AI and the Manufacturing and Services Industry in India

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Executive Summary

Reports on the impact of AI in the manufacturing and IT and Services sector in India often paint a picture of stagnant job growth and even job loss.[1] AI is disrupting traditional business models in the IT sector, the auto sector, and other manufacturing industries.[2] Experts have highlighted the need to adapt to these changes, beginning with education towards enabling individuals to move and work higher up the value chain in innovative capacities.[3] Forms of smart manufacturing are also starting to come up in India: Wipro and Infosys have launched AI platforms, and the Indian Institute of Science is developing a smart factory with support from Boeing Company and General Electric.[4] Identified challenges to the incorporation of AI in the manufacturing sector in India include lack of value creation in the industry, discrepancies in needed skills and available skills, capacity issues amongst professionals, infrastructure inadequacies and challenges in access to technologies.[5]

This report seeks to map the present state of AI in the manufacturing and services industry in India. In doing so, it explores: ***Use***: What is the present use of AI in different sub sectors of manufacturing and services? What is the narrative and discourse around AI and manufacturing and services in India? ***Actors***: Who are the key stakeholders involved in the development, implementation and regulation of AI in the manufacturing and services industry? ***Impact***: What is the potential and existing impact of AI in manufacturing and services? ***Regulation***: What are the challenges faced in policy making around AI in the manufacturing and services industry? Are there key steps that regulators and industry need to take when adopting AI into the sector?

Introduction

With the inroading of Artificial Intelligence (AI) and Internet of Things (IoT) into the manufacturing sector, countries are inevitably faced with a number of policy concerns which need to be addressed at various levels keeping in mind the socio-economic factors that influence policy making in that particular country. India, unlike its G20 counterparts is yet to fully tap the available opportunities that AI presents.[6] Reports have noted that business sectors and manufacturing units are yet to fully exploit the available talent pool from leading technological universities and budding startups. Companies have analysed that deployment

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1 Why Automation is a Threat to India's Growth, Edd Gent. Retrieved February 23, 2018, from **http://www.bbc.com/future/story/20170510-why-automation-could-be-a-threat-to-indias-growth**

2 Machines vs Humans: The Battle for Jobs in India is Affecting Not Just IT engineers, Madhura Karnik. Retrieved February 23, 2018, from: **https://qz.com/990558/machines-vs-humans-the-battle-for-jobs-in-india-is-affecting-not-just-it-engineers/**

3 India and The Artificial Intelligence Revolution, Shashi Shekhar Vempati. Retrieved February 23, 2018, from **http://carnegieendowment.org/files/CP283_Vempati_final.pdf**

4 Towards Smart Manufacturing: Industry 4.0 and India, Make in India Portal. Retrieved February 23, 2018, from **http://www.makeinindia.com/article/-/v/towards-smart-manufacturing-industry-4-0-and-india**
44 AI dominates: Indian IT stares at talent shortage in digital, cloud skills, Ayan Pramanik. Available at: **http://www.business-standard.com/article/companies/ai-dominates-indian-it-stares-at-talent-shortage-in-digital-cloud-skills-117010700469_1.html**

5 AI dominates: Indian IT Stares at Talent Shortage in Digital, Cloud Skills, Ayan Pramanik. Retrieved February 23, 2018, from **http://www.business-standard.com/article/companies/ai-dominates-indian-it-stares-at-talent-shortage-in-digital-cloud-skills-117010700469_1.html**

6 Accelerating India's Economic Growth With Artificial Intelligence, Accenture (2017), Retrieved March 5, 2018, from **https://www.accenture.com/t20171220T030619Z__w__/in-en/_acnmedia/PDF-68/Accenture-ReWire-For-Growth-POV-19-12-Final.pdf.**

of AI to its full potential can add US$975 billion to India's economy by 2035. This can be achieved with policy makers and the business sector actively working together to achieve this goal.[7]

The most significant impact of AI in the manufacturing sector will be enhancing efficiency, and bringing simplicity into the process of production through mechanization of tasks previously performed by humans. This will also improve machine interactions and promote real time decision making in the process of manufacturing. While a move towards complete automation has its own benefits of accuracy and efficiency, it raises socio-economic and ethical concerns which need to be addressed before fullly integrating AI into the manufacturing sector. This requires policy makers, business sector, IT sector and the government along with other players in the field to reconcile such clashing concerns to arrive at policy solutions which exploit the available technology to achieve economic benefits while balancing the ethical concerns and issues of job displacement.

Methodology

From CIS' literature review on AI undertaken in December 2017, we learned that there is no single definition of AI.[8] For the purposes of this report, we have drawn upon the definitions outlined in the literature review and reached a broad understanding of AI as a dynamic learning system that can be used in decision making and actioning.

This report seeks to map the growth and potential of AI across the manufacturing and services sector in India. The study will look at the existing stakeholders, current and potential uses of AI, impacts of deploying AI in the sector, barriers to AI in India and other relevant topics in order to provide a comprehensive understanding of the state of AI in India and the way forward. Manufacturing is a broad industry that encompasses a number of different sub sectors.[9] After undertaking a review of sectors via desk research for considerable uptake or potential for uptake of AI in India, for the purposes of this report, the study has been narrowed down to focus on electronics, heavy electricals, agriculture, and automobiles under the manufacturing sector and IT Services under the service sector. For example, through a review of online reports and speaking with experts in the field we learned that AI is not presently being used textiles in India. The study encompasses the development of AI solutions that can be adopted in a company's processes, the use of AI in the process of manufacturing, and insights into the use and incorporation of AI into the end product itself. For the purpose of identifying the use of AI and distinguishing from other technologies, we captured solutions and use examples that self identified as 'AI' or that appeared to take on 'brain related' functions.[10] Search terms for identifying the use AI included: artificial intelligence, autonomous, machine learning, natural language processing, robotics, computer vision, neural networks, smart factory, and future of work. Search terms to identify sectors included: manufacturing agriculture, IT, IT and services, electronics, heavy electricals, autonomous vehicles, automobiles, and automotive.

