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ARTIFICIAL INTELLIGENCE

India's Strategic Opportunity

Artificial Intelligence: India's Strategic Opportunity

Introduction

Artificial intelligence stands as the most transformative technological development of the 21st century, with far-reaching implications for human society, economic structures, and geopolitical relationships. As AI capabilities expand from narrow, task-specific applications to increasingly general-purpose and capable systems, the pace of AI development has raised both tremendous opportunities and significant downsides for some sectors. While AI might offer solutions to problems in healthcare, agriculture, education, and governance, it poses risks related to employment displacement, privacy, security, and social inequality.

For India, this potential is especially critical. As a developing economy with a large, youthful population, declining productivity growth, and a digital foundation through Aadhaar, UPI, and other digital public goods, India stands at a crossroads. The question is whether AI can be used not only to bridge the productivity gap but also to leapfrog traditional stages of economic development and help meet India's goals of Viksit Bharat 2047.

Why now?

Artificial intelligence has reached a turning point because several key factors have come together over the past decade. Breakthrough algorithms such as transformers, diffusion models, and reinforcement learning from human feedback have significantly expanded what AI systems can do. These advances have been powered by massive increases in computing power, thanks to the rise of GPUs and custom AI chips, and have been fuelled by the enormous amount of digital data generated every day, including text, images, and sensor readings.

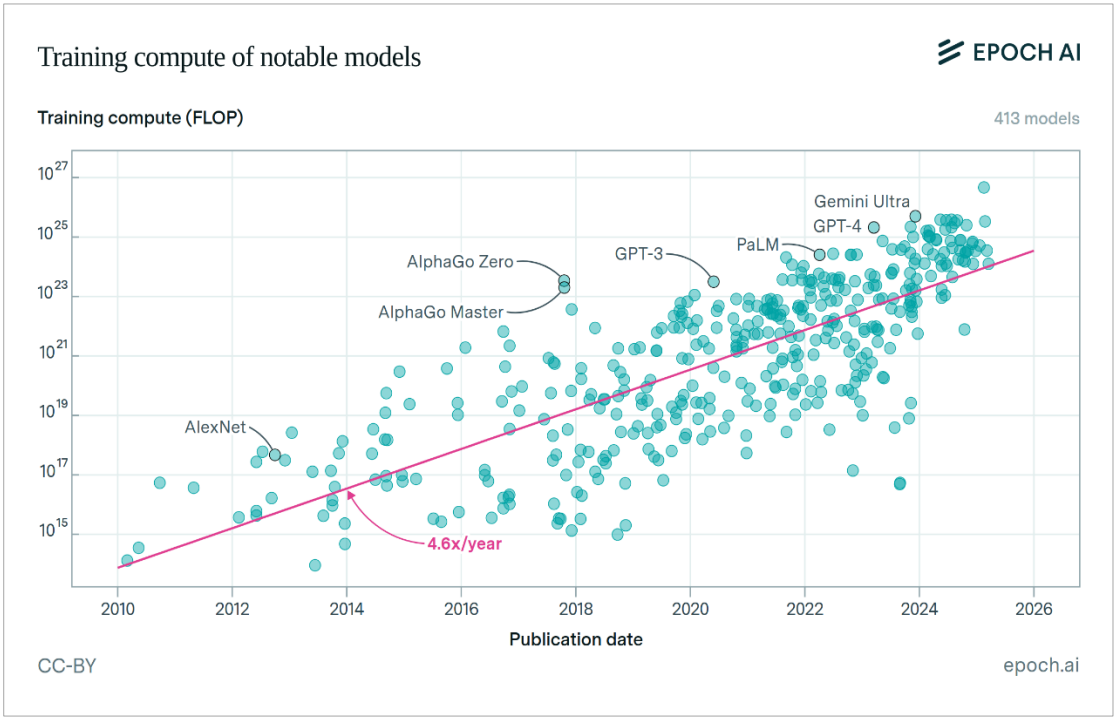
At the same time, both public and private investment in AI has grown rapidly. This funding has helped move AI from being a research-focused field to one

that now produces widely used, general-purpose tools. As a result, AI has evolved beyond narrow, task-specific applications into flexible, multimodal systems that can reason, create, and interact across a wide range of areas. India secured US$ 1.4 bn in private AI investment in 2023, ranking 10th globally. It remains one of only two major emerging economies, alongside China, with significant AI funding.

