

# GS SCORE

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**REPORTS**

GIST OF IMPORTANT

## National strategy for Artificial Intelligence

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*For Civil Services Examination*

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## **NATIONAL STRATEGY FOR ARTIFICIAL INTELLIGENCE**

*Artificial Intelligence (AI) with intelligent machines enabling high-level cognitive processes like thinking, perceiving, learning, problem solving and decision making, coupled with advances in data collection and aggregation, analytics and computer processing power, AI presents opportunities to complement and supplement human intelligence and enrich the way people live and work.*

*Recognising AI's potential to transform economies and the need for India to strategize its approach related to it, NITI Aayog has come up with the Discussion Paper on Artificial Intelligence. Hereby, providing the gist of it - meaning of AI, applications in different sectors, international experience and way forward.*

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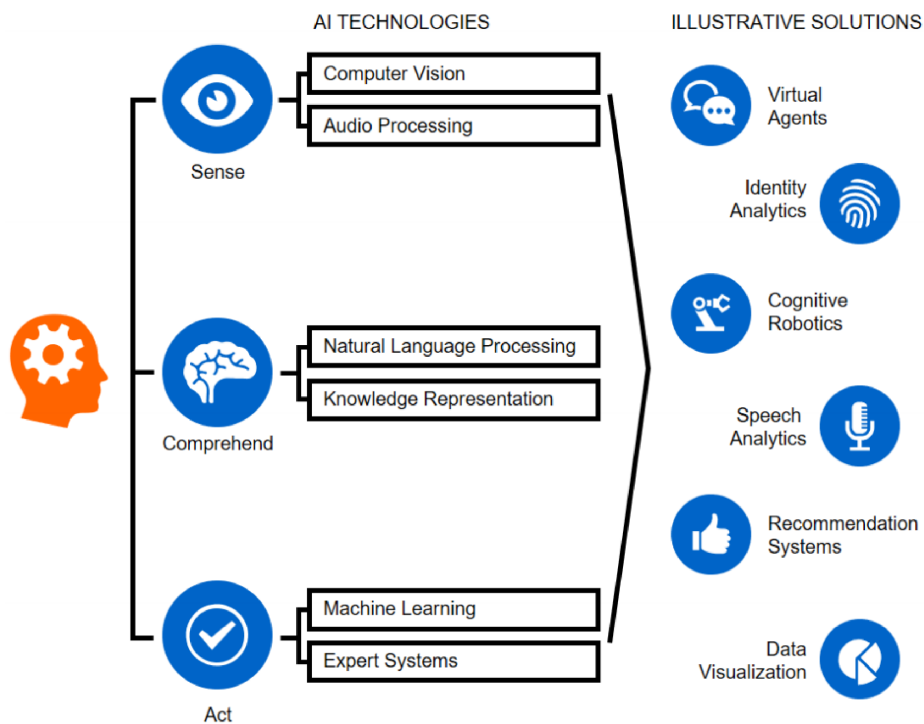
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## NATIONAL STRATEGY FOR ARTIFICIAL INTELLIGENCE

### What is Artificial Intelligence?

AI refers to the ability of machines to perform cognitive tasks like thinking, perceiving, learning, problem solving and decision making. Initially conceived as a technology that could mimic human intelligence.

Emerging AI technologies



The sub-sets of AI are: Machine learning and Deep Learning. Machine Learning involves the use of algorithms to parse data and learn from it, and making a determination or prediction as a result. Deep Learning is a technique for implementing Machine Learning. Artificial Neural Networks (ANNs) are algorithms that are based on the biological structure of the brain. In ANNs, there are ‘neurons’ which have discrete layers and connections to other “neurons”. Each layer picks out a specific feature to learn. It’s this layering that gives deep learning its name, depth is created by using multiple layers as opposed to a single layer.

### Where Artificial Intelligence sector booming?

A study by EY and NASCCOM found that by 2022, around 46% of the workforce will be engaged in entirely new jobs that do not exist today, or will be deployed in jobs that have radically changed skillsets. Thus different nations are moving for development of Artificial Intelligence.

- Universities in USA, primarily Carnegie Mellon University, Massachusetts Institute of Technology and Stanford, took an early lead in AI research by offering new courses, establishing research facilities and instituting industry partnerships. Off late, Chinese universities, especially Peking and Tsinghua Universities have caught on to the race by utilising large scale public funding and extensive research partnerships with private companies.

