National AI Policy/Strategy of India and China:
A Comparative Analysis

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Abstract: In the recent times, many countries across the world have devised their national policies and strategies in the domain of Artificial Intelligence (AI). The primary aim of all these strategies/policies is to ensure a leadership position in AI while harnessing this technology for increasing their global competitiveness as well as for addressing their societal challenges and developmental needs. The objective of this discussion paper is to provide a comprehensive and in-depth overview and analysis of such policies/strategies in India and China while carrying-out a comparative analysis of them as well.

Keywords: Artificial Intelligence (AI), National AI Policy/Strategy, India, China, Responsible AI, Ethics

I. Introduction

Like many countries, both India and China have released their national policy/strategy on Artificial Intelligence (AI). These policies/strategies have charted out the vision, objectives, goals, instruments, and plans for the development of AI in the country. In the literature, there are studies on policies and strategies of different countries (see for example OECD, 2019; ORF, 2018; APFC, 2019; HolonIQ, 2020; Dutton, 2018), while OECD has launched an observatory on AI with information on policies[1]. The approaches undertaken by the countries vary according to their priorities and aspirations. One would find some convergences as well as some divergences in these approaches. Same holds true for both India and China.

For a comprehensive and holistic understanding of the national AI policy or strategy of India and China, this discussion paper has attempted to undertake the overview and analysis within the following six components: Guiding Principle/Motivation; Overall Objectives; Strategic Goals; Key Tasks; Resource Allocation; and Supporting Institutional Architecture.

The paper has also carried-out an in-depth analysis of the such policy/strategy and provided a comparative analysis.

II. AI Policy in China

China, building on its previous technological and industrial plans such as "2006 National Medium- and Long-Term Program for Science and Technology Development (2006- 2020)", "2015 Made in China-2025 Policy", "2016 National 13th Five-Year Plan for S&T Innovation (2016-2020)", "2016 Internet Plus Action Plan" and "2016 Robotics Industry Development Plan", released the *"New Generation of Artificial Intelligence Development Plan*" in July 2017. This Plan is marked as the most comprehensive of all the national AI strategies or plans announced by any other country in the world.

Guiding Principle/Motivation: The guiding principle towards the development of an AI Plan is the strategic importance of AI in increasing China's global competitiveness and enhancing the national security. The Plan Document has clearly recognised AI as the core driving force for the new round of industrial transformation (MOST, 2017; FLIA, 2017) and as a medium of fostering transformation from "Digitisation and Internetisation" to "Intelligentisation" in all aspects of social and economic sphere (MOST, 2017). It further envisaged the application of AI in certain social sectors such as education, healthcare, social security, environmental protection, public service delivery and so on; thus comprehensively improving the quality of life of the people and social governance.

Overall Objectives: There are four principle objectives that have been stated in the AI Plan Document (MOST, 2017; FLIA, 2017 p. 4). These are as follows:

- *Leadership of Technology:* The primary objective is to attain the global leadership position in AI through accelerating the 'first-mover advantages' by enhancing the original innovation capability of AI in order to achieve transformational breakthroughs in AI theory, methods, tools and systems.

- *Systematic Layouts:* The second important objective is to develop a holistic systematic approach where basic research, technology development and industrial development are organically in tandem with the supporting institutional and policy architecture.

- *Market-Oriented:* The third important objective is to adhere to the application-oriented market-led product development by the AI enterprises so as to ascertain China's global competitive advantage. The government's role would be to facilitate the industry to flourish by providing them with policy support and guidance.

- *Open Source:* The fourth objective is to promote the concept of open source and sharing especially in terms of the two-way conversion application of military and civilian scientific and technological achievements.

Strategic Goals: The three strategic goals with timelines have been stated in the AI Plan Document (MOST, 2017; FLIA, 2017 p.5). These are as follows:

- *"Keeping-Up":* By 2020, it is expected that China would try to keep up its overall technology and application of AI at par with the advanced level of the world. It also endeavours to establish AI standards, service system and industrial value chain by cultivating world-level backbone enterprises. On account of the scale of AI industries, it is envisaged that by 2020, the scale of AI Core industry and the related industries will be more than RMB 150 Bn and RMB 1 Tn respectively.

- *"Leading Partially":* By 2025, China shall achieve the major breakthrough in AI basic theory and will be at the "world-leading" level in some of AI technology and applications. The AI will

become the main driving force of China's industrial and economic transformation, while making progress towards developing a global high-end value-chain and constructing an AI society encompassing intelligent manufacturing, intelligent healthcare, intelligent cities, intelligent agriculture, and intelligent defence and so on. It also endeavours to establish AI laws and regulations, ethical norms and development of AI safety assessment and control capabilities . On account of the scale of AI industries, it is envisaged that by 2025, the scale of AI Core industry and the related industries will be more than RMB 400 Bn and RMB 5 Tn respectively.

- *"Leading Completely"*: By 2030, the AI Plan Document expects China to solidify its leading position completely by becoming the major AI "innovation center of the world", laying the critical foundation for China's entry into the forefront of the innovative countries, thus occupying the commanding heights in AI technology. It endeavours to build more advanced industrial chain and high-end industrial cluster of core technology, support platform and intelligent applications. It also envisages the development of comprehensive laws, regulations and ethical framework for AI. On account of the scale of AI industries, it is envisaged that by 2030, the scale of AI Core industry and the related industries will be more than RMB 1 Tn and RMB 10 Tn respectively.

Key Tasks: In order to fulfil the stated objectives and achieve the strategic goals, the AI Plan Document has enumerated the following key tasks that are supposed to be accomplished in due course of time (MOST, 2017; FLIA, 2017 p.7):

- *Promoting strong basic and applied R&D:* The need to promote world-class basic and applied research and development has been very aptly stated in the Plan Document.

- *Promoting interdisciplinary exploratory research:* The Plan Document encourages the interdisciplinary R&D by promoting convergence of AI with other science and social science disciplines

such as neuroscience, cognitive science, quantum science, psychology, mathematics, economics, ethics and sociology, so as to the strengthen the formulation of sound AI algorithms.

- *Strengthening high-end computing infrastructure:* The requirement of establishing high-end computing hardware and information infrastructure (including 5G) has been very well recognised in the Plan Document and ample focus has been given in this direction.

