



IMPACT OF ARTIFICIAL INTELLIGENCE ON THE ECONOMY

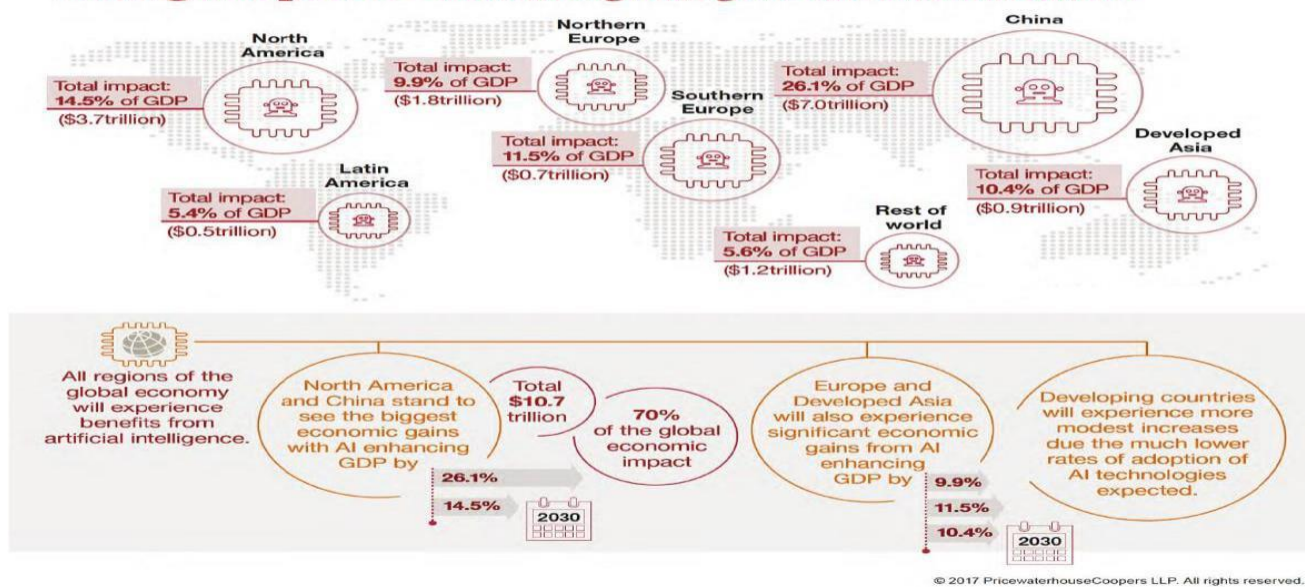
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INTRODUCTION

India's Artificial Intelligence (AI) moment is truly here and now. At a time when a diverse range of applications based on AI are being developed, pushing its frontier further into uncharted realms of business and society, Indian policy makers are contemplating and charting its potential for growth and social transformation. Our study attempts to understand the impacts of AI in India and trace the pathways that help realise it. AI's transformational potential stems from its ability to lend itself to a diverse range of applications across a range of sectors. One can witness AI-based applications in manufacturing, transforming quality control, production lines, and supply chain management, and in services creating personalized product offerings and highquality customer engagement.

AI applications are also common in sectors such as agriculture that had taken a back seat in technological innovations in the post-industrial world. AI also demonstrates the potential to address developmental challenges by responding to societies' immediate demands for healthcare, education and expanding access to finance and banking. The consequences of AI diffusion stem from AI's pervasiveness in society, its ability to trigger innovation, and its tendency to transform and evolve. These are typical characteristics of a class of technologies that can be found across history, the emergence and diffusion of which have enabled the wealth of nations. These are called General Purpose Technologies (GPT).