- For building the future workforce for AI, countries are also significantly increasing the allocation of resources for Science, Technology, Engineering and Maths (STEM) talent development through investment in universities, mandating new courses (e.g., AI and law), and offering schemes to retrain people. For instance, U.K. has planned to build over 1,000 government supported PhD researchers by 2025 and set up a Turing fellowship to support an initial cohort of AI fellows while China has launched a five-year university program to train at least 500 teachers and 5,000 students working on AI technologies.
- Governance structures for enabling all the above mandates vary across countries. Many countries have instituted dedicated public offices such as Ministry of AI (UAE), and Office of AI and AI Council (U.K.) while China and Japan have allowed existing ministries to take up AI implementation in their sectoral areas. Not just national governments, but even local city governments have become increasingly aware about the importance and potential of AI and have committed public investments.
- National governments have significantly increased public funding for AI through commitments such as increasing the R&D spend, setting up industrial and investment funds in AI startups, investing in network and infrastructure and AI-related public procurements. China, USA, France and Japan have committed significant public spending for AI technology development and adoption.
- These countries are also leveraging different combinations of public-private-academia to develop and promote AI.

### Where does India stand in Artificial Intelligence research?

- India has the necessary building blocks to develop a thriving AI research and development ecosystem, viz. availability of highly educated talent pool, world class educational institutes and an illustrious list of top notch IT companies dominating the global IT landscape. Despite these advantages India sees itself lagging considerably in producing world-class research and innovation in most technology fields, more so in AI.
- India produced a whopping 2.6 million STEM graduates in 2016, second only to China and more than 4 times the graduates produced by USA, thus producing the requisite talent pool to drive innovation in emerging technologies. Disappointingly though, an overwhelming majority of this talent pool is focused on routine IT development and not so much on research and innovation.
- Exacerbating the problem further, a majority of the small population focused on research almost always prefers to pursue advance degrees (Masters or PhD degrees) to subsequently apply their expertise abroad.
- An analysis of India's competence in core research in AI paints a somber picture. As per the Global AI Talent Report 2018, which crawled LinkedIn for its analysis, India only has 386 of a total of 22,000 PhD educated researchers worldwide, and is ranked 10th globally. The report also looks at leading AI conferences globally for presenters who could be considered influential experts in their respective field of AI. On this metric, India was ranked 13th globally, with just 44 top-notch presenters. While these two approaches have their limitations and inherent biases, anecdotal evidence based on discussions with top researchers reveals that serious research work in India is limited to less than 50 researchers, concentrated mostly at institutes like IITs, IIITs and IISc.
- In terms of the citable documents published in the field of AI from 2010 - 2016, India ranks a distant 5th, far behind the likes of China and USA and just about edging ahead of Germany and France who have considerably smaller STEM population.
- The Indian IT services companies, the likes of TCS, Wipro and Infosys, have been the flag bearers of India's competence in implementation of cutting edge technology solutions, yet their contribution to research has been limited.