The report further looks at the impact of AI on the identified sectors along with analysing existing barriers to its deployment, ethical and legal questions and concerns, and possible

7 Ibid.

8 Artificial Intelligence: Literature Review (2017, December 16). Retrieved January 5, 2018, from **https://cis-india.org/internet-governance/blog/artificial-intelligence-literature-review**

9 For example, The India Brand Equity Foundation 23 Different Sub Sectors Under Manufacturing. For more information see: **https://www.ibef.org/download/Manufacturing-Report-Jan-2018.pdf**

10 This was a distinction and possible way of identifying AI shared in the "AI and Manufacturing" roundtable held on January 19th 2018.

solutions. It also seeks to outline key government initiatives in the field which boost the use, adoption and development of AI in India.

This report forms a part of the larger project on Artificial Intelligence undertaken by the Centre for Internet and Society[11] and relies on primary and secondary sources including news items, company websites, industry reports, policy and legislation, interviews, and roundtable inputs.[12]

State of AI in Manufacturing and Services in India

Deployment of AI in manufacturing and services operations will ensure accuracy and precision in the process and will avoid delays with faster change in operations when required. It will also forecast risks and demands based on available data to ensure optimal production.[13] The process of manufacturing can be made smarter and environmentally sound, thus avoiding mishaps. The use of AI on the factory floor can help increase productivity and quality along with ensuring a robust safety framework.[14]

The Indian government's push towards 'Make in India' and 'Industry 4.0' has incentivized startups, software companies and manufacturing units to integrate technology, including AI, into their day-to-day processes to increase accuracy, productivity and efficiency.[15] To understand the state of AI, this section is comprised of a number of sub-sections that delve into the use of AI in manufacturing and services, legal and ethical considerations, relevant government initiatives, challenges, and recommendations associated with the uptake and deployment of AI in manufacturing and services.

Sector Deep Dives

While our research showed that the adoption of AI is not widespread across all sectors of the manufacturing industry, there has been significant transformation in certain parts of the industry with companies developing, adopting, and integrating AI technologies and solutions into their processes and products - including electronics, heavy electricals, automobile, and agriculture. The services sector has seen significant uptake of AI - in particular the IT sector. At the same time there are a number of 'sector neutral' companies that develop AI technologies that can be applied to the process of manufacturing and services.

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11 Y. Paul, Centre for Internet and Society (2018, January 26). Artificial Intelligence and the Healthcare Industry in India, Retrieved February 23, 2018, from **https://cis-india.org/internet-governance/blog/artificial-intelligence-and-the-healthcare-industry-in-india**

12 S. Mohandas, Centre for Internet and Society (2018, February 13). AI and Manufacturing and Services in India: Looking Forward. Retrieved February 23, 2018, from **https://cis-india.org/internet-governance/blog/ai-and-manufacturing-and-services-in-india-looking-forward**

13 Artificial Intelligence and Robotics - 2017: Leveraging Artificial Intelligence and Robotics for Sustainable Growth, PWC. Retrieved February 23, 2018, from **https://www.pwc.in/assets/pdfs/publications/2017/artificial-intelligence-and-robotics-2017.pdf**

14 Ibid.

15 AI, Cognitive Technologies and IoT Spurring Digital India: Microsoft, Jasmeen Nagpal. Retrieved February 23, 2018, from **https://cio.economictimes.indiatimes.com/news/strategy-and-management/ai-cognitive-technologies-iot-spurring-digital-india-microsoft/62077694**

Sector Neutral

There are a number of companies that offer AI technologies and solutions that can be used in a number of sectors in manufacturing and services. Our study identified four such domestic companies and one international company that was providing solutions across sectors. These companies provided AI solutions including training a virtual robot on an AI based software platform, providing diagnostics and prognostics through Machine Learning and Artificial Intelligence and AI based surveillance solution. For example, GreyOrange, a multinational firm which designs, manufactures and installs modern robotic systems for automation at fulfilment centres and warehouses, has set up a Research and Development Centre in Gurgaon.[16] GreyOrange provides warehousing solutions with the help of bots, pick-up stations, Mobile Storage Units (MSUs), along with a software that runs business logic of inventory management and robotics.[17] Flutura Decision Sciences and Analytics is a company heavily relying on IoT which uses machine signals in order to power new monetizable business models.[18] It uses its data science platform, Cerebra, to spring up undetected machine signals which are capable of impacting industrial outcomes in order to fill gaps in the marketplace. Covacsis designs and implements Intelligent Plant Framework (IPF) which is being used by manufacturing plants across sectors. IPF works without any peer assistance and relies on big data analytics, IoT and provides real-time outputs. Further, it extracts data from all the machines on the factory floor without any differentiation based on their make.[19]

Electronics

The electronics sector in India includes producers of electronic equipment for industries and consumer electronics products, such as computers, televisions and circuit boards. These industries include telecommunications, equipment, electronic components, industrial electronics and consumer electronics, and the companies that produce electrical equipment, manufacture electrical components and retail these products to make them available for consumers. The electronics market of India is one of the largest in the world and is anticipated to reach US$ 400 billion in 2022 from US$ 69.6 billion in 2012. The market is projected to grow at a compound annual growth rate of 24.4% during 2012-2020.[20]

Machines driven by AI are now being used in production units in India that manufacture electronic goods and appliances. The use of intelligent systems is helping the sector avoid manual testing processes with the help of IoT and detection mechanisms.[21] AI is also being integrated into end products as robotic appliances, user interfaces, and virtual assistants.

Through our mapping exercise, we identified five domestic companies and one international company that was providing AI solutions in the electronics sector in India. The focus area of these companies included robotic automation and language processing. The solutions that these companies provided include Robotic Manipulators that can mimic human action, robot-based automation and using AI as chatbots to help repair electronics.