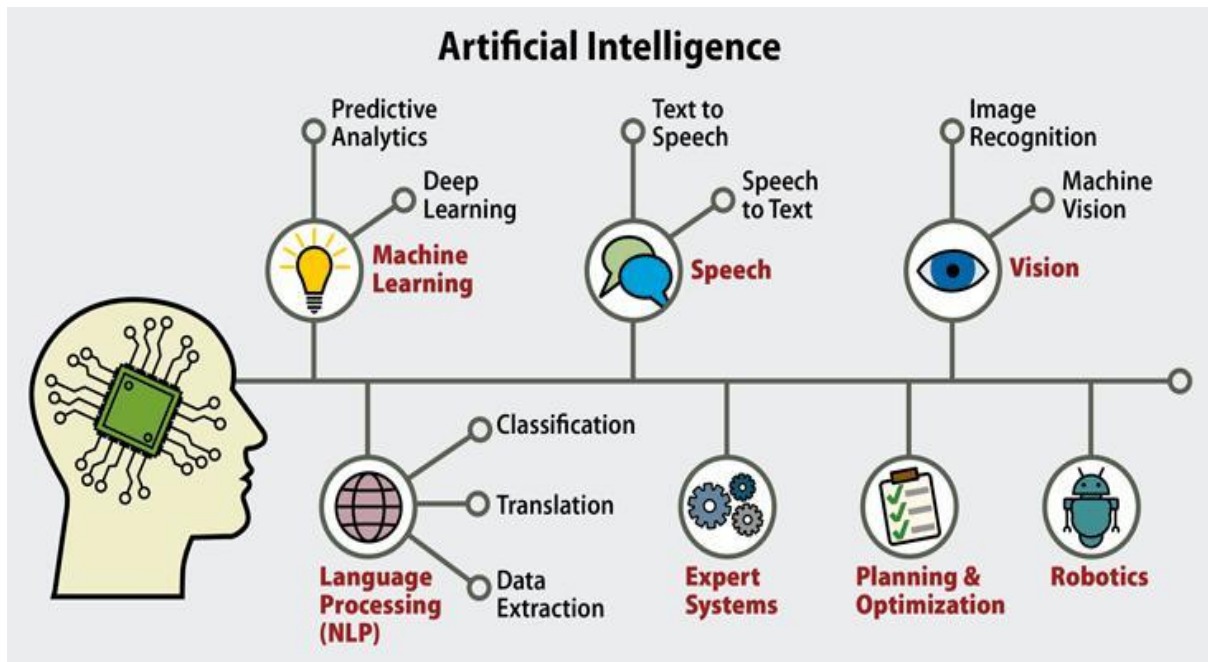
Sizing the prize – Which regions gain the most from AI?



Technologies such as steam engines, electricity, computers, semiconductors, and more recently the internet, can all be considered as belonging to the GPT class of technologies. Our study is based on the understanding that the implications of AI can be best understood by viewing AI as a GPT. Historically, the economic impacts of GPTs have not been immediate but follow after its diffusion in the economy over time, i.e. once scale is achieved.

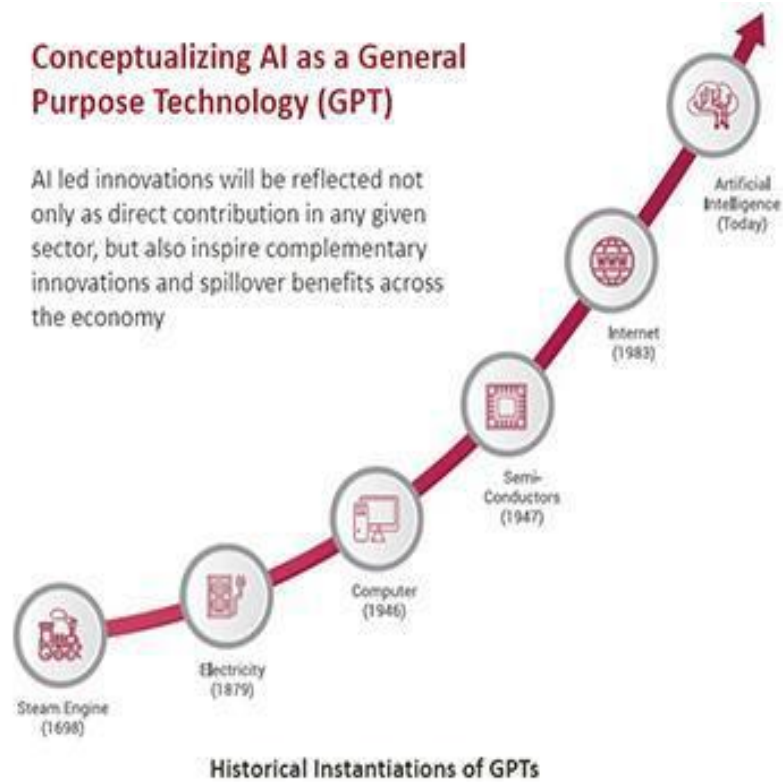
There are two reasons that explain this phenomenon: firstly, in early phases of technology diffusion, an economy diverts part of its resources from productive activities to costly activities aimed at enabling the GPT. For instance, organisations adopting computers must also invest in training employees or hire computer scientists, rearrange production activities or organisational structures to accommodate computer driven workflows, all of which are costly.