### Status in USA

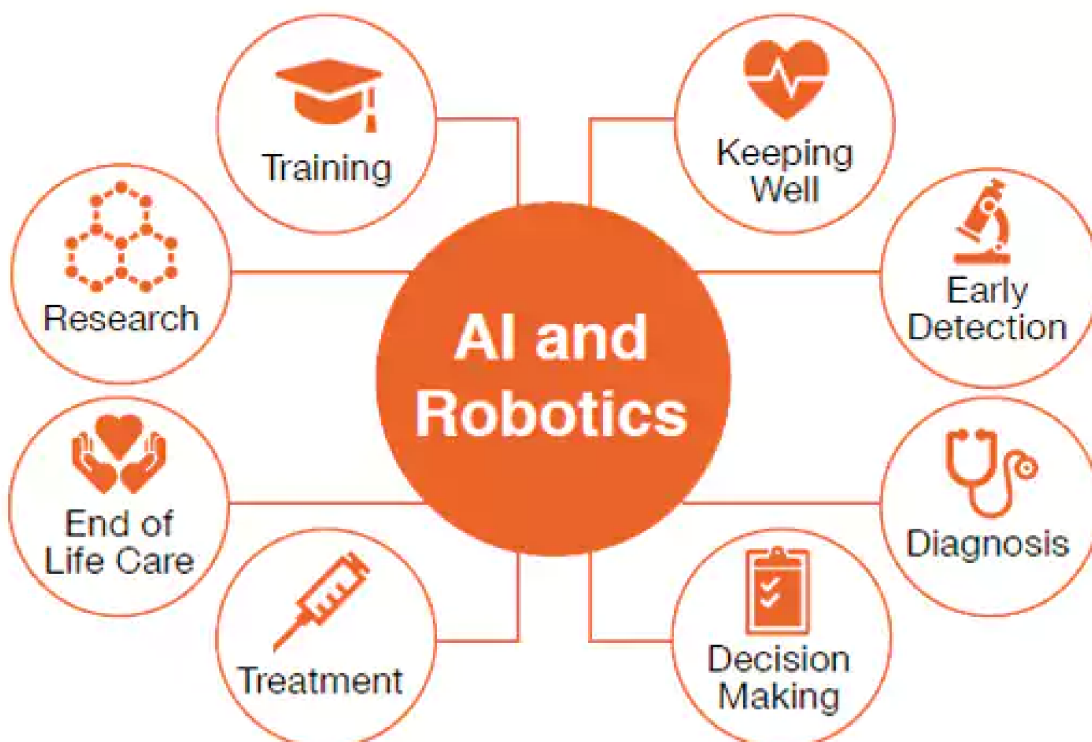
The US Government is estimated to have spent USD1.2 billion in non-classified research in 2016-18 and the Defence Advanced Research Projects Agency (DARPA) is seeking a budget of USD3.44 billion in fiscal year 2019-20, an increase of 8.5% compared with its request for fiscal 2018-19. However, US leadership in AI investment has largely been driven by the private sector. The world's leading companies in AI research in 2016 were Microsoft, Google and IBM, all US companies. According to CB Insights, based on 2017 figures, Amazon, Google and Microsoft dominate enterprise AI – again all US companies. It is estimated that more than half the world's unicorns are from the US. The digital ecosystems around the hubs of Silicon Valley, Seattle, Boston and New York, which bring together talent and research capabilities from leading universities, private investment and cross-science / industry collaboration, can be considered to have played an important role in developing the US's AI capabilities.

### Why India should move for implementation of AI?

Artificial Intelligence has the potential to provide large incremental value to a wide range of sectors globally. Some are discussed below:

#### 1. Healthcare:

- Healthcare is one of the most dynamic, yet challenging, sectors in India, and is expected to grow to USD280 billion by 2020, at a CAGR of upwards of 16%, from the current USD100 billion.
- Yet, it faces major challenges of quality, accessibility and affordability for a large section of the population: Shortage of qualified healthcare professionals and services, Non-uniform accessibility to healthcare across the country, Affordability of services and Reactive approach to essential healthcare largely due to lack of awareness, access to services and behavioral factors.
- *Applications of AI:*



- a) AI solutions can augment the scarce personnel and lab facilities; help overcome the barriers to access and solve the accessibility problem; through early detection, diagnostic, decision making and treatment, cater to a large part of India.
- b) NITI Aayog is working with Microsoft and Forus Health to roll out a technology for early detection of diabetic retinopathy as a pilot project. 3Nethra, developed by Forus Health, is a portable device that can screen for common eye problem.
- c) Integrating AI capabilities to this device using Microsoft's retinal imaging APIs enables operators of 3Nethra device to get AI-powered insights even when they are working at eye checkup camps in remote areas with nil or intermittent connectivity to the cloud. The resultant technology solution also solves for quality issues with image capture and systems checks in place to evaluate the usability of the image captured.