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16 GreyOrange. Retrieved February 23, 2018, from **http://www.greyorange.com/about-us/company**

17 How 27-year-old Akash Gupta Built the Largest Automation Startup of India, Alok Soni. Retrieved February 23, 2018, from **https://yourstory.com/2017/08/techie-tuesdays-akash-gupta-grey-orange/**

18 Flutura. Retrieved February 23, 2018, from **https://www.flutura.com/flutura-in-a-nutshell.php**

19 Covacsis. Retrieved February 23, 2018, from **http://www.covacsis.com/features.php**

20 Indian Manufacturing Industry Analysis, IBEF. Retrieved February 23, 2018, from **https://www.ibef.org/industry/electronics-presentation**

21 The Indian Electronics Industry in 2017-18: Ke Opportunities and Trends, Sudeshna Das. Retrieved February 23, 2018, from **http://www.electronicsb2b.com/eb-specials/industry-report/indian-electronics-industry-2017-18-key-opportunities-trends/**

The companies that provide AI solutions in electronics include companies that use AI and robotics to help in the manufacture of electronic devices. For example ASIMoV's Robotic's manipulator (CooL Arm)[22] can be used for assembling and delivery products. Gridbots has also developed robots such as the High Performance SCARA Robot[23], which can be used for activities that require high speed and precession, which is especially needed in the manufacture of electronics. Another interesting startup that provides services in the field of electronics is Helpforsure[24], that uses an AI powered chatbot that helps automat electronics maintenance and repair jobs. Although the startup is current only using the AI internally, the startup aims at helping households that could use a self-care conversational chatbot.[25]

Manufacturing Process

For example, Panasonic, the Japanese company manufacturing consumer durables, has opened a 'Technopark' in Jhajjar in the state of Haryana.[26] The plant manufactures air conditioners and washing machines whose production and testing process is automated and controlled by artificial intelligence.

End Product

Panasonic has also opened a design division in Bengaluru in collaboration with Tata Elxsi in order to develop robotics and artificial intelligence that can be used in appliance products not just limited to India, but also in Japan.[27] In 2017 Panasonic India launched two new models of the Eluga phone which run their in house software Arbo[28] - an AI driven user interface.[29]

Heavy Electricals

The Heavy Electricals Industry in India caters to the need of energy and other industrial sectors through the manufacturing of equipment like steam generators, turbo generators, turbines, and related accessories. Presently, the domestic electrical equipment industry size exceeds 1.20 lakh crore (US$ 25 billion) with the share of generation equipment (boilers, turbines, generators - BTG) being about one-fourth and that of T&D being three-fourth of the total. The domestic EE industry contributed 1.4% to the nation's GDP in 2011-12 and 10.0% to the manufacturing GDP. The industry provides direct employment to about 0.5 million

22 Asimov Robotics. Retrieved February 23, 2018, from **http://www.asimovrobotics.com/**

23 SCARA Robot Overview, Adept. Retrieved February 23, 2018, from **http://www.adept.com/robots/scara-robots-4-axis**

24 Help For Sure. Retrieved February 23, 2018, from **http://helpforsureapp.com/**

25 Service Startup Helpforsure's AI Backed Chatbots Helps to Automate Electronics Repair, Pankaj Maru. Retrieved February 23, 2018, from **https://cio.economictimes.indiatimes.com/news/business-analytics/service-startup-helpforsures-ai-backed-chatbots-helps-to-automate-electronics-repair/60090701**

26 Rise of the Machines, Goutam Das. Retrieved February 23, 2018, from **http://www.businesstoday.in/magazine/features/mncs-indian-companies-started-investing-in-smart-factories/story/207247.html**

27 Panasonic to Expand Appliances Business in India. Retrieved February 23, 2018, from **http://news.panasonic.com/global/press/data/2016/12/en161206-4/en161206-4.html**

28 Panasonic India Developers "Arbo", a New AI Embedded UI Software for Smartphones. Retrieved February 23, 2018, from **http://news.panasonic.com/global/topics/2017/46392.html**

29 Panasonic Launches Eluga A3, A3 Pro in India With AI Assistant "Arbo" and 4000mAh Battery, M Devan. Retrieved February 23, 2018, from **https://www.thenewsminute.com/article/panasonic-launches-eluga-a3-a3-pro-india-ai-assistant-arbo-and-4000mah-battery-66692**

persons and indirectly to about 1 million persons. The entire value chain would account for a total employment of over 5 million persons.[30]

Manufacturing heavy electricals in India has been steadily mechanised over the years in order to ensure productivity, efficiency, quality, and flexibility in the production of heavy industrial parts. Initiatives surrounding these in India have largely depended on Industrial Internet of Things(IoT) and 3D printing. For example, Industrial IoT is being utilised to ensure the safety of work environments.[31] The sector is now developing Smart Factories through adoption of AI, natural language processing and machine learning platforms. This includes using intelligence for ensuring process control, monitoring, predictive planning, detecting abnormalities, automation of routine or manual tasks. Through our mapping, we identified three companies providing AI solutions for of heavy electricals in India. These companies provided AI solutions such as robotic arms and automation platforms.

Smart Factories

For example, the Centre for Product Design and Manufacturing (CPDM) at Indian Institute of Sciences is setting up India's first smart factory with financial support from Boeing.[32] This smart manufacturing unit completely functions with the help of automation and IoT. The features of this factory include collecting and collating legacy data and real time data after which the two are analysed together by intelligent systems. This analytical data is then used for planning, monitoring, detecting and improving manufacturing situations. One of the major leaps of this smart factory is its progress towards natural language processing, which is used for acquiring knowledge that can solve issues. The unit also features an autonomous tool which acts as an integrated software for implementing a framework that is completely network enabled through accumulating the requisite data and processing it. The factory is described as being"self-aware" as it records large-scale data including the posture of a welding man and the amount of energy being expended by the welding machine. IISc has recently announced further expansion of the factory, the funding for which is provided by the Society for Innovation and Development.[33] These factories also employ sensors connected over the IoT that collect data which is then utilised by an AI tasked with maintaining the safety of the working environment. There are also ongoing talks to collaborate with automobile manufacturers and implement a similar system in automobile manufacturing factories. Additionally, other conversations between IISc and industry stakeholders indicate that there is a strong desire to implement these systems in the heavy manufacturing industry.[34]

Another example is the Brilliant Factory by General Electric (GE). The functioning of this factory relies on Industrial Internet of Things through which the manufacturing equipment and computers communicate in real time to share information, arrive at decisions to maintain quality and avoid downtime.[35] GE's Brilliant Factory brings together technologies

30 Indian Electrical Equipment Industry Mission Plan 2012-22, Ministry of Heavy Industries & Public Enterprises. Retrieved February 23, 2018, from **http://ieema.org/wp-content/uploads/2015/05/LFE_Mission_Plan_2012_2022.pdf**