Secondly, it is only after the GPT is diffused and widely used in the economy that the statistics measuring GDP start counting and fully measuring the GPT. Empirical research on GPTs such as AI, including ours, throws up the challenge of measurement. Early estimates on the economic impact of AI should be interpreted with the caveat that data on AI's adoption is not fully available or not adequately reflected in the data used to compute economic growth, at least not yet.



Measuring the economic impact of AI is also difficult because of the magnitude of indirect effects on productivity that GPTs trigger. It is therefore common that studies on GPTs, while attempting to estimate their economic impacts, also engage in in-depth case studies and historical analysis of its impacts. In the absence of a direct measure of AI at the firm level, we extend the idea from other studies to use investment in software, databases and computer machinery as a proxy of AI. Although software and databases may not accurately measure the impacts of AI, it is perhaps the best proxy given the commonality of infrastructure and capabilities involved in the use and adoption of AI. AI algorithms are essentially software trained to analyse and predict data patterns with the aid of computer hardware, optimised for such use. This measure of AI also provides the potential of ICT using firms to adopt AI in the future.

The companies are currently developing applications for ten different sectors including law enforcement, healthcare, banking and finance, agriculture and manufacturing. In terms of the AI used, we find machine learning and its subsets, deep learning, deep neural networks, convolutional neural networks, among others, featuring prominently across organisations building and providing AI-based services. Natural Language Processing, Speech Recognition, and Computer Vision are other AI-based technologies that also feature across several use cases. We use the capability theory framework to illustrate how AI firms in India are currently building skills, organising and utilising research and resources needed to run and test AI applications.



We also explore the capability of AI firms in India to form networks that finance and market their products and services that links the firm to the economy at large, and enables the diffusion of AI across the economy. We observe that at the root of all benefits stemming from AI-based applications is AI's ability to predict across a range of tasks. Examples of AI innovations across sectors find its positive impact on organisational efficiency that manifests in reduced time and costs, for various business processes, and enhanced quality control. There are also several interesting applications of AI in the social sector that impact a range of development and governance outcomes such as law enforcement, improvements in health and education, utilisation of natural resources, etc. Going by the nature of private and public interest in AI and the kinds of AI-based applications being developed, India is carving out a niche in the global ecosystem, deploying AI applications that focus on the social sector. The rise of AI however, comes with several statutory warnings.

One look around and we find applications of AI everywhere, be it finding insights from mountains of data or automating production and deliver services. AI is being embraced by an increasing number of businesses, individuals and even governments to boost productivity and raise efficiency. At a country level, while most countries have just started using AI, the technologically advanced countries have considerably leaped ahead. In this context, it will be interesting to find out India's vision regarding AI and the growth consequences attached to it.

AI to play a significant role in realizing India's Vision for 2025

Data and AI could add \$450-500bn to India's GDP by 2025. Close to 45% of this value is likely to be delivered by 3 sectors: consumer goods and retail, agriculture and banking and finance. In the agricultural sector, AI can help double farmers' income through improved production planning and yield. While in the BFSI sector, AI can assist in financial risk modelling and credit underwriting, in the consumer goods and retail sector, it can provide personalized campaigns and targeted marketing.