- *Promoting Sectoral Applications of AI:* Promoting the extensive integration of AI in various sectors such as manufacturing, agriculture, healthcare, education, logistics, finance, governance, transport, environment etc.

- *Strengthen AI in the field of military-civilian integration*: Promoting deeper integration of AI technology in military-civilian two-way transformation.

- *Laying out new generation of AI major R&D projects:* The Plan Document highlights the need for the existing R&D layout to support the *"1+N" AI Programme.* '1' refers to a new generation of S&T projects in AI, while 'N' refers to the national planning and deployment of AI R&D projects. This approach signifies the importance of coordinated approach of placing the productive outcomes out of the R&D projects into use immediately.

- *Training high-end AI talent*: The Plan Document envisages the cultivation of highly trained human resource in the field of AI by introducing AI in education system in colleges and universities; and by encouraging the linkages of domestic human resource with the world's top research institutions of AI. The Plan Document also envisages the leveraging of existing talent plans such as "*Thousands of People Plan*" to strengthen the inflow of AI talents and the cross-integration of AI education with other disciplines as well.

- *Promoting AI-based economy and industry*: Realising the significant role of industries to lead the cultivation of AI-led data economy, the Plan Document stresses the need to speed up the application of AI

in industries. Various avenues of product developments have been indicated in the Plan Document where Chinese domestic industries can take lead on such as intelligent hardware and software, smart robots, intelligent vehicles, self-driving cars, UAVs, Virtual reality/ Augmented reality devices, smart terminals, etc.

Resource Allocation*:* Various ways to support and finance the AI development in the country has been mentioned in the AI Plan Document (MOST, 2017; FLIA, 2017 p.24). These are as follows:

- *Government and Market-led financial support mechanism*: In addition to the financial support provided by the government, it is expected that the leading enterprises, venture capital funders and angel investors would led the establishment of market-oriented AI development fund to support AI R&D in China.

- *Leveraging international and domestic innovative resources:* Plan Document promotes FDI, mergers and acquisitions, venture capital, equity investments and setting up of foreign R&D centres in China.

Supporting Institutional Architecture: According to the AI Development Plan Document, the following additional measures are to be taken by China in order to support the faster and robust development of AI in the country (MOST, 2017; FLIA, 2017 p.25):
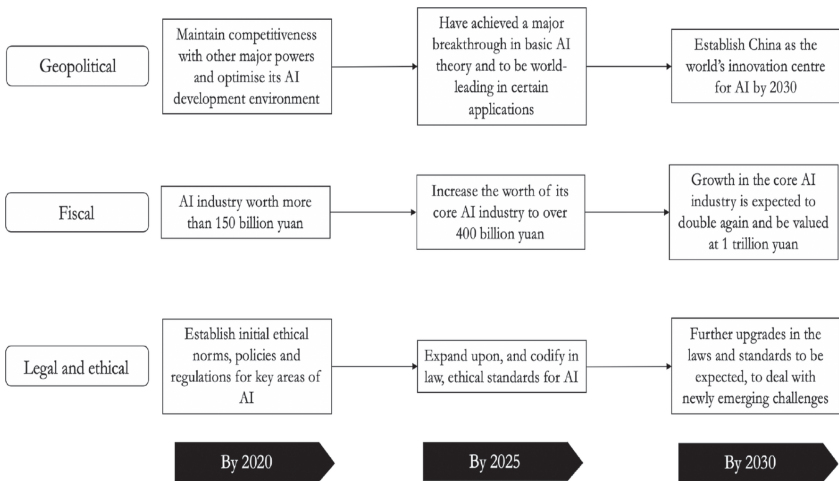
- *Key incentive policies*: To support small and medium AI enterprises and start-up companies, the Plan Document highlights the need to implement tax incentive schemes.

- *Development of laws, regulations and ethical norms*: To ensure healthy development of AI in China, the Plan Document stresses for the timely development of laws, regulations and ethical frameworks based on ELSI research. It also argues for the establishment of traceability and accountability system for AI while adhering to the principles of security, availability, interoperability and data privacy and protection. The need for China to actively participate in the global governance of AI has been clearly stated in the Plan Document.

- *Establishment of standards and intellectual property system for AI*: The Plan Document encourages the Chinese AI enterprises to

participate in or lead the development of international standards. It also calls for the protection of IP in the field of AI by establishing AI public patent pools.

- *Establishment of safety supervision and evaluation system for AI:* The Plan Document stresses for the need to increase disciplinary measures against the abuse of data, violations of personal privacy and anything morally unethical. It also calls for the strengthening of AI network security system and promotion of AI safety certification and assessment of AI products.

The figure 1 summarises China's AI Development Plan (AIDP) in terms of its major geopolitical, fiscal, legal and ethical goals.

Figure 1: Visualising China's AIDP

Geopolitical	Maintain competitiveness with other major powers and optimise its AI development environment	→	Have achieved a major breakthrough in basic AI theory and to be world-leading in certain applications	→	Establish China as the world's innovation centre for AI by 2030
Fiscal	AI industry worth more than 150 billion yuan	→	Increase the worth of its core AI industry to over 400 billion yuan	→	Growth in the core AI industry is expected to double again and be valued at 1 trillion yuan
Legal and ethical	Establish initial ethical norms, policies and regulations for key areas of AI	→	Expand upon, and codify in law, ethical standards for AI	→	Further upgrades in the laws and standards to be expected, to deal with newly emerging challenges
	By 2020		By 2025		By 2030

Source: Adapted from Roberts *et al* (2020).

Subsequent to the AI Development Plan, the Chinese Ministry of Industry and Information Technology (MIIT) issued the three-year **"***Action Plan for Promoting the Development of a New Generation of AI Industry (2018-2020)"* in December 2017. This Plan needs to be seen as a supplementary plan to the AI Development Plan, while taking forward its agenda. It focuses on the in-depth integration of IT and

manufacturing technology, with the integration of the new generation of AI technology application, to promote the in-depth integration of AI and the manufacturing industry to accelerate the building of China into a manufacturing superpower. The action plan lays out an implementation plan and goals in the following four key initiatives by 2020 (MIIT, 2017):

- First key initiative deals with the innovative products and services in industry, healthcare, transportation, agriculture, finance, logistics and education. Intelligent and Connected Vehicle (ICV) has been marked as a first key product that was included in the plan. The plan supports the R&D of critical technologies for intelligent computing platform architecture for vehicles, semiconductors for ICV, autonomous driving operating systems, and intelligent algorithms for vehicles. By 2020, the goal is to build a reliable, safe, real-time intelligent platform for ICV and develop related standards to support high availability level.