31 P. Talukdar (IISc). Personal Interview.

32 Industry 4.0: IISc Building India's 1st Smart Factory in Bengaluru, Chethan Kumari. Retrieved February 23, 2018, from **https://timesofindia.indiatimes.com/city/bengaluru/Industry-4-0-IISc-building-Indias-1st-smart-factory-in-Bengaluru/articleshow/53441112.cms**

33 IISc to Expand Smart Factory, Aid Startups, Research, Chethan Kumari. Retrieved February 23, 2018, from **https://timesofindia.indiatimes.com/city/bengaluru/iisc-to-expand-smart-factory-aid-startups-research/articleshow/61588005.cms**

34 Interview with P. Talukdar (IISc).

35 PM Narendra Modi Inaugurates GE's 'Brilliant Factory' in Pune. Retrieved February 23, 2018, from **http://www.business-standard.com/content/b2b-manufacturing-industry/pm-narendra-modi-inaugurates-ge-s-brilliant-factory-in-pune-115022000684_1.html**

such as 3D printing, IoT, big data analytics, cloud computing, and artificial intelligence to support decision making within the factory with real time visibility and operational intelligence, enable higher uptime and quality at each individual manufacturing machine tool, increase throughput and inventory turns by enhancing data visibility at factory level and in the supply chain.[36] The factory will facilitate the production of jet engines, locomotive technology and wind turbines among other things.[37] This initiative served as an acceleration to the 'Make in India' policy and the government has invited GE to expand its production to include shipbuilding and defence manufacturing.[38] News items also quote government officials noting that the factory will open up 1,500 jobs and support local business.[39] In another example, Bharat Heavy Electricals Limited has also undertaken research into the integration of AI techniques for process monitoring, control, and maintenance systems.[40]

Agriculture

The agricultural manufacturing industry in India consists of two sectors. The heavy agricultural machinery sectors primarily manufactures products such as tractors and tractor-driven equipment, while the light agricultural machinery sector is involved in manufacturing smaller tools, like motorised tillers, pumps, and harvesters.

Initiatives surrounding the use of AI technologies in agriculture in India are focused on enabling data driven agriculture through technologies such as image recognition, drones, machine learning, sensors, 3D laser scanning, driverless tractors, and chatbots - for monitoring, detection of abnormalities or defects, undertaking tasks like spraying chemicals, and predicting and forecasting growth and price. Our study identified six start up companies using AI in agriculture sector by using AI driven analytics to improve crop production in agriculture. Though the adoption of AI in agriculture can lead to more efficient farming and greater yields, challenges that have been identified include access to robust data as a result of a lack of power and connectivity in fields and technical capacity to deploy the technology.[41]

Data Driven Agriculture

For example, Microsoft has collaborated with ICRISAT (International Crop Research Institute for Semi-Arid Tropics) to develop an AI Sowing App which is powered Machine Learning, Power BI and Microsoft's Cortana.[42] Participating farmers receive information through text messages on the optimal date to sow their seeds. This process only requires the farmers to possess a phone which can receive text messages. The App is being tested in Andhra Pradesh

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36 Brilliant Factories are Making Manufacturing Pretty Brilliant, Lalit Khandelwal. Retrieved February 23, 2018, from **https://www.ge.com/digital/blog/brilliant-factories-are-making-manufacturing-pretty-brilliant**

37 GE'S Brilliant Advanced Manufacturing Plant in Pune, India, Tomas Kellner. Retrieved February 23, 2018, from **https://www.ge.com/reports/post/110927997125/ges-brilliant-advanced-manufacturing-plant-in/**

38 Rise of the Machines, Goutam Das. Retrieved February 23, 2018, from **http://www.businesstoday.in/magazine/features/mncs-indian-companies-started-investing-in-smart-factories/story/207247.html**

39 PM Narendra Modi Inaugurates GE's 'Brilliant Factory' in Pune. Retrieved February 23, 2018, from **http://www.business-standard.com/content/b2b-manufacturing-industry/pm-narendra-modi-inaugurates-ge-s-brilliant-factory-in-pune-115022000684_1.html**

40 Bharat Heavy Electricals Limited - Research and Development. Retrieved February 23, 2018, from **http://www.bhel.com/about_rd_electronic_control.php**

41 FarmBeats: AI & IoT for Agriculture. Retrieved February 23, 2018, from **https://www.microsoft.com/en-us/research/project/farmbeats-iot-agriculture/**

42 Digital Agriculture: Farmers in India are using AI to Increase Crop Yields. Retrieved February 23, 2018, from **https://news.microsoft.com/en-in/features/ai-agriculture-icrisat-upl-india/**

in order to calculate the crop-sowing dates and periods, climate data between 1986 to 2015 in that region was analysed using AI.[43] To arrive at the exact date for optimal sowing, real-time Moisture Adequacy Index (MAI) is calculated with the help of rainfall recorded by the Andhra Pradesh State Development Planning Society.[44] Weather forecasting models are used for calculating MAI which is provided by aWhere Inc. Further, Microsoft has also collaborated with United Phosphorus to create a Pest Risk Prediction API.[45] This model also uses and depends on Machine Learning and AI to provide warnings of pest attacks in advance.[46] Microsoft has also developed the project FarmBeats towards enabling data driven agriculture through the use of low-cost sensors, drones, and vision and machine learning algorithms.[47]

As another example, Gobasco is a company that aims at increasing efficiency of the existing agri-supply chain through using data-streams and real-time data analytics from sources throughout the country facilitated by AI-optimised automated pipelines.[48] While SatSure integrates geospatial and economic datasets with climatic variables in order to assess the risk of crop yield in an accurate fashion. The company uses big data, machine learning, cloud computing, IoT in furtherance of providing accurate decision points to traders, banks, insurance companies, government through a web-based platform.[49]

Aibono is an agri start-up that leverages technologies like AI, IoT and Crop Science to help farmers grow a profitable yield. The start-up is in furtherance of Agri 4.0 which is an agricultural revolution through the embracement of technology and Data Science. Aibono aims to use AI, Shared Services and Equipment, and Data Science to help farmers make informed decisions in order to minimise risk and maximise produce. Data led decisions are demonstrated in Aibono labs after the farmers share Farm Experts, Sensors, Data, Farm Managers, Tech Support and Farm Equipment backed by Data Analytics and AI.[50]

Automobiles

The automobile manufacturing industry in India comprises the production of commercial vehicles, passenger cars, and three & two-wheelers.The automobile industry in India is world's fourth largest, with the country currently being the world's seventh largest commercial vehicle manufacturer. Indian automotive industry (including component manufacturing) is expected to reach Rs 16.16-18.18 trillion (US$ 251.4-282.8 billion) by 2026.[51]

AI is being leveraged in the automotive sector both in the process of manufacturing automobile parts and in the end product. AI is enabling monitoring, efficiency, and precision in the process of manufacturing automobile parts and is being integrated into autonomous cars and intelligent transport systems. Our study identified five domestic companies working in the automobile sector. The solutions they provided include driving pattern analysis, motion planning and control, use of AI in the manufacturing sector, vehicle safety, and the development of autonomous electric vehicle.