However, to recognize the full potential of AI in a sector, an important factor to be considered is the structural composition and the technological maturity of the sector. In general, digitized sectors and firms are more likely to adopt AI than their peers who lack the necessary infrastructure for adoption. Some of the deterrents that stand on the road to adoption are cost of technology, lack of skilled talent and legacy systems which affects the efficiency and quality of outcomes. The journey towards AI maturity can be best described from the diagram below.

Sector	Contribution (in USD bn)
Consumer Goods and Retail	90-95
Agriculture	60-65
Banking and Insurance	60-65
Telecom, Media, and IT	50-55
Energy and Industrials	50-55
Transport and Logistics	50-55
Auto Manufacturing and Assembly	40-45
Public Sector	25-30
Healthcare	25-30

The ability of AI applications to predict across a range of tasks has tremendous implications. A growing number of start-ups with their unique ideas have translated this into reality

Economic Implications

- Reduction in turnaround time and costs
- Increased efficiency in supporting functions Ex: Nebulaa (with the help of AI and data from various agricultural markets in India for quick, accurate and cheap quality testing) Ex: Aspiring Minds (blends AI with psychometric tests to help employers screen potential employees more efficiently)

Social Implications

- Early prediction of certain diseases such as TB, lung and breast cancer
- Regulating critical natural resources such as groundwater and renewable energy. Ex: Artelus (uses AI-backed screening tool that uses deep learning to check for Diabetic Retinopathy, early onset of TB, lung and breast cancer) Ex: Vassar Labs (predicts groundwater rich areas and the rate of groundwater depletion using data from sensors and satellite as inputs to local governments)

Labour Market Implications

- AI-based solutions creating narratives similar to human

2. Deep-dive into sectors: Retail and Healthcare

RETAIL

The Indian retail industry is undergoing momentous transformation on the back of changing consumer behaviour and adoption of new technologies by businesses. Given the fact that the Indian retail sector is largely unorganized, AI can play an important role in plugging in the gaps.

Key points:

- The retail sector in India is set to double by 2024 to touch \$1.4 trillion from the current \$790 billion
- AI-led disruptions in business functioning will aid in the expected ~3X growth in organized retail and e-commerce. The unorganized sector, too, will grow by 40%
- The COVID-19 pandemic is pushing the need for digitization and automation, thereby increasing reliance on AI
- Top priority areas for AI implementation include: customer experience (customer feedback, customer service chatbot), in-store and online operations (product personalization, shopping assistant) and logistics and distribution management (automated product sorting, delivery agent assistant)
- 90% of retailers who have implemented AI solutions are not fully satisfied. Trust is seen as a major hindrance in AI adoption. Also, existing governance and risk management policies for AI are considered inadequate
- Collaborating and partnering with AI providers will help solve implementation bottlenecks and built right capabilities for AI implementation

- More than 80% of retailers believe that reskilling existing talent with necessary AI-related skills will be effective

HEALTHCARE

The Indian healthcare industry is expected to witness a strong growth backed by robust government and corporate investments. India, with its huge resources of unstructured medical data and population diversity, combined with the vast pool of human talent and mushrooming health-start-ups is perfectly positioned to embrace large-scale AI implementation.

- Despite several challenges which are further fueled by the pandemic, the healthcare sector is still expected to reach \$372 billion by 2022
- Government-led expenditure towards the sector will increase from 1.6% of GDP in 2020 to 2.5% by 2025
- AI can be effectively used to digitally transform the sector thereby resulting in affordable treatment and improvement of quality and accessibility of services
- Top priority areas for AI implementation include: patient care and experience (personalized treatment, smart wearable sensors, patient assistance chatbots), operations (appointment assistant, hospital patient flow management), R&D (drug development, disease simulation, drug repurpose)
- 60% of healthcare organizations are not satisfied with AI implementation. More than 70% believe hiring new talent to build AI capabilities is effective
- Dedicated AI strategy and budget is a key imperative to scale AI initiatives
- Need for robust platforms and solutions with right capabilities for successful AI implementation
- Long-term partnership, shared risk models works best with AI providers in the healthcare sector. Special focus on health-care start-ups