Key Milestones in Modern AI (1997–2024)

Year	Milestone	Significance
1950	Alan Turing publishes "Computing Machinery and Intelligence"	Introduces the Turing Test – early conceptual foundation for machine intelligence
1956	Dartmouth Conference	Birth of AI as a formal field; term "Artificial Intelligence" coined by John McCarthy
1950s–60s	Early symbolic AI	Focus on logic, theorem proving, and games like chess
1970s–early 1980s	First AI Winter	Overpromising and underdelivering leads to funding cuts and skepticism
1980s	Rise of Expert Systems (e.g., MYCIN, DENDRAL)	Narrow AI applications succeed in specific domains using rule-based logic
Late 1980s–1990s	Second AI Winter	Expert systems prove brittle; shift begins toward statistical and learning-based methods
1997	IBM Deep Blue defeats Garry Kasparov	First time a machine defeats a reigning world chess champion
1990s–2000s	Emergence of machine learning	Rise of SVMs, decision trees, and early neural networks
2011	IBM Watson wins Jeopardy!	Milestone in NLP and information retrieval across broad topics
2012	AlexNet wins ImageNet	Start of the deep learning revolution; GPU-accelerated CNNs outperform previous methods
2014	Generative Adversarial Networks (GANs) introduced	Launches a new era of AI-generated content
2015	AlphaGo defeats Lee Sedol	Reinforcement learning and deep networks conquer a previously unsolved game
2017	Transformer architecture introduced	Foundation for modern large language models (LLMs); enables long-context NLP
2018–2020	GPT-2, BERT, T5, GPT-3 released	LLMs demonstrate emergent general-purpose capabilities
2021–2023	Diffusion models emerge (DALL·E, Stable Diffusion)	Transform image generation with photorealistic and creative outputs
2022–2024	Rise of multimodal systems	Integration of text, image, video, audio in unified AI models (e.g., GPT-4, Gemini, Claude)

Although the basic ideas behind AI, such as neural networks, have existed for decades, earlier systems were limited by a lack of sufficient computing power and high-quality data. Today, large-scale data infrastructure (and constant human feedback loop through free platforms such as Open AI's Chat GPT, Anthropic's Claude, etc) enables AI models to be trained on billions or even trillions of parameters, enabled by massive datasets and continuous improvements in algorithms that have made AI models more powerful and efficient.



What has worked for AI in the recent years

Category	Details
Technological Advancements	- LLMs scaled from millions to trillions of parameters (GPT-4, Claude, Gemini)
	- Generative AI expands to images, video, audio, 3D models
	- Superhuman performance in computer vision & medical imaging
	- Robotics & embodied AI integrate with advanced intelligence
	- Multimodal reasoning across text, image, sound
Data	- Explosion of digital data from web, mobile, IoT
	- Self-supervised learning and synthetic data creation
Computing Power	- GPU, TPU, NPU acceleration
	- Cloud & distributed computing enables training at scale
	- ~10,000× efficiency improvement in training (2012–2024)
Financial & Institutional Support	- $120B+ in VC funding annually
	- Government support (e.g., US AI Initiative, China's AI Plan)
	- Open-source AI communities expand accessibility
Algorithmic Innovations	- Transformers, attention mechanisms
	- Reinforcement learning from human feedback (RLHF)
	- Diffusion models for content generation

AI in India: Infrastructure, Innovation, and Inequality

India's large and youthful population presents both a challenge and an opportunity in the AI era. On one hand, the working-age demographic must quickly adapt to the shifting demands of an AI-enabled economy. Traditional job creation models may falter as automation displaces certain categories of employment, particularly in low-skilled segments. On the other hand, there is a tremendous opportunity to boost productivity by equipping the young workforce with AI-relevant skills. This would require a push towards education and skilling in the new age technology.

With AI efforts being concentrated in the urban areas, the urban-rural divide could widen further, as AI ecosystems currently concentrate in metropolitan hubs.