## 2. Agriculture:

- While India has come a long way from being categorized as purely an agrarian economy, agriculture and allied sector still accounts for 49% of India's workforce, 16% of the country's gross domestic product (GDP), and ensures food security to roughly 1.3 billion people. Agriculture and allied sector is critical to India's growth story.
- The Government of India has recently prioritised Doubling Farmers' Income as a National Agenda; putting considerable focus on supply chain perspectives in agriculture and market development in addition to productivity augmentation.
- Degradation of land, reduction in soil fertility, increased dependence on inorganic fertilizers for higher production, rapidly dropping water tables and emerging pest resistance are some of the several manifestations of India's unsustainable agricultural practices. The sector also suffers from poor resource utilisation, with the production quantum and productivity still being quite low. On the market side, non-existent functional end-to-end agriculture value chains have caused the price realisation for farmers to remain low. Access to, and timely availability of services, across agricultural value chain at the farmers' end thus becomes a challenge.
- **Applications of AI:**
  - a) Soil health monitoring and restoration
  - b) Crop health monitoring and providing real time action advisories to farmers
  - c) Increasing efficiency of farm mechanization
- **Examples:**
  - a) Intello Labs, for example, uses image-recognition software to monitor crops and predict farm yields.
  - b) Aibono uses agridata science and AI to provide solutions to stabilise crop yields.
  - c) Trithi Robotics uses drone technology to allow farmers to monitor crops in real time and provide precise analysis of their soil.
  - d) SatSure, a startup with roots in India, uses ML techniques to assess images of farms and predict economic value of their future yield.

### 3. Education:

- An effective education sector has the ability to transform a country through development of human resources and increased productivity
- **Issues in Education sector are:** Low Retention ratio, poor learning outcomes, Lack of interactive pedagogy and ineffective remedial instruction, Large teacher vacancies due to uneven distribution across locations, Professional development courses / training do not cater to real needs and have poor coverage, Low adoption of existing technologies.
- AI has the potential to bring about changes in the sector by supplementing pedagogy and establishing systems to inform and support decision making across stakeholders and administrative levels through:
  - a) **Adaptive learning tools for customised learning:** While AI may not completely replace a teacher, it has the potential to greatly assist teachers in efficiently and effectively managing multi-level / multigrade classrooms, by judging learning levels of individual students, and allowing automated development of customised educational content adapted to each child's class and learning level. Assessing time spent by a student on each part / page of the learning material, for example, would allow real-time feedback on student performance to help the teacher appropriately tailor her guidance to the child. This concept can be extended to automatic grading of tests, as well.
  - b) **Intelligent and interactive tutoring systems:** Intelligent Tutoring Systems can provide great benefit to students through delivery of learning materials adapted to the child's proficiency level, learning style, and pace of learning. In-built pop-up questions tailored to students, for example, can help increase interactivity, and catch student's attention and interest. It can also help in assessment of student's level of attention or comprehension to appropriately design remedial instruction. Grade Guardian, for example, uses predictive models and visualisations for student performance with an interactive dashboard showing anticipated effect of policy changes. Submission includes 3 components packaged as a single web app – a Chatbot that inputs student information, an Advisor Console that shows students at risk, and a prediction module for policymakers.
  - c) **Predictive tools to inform pre-emptive action for students predicted to drop out of school:** Analysis of test results and attendance records using AI can be used to predict probable student activities and inform pre-emptive action. For instance, in a recent preliminary experiment conducted in Andhra Pradesh, AI applications processed data on all students based on parameters such as gender, socioeconomic factors, academic performance, school infrastructure, teacher skills, etc., with the objective of helping the government identify students likely to drop out.
  - d) **Automated rationalization of teachers:** AI tools can be used to develop automated teacher posting and transfer systems, using analytics based on demand – supply gaps across schools in the State, candidate's prior postings, candidate preferences, etc. This would help in plugging of gaps in teacher distribution more effectively.

### 4. Smart Cities and Infrastructure:

- India is currently in the midst of a surge of urbanisation. While the percentage of the population living in urban areas was estimated to be 31% in 2011, recent research on satellite data indicates that this figure is close 45% today, and predicted to rise to up-to 60 percent by 2050. Though seen as an important aspect of a country's economic growth and a major step in the overall development of the country, unplanned urbanisation presents challenges such as congestion, over pollution, high crime rates, poor living standards, and can potentially put a huge burden on the infrastructure and administrative needs of existing Indian cities.