3. Building blocks to promote AI and data utilization across sectors

Countries promoting data utilization and AI are doing so based on 5 building blocks

Strategy:

- Identify priority use cases based on feasibility and impact potential
- Prepare integrated action plan
- Create a long-term implementation plan and funding mechanism

Data:

- Identify data sets required to solve priority use case
- Set standards for data collection, classification and security
- Design programs to generate data and derived services on a large scale

Technology Stack:

- Create a compatible platform to securely host data, AI services, models, open-source libraries
- Create enabling infrastructure to support the ecosystem (ex: 4G, 5G connectivity, sensors)
- Formulate policies to ensure security, reliability and interoperability of the stack

Talent:

- Define AI specific roles such as data scientists, data engineers and spell the required trainings and certifications
- Estimate demand-supply gaps in AI workforce
- Develop strategy to build the gap and upskill existing talent

Execution:

- Design a national program for AI with clear structures, roles and processes for various stakeholders (government, industry, academia)
- Drive innovation and change management
- Set up an independent body to enforce AI policies

Examples of AI applications and its impact across different sectors in India

Sector	Application	Impact
Retail	ML powered customized recommendations and inventory management to assist in smart shopping	Creating seamless shopping and personalized customer experience and a wow factor
Agriculture	ML and image processing-based crop and soil monitoring and predicting impact of weather on crop output	Efficient allocation of farm inputs and crop cycle management
Banking	NLP for conversational bots and fraud detection based on deep learning methods	Minimizing security breaches, money laundering, credit-card anomalies and enhanced customer experience
Transport	Semi-autonomous vehicle programs and traffic management systems	Dual effect of decreased cost of labour and enhanced safety through proper regulation of traffic congestion
Healthcare	Detecting early stage diseases through predictive analysis	Rapid and efficient diagnosis, improved workflow and reduced physician error
Utilities	Artificial Neural Nets based smart grids which will assist in demand forecasting and management	Increased efficiency in utility allocation and use and effective energy management

4. Immediate actions required to improve data utilization and AI in India

6 coordinated actions over the next one and a half years required to catalyze the utilization and adoption of AI

- Launch the National Program for AI and create a central and apex body consisting of representatives from various stakeholders for its execution
- Finalize India's Data and AI Action Plan and develop a self-sustaining financing model for the future
- Based on selected initiatives, identify datasets of national importance (ex: healthcare data, farm data, weather data, land records, education, power and grid)
- Initiate work on a few socio-economic programs which requires scaling up
- Create schemes to engage the AI ecosystem which consists of industry, start-ups, academia and the civil society
- Provide access to datasets of national importance through reliable technology platforms which will act as a marketplace for both private and public sector