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43 Ibid.

44 Ibid.

45 Ibid.

46 Ibid.

47 FarmBeats: AI & IoT for Agriculture. Retrieved February 23, 2018, from **https://www.microsoft.com/en-us/research/project/farmbeats-iot-agriculture/**

48 Gobasco - Globally Optimised Bulk Agri Supply Chain Organisation. Retrieved February 23, 2018, from **http://gobasco.com**

49 SatSure. Retrieved February 23, 2018, from **http://www.satsure.in/#aboutUs**

50 Artificial Intelligence is Changing the Farms of the Future, Sohini Bagchi. Retrieved February 23, 2018, from **http://www.cxotoday.com/story/artificial-intelligence-is-changing-the-farmsofthe-future/**

51 Automobile Industry Analysis, IBEF. Retrieved February 23, 2018, from **https://www.ibef.org/industry/automobiles-presentation**

Autonomous Vehicles

As an example of AI in autonomous vehicles, Flux Auto is developing a modular self driving technology for new and existing commercial vehicles. This is done through features like AI assisting with cruise control, lane keeping, and collision avoidance.[52] Novus–Drive is a completely autonomous electric vehicle by the company Hi Tech Robotic Systemz, which lets passengers manage destinations, and utilise Cloud Based Intelligence for a fleet management system. It also offers core competencies in machine learning, sensor fusion, computer vision technologies, motion planning and control, amongst others.[53] Similarly, ATImotors designs autonomous all-electric cargo vehicles, with a major focus on customers outside India.[54] The device Driveri has intelligent and situationally aware cameras that connect the devices over a global network.[55] Swaayatt robots is developing on-and off roads self driving technology that is designed for use in India's extremely difficult traffic scenarios and unstructured environmental conditions by enabling self driving vehicles to perceive their environments using off-the-shelf cameras.[56] Auro Robotics is working on autonomous shuttles currently in a campus trial stage, at the University of Santa Clara. Two separate models of their shuttles are being developed depending on the needs of the area, with vehicles that can either follow closed loop route with predefined stops or be called on-demand to pick and drop at user defined location.[57] One of India's leading robotics manufacturer is OmniPresent Robot, which manufactures drones for industrial inspections, as well as driverless cars.[58] SeDriCa is an autonomous ground vehicle by IIT Bombay's Innovation Cell, which plans to use GPS/INS, LiDAR and stereo cameras to gather information about the immediate environment at different range.[59] Another project, Aerodrive, by the Indian startup Fisheyebox, is aimed at making low tech cars loaded with cameras, sensors and antennae, packed with voice recognition software that that allows control of the car by voice command.[60]

Road Safety

Netradyne uses artificial intelligence to improve road and driver safety, through the use of a powerful camera that analyses driving patterns and can help determine the cause of accidents.[61] Similarly, Microsoft has partnered with the Department of Transport in various states to implement 'Harnessing AutoMobiles for Safety'. HAMS seeks to improve road

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52 Fluxauto. Retrieved February 23, 2018, from **http://fluxauto.xyz**

53 Hitechroboticsystemz - Novus Drive. Retrieved February 23, 2018, from **http://www.hitechroboticsystemz.com/novus-drive-autonomous-vehicle.html**

54 A New Beginning - ATI Motors. Retrieved February 23, 2018, from **https://medium.com/ati-motors/a-new-beginning-dea8a7f4ac7f**

55 Driveri - An Intelligent, Connected Driver Monitoring System, Stephen Neil. Retrieved February 23, 2018, from **https://www.drivespark.com/off-beat/driveri-an-intelligent-connected-driver-monitoring-system-024160.html**

56 Swaayatt Robots. Retrieved February 23, 2018, from **http://swaayatt-robots.com**

57 Auro. Retrieved February 23, 2018, from **http://auro.ai/product/**

58 Omnipresent Robot Tech. Retrieved February 23, 2018, from **http://www.omnipresenttech.com**

59 SeDriCa - Innovation Cell, IIT Bombay. Retrieved February 23, 2018, from **http://www.insightiitb.org/sedrica-1-0-innovation-cell-iit-bombay/**; 9 Startups in India Working on Self Driving Technology, Srishti Deoras. Retrieved February 23, 2018, from **https://analyticsindiamag.com/9-startups-india-working-self-driving-technology/**

60 DriveX - An Autonomous Celerio. Retrieved February 23, 2018, from **https://fisheyebox.wordpress.com/2017/08/06/aerodrive-an-autonomous-car-technology/**

61 Netradyne. Retrieved February 23, 2018, from **http://netradyne.com**

safety by assessing the state of the driver and the state of the road. It uses sensing devices that interact with a cloud based controller. The data is collected and analysed through a smartphone, an OBD-II scanner, and an Azure based backend.[62]

Manufacturing Automotive Parts

As an example of AI being used in the manufacturing process of the automotive sector, , Bosch, the German company headquartered in Bengaluru, has 14 manufacturing plants across India. It aims to adopt and implement smart manufacturing across all these plants in furtherance of 'Industry 4.0' by 2018.[63] At its headquarters, it uses real-time data to reduce "throughput times for the calibration of pumps for tractors". With the help of real-time monitoring, it is now possible to avoid manufacturing downtime and improve productivity.[64] Bosch also started production at a manufacturing plant located in Bidadi which consists of an automotive component that uses connected industry principles in order to ensure an efficient manufacturing process.

