors, sensors, and photonics** to reduce import dependency.
    - Strengthen collaboration with **global semiconductor leaders while developing indigenous IP** to secure supply chains.
        - Scale **compound semiconductor and packaging units** to complement fabrication capacity.
- **Developing India-Centric AI & Cloud Infrastructure:** Invest in **sovereign AI models and cloud computing** to reduce dependency on foreign platforms like Google Cloud and AWS.
    - Launch **AI supercomputing clusters** under a national AI computing initiative to support research, startups, and enterprises.
    - Establish **data localization mandates with a balanced regulatory approach** that ensures security without stifling innovation.
        - Promote **open-source AI frameworks** tailored for Indian languages and governance needs.
- **Enhancing Cybersecurity & Digital Resilience:** Strengthen the existing **National Cyber**

Coordination Centre (NCCC) to proactively mitigate cyber threats in banking, governance, and defense.
    - Mandate **cyber hygiene education in schools and enterprises** to build a digitally secure workforce.
    - Scale up **indigenous cybersecurity startups** through dedicated funding and government procurement policies.
- **Strengthening India's Space-Tech & Satellite Capabilities:** Expand **low-cost satellite manufacturing and private-sector participation** under the IN-SPACe framework.
    - Expand **satellite-based broadband** to enhance rural connectivity, bridge the digital divide, and reduce reliance on foreign satellites for internet access.
    - Develop **geospatial intelligence tools** for secure navigation and defense applications.
        - Promote **AI-integrated remote sensing solutions** for climate monitoring, disaster management, and precision agriculture.
- **Fostering Deep-Tech R&D & Industry-Academia Collaboration:** Create **dedicated deep-tech research hubs** for quantum computing, biotech, and advanced materials under the **National Research Foundation.**
    - Incentivize **private sector R&D in frontier technologies** through tax breaks and funding support.
    - Strengthen **collaboration between IITs, IISc, and global tech giants** to co-develop next-gen solutions.
        - Implement **PhD-to-startup pathways** to commercialize research innovations.
- **Expanding the Scope of Fintech & Digital Financial Inclusion:** Enhance **cross-border UPI and CBDC adoption** to establish India as a leader in digital payments infrastructure.
    - Develop **AI-driven credit scoring models** for MSMEs and informal sector workers to improve financial access.
    - Strengthen **blockchain-based regulatory tech (RegTech)** for fraud prevention and transparent transactions.
        - Scale **embedded finance solutions in agriculture, healthcare, and micro-enterprise ecosystems**.
- **Reforming Tech Policy & Regulatory Landscape for Innovation:** Streamline **tech policy-making with a single-window digital clearance system** for startups and deep-tech projects.
    - Develop **sector-specific AI regulations** to address ethical concerns while fostering innovation.
    - Reduce compliance burdens on **Indian SaaS, fintech, and cloud startups** to promote global competitiveness.
        - Ensure **stable, long-term digital policies** that attract foreign investments while protecting national interests.
- **Developing a Future-Ready Workforce:** Strengthen science, technology, engineering, and mathematics programs in schools and universities.
    - Offer courses in AI, cybersecurity, blockchain, and semiconductors.
    - Implement large-scale digital skilling programs under **Skill India** to prepare for Industry 4.0.

Conclusion:

India's tech revolution must be driven by a **forward-looking policy framework that fosters innovation, strengthens digital resilience,** and bridges regulatory and infrastructural gaps. By scaling indigenous semiconductor production, expanding Digital Public Infrastructure, and ensuring ethical AI governance, India can achieve **sustainable and inclusive technological leadership.**

Drishti Mains Question:

India is witnessing a rapid technological revolution, driven by digital infrastructure, artificial intelligence, and indigenous innovation. Discuss key challenges in ensuring inclusive and sustainable technological growth.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. With the present state of development, Artificial Intelligence can effectively do which of the following? (2020)

1. Bring down electricity consumption in industrial units
2. Create meaningful short stories and songs
3. Disease diagnosis
4. Text-to-Speech Conversion
5. Wireless transmission of electrical energy

Select the correct answer using the code given below:

(A) 1, 2, 3 and 5 only

(B) 1, 3 and 4 only

(C) 2, 4 and 5 only

(D) 1, 2, 3, 4 and 5

Ans: (B)

Q. With reference to “Blockchain Technology”, consider the following statements: (2020)

1. It is a public ledger that everyone can inspect, but which no single user controls.
2. The structure and design of blockchain is such that all the data in it are about cryptocurrency only.
3. Applications that depend on basic features of blockchain can be developed without anybody’s permission.

Which of the statements given above is/are correct?

(A) 1 only

(B) 1 and 2 only

(C) 2 only

(D) 1 and 3 only

Ans: (D)

Mains:

Q. COVID-19 pandemic has caused unprecedented devastation worldwide. However, technological advancements are being availed readily to win over the crisis. Give an account of how technology was sought to aid management of the pandemic. (2020)