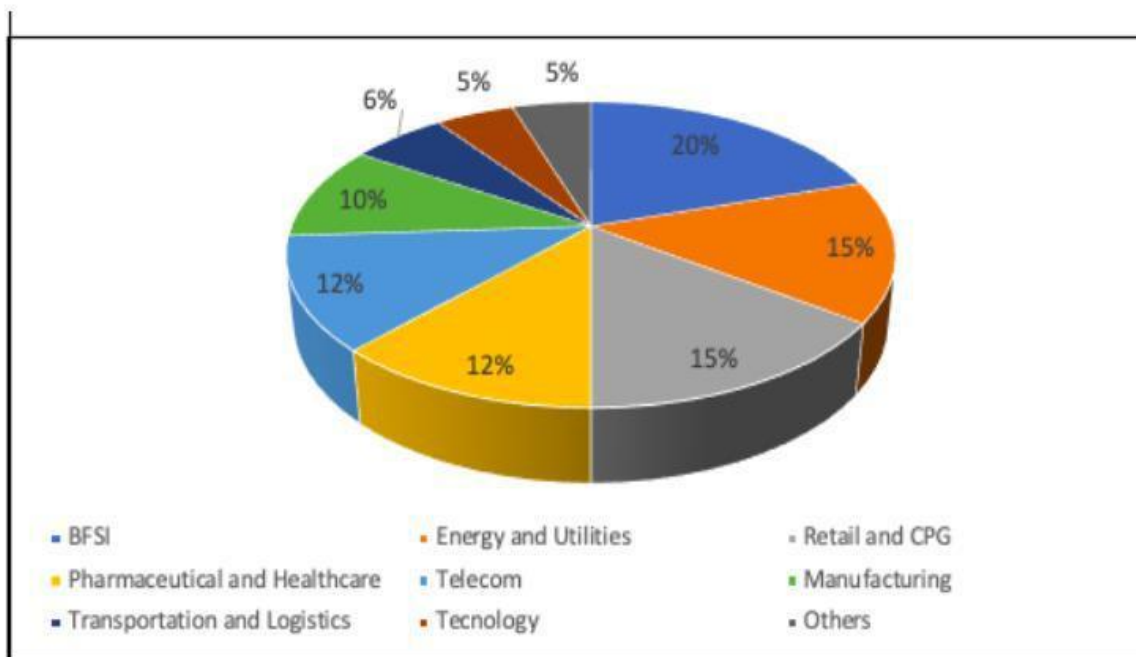
5. A look at the Technology Stack and AI platform

An AI platform acts as an accelerator to support quick to build solutions and services for enterprise adoption. The platform should not only ingest and manage data but also generate models. AI platforms are the future of technology services delivery where Indian technology companies have already exhibited strong AI capabilities and successfully developed full-stack of AI platforms. Even though the current state of AI platforms is considered as maturing, the Indian companies are catching up with their global counterparts in terms of complexity and enterprise-wide deployment.

Key Points:

- The AI platforms have served more than 500 clients across the globe
- Have served more than 15 sectors
- Have a collective platform experience of more than 20 years

Sector Adoption (%) of AI Platforms



Advantages of AI platform

- End-to-end AI Model lifecycle and workload management
- Address various challenges relating to system failure and issue resolution
- Build quick solutions for enterprise use-case
- Extract, analyze and use data to make meaningful insights
- Offer solutions that are easy to consume and govern across enterprises

POLICY RECOMMENDATIONS

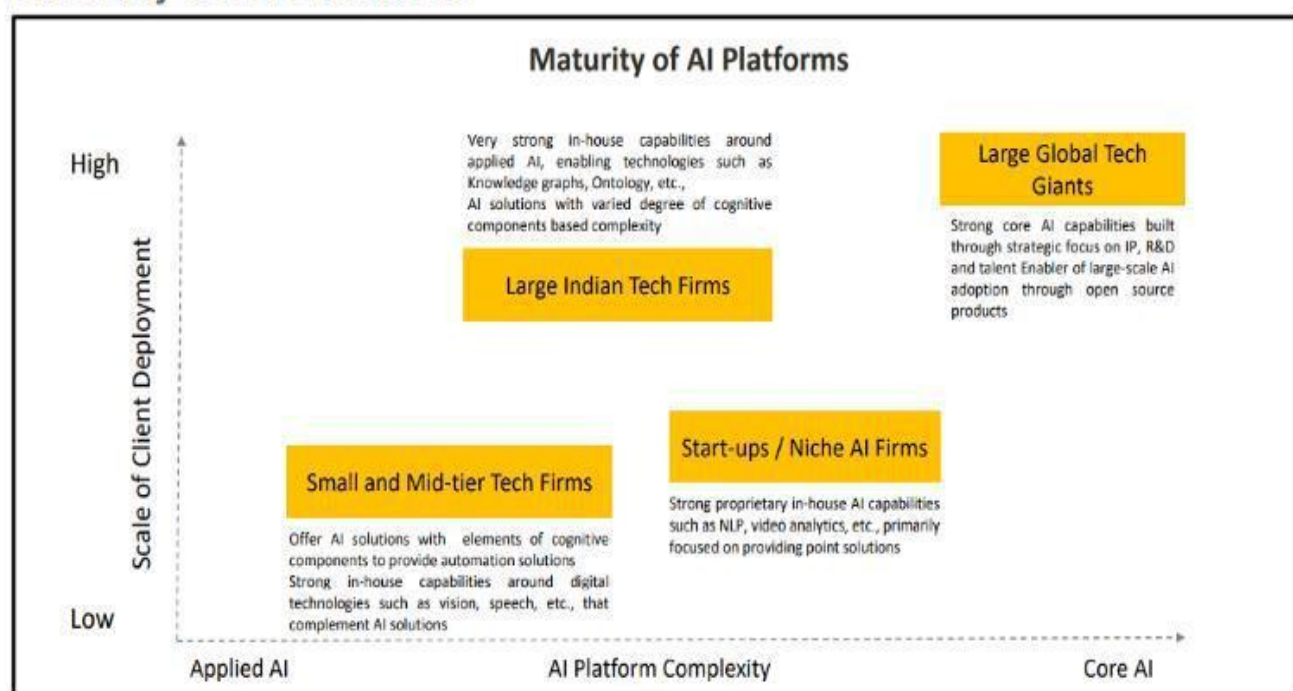
Identifying a Nodal Agency:

Within the Government for Development and Diffusion of AI, the design and workings of which will be critical to push wide-scale AI adoption in India

- Identify a nodal agency for coordinating all AI related activities in India.
- Nudge government departments to develop capabilities to adapt to AI-based governance mechanisms.
- Prioritise resources to build pockets of excellence for sectors that have already demonstrated positive economic and social impacts from AI.

- Offer government handholding to socially relevant applications. Building Collaborative Frameworks for Engagement between Governments, Industry and Academia to foster growth and promote innovative localised solutions.
- Governments at the state and national level can directly foster growth among startups by inviting public-private partnerships and promoting innovative localized solutions.
- Cross-country collaborations catalyse the transfer and adoption of frontier technologies. Building on existing technologies can help promote AI-related capabilities in India, especially the hardware sector in which India is lagging behind. Building an All Encompassing Data Strategy to improve state capacity to provide AI-compatible publicly available data and encourage unbiased, reliable, safe and inclusive data sharing practices
- Evaluate alternate data sharing models. Laws and regulations that encourage unbiased, reliable, safe, open and inclusive data sharing must be formulated for integration and dissemination of data.
- Examine the integration of public data that currently exists in silos and ensure compatibility for different uses.
- Enhance capacity of existing statistical agencies to collect and process publicly available data for AI use.
- Evolve data.gov.in to become a national resource for Artificial Intelligence: Develop a generalised meta-data standard for data.gov.in to enable integration of resources including but not limited to data, tools, literature, etc.




Maturity of AI Platforms



Addressing India's Skill Gap in AI to help build directly adaptable skills for the industry and facilitate recruitment of AI specialists

- Focused collaborations at the sector level, engaging students with corporates, can help build directly adaptable skills for the industry.
- Revise the education curriculum, especially for technology institutes, to necessarily include a program on AI
- AI training should go beyond technology curricula to include social sciences, that contribute to the process of constructing the algorithm and conducting an algorithmic impact assessment.
- Explore a market place for skilled AI professionals to meet the immediate skill gap that AI startups currently face.
- Facilitate recruitment of technology specialists from other countries.

Interesting Use-cases of AI Platforms

AI Platform	Sector	Use Case
 Infosys NIA	BFSI	Fraud Detection
 AiKno	Energy & Utilities	Predictive Analytics
 Mosaic AI	Retail & CPG	Return Management

Addressing Governance Challenges in AI to promote AI safety standards and guard against impacts of biased outcomes.

- Algorithmic Impact Assessments to be adopted by ethics councils proposed to be set up at least at all Government funded research centres building AI for public use cases.
- Researchers from the public, private, and academic sectors should work together to outline basic workflows and standards of documentation for specific application contexts which would be sufficient to show due diligence in carrying out safety checks.
- Explore ways for India to enhance its participation in the AI standardisation process.
- Involve other specialists along with scientists in the process of AI design and application to

check biases and their discriminatory impacts.

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