- **Applications of AI:**
  - a) **Smart Parks and public facilities:** Public facilities such as parks and other spaces contribute substantially to a city's liveability. Use of AI to monitor patronage and accordingly control associated systems such as pavement lighting, park maintenance and other operational conditions could lead to cost savings while also improving safety and accessibility.
  - b) **Smart Homes:** Smart homes concept is creating buzz with AI technologies being developed to optimise human effort in performing daily activities. Extending this concept to other domestic applications such as smart rooftops, water saving applications optimising domestic water utilisation for different human activities etc.
  - c) **AI driven service delivery:** Implementation of AI to leverage data on service delivery could see application such as predictive service delivery on the basis of citizen data, rationalisation of administrative personnel on the basis of predicted service demand and migration trend analysis, and AI based grievance redressal through chat-bots.
  - d) **Crowd management:** Use of AI in providing effective solutions in crowd management in recent times have been in vogue and given fruitful results in averting city-scale challenges such as managing mega footfall events, emergency and disasters. Accenture worked with the Singapore Government during their SG50 Celebrations (50th anniversary of Singapore' independence), and developed solution aimed at predicting crowd behavior and potential responses to incidents. The solution resulted in 85% accuracy in high crowd activity, crowd size estimation and object detection. Closer home, the "Kumbh Mela Experiment" is aimed at predicting crowd behavior and possibility of a stampede. Similar Big Data and AI solutions could help with advance prediction and response management.
  - e) **Intelligent safety systems:** AI technology could provide safety through smart command centres with sophisticated surveillance systems that could keep checks on people's movement, potential crime incidents, and general security of the residents. Social media intelligence platforms can provide aid to public safety by gathering information from social media and predicting potential activities that could disrupt public peace. In the city of Surat, the crime rate has declined by 27% after the implementation of AI powered safety systems.
  - f) **Cyber-attacks:** Cyber-attacks seem to pose a great threat to our institutions and public systems, today. AI technologies possess the capability to detect vulnerabilities and take remedial measures to minimise exposure of secure online platforms containing highly sensitive data from being targeted by unscrupulous social elements.

## 5. Smart Mobility and Transportation:

- Mobility and transportation form the backbone of the modern economy due to their linkages with other sectors and importance in both domestic and international trades. Today's society demands a high degree of mobility of various kinds, so as to enable efficient and safe transportation of both people and goods. As a major contributor to overall emissions, this sector must also be sensitive to ideas of environmental sustainability.
- Issues: Congestion and road accidents; according to a PIB release by the Ministry of Road Transport and Highways (MORTH) in March 2017, the total number of road accidents in the country during 2015 was 501,423 which resulted to 146,133 fatalities; Public transport infrastructure development remains laggard in the overall discourse.
- **Applications of AI:**



- a) **Autonomous trucking:** Autonomous technology in trucking has the potential to transform the way we move goods today. AI can help increase safety and hauling efficiency through intelligent platooning, wherein trucks form platoons giving drivers the liberty to rest while the platoon keeps moving. Such a method also ensures optimal road-space utilisation, helping improve road infrastructure capacity.
- b) **Intelligent Transportation Systems:** Through the use of an intelligent traffic management system including sensors, CCTV cameras, automatic number plate recognition cameras, speed detection cameras, signalised pedestrian crossings and stop line violation detection systems and the use of AI, real time dynamic decisions on traffic flows such as lane monitoring, access to exits, toll pricing, allocating right of way to public transport vehicles, enforcing traffic regulations through smart ticketing etc. can be made.

Accident heat maps could be generated using accident data and driver behaviour at specific locations on the road network related to topology, road geometric design, speed limit etc. and suitable measures could be pre-emptively taken to prevent possible accidents.

Also, AI could help to design sophisticated urban traffic control systems that can optimise signal timings at the intersection, zonal and network level, while also facilitating services such as automatic vehicle detection for extension of red/green phase or providing intermittent priority.

- c) **Travel route/flow optimisation:** With access to traffic data at the network level, AI can help make smart predictions for public transport journeys by optimising total journey time including access time, waiting time and travel time.

Considering factors such as accessibility to nearest mode of travel, most convenient access path based on local conditions and one's preferences, AI can revolutionise first-last mile travel which could change the way we perceive public transport journeys, today. About private car usage, AI could utilise a range of traffic data sets and one's own preferences to make human-like decisions on route selection.