- Second key initiative focuses on intelligent sensors and neural network semiconductors. The plan supports the development of high-precision, low-cost sensors, R&D for compact and reliability design, precision manufacturing, integrated development tools, embedded algorithms, etc. It also supports the R&D and application of intelligent sensors designed based on new needs, new materials, new techniques, and new theories and the R&D of new intelligent sensors based on MEMS and CMOS. Neural network semiconductors are another key area mentioned in the plan.

- The third key initiative is on the development of smart manufacturing, in particular, key technical equipment and new manufacturing models incorporated with AI.

- The fourth initiative has been to build a comprehensive AI support system, including setting up an industry training data pool for sectors such as industry, healthcare, finance, transportation, etc. Similar to the AI Development Plan, this plan also points out the need to build an AI industry standards system, encouraging industry leaders to

participate in international standards work. At the same time, the plan calls for building an AI product assessment system and an AI patents and IPR protection platform. In order to ensure the fast development of AI, the plan contains goals for the development and deployment of 5G technology.

In the sphere of formulating the framework and action guidelines for AI governance towards developing responsible AI in China, the National New Generation AI Governance Professional Committee issued the "*New Generation AI Governance Principles: Developing Responsible AI*" in June 2019. These governance principles aim to foster better coordination between AI development and governance so as to ensure that AI is safe, controllable and reliable, and promote sustainable economic, social and ecological development, thus building a community with a shared future for mankind. It charts out the flowing eight principles of governance (MOST, 2019): Harmony and Friendship; Fairness and Justice; Tolerance and Sharing; Respecting Privacy; Safe and Controllable; Share Responsibilities; Open Collaboration; and Agile Governance.

From the above, it can be inferred that China has come out with a focussed approach towards the development and deployment of Artificial Intelligence in a wide array of sectors with dedicated funding and guidance coming from both public and private sectors. Given its strategic goals and visions, this approach might not turn out to be productive, if some of the prevailing weaknesses are not addressed in time.

III. Analysis of China's AI Policy

There are several factors in China which complement and supplement government's primary vision of attaining global leadership position in AI. First and foremost, China has announced plans to invest huge amount of funding in AI research and development. Chinese cities have also embarked upon their AI promotion efforts. For example, Beijing announced to set up of a USD 2.1 billion AI-centric technology park, while Tianjin plans to set up a USD 16 billion AI Fund. In 2018, China had more than 60 AI tech parks. Such industrial parks are already providing

preferential financial policies to attract AI companies, such as rental subsidies and tax concessions (Daxue Consulting, 2020).

In addition to the government, huge investment is also coming from the private sector. In 2018, the investment value in China's AI industry reached RMB 131.1 bn, making it first in the scale of AI investment in the world (Daxue Consulting, 2020). The government has invested more than USD 1 billion on domestic start-ups through "Government Guidance Funds" (GGF) set up by local governments and state-owned companies (Ding, 2018).

In 2017, Chinese AI start-ups received 48 per cent of total global AI venture funding, outpacing the USA. China reportedly has also the world's second-highest number of AI companies, only behind USA and is home to the world's most highly valued AI start-up company, SenseTime Group Ltd[2].

The AI market in China has been booming since 2015 at a high rate. In 2019, the size of China's AI market reached RMB 50 bn from only RMB 11.24 bn in 2015 with the CAGR of more than 44 per cent from 2015 to 2019. By 2020, the AI market size in China is expected to reach RMB 71 bn. (Daxue Consulting, 2020).

In addition to these factors, the presence of AI-specific bodies such as 'China's AI Plan Promotion Office' under the Ministry of Science and Technology in China helps in steering the AI development in a focussed manner.

Chinese government has placed private sector at the centre of AI's development in China. Tech giants such as Baidu, Alibaba and Tencent (BAT) have been named as 'National Champions in AI' to help stimulate and steer AI innovation and development in China. In terms of scientific publications in AI, China's AI papers as a percentage of the global total increased from 4.26 per cent in 1997 to 27.68 per cent in 2017, far ahead of other countries (CISTP, 2018). Out of the top 20 publishing organisations, 10 are in China. According to an analysis by the US-based Allen Institute for Artificial Intelligence, of the most-cited

AI papers indexed on the scholarly search engine Microsoft Academic, it was found that China has steadily increased its share of authorship of the top 10 per cent most-cited papers. It was 26.5 per cent in 2018, not far behind the USA (29 per cent). If this trend continues, China could overtake the USA very soon. Other analyses show that average citations for AI papers by authors in China have been steadily increasing and are above the world average, but lower than for papers by US authors though (O'Meara, 2019).

In terms of patents in the field of AI, China recently surpassed USA in terms of AI patent filings. It filed more than 110,000 AI patent applications last year.[3]

According to WIPO's Technology Trends 2019 Report (WIPO, 2019), about one-fifth of the top 500 applicants in AI, ranked by number of patents, are from universities and public research organisations from China. In the list of the top 500 applicants, China is represented by more than 100 institutions; whereas the USA. and the Republic of Korea each have around 20, while Japan and Europe have only four each.

In terms of availability of AI human resource, according to a 2018 report on AI development in China, China was home to the second-largest pool of AI scientists and engineers by the end of 2017 with about 18,200 people (representing 8.9 per cent of the global total), ranking just behind the USA which had roughly 29,000 (representing 13.9 per cent of the global total) (CISTP, 2018).

In order to build more AI skilled human resource, the Chinese Ministry of Education released its first AI Innovation Action Plan for Colleges and Universities in April 2018 which aims to establish China's universities as hotbeds for AI talent by 2030. The Plan aimed to establish 50 AI research centres, bring out 50 world class AI textbooks and set up 50 national-level high-quality online AI courses by 2020. Along with this, the Ministry of Education also plans to train 5,000 students and 500 teachers in AI within five years (Kewalramani, 2018).