IT Services

The IT services sector has possibly seen the strongest push towards the use of AI in their day-to-day functioning in India. IT giants, both multinational and indigenous, have developed their own AI platforms that have now replaced repetitive software maintenance jobs and provide effective and accurate business solutions with the help of data analytics, machine learning, deep learning, natural language processing, and neural networks among others. IT giants in India have already discussed the potential use of AI in software maintenance in order to reduce roles at repetitive tasks and instead replace the workforce to perform complex works by creating new roles.[65] The business solutions assist in predictive decision making, fraud detection, regulatory compliance, and behavioral analysis of customers. Another trend in IT services is the growing prevalence of chatbots. The startups in India provide services from virtual assistants to customized chatbots for every industry. Another interesting use of AI in services is for recruitment where analytics and AI are used to find the best candidates for the clients.

In the case of services, our study identified forty-two domestic companies and nineteen international companies working in the sector specializing in services especially in the field of IT. Out of the forty-two companies identified, eight companies were in the field of customer analytics, the services these companies provided included product recommendation, performance indicators, and chatbots that understand customer preferences. The six domestic companies that provided services in the field of analytics mostly provided solutions such as using data to provide key insights, improving workflow through analytics, and giving insights to complex matters of data. In the field of process management, seven domestic companies were identified that were providing solutions such as consolidating business data, predictive analysis, image processing, deep learning

62 HAMS: Harnessing AutoMobiles for Safety. Retrieved February 23, 2018, from **https://www.microsoft.com/en-us/research/project/hams/**

63 Bosch to Introduce 'Smart Manufacturing' at India Plants by 2018. Retrieved February 23, 2018, from **http://www.financialexpress.com/industry/bosch-to-introduce-smart-manufacturing-at-india-plants-by-2018/146922/**

64 The Potentials and Pitfalls of 'Smart Manufacturing' in India, Juergen Moessinger. Retrieved February 23, 2018, from **http://blog.boschindia.com/manufacturing/the-potentials-and-pitfalls-of-smart-manufacturing-in-indiabosch-india-is-implementing-industry-4-0-projects-in-all-plants-to-achieve-smart-results/**

65 Artificial Intelligence and Automation will Result in Reduction of IT Services Staff by 7-10% in India, US by 2022, Ayan Pramanik. Retrieved February 23, 2018, from **https://economictimes.indiatimes.com/tech/software/artificial-intelligence-automation-will-result-in-reduction-of-it-services-staff-by-7-10-in-india-us-by-2022/articleshow/62322033.cms**

and computer vision and NLP. The other major area where the domestic AI developers were providing service as a solution was in the case of virtual assistants. In the case of international companies, eleven companies focused on providing solutions in the field of process management where these companies provided solutions ranging from using AI for customer retention, using deep learning to mimic human decision making, and making autonomous actions with data insights. The other area where international companies were providing AI services were in the fields of customer analysis and analytics, where the AI solutions offered included, using deep learning to know when the customer had stopped using a service, to predicting remarketing opportunities. It was also noted that a few of the domestic IT services startups were providing solutions, mostly in the form of virtual assistants, to a number of companies. Challenges called out to the adoption of AI in the services sector relate to skills, specifically highly skilled data scientists, and access to clean, accurate, and interoperable data.[66]

Personalization

For example, Mad Street Den's AI[67] solution Vue.ai uses AI to improve customer interaction and helps them tailor to their tastes, and in discovering products they may otherwise not have been aware of. This also helps retailers reduce cataloguing errors and product returns and make merchandising more customer-friendly. Marax[68] uses AI and Deep Learning to detect customers who may potentially stop using the enterprise's products and use consumer insights to help retain them. Morph an Indian startup has also developed a conversational marketing chatbot that understands customer's needs and preferences with the help of Natural Language Processing. Another company Zylotech[69] also uses an AI powered platform, CIP, to enable marketing operations to monitor and refine customer data to further power the embedded analytics engine which allows deeper insights to predict re-marketing opportunities. Fluid AI[70] has also developed a solution that focuses in the area of customer experience by changing the retail experience of a customer walking into a shop, bank branch or hotel lobby where they are greeted by an AI assistant smart screen.

Analytics

For example Abzooba has developed XPRESSO[71], a natural language processing and understanding engine that processes information that helps enterprises. Abzooba uses Artificial Intelligence (AI), Data Science, Big Data and Crowdsourcing to help business overcome challenges. Genpact's Cora also uses analytics to provide AI solutions. The startup vPhrase has also developed the AI platform Phrazor which analyses data and gives the key insights needed for decision making. Ayasdi's[72] core of the platform uses Topological Data Analysis (TDA) which when powered with Machine Learning derives insights from data.

Intelligent Platforms and Virtual Assistants

For example, Tata Consultancy Services has launched its artificial intelligence platform Ignio Systems, Applications, Products (SAP) ERP to facilitate the customers in running their

66 India Wants to go All-in on AI, But Must First Tackle the Shortage of Talent and Data, Prakash Mallya. Retrieved February 23, 2018, from **https://www.forbes.com/sites/prakashmallya/2018/01/02/india-wants-to-go-all-in-on-ai-but-must-first-tackle-shortage-of-talent-and-data/#7881a23d7454**

67 Mad Street Den. Retrieved February 23, 2018, from **https://www.madstreetden.com/about-us/**

68 Marax. Retrieved February 23, 2018, from **https://marax.ai/**

69 Zylotech. Retrieved February 23, 2018, from **https://www.zylotech.com/**

70 Fluid AI. Retrieved February 23, 2018, from **http://fluid.ai/**

71 Case Studies - Abzooba. Retrieved March 4, 2018, from **http://www.abzooba.com/case-studies/**

72 Ayasdi, Retrieved March 3, 2018, from **https://www.ayasdi.com/**

operations in SAP in a more effective and efficient fashion.[73] Ignio avoids the convolutedness related to SAP Business Management, settles usual errors and mistakes which affect important business processes, and decreases knowledge holes across operational technologies and teams. The platform has the capability to understand how the SAP ERP is being used by customers and improves the value of investments made by customers in SAP platforms.