India's AI research output remains limited, with only a few academic institutions driving efforts at varying capabilities. Key contributors include the IITs (particularly Bombay, Delhi, and Madras), IIITs, and IISc, all of which run active AI research programs. However, India currently accounts for just 9.2% of global AI research publications, far behind China's 23.2% and the U.S.'s 15.2%, according to Stanford's AI Index Report 2025. The Indian government approved the IndiaAI Mission in 2024, committing ₹10,300 crore over five years to strengthen AI infrastructure, talent development, and research. Despite this, fundamental research output remains limited both in quantity and quality, largely due to weak high-performance computing capacity and continued brain drain. India has just 6 supercomputers in the global top 500, compared to 63 in China and 173 in the U.S., while many of its top AI researchers work abroad, especially in North America.

On the digital infrastructure front, India possesses a robust foundation that supports AI deployment at scale. The Aadhaar system has enrolled 99% of the adult population, creating one of the world's largest digital identity databases. Meanwhile, the Unified Payments Interface (UPI) processed over 118 billion transactions worth $1.8 trillion in 2023, growing at a remarkable 46% year-on-

year. Mobile internet usage is high, with 796 million users and 16.4 GB average monthly data consumption per user, the highest globally. However, digital divides persist; rural internet penetration is still only 37%, compared to 69% in urban areas. This gap will mean that AI adoption across sectors will remain inequitable.

According to a 2023 NASSCOM survey, 45% of large enterprises have adopted some form of AI, but only 12% in the MSME sector, which remains India's growth driver. Financial services lead AI adoption at 65%, followed by IT/ITeS (58%), retail (43%), healthcare (32%), and manufacturing (29%). In contrast, agriculture, despite employing 42% of the workforce, shows minimal AI penetration. Cloud infrastructure is expanding rapidly, with data center capacity rising from 375 MW in 2020 to 770 MW in 2023 and is expected to reach 1.4 GW by 2025. However, 89% of this capacity is concentrated in just five metros (Mumbai, Chennai, Delhi NCR, Hyderabad, and Bengaluru), highlighting limited access for even tier-2 and tier-3 cities.

At the macroeconomic level, effective AI adoption could add 1.3% to India's annual GDP growth, potentially contributing $500 billion to the economy by 2035. However, this transformation comes with major labour market challenges. India's workforce of over 588 million is vulnerable, with some market estimates suggesting that 40% of working hours could be automated by AI by 2030, impacting over 200 million jobs. High-exposure sectors include IT services (65–70% of roles), financial services (60–65%), and customer service (55–60%), while lower exposure is seen in construction (25–30%), agriculture (20–25%), and healthcare and delivery (30–35%). Routine cognitive roles, such as those held by India's 90 million clerical and administrative workers, face the greatest automation risk (70–75%).

Sectoral Impacts in the Indian Context

High-Potential Benefit Sectors

AI has the potential to address key challenges in India across multiple sectors. In healthcare, AI tools can help bridge the gap caused by specialist shortages, particularly in rural areas, by enabling primary care providers to offer higher-level care. Predictive analytics can improve disease outbreak monitoring, while administrative automation reduces costs, making healthcare more affordable.

In agriculture, AI can boost productivity through precision farming, mobile-based crop disease detection, and climate adaptation planning. By optimizing inputs and early intervention, these tools help smallholder farmers increase yields and mitigate the effects of climate change. AI can also help with reducing post-harvest losses, which ends up being huge in India.

In education, AI can bridge quality gaps through personalised learning platforms, teacher support tools, and specialised language technology, improving access and outcomes.

AI can drive financial inclusion by enabling credit scoring for unbanked populations using alternative data, improving fraud detection, and offering AI-powered insurance to underserved groups.

Sectors Facing Disruption

India's IT sector, a cornerstone of exports and employment, faces a shift as AI will automate a lot of routine tasks like programming, software testing, and low-level BPO operations. This forces IT firms to pivot from service providers to product developers. The workforce must upskill in areas like AI development, cloud computing, data science, and cybersecurity to stay relevant in an AI-driven environment.

Labor-intensive assembly lines in the manufacturing sector might be replaced by robotics and AI-driven quality control systems, improving efficiency and

precision, which also might end up being cost effective. Generative AI is also affecting jobs such as content writing, designing, graphics and other media related jobs. However, India needs significant investment in smart manufacturing infrastructure and a skilled workforce proficient in robotics and AI process engineering.