Data is the most important factor in the development of AI. Availability of huge amount of data in China will greatly help it in developing more robust AI algorithms. In terms of the volume of data, China has the largest number of internet users in the world, reaching about 903 million in March 2020[4]. About 847 million Chinese people used mobile phones to surf the internet and mobile phone users accounted for 99.1 percent of the total netizens.[5] The enormous quantity of netizens means that "*the data Chinese companies can access to are more complex and multiple-dimensional and serve as a solid foundation for the algorithm upgrade of AI technologies and the expansion of application scenarios*" (Deloitte, 2019). These favourable conditions are expected to provide a strong impetus and thrust for the development and deployment of AI in a much faster and concerted manner in China. Nonetheless, there are some limiting factors too that are prevailing in China, as discussed below.

These limiting factors can potentially limit or check China's progress in its pursuit for attaining AI global leadership. First and foremost is the availability of the core technological hardware base that acts as the foundational platform to develop AI. China lags behind in AI hardware capabilities. Most of the world's leading AI-enabled semiconductor chips are made by US companies such as Nvidia, Intel and Advanced Micro Devices. China lacks expertise in designing computing chips that can support advanced AI systems. Despite being the world's biggest semiconductor market, data shows that China manufactures only around 16 per cent of the semiconductors it uses domestically (Laskai and Toner, 2019).

According to some estimates, it could take about 5 to10 years for China to reach the level of innovation in AI's fundamental theories and algorithms that is currently occurring in the USA and UK. Without progress in this sector, which could enable genuine breakthroughs in AI or ML, there might be a "*ceiling to the growth that China can achieve in the field of AI*" (O'Meara, 2019).

If China is to emerge as a global leader or to have global influence in the field of AI, it is important that it has a proper governance framework in place. In the case of China, the growing concern towards its mass surveillance endeavour using AI is perhaps the ==most concerning development.== Recently China has attracted criticism from human-rights advocates over its alleged use of AI-based facial recognition technology to track members of the Uighur people, a predominantly Muslim community in Xinjiang region (O'Meara, 2019). Zeng (2020) has argued that AI is merely a instrument that "*the Chinese authoritarian regime has actively employed not only to improve public service, but also to strengthen its authoritarian governance*".

In the AI Readiness Index Report 2020, its been expressed that there is a potential danger of China exporting these surveillance technologies to other countries. The Report argued that "*as the geopolitical influence of China grows, there is a risk that it will become an 'irresponsible AI' leader that other countries seek to emulate*" (Oxford Insights and IDRC, 2020).

On the availability of huge data, it has been argued that the mere availability of large quantities of data does not imply that it would lead to the desired and sound AI development. The qualitative component of training data for AI systems is equally crucial. Among other things, quality is primarily a factor of diversity and inclusivity. Therefore, it would be interesting to see how China includes these aspects into its AI algorithm development to ensure fairness and un-biasness, without which the AI system or solution would be rendered less effective and discriminatory.

Roberts *et al* (2020), Soros (2019) and Allen (2019) have expressed serious concerns regarding the Chinese push towards AI-powered mass surveillance system to control certain communities. They also emphasise the problematic nature of the AI-driven social governance architecture including the Social Credit System in China, due to the "*authoritarian undertones of this pervasive control*" (Roberts *et al*, 2020). In terms of privacy too, there are many loopholes and exceptions that enable the government (and private companies implicitly endorsed by the government) to bypass privacy protection and have unrestrained access

to the huge about of personal data. Moreover, China's AI strategy explicitly recognises the dual-use nature of artificial intelligence for both the civil and military use. This Civil-Military fusion approach in AI is a matter of serious concern too as it will allow for the easy exchange of personal and commercial data for the military technology development and deployment.

IV. AI Strategy in India

Though there is no national AI policy that has been released by the government as such, there is a "National Strategy on AI" which has been announced by the NITI Aayog (an apex think-tank of the government) in 2018. Prior to this Strategy, there has been a report submitted by the AI Task Force constituted by the Ministry of Commerce and Industry in January 2018 The Ministry of Electronics and Information Technology (MeitY) also constituted four expert committees in February 2018 in order to suggest ways to promote AI and to develop a policy framework for India. These committees dealt with the following four areas: Platforms and data for AI; leveraging AI for identifying National Missions in key sectors; mapping technological capabilities, key policy enablers required across sectors; skilling and re-skilling, R&D; and cyber security, safety, legal and ethical issues.

These four committees submitted their final reports in July 2019. MeitY and NITI Aayog are presently working on the development of a "National Programme and Policy on AI".

Guiding Principle/Motivation*:* The guiding principle or motivation behind the formulation of the National Strategy on AI is to leverage AI to ensure social and inclusive growth in line with the development philosophy of the government. The theme of the AI Strategy is *#AIforAll: Technology Leadership for Inclusive Growth.* It clearly states that India's approach towards AI would be guided by "*optimisation of social goods, rather than maximisation of topline growth*" (NITI, 2018). The AI Task Force Report too has stated that the guiding vision is to leverage AI as a "*socio-economic problem solver at large scale rather than only a booster of economic growth*" (MoCI, 2018).

Overall Objectives: There are broadly three objectives that can be drawn from the National AI Strategy Document. These are as follows:

*   *Leveraging AI for Economic Growth*: Considering AI as a new emerging factor of production, the AI Strategy stated that AI has the potential to drive growth through enabling: (a) intelligent automation (b) labour and capital augmentation and (c) innovation diffusion. Huge economic value is expected to be created from the new goods, services and innovations that AI will enable.

*   *Leveraging AI for Social development and Inclusive growth*: The AI Strategy views AI from the perspective of the transformative impact it would be having on improving the quality of life and access of choice to a large section of the country. The challenges in sectors such as agriculture, healthcare, financial inclusion etc are some of the examples that can be most effectively dealt through the advantages that a technology such as AI can provide.

*   *Developing India as "AI Garage":* The AI Strategy envisages developing India as the *"AI Garage"* for 40 per cent of the world; wherein India would act as a "*playground*" for enterprises and institutions globally to develop scalable solutions in India, which can be easily implemented in the rest of the developing and emerging economies. In other words, *"Solve for India"* would mean solve for 40 per cent or more of the world; thus projecting India as the most appropriate R&D&I destination for AI.

Strategic Goals: The strategic goal basically pertains to the application of AI in five key sectors, which are envisioned to benefit the most from the application of AI in solving pressing societal challenges. There are as follows:

*   *Healthcare:* AI can lead to increased access and affordability of quality healthcare;

*   *Agriculture:* Application of AI is expected to increase the farm productivity and lead to reduction of wastage, thus enhancing farmer's income;

- *Education*: Use of AI can result in improved access and quality of education across a wide population;
- *Smart Cities and Infrastructure:* There is a huge scope of AI role in building smart cities and infrastructure; and
- *Smart Mobility and Transportation:* AI can be used for smarter and safer modes of transportation and for managing safe traffic movements thus lowering the accidents.