Similarly, Infosys released their artificial intelligence platform Mana which automates repetitive software maintenance tasks. Mana has the capability to combine machine learning with the 'deep knowledge of an organisation'.[74] This platform has been used by business organisations to reduce the cost of maintenance of assets and to constantly change and reinvent their system landscapes.

Infosys also launched Nia in April 2017 which is an advanced version of their earlier launched Mana. Nia connects knowledge management, machine learning, cognitive automation capabilities and big data analytics of Mana; optical character recognition, infrastructure management services, natural language processing; advanced scalable machine learning capabilities of Skytree; and end-to-end RPA capabilities of AssistEdge.[75] Infosys' next generation platform Nia has the ability to tackle business problems including forecasting the kind of products that need to be built, predicting revenues, analysing and comprehending customer behaviour, fraud, compliances along with the contents of legal documents and contracts.[76]

DRYiCE Autonomics and Orchestration is the artificial intelligence platform deployed by HCL Technologies which helps enterprises to "operate leaner, faster and cheaper" in order to ensure optimal business outcomes.[77] The DRYiCE AI Foundation includes autonomics, natural language processing, deep learning, machine learning, Robotic Process Automation, Predictive Analysis, Neural Networks, Process Orchestration, and Cognitive Computing. DRYiCE also facilitates the functioning of various platforms, products and services which provide solutions and consulting services for better outcomes. The Foundation has developed solutions for a range of domains including IT operations.

Wipro has developed its artificial intelligence platform, 'Holmes', to automate the processes in its 'fixed price projects' which will overtake the software maintenance jobs of around 3000 engineers.[78] Holmes has been developed using semantic ontologies, machine learning, genetic and deep learning algorithms, pattern recognition, knowledge modelling technologies and natural language processing to offer results that speed up process through automation, provide cognitive enhancement to experience and productivity and at the "highest stage of maturity reach autonomous abilities".[79] Holmes has the ability to predict

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73 TCS Launches AI for SAP Operations. Retrieved February 23, 2018, from **https://www.tcs.com/tcs-ai-sap-operations**

74 Infosys MANA & NIA - The Next-gen AI Platform for Enterprises, Amit Paul Chowdhury. Retrieved February 23, 2018, from **https://analyticsindiamag.com/infosys-mana-nia-next-gen-ai-platform-enterprises/**

75 Infosys Launches Infosys Nia - The Next Generation Integrated AI Platform. Retrieved February 23, 2018, from **https://www.infosys.com/newsroom/press-releases/Pages/nia-artificial-intelligence-enterprise.aspx**

76 Ibid.

77 Autonomics and Orchestration - HCL. Retrieved February 23, 2018, from h**ttps://www.hcltech.com/autonomics-and-orchestration**

78 Wipro to Deploy AI Platform Holmes to do the Job of 3,000 Engineers, Varun Sood. Retrieved February 23, 2018, from **http://www.livemint.com/Companies/wnAHNojuGO2En8zQpItZLP/Wipro-to-deploy-AI-platform-Holmes-to-do-the-job-of-3000-en.html**

79 Wipro Holmes. Retrieved February 23, 2018, from **http://www.wipro.com/microsite/holmes/**

failures, offer solutions and constantly learn from new data. Specific attention is put on Business and IT operations and their enterprise use cases. The application of Wipro Holmes includes predictive systems, cognitive process automation, knowledge virtualization, digital virtual agents, visual computing applications, robotics and drones.

- **Predictive Systems**: Examples of this include Automated Scenario Modeling, Recommended Systems and Anticipatory Systems which extract meanings from distinct sets of data, using techniques that find patterns and predict trends and future outcomes.
- **Cognitive Process Automation**: This includes Modal Interactions and Experience Management, Automated Problem Resolution which execute functions based on a set of logic or instructions. These instructions are constantly evolving and are machine learnt.
- **Knowledge Virtualization**: These systems can use AI techniques to curate knowledge and arrive at decisions based on the use of expert knowledge databases. This includes systems such as Natural Language Generation and Diagnostic Experts.
- **Digital Virtual Agents**: These systems possess capabilities such as natural language understanding and speech recognition that enhance user experience. Examples of this include DIY Support, Collaborative Agents and Customer Support.
- **Visual Computing Applications**: Applications such as Dynamic Pattern Clustering and Computer Vision identify patterns along with acquiring, analysing and synthesizing realistic interactive interfaces.
- **Robotic and Drones**: Brain controlled robotics and smart drones are powered by recurring instructions which are either user defined or machine-learnt. Recurring patterns can be analysed through which these instructions can be fed into the system.

In furtherance of moving towards a digital age, with the use of technologies such as predictive analytics, machine learning, autonomics, RPA and natural language processing, Tech Mahindra has launched its automation platform called AQT (Automation, Quality, Time).[80] This helps increase business effectiveness and efficiencies for the stakeholders through consolidating automation platforms, tools and platforms. AQT will use Automation Thinking and Intelligent Automation in order to make 'Faster, Better and Economical' deliveries to the customers. This automation platform will impact user experience, quality, time to market, cost to deliver and other processes by increasing their efficiency. Tech Mahindra's AQT Automation Framework includes Centre for Automation Technologies (CAT), SureSmart - Automation platforms and tools, Automation Thinking and #Automate2Accelerate.

- **Centre for Automation Technologies (CAT)**: This team looks over Tech Mahindra's automation strategy and offers enablement support for all its deliveries and engagements. Its objective is to increase the adoption of automation platforms in all projects for greater efficiency, better ROI for customers and faster time to market.
- **SureSmart - Automation platforms and tools**: The best technologies and IPs have been put together under Tech Mahindra SureSmart. This is a set of automation tools and platforms which help increase and expand the use of automation across the service lines. This involves both third party platforms and tools along with in-house developed models. Some of the platforms include TACTIX, UNO, CUBES, Meridian, Epselon, IAF and PRISM.
- **Automation Thinking**: Inculcation of automation requires retraining and upskilling of existing workforce in order to create a conducive environment where such workforce and the machines can function in harmony which will bring in efficiency at workplace.