With information on dynamic tolls and traffic flows on links, the dependency on overhead Variable Messaging Systems (VMS) could be minimised, reducing substantial infrastructure costs. On the systemic level, AI can help predict flow of traffic at the network level and suggest alternative flow strategies in order to contain congestion, alleviating cities of this major issue.

- d) **AI for Railways:** According to official figures, more than 500 train accidents occurred between 2012- 2017, 53% of them due to derailment. Train operators can obtain situational intelligence through realtime operational data and analyse them in three different dimensions: spatial, temporal and nodal. Fleet management and asset maintenance including that of rolling stock are pertinent AI use cases.

Recently, the Ministry of Railways, Govt. of India has decided to use AI to undertake remote condition monitoring using non-intrusive sensors for monitoring signals, track circuits, axle counters and their sub-systems of interlocking, power supply systems including the voltage and current levels, relays, timers.

- e) **Community Based Parking:** The availability of parking is a major issue for Indian cities. AI can help optimise parking, likely by minimising vehicle downtime and maximising driving time. With the advent of electric vehicles, AI will be needed to mediate the complex vehicle grid interactions(VGI) as well as for charging optimisation.

Parking guidance systems help drivers to find vacant parking spaces while they are using the road network and have approached close to their destination.

Community based parking using AI helps cars in traffic to collect data on vacant parking spaces, and allocates cars to spaces such that the demand is always met.

### HOW to handle the challenges and recommendations to improve that?

The challenges are concentrated across common themes of:

- a) Lack of enabling data ecosystems
- b) Low intensity of AI research i. Core research in fundamental technologies ii. Transforming core research into market applications
- c) Inadequate availability of AI expertise, manpower and skilling opportunities
- d) High resource cost and low awareness for adopting AI in business processes
- e) Unclear privacy, security and ethical regulations
- f) Unattractive Intellectual Property regime to incentivise research and adoption of AI
- g) Lack of collaborative / interdisciplinary approach: research is mostly focused in silos in academic institutions
- h) Lack of scale for experimental validation: due to various practical and financial reasons, university research is largely restricted to theoretical or laboratory scale.
- i) Lack of facilities to support large scale experimental test beds
- j) Lack of connect with stakeholders and practitioners to convert outputs to outcomes
- k) Lack of large scale mission mode project management capabilities

These challenges, while by no means exhaustive, if addressed in an expeditious manner through concerted collaborative efforts by relevant stakeholders, with government playing a leading role, could lead to fundamental building blocks that form the core to India's march towards leadership in AI.

### Recommendations

- Re-skilling of the current workforce will require integration with relevant existing skilling initiatives, building of new platforms that can enable improved learning, and novel methods of allowing large scale employment generation through promotion of AI.
- The increasing demand for AI or data related job positions has not gone unnoticed by the Indian workforce, with a large percentage of them opting for training institutions to bridge their knowledge gaps. In technology hubs such as Bengaluru, this has led to many traditional IT training institutions establishing courses in new age technologies. Thus Recognition and standardisation of informal training institutions is must.
- The education sector needs to be re-aligned in order to effectively harness the potential of AI in a sustainable manner. In primary and secondary schools, there is a need for transition to skill based education in subjects relevant to AI.
- In higher education institutions there is need for increased collaboration between industry and academia through creation of channels of communication between faculty and industry to promote exchange of ideas and expertise.
- AI is a highly collaborative domain, and any framework aimed at promoting AI needs to be aligned accordingly. A multi-pronged approach, involving various stakeholders and promoting a collaborative approach is required for promoting development of AI tools as well as adoption of AI in different fields of activity.

- In order for India to ride the AI innovation wave, a robust intellectual property framework is required. Despite a number of government initiatives in strengthening the IP regime, challenges remain, especially in respect of applying stringent and narrowly focused patent laws to AI applications – given the unique nature of AI solution development. The importance of data to development of useful models is one such example. To tackle these issues, establishment of IP facilitation centers to help bridge the gap between practitioners and AI developers, and adequate training of IP granting authorities, judiciary and tribunals is suggested.
- Achieving the goal of #AIforAll requires long term and engaged institutional collaboration between all the stakeholders including the citizens. However, while playing the primary role in ensuring that this collaborative strategy succeeds, the government needs to be mindful of not crowding out the private sector. Role of the government thus needs to be one of a facilitator, an active promoter and wherever required, of an owner.

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