Key Tasks: The following set of key tasks has been mentioned in the National Strategy for AI. These tasks have been enshrined upon the government to take them forward in its role as facilitator and active promoter.

- *Promoting AI Research and Application*: To foster advanced research and application of AI in India, the government needs to set-up Centres of Research Excellence *(CORE)* for AI and International Centres for Transformational AI *(ICTAI)*, announce PhD Scholarships, promote inter-academia collaboration and provide Faculty Fellowships.
- *Establish Common Data Computing Platform:* The government should establish a national level AI Research Analytics and Knowledge Assimilation Platform *(AIRAWAT)*, which will act as a common cloud platform for Big Data Analytics with large AI computing infrastructure connecting all COREs, ICTAIs and other academic institutions with National Knowledge Network.
- *Creating a "CERN for AI":* Indian government should take lead in establishing a supra-national institutional architecture namely "*People's AI: CERN for AI*" by bringing together other interested national governments.
- *Re-skilling and Training:* Government should incentivise investment in re-skilling and training of employees through tax-breaks and grants for employers.
- *Promotion of Future Jobs Creatio*n: Government needs to promote creation of future service jobs by incentivising through tax holidays or inclusion in CSR activities.

- *Monitoring Job Scenario*: There is a need to constitute a Standing Committee or Task Force to examine and report on the changes in employment due to AI adoption.

- *Development of Human Resource*: Government should introduce AI/ML teaching and training right from the school level to build skilled AI workforce suitable for taking up the future jobs.

Resource Allocation: On resource allocation or budgetary support, the Strategy Document is silent. It states that these details will be ascertained after more detailed consultations with all the stakeholders in due course of time. However, the AI Task Force in its report stated that a budget of INR 1200 Cr (USD 162 Mn) (for 5 years) should be allocated for the proposed National AI Mission (N-AIM).

Supporting Institutional Architecture: According to the National AI Strategy Document, the following additional measures should be taken in order to support the faster and robust development and diffusion of AI in the country:

- *Key Incentive Policies*: Government should establish Incubation Hubs and Venture Funds especially for AI Start-Ups in collaboration with State governments. Such an initiative will help the building up of a sound Start-Up ecosystem in the country. Schemes such as tax breaks and tax holidays should be offered to the companies which are involved in re-skilling/up-skilling their employees to take on AI jobs or those which are creating new set of AI-related future jobs.

- *Building an Appropriate IP Regime for AI:* Government needs to build an attractive IP regime for supporting AI innovations by applying appropriate modifications to the IP regulatory regime pertaining to AI.

- *Promoting Responsible AI:* To ensure healthy development of AI in India, the Strategy Document advocates for development of Responsible AI in the country. To this end, it suggests that the government should set-up a Consortium of Ethics Councils at the leading AI research and academic institutions.

- *Instituting Data Privacy and Protection Framework:* The Strategy Document highlights the need to formulate a Data Protection Legal Framework, which would be protecting human rights as well as privacy without stifling innovation in India.

- In addition to the points made in the National Strategy for AI, there are certain points as stated in the AI Task Force Report, which should be taken into consideration while drafting a National Policy on AI. These are as follows (MoCI, 2018):

- *Setting Up of Data Banks, Data Exchanges and Data Ombudsman*: The government should enable setting-up of digital data banks, exchanges, marketplaces to ensure availability of cross-industry data and information necessary sharing-related regulations. There is also a need to create a "Data Ombudsman" on lines similar to Banking and Insurance, to quickly resolve data-related issues and grievances.

- *Standard-Setting:* There needs to have a Standard-Setting institutional mechanism in the country to look into the formulation and compliance of AI-related standards on lines of international norms. India should actively participate in these Standards-Setting international working groups.

- *Global Governance:* India should also participate actively in the global discussions on governance of AI. This is very crucial as it will help India ensuring its positioning in shaping the governance architecture in the international forums.

In February 2021, NITI Aayog came out with a report titled *"Responsible AI #AI for All: Approach Document for India Part I: Principles for Responsible AI".* In this report, case studies of AI systems in India and around the world have been studied and the principles for Responsible AI are derived from the Constitution of India and various related laws. The case studies and considerations in this report have been grouped into two broad categories viz. 'Systems considerations' and 'Societal considerations'. 'Systems' considerations are those arising as a result of the system design choices and deployment processes such

as inherent bias, potential exclusion, accountability, privacy risks and security risks; and have the potential to impact stakeholders interacting with a specific AI system; while the 'Societal' considerations, includes broader ethical challenges pertaining to risks arising out of the very usage of AI solutions for specific functions such as impact on jobs and malicious psychological profiling, and have potential repercussions on the society beyond the stakeholder interacting directly with specific systems. On the basis of these considerations, the report has listed seven broad Principles of Responsible AI, which are as follows (NITI, 2021): Principle of Safety and Reliability; Principle of Equality; Principle of Inclusivity and Non-Discrimination; Principle of Privacy and Security; Principle of Transparency; Principle of Accountability; and Principle of Protection and Reinforcement of Positive Human Values

Earlier in November 2020, NITI Aayog released a working document on *"Enforcement Mechanisms for Responsible #AIforAll"* (NITI, 2020). This document recognised that risks from AI systems vary with context and use case and suggests that a flexible risk approach be adopted to manage risks and recommends for setting-up of a 'Council for Ethics and Technology', with a multi-disciplinary composition. The proposed oversight body would play an enabling role in the following areas: Manage and update principles for responsible AI in India; Research technical, legal, policy, societal issues of AI; Provide clarity on responsible behaviour through design structures, standards, guidelines, etc; Enable access to Responsible AI tools and techniques; Education and Awareness on Responsible AI; Coordinate with various sectoral AI regulators, identify gaps and harmonise policies across sectors; andRepresent India (and other emerging economies) in International AI dialogue on responsible AI.

The document also proposed for constituting an Ethics Committee for the procurement, development, operation of AI systems and be made accountable for adherence to the Responsible AI principles.