Automation is impacting transport and logistics sectors, with autonomous vehicles and drones might threaten jobs in delivery and driving, although the masses are not yet using this and still is at an experimental stage in India. We already have AI powered self-driving cars and bots abroad.

Retail is increasingly automated, with self-checkout systems and AI-powered chatbots replacing human roles in transactions and customer service. While these shifts reduce the need for certain jobs, they create new roles that blend technology with human service delivery, such as in customer experience design and managing complex queries.

Main Barriers for India for AI adoption

	Challenge
Human Capital	Limited digital and analytical skills among the workforce
Digitisation	Low penetration of digital tools and cloud infrastructure in non-IT sectors
Data Infrastructure	Fragmented, low-quality, or non-digitised data, especially in public services
Computers	Dependence on foreign cloud infrastructure; lack of indigenous chips
Incentives & Costs	Low labour costs reduce incentives for automation
Regulation	Absence of clear laws on AI use, privacy, bias, and liability

Created with Datawrapper

Opportunities In Sight

Sector	AI Potential	Where
IT/Services	High	Code generation, analytics
Healthcare	High	Diagnostics, workflow support
Education	Medium	Personalised learning
Agriculture	Medium	Crop forecasts, automation
Manufacturing	Medium	Predictive maintenance
MSMEs	Medium	Chatbots, automation
Governance	High	Public service delivery

Global Positioning and Strategic Challenges

Globally, AI is reshaping global competitiveness by transforming productivity, industry structures, and trade. Early AI adopters (most likely developed economies) may grow 1.5–3.0% faster annually than laggards, widening economic gaps. Digitised sectors report better productivity gains, with knowledge-based economies benefitting first, while labour-intensive ones, such as India, might face disruptive transitions.

Traditional industry structures are evolving. Automation is localizing manufacturing by eroding offshore labour cost advantages. This is disrupting global value chains.

Employment patterns are shifting as automation capabilities expand beyond routine physical tasks to cognitive domains. Research suggests 30-40% of job tasks globally are potentially automatable within a decade, though complete job elimination will be less common than task reconfiguration. New job categories are emerging around AI supervision and development, including prompt engineering, model training oversight, and AI-human collaboration roles, which did not exist a decade ago.

Advanced economies, with strong digital infrastructure, skilled workforces, and higher labour costs, would have an advantage, leading to early AI adoption and productivity gains. Automation helps offset aging populations and sustain growth, which are faced by many countries such as the UK and Japan currently.

Emerging and middle-income countries, especially with abundant labour might face difficulties. While AI offers a chance to leapfrog legacy systems and boost productivity, especially among young populations, limited infrastructure and regulatory capacity pose major hurdles. Countries like India, Brazil, and Indonesia show uneven readiness such that urban, service-driven sectors are outpacing rural and manufacturing areas.

India is currently somewhere in the middle of this transformation. Its startup ecosystem ranks third globally by number (behind the US and China) but eighth by funding. Indian AI research publications have grown at 30% annually since 2018, faster than the global average of 23%, yet citation impact remains lower than the global average.

India occupies a unique middle position in the global AI landscape. Unlike China and the US competing for overall leadership, or the EU positioning around regulation and ethics, India could have various advantages:

- **Demographic advantage**: With 1.4 million IT graduates annually and the median age of 28, India has human capital scale unmatched outside China.
- **Digital public infrastructure**: India's digital stack provides implementation advantages for AI applications, particularly in governance and inclusion.
- **Linguistic diversity**: With 22 official languages and hundreds of dialects, India has become a natural laboratory for multilingual AI development.
- **Cost advantages**: AI development costs in India average 40-50% lower than in the US or Europe, creating opportunities for cheaper innovation.
- **Democratic framework**: Unlike China, India balances AI advancement with democratic governance, positioning it as a potential leader in "democratic AI" development.

India lags behind top AI powers like the US and China due to limited chip production, weaker research, poor IP protection, and rural digital divides. These gaps keep India in the middle tier, though it has strong growth potential.

India's AI landscape holds both great opportunities and significant challenges. The country has clear strengths, strong digital infrastructure, a large, skilled workforce, and a unique role connecting developed and developing economies. But to unlock this potential, India needs to act fast. Investment in

computing power and research must grow multifold. Re-skilling 15–20 million workers each year is essential, and regulations must protect users without slowing innovation.

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