From the above**,** it can be observed that though India sees Artificial Intelligence as a key factor in economic growth, it is pitching more for the applications of Artificial Intelligence in social sectors such as health,

education, agriculture and transportation, to foster inclusive growth. The noble vision of *#AIForAll* as the underline approach can be considered as a right approach for India, given the scope of AI in addressing many of such societal challenges. With the release of working documents on Responsible AI, NITI Aayog has also indicated that India intends to pursue the AI development in a responsible manner and has also planning to place an oversight body to ensure that the development and deployment of AI in India adheres to the 'Responsible AI principles'. However, the key role of private sector needs to be envisioned more deeply for wider scale deployment of AI-based technological solutions.

V. Analysis of India's AI Strategy

As far as government funding is concerned, to make India a leading player in Cyber Physical System (which includes AI, ML and IoT), the Union Cabinet, in 2019, approved the launch of National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) to be implemented by the Department of Science & Technology (DST) with a total outlay of INR 3660 Cr (USD 494 Mn) for a period of five years (FY 2019-20 to 2023-24). The Mission aims to create a strong and sound ecosystem for CPS technologies in India. It aims to develop 15 Technology Innovation Hubs (TIH), six Application Innovation Hubs (AIH) and four Technology Translation Research Parks (TTRP). The focus of the mission would be on the sectors such as health, education, energy, environment, agriculture, security, Industry 4.0, smart cities, SDGs, etc.[6]

In addition, the Ministry of Finance had also sanctioned the budget of INR 7,000 Cr (USD 945 Mn) to NITI Aayog for the period (2019-20 to 2024-25)[7] for the creation of a cloud computing platform called AIRAWAT and research institutes and set up a high-level taskforce to oversee the rollout and implementation of AI in the country. [8] Since, NITI Aayog is a think-tank and not a line Ministry, it would be interesting to see how these funds are being utilised to achieve the desired outcome.

According to the latest IDC's *Worldwide Artificial Intelligence Spending Guide* Forecast, India's AI spending will grow from USD

300.7 Mn in 2019 to USD 880.5 Mn in 2023 at a CAGR of 30.8 per cent (IDC, 2020). The private sector has also expressed its intention to partner the government in building a strong AI ecosystem in India. Recently, Confederation of Indian Industries (CII) has set up a forum on AI which will focus on four priority sectors viz. banking and financing services industries, retail, social (healthcare) and manufacturing (automotive).[9]

As far as the AI Market size in India is concerned, it has been valued at USD 6.4 Bn as of August 2020 and the entire AI market is expected to grow at CAGR of 13.8 per cent, taking the valuation of the Indian AI market to USD 11.4 Bn by 2025 (Jigsaw Academy and AIM, 2020).

Moreover, the Indian AI Start-Up funding in 2019 rose to USD 762.5 Mn, with a 44 per cent increase over the USD 530 Mn funding it received in 2018 (AIM, 2020). The ten-fold increase in the funding from just USD 75 Mn in 2014 to USD 762 Mn in 2019, by global investment firms signals the strengthening of the Indian AI Start-Up ecosystem. It is also comforting to note that the funding has not only been made into those start-ups which focussed on general AI data science domains, but also to those working in niche domains (such as NLP, computer vision) as well as on sectoral domains such as agriculture and healthcare.

According to the latest *Government AI Readiness Index* (Oxford Insights and IDRC, 2020), India has the fourth highest number of technology unicorns after the USA, China and the UK, and the third highest market value for technology companies in the Forbes Global 2000, which demonstrates India's strong footing in terms in the domain of technology.

In terms of AI talent, India is in third place with 17384 AI scientists and engineers, only behind the USA and China (CISTP, 2018). According to a LinkedIn study, India ranked 3rd in the list of countries with the highest penetration of AI skills, while the USA and China occupied the 1st and 2nd ranks respectively (Perisic, 2018).

In terms of scientific publications, India ranks third in the world in terms of high quality research publications in artificial intelligence

(AI). However, when parsed by another metric 'citations' or the number of times an article is referenced, India ranked only fifth and trailed the United Kingdom, Canada, the U.S. and China. This implies that India must work at improving the quality of its research output in AI. [10]

In terms of AI publications, India ranks third in fuzzy logic and fourth in machine learning, whereas it is eighth or lower in patenting activity. This suggests that India has strengths in AI research that might become even more evident within the next few years in terms of patenting activity (WIPO, 2019).

The availability of data is huge in India too. India has about 700 million internet users[11] and about 450 million mobile internet users.[12] This can provide for the adequate data requirements for the development of AI algorithms and training the AI systems, if required. However, India ranks 100th in the latest UN E-Government Development Index (UN, 2020) which is based on three indices namely Telecommunications Infrastructure Index (TII), Online Service Index (OSI) and Human Capital Index (HCI). The Telecommunications Infrastructure Index comprises of four parameters viz., mobile cellular telephone subscriptions per 100 inhabitants, percentage of individuals using the internet, fixed (wired) broadband subscriptions per 100 habitants and active mobile broadband subscriptions per 100 inhabitants. The score for India across these four parameters are 86.94, 34.45, 40.56 and 37.5 respectively.

Clearly, even though India has second highest number of internet users in the world (only after China), the percentage of individuals using the internet and the active mobile broadband subscriptions are very low. Improving infrastructure and access to high-quality data can, therefore, be a major impediment in making India to break into the top tier of countries in terms of AI readiness (Oxford Insights and IDRC, 2020).

In terms of creating skilled human resource in AI, NITI Aayog Atal innovation Mission (AIM), in collaboration with MietY and NASSSCOM, has recently released an "AI Module" for School Students.

The National e-Governance Division, Ministry of Electronics and Information Technology (MeitY), and Intel India have also designed a National Programme for Government Schools titled "Responsible AI for Youth". The aim of this programme is to teach and train the young students of the country relevant AI skill-sets and tool-sets to make them ready for the digital future.[13]

Knowledge of coding is extremely necessary to develop computer algorithms including that for AI. The recently released New Education Policy (NEP) 2020 has rightly recognised the importance of computer programming and has advocated for teaching 'Coding' as a subject from Class 6 onwards (MHRD, 2020). Similarly, in the sphere of re-skilling or up-skilling existing workforce, NASSCOM through its "Future Skills" initiative, with the financial support from MeitY, has started training industry professionals from across different segments including higher education students and government officials, with a aim to train about four lakh professionals in the next three years.[14]

All these factors can help India to leverage the huge potential of AI for advancing its social and economic development. However, there are certain inherent challenges which need to be taken care for building a strong and productive ecosystem for AI development and deployment in India. NITI Aayog (NITI, 2018) has enumerated some of these challenges in its AI Strategy Document itself. These are as follows:

• Lack of enabling data ecosystems

• Low intensity of AI research

• Inadequate availability of AI expertise, manpower and skilling opportunities

• High resource cost and low awareness for adopting AI in business processes

• Unclear privacy, security and ethical regulations

• Unattractive Intellectual Property regime to incentivise research and adoption of AI

- Difficulty in access to industry specific data required to build customised platforms and solutions currently concentrated in the hands of a few major players.

- High cost and low availability of computing infrastructure required for development, training and deployment of AI based services

- Low awareness of AI for resolving business problems in most public enterprises and government agencies, especially given the scarcity of AI professionals, is obstructing adoption.

In addition to these challenges, there have also been some literature highlighting few critical gaps in the National AI Strategy. Basu (2019) argued that the Indian AI Strategy is "*an impressive theoretical objective but questions surrounding implementation and structures of operation remain to be answered*". He compared it with Chinese AI policy, in which China has not only conceptualised an AI policy but through the subsequent "Three Year Action Plan to Promote the Development of New Generation Artificial Intelligence Industry", it has also taken a focussed approach to promote the AI-based industrial development.

On the idea of making India as "AI Garage", Basu (2019) argued that this could lead to use of the Indian citizens (and their data) as guinea pigs for developing AI-driven solutions at the cost of their individual rights and privacy. Without a proper regulatory mechanism in place to protect individual data and privacy, such an objective needs to be followed cautiously.

Abraham *et. al* (2019) noticed the failure to include the manufacturing and services sector as key focus areas in the National AI Strategy. They argued that focussing on manufacturing was crucial not only in terms of economic development, but also regarding the questions related to safety and impact on jobs. The same holds true for the services sector. They also highlighted the failure of the AI Strategy on issues related to the use of AI in ensuring accessibility and inclusion for the disabled. They further argues that the National AI Strategy barely touched upon societal, ethical cultural and sectoral challenges to the adoption of AI in India and has not dealt with the issues of privacy, transparency, fairness , safety and capacity building in a satisfactory manner.

Aneja (2019) highlighted three challenges in realising the aspirations of *#AIForAll,* as stated in the National AI Strategy. First is the fragmented, unrepresentative and outdated nature of the existing data-sets in India. She argued that the algorithms based on existing data sets will lead to a "*distorted picture of social reality*". Second challenge is ensuring data privacy and protection. Given the low literacy levels and education of the majority of population, devising a robust data protection regulatory framework is not going to be easy. Third challenge stems from the grim reality that the deployment of AI solutions in the industry will disrupt labour markets in India. The 're-shoring' of numerous manufacturing industries to the industrialised countries in the Global North, may make it difficult for India to generate employment through an export-oriented manufacturing strategy. The new jobs created in the wake of AI infusion will require skilled human resource, not the low-skilled ones. The displacement of such low-skilled labours could emerge as a major challenge.

These challenges are by no means exhaustive. There is an imperative to address them through a concerted and collaborative manner with the engagement of all the relevant stakeholders and with the government playing a leading role so that it would build a strong foundational base which would eventually help India in its pursuit for achieving the vision of #AIForAll: Technology Leadership for Inclusive Growth *(in line with the Government's policy of Sabka Saath Sabka Vikas Sabka Vishwas).*

VI. Comparative Analysis

In the latest Government AI Readiness Index 2020, China is ranked 19th while India ranks 40th (Oxford Insights and IDRC, 2020). Clearly, China's readiness level to use and deploy AI is higher than that of India's. Nevertheless, there is no doubt that both these countries are gearing up to harness AI for addressing their social and economic development while ascertaining their global leadership in AI. However, upon a careful analysis of their national AI strategies or plans, several divergences in their approach can be noticed.

First and foremost, the main guiding principle or motivation behind such strategies or plans bears stark difference between India and China. For China, AI serves as a strategic avenue to enhance China's global competitiveness and its national security. India, on the other hand, sees AI also as a medium to achieve technology leadership for inclusive growth (#AIforAll). It aspires to use AI along with other technologies to address first the domestic societal challenges in the domain of healthcare, agriculture, education, etc.

Secondly, China has stated very clearly in its AI Plan that it will promote two-way conversion between civilian and military AI research and applications. This particular stance vindicates China's stand that it can access and control all the data in the civilian domain for its military purposes, if required. This must ring a bell of caution among other countries when they are dealing with Chinese data companies. India, on the other hand, does not promote any civilian-military blend of data exchanges.

As discussed earlier, there are certain concerns regarding the deployment of AI for the surveillance of its citizens. India does not endorse the use of AI for such purposes in its Strategy Document. On the strategic visions and goals, China has set clear goals of attaining global leadership in AI by 2030. It has given milestones of this progress from 2020 to 2025 and then to 2030. No such timelines or milestones have been stated in the Indian AI Strategy Document as such.

China has also been very explicit in its vision of using AI to transform its industrialisation paradigm. It has come out with an AI Industry Plan with clear-cut agenda. India, on the other hand, does not have any such supplementary industry policy on the table right now. However, discussion on Industry 4.0 is very much on within the government.

On funding AI research and development as well as on providing support to the domestic industries, China has been investing huge amount of money. Its AI Plan supports mergers and acquisitions and provide

for huge venture capital funding to the domestic AI-based companies. Its AI Development Plan is complemented and supplemented by the corresponding AI Industry Development Plan.

In India, however, the amount of funding available from the government side or through Venture Capital is not much at the moment, in comparison to China. Over the last 5 years, over USD 4.5 billion has been invested into more than 200 Chinese AI companies through venture capital funding. In addition, the Chinese government has invested huge amount of funds in promoting AI innovation and development. For instance, a USD 2.1 billion was invested by the Chinese government to build a technology park to facilitate AI innovation in Beijing. In comparison, in India, only an amount of about INR 3500 Cr (USD 472 Mn) was sanctioned for the AI innovation and development by the government last year [15]   In light of this resource constraint, India has been projecting itself as "AI Garage" for the world, inviting FDI and foreign companies to develop AI-based solutions in India for India and the world.

Through flagship programmes such as Digital India, Start-Up India and various Performance-Linked Incentive (PLI) Schemes launched by MeitY, efforts in prompting the development of related industrial sector is being undertaken. The new National Policy on Electronics (NPE) 2019 has clearly stated that one of the objectives of the Policy will be to "*promote and create a framework for comprehensive Start-up eco-system in emerging technology areas such as 5G, IoT, Artificial Intelligence, Machine Learning, Drones, Robotics,…….., and their applications in areas such as defence, agriculture, health, cyber security, smart cities and automation, with special focus on solving real-life problems*" (MeitY, 2019).

In terms of human resource development, both the countries have embarked upon extensive programme of developing skilled human resource for the future and have launched teaching and training courses on AI right from the school levels, as mentioned earlier. However, while China has an official blueprint dedicated to AI for academic

institutions, India does not have an exclusive action plan to prepare academic institutions for AI readiness. The Indian AI Strategy document provides a broad vision for courses and training in AI, whereas China's AI Action Plan charts out AI training-specific targets. These include the development of 100 "AI + X" majors for interdisciplinary growth, publication of 50 world-class undergraduate and graduate textbooks, establishment of 50 AI schools, and the launch of 50 national-level quality open online AI courses (Jain, 2020)

As far as the impact of AI on the jobs and employement in India and China is concerned, it is observed that in both the countries there would be a mixed impact implying that there could be a potential job loss scenario in certain sectors which have more routine sort of job profiles; however, in various other sectors there would be a creation of much higher number of jobs, thus offsetting the negative impact in medium to long-term period (*for details on the impact of AI on jobs in India*, please refer to RIS Policy Brief No. 104 written by the author (Kumar, 2021); and *for details on the impact of AI on jobs in China*, please refer to PwC, 2018; Gayton, 2018; Hui, 2018; Lee, 2019; Zhou *et al*, 2020; Shen, 2020; Roberts *et al*, 2021).

For the development of "Responsible AI", both India and China have come out with principles for Repsonsible AI. These principles are more or less similar. Both India and China are proactive and actively participating on various international forums which are discussing the development of global governance of AI, AI standards and ethical frameworks.

India has become a founding member (along with USA, UK, EU, Australia, Canada, France, Germany, Italy, Japan, Mexico, New Zealand, Republic of Korea, Singapore and Slovenia) of an international and multi-stakeholder intuitive called *"Global Partnership on Artificial Intelligence"* (GPAI), which was launched recently, to guide the responsible development and use of AI, grounded on the principles of human rights, inclusion, diversity, innovation and economic growth. GPAI will be supported by a Secretariat, which will be hosted by OECD and will initially have four working groups focussed on responsible AI,

data governance, future of work; and innovation and commercialisation.[16] It is to note that China is not a part of this initiative.

However, China has been very active in the international deliberations regarding the development of AI Standards. It has come out with *"Artificial Intelligence Standardisation White Paper"* in January 2018 itself, where it has categorically highlighted the importance of standards in light of today's 'deepening globalisation' and 'market internationalisation'. It stated that "*standards serve as an important technical basis for economic and social activities, and they have become important indicators for gauging the technology development levels of countries and regions, as well as the basic rules for products to enter markets, and the concrete manifestations of the market competitiveness of enterprises*" (CESI, 2018).

In October 2017, ISO/IEC Joint Technical Committee for Information Technology created a standards sub-committee for Artificial Intelligence (SC42). Both China and India are the participating members of this sub-committee. However, in its first meeting in April 2018 at Beijing, China presented its White Paper on AI Standardisation in a move to influence the course of discussion of the sub-committee.

This clearly demonstrated China's eagerness to participate in the international standards-setting bodies "*on the question of whether and how to set standards around controversial aspects of AI, such as algorithmic bias and transparency in algorithmic decision making*" (Ding *et al*, 2018) and also to offset its bad experience in the cellular networking recently in the light of the ban on Huawei and ZTE's export restrictions. As argued by Allen (2019), Chinese government and Chinese corporations want to ensure that "*their intellectual property and products are critical features of the future of AI and perceives its success in setting the technical standards as critical to both economic growth and national security*".

India should play a more active role in agenda-setting platforms keeping in mind its own priorities in terms of economic development and national security. As a founding member of the "Global Partnership

on Artificial Intelligence", hosted by OECD, India should leverage this platform to place its priorities at the various platforms undertaking initiatives on the development of ethical principles, standards, etc.

VII. Conclusion

The analysis presented in this paper demonstrates that there are some fundamental differences in the approaches taken by India and China towards the development of AI. While India has devised its National AI Strategy based on the tenet of #AIForAll, China intends to leverage AI to ascertain its global technology leadership and competitiveness. However, both the nations have certain challenges and critical gaps, which need to be addressed to help them realise their aspirations.

As far as India is concerned, the challenges as enumerated by NITI Aayog (2018) in terms of lack of enabling data ecosystems; low intensity of AI research; inadequate availability of AI expertise, manpower and skilling opportunities; high resource cost and low awareness for adopting AI in business processes and unclear privacy, security and ethical regulations etc, needs to be looked into. Similarly, without proper regulatory mechanism in place to protect individual data and privacy, foreign data companies should not be allowed to access the enormous personal data of Indian citizens (Basu, 2019). For comprehensive understanding, the impact of AI on manufactrrung sector needs to be captured in details along with its impact on disabled section of society (Abraham *et al*, 2019). The issues such as lack of availability of proper 'data-sets', effective data privacy and data protection framework and potential negative impact of AI on labour markets, also needs to be taken into consideration (Aneja, 2019). The goverment has been pursuing many initiatives as discussed previously to address all such challenges so that the vision of *#AIforAll* is well acheived in India.

Finally, needless to state that there is an imperative to promote AI development and deployment in a responsible manner and to devise an inclusive global governance institutional architecture to ensure this.

Endnotes

1   https://oecd.ai/

2   https://www2.deloitte.com/us/en/insights/focus/cognitive-technologies/ai-investment-by-country.html

3   https://www.scmp.com/tech/innovation/article/3111510/china-tops-world-ai-patent-filings-surpassing-us-first-time

4   https://www.statista.com/statistics/265140/number-of-internet-users-in-china/

5   http://www.xinhuanet.com/english/2019-08/30/c_138351278.htm

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