80 AQT - Tech Mahindra's Automation Framework. Retrieved February 23, 2018, from **https://www.techmahindra.com/Company/Automation.aspx**

- #**Automate2Accelerate**: One of Tech Mahindra's central automation strategies include the use of AI and automation at every level of all projects that they deliver. Through #A2A, they aim to work in immediate proximity with their customers in order to recognise potential areas for improvement where the application of AI can give rise to substantial benefits. These identifies projects are then allotted with specialists who facilitate the implementation of intelligent technologies and AI.

Security

HCL has also been able to leverage AI techniques to ensure application security. When a product is released to customers, and feedback is requested, the responses run into thousands. AI is crucial in sifting through the responses and, based on past data, reduce the number of priority issues to mere hundreds or fewer, which are then processed by human developers who begin to address the issues.

Process Management

Additionally, HCL also uses ISE (Intelligent sustenance engineering) and ITS (Intelligent technical support), which are AI based tools that help retain employee knowledge and sometimes skill, for the purpose of passing them on to new employees, or work alongside them to reduce initial delays.

Stakeholder Ecosystem

There are a number of stakeholders that make up the manufacturing and services ecosystem and they work together for the successful adoption and implementation of AI in this sector. In order to map the stakeholder ecosystem, we began by identifying the key stakeholders that have an impact on AI in manufacturing and services. The stakeholders were divided into five categories: practitioners, developers, research and industry bodies, government, and funders and investors. The developer mapping was further categorized on the basis of the type of company, sector, focus area and AI solution offered. The mapping also covered the various conferences that were held in India on topics relating to AI in the manufacturing and services sector. The data about the stakeholders was derived from publicly available information on websites, and newspaper reports, after which the data was further categorized based on our mapping parameters. As a note, the intention of this mapping is to provide a snapshot of the AI and manufacturing ecosystem in India and does not attempt to be exhaustive. The list of stakeholders identified as well as a brief summary of our findings is as presented below. The complete mapping can be found at the end of this Report in Annex 1.

Practitioners: In our study, we identified thirty-nine companies that are using AI services and products in the manufacturing and services industry. In the companies identified eight were using chatbots, four were using automated decision-making tools, and seven were using AI-powered robots. The clients of these AI tools included media companies like Zee media to e-commerce websites such as Myntra[81], Lenskart[82], Flipkart[83], Jabong, and Quikr[84] that were

81 GreyOrange Supply Chain Automation Company - About GreyOrange. Retrieved March 4, 2018, from **http://www.greyorange.com/about-us/company**

82 10 standout start-ups taking an AI leap in India, Mihir Dalal. Retrieved March 4, 2018, from **http://www.livemint.com/Leisure/u7M3e5ymwmGf6QRLaXBoAJ/10-standout-startups-taking-an-AI-leap-in-India.html**

83 GreyOrange Supply Chain Automation Company - About GreyOrange. Retrieved March 4, 2018, from **http://www.greyorange.com/about-us/company**

84 10 standout start-ups taking an AI leap in India, Mihir Dalal. Retrieved March 4, 2018, from **http://www.livemint.com/Leisure/u7M3e5ymwmGf6QRLaXBoAJ/10-standout-startups-taking-an-AI-leap-in-India.html**

using both AI robots as well as decision-making tools. Bigger companies such as Hindustan Lever[85], Infosys[86], HCL[87], Wipro[88], and TCS[89] are also using AI in its various operations.

Researchers and Industry Bodies: With regard to research in the field of AI and manufacturing and services our study identified thirty-six organizations involved in or had published studies on the subject. The organizations ranged from institutions such as the IITs and IIMs to industry bodies such as PricewaterhouseCoopers (PWC) and Ernst & Young (EY). Where the papers by the professors from institutions dealt with the use of AI in manufacturing and services, industry bodies such as PWC and EY, published reports on the future of AI and Robotics in India and the Future of jobs, respectively. It was also noted that the EY Report on the future of jobs was developed in coordination with Indian industry bodies Federation of Indian Chambers of Commerce and Industry (FICCI) and NASSCOM. International Labour Organization (ILO) was also noted to have published significantly on the effect of AI in the labour market. KPMG and the Confederation of Indian Industries (CII) has also published a Report on emerging technologies in the "intelligent economy"[90], which includes how AI could change the manufacturing and services sector.

Government: The government, in an attempt to address the looming threat that AI potentially poses to employment in India, has only just begun to direct funds to the various research projects to kick start policy discourse on the subject. In our study we identified twelve government initiatives to tackle the AI issue with regard to the service ecosystem. The state governments of Karnataka and Andhra Pradesh have taken active steps towards AI adoption, with Karnataka not only setting up policy research bodies but also working with Microsoft[91] to improve crop yield using AI. Similarly, Andhra Pradesh's 'Cloud Hub' policy is aimed at the promotion of advanced testing facilities.[92] Government institutions like the FICCI[93] and Make in India[94] have focused on heavily on research with regard to the potential impact of AI on the Indian economy while Meity has setup up an expert committee on AI to inform government policy and have also framed a seven point strategy for the same. NASSCOM[95] and

85 Ibid.

86 Infosys Launches Infosys Nia™ - The Next Generation Integrated Artificial Intelligence Platform. Retrieved March 4, 2018, from **https://www.infosys.com/newsroom/press-releases/Pages/nia-artificial-intelligence-enterprise.aspx**

87 DryICE Platform & Enterprise Automation Trends - HCL Technologies. Retrieved March 4, 2018, form **https://www.hcltech.com/enterprise-technology-office/trends**

88 HOLMES - Wipro. Retrieved March 4, 2018, from **https://www.wipro.com/holmes/**

89 Artificial Intelligence (AI) - Deep Learning, Machine Learning - TCS. Retrieved March 4, 2018, from **https://www.tcs.com/artificial-intelligence**

90 The Intelligent Economy - Leveraging Technology for a New Era, KPMG. Retrieved February 23, 2018, from **https://assets.kpmg.com/content/dam/kpmg/in/pdf/2017/11/CIIConnect6nov2017.pdf**

91 Karnataka govt inks MoU with Microsoft to use Artificial Intelligence for digital agriculture. Retrieved March 4, 2018, from **http://indianexpress.com/article/india/karnataka-govt-inks-mou-with-microsoft-to-use-artificial-intelligence-for-digital-agriculture-4909470/**

92 AP aims for $5B investments with new Cloud Hub policy, Patri Vasudevan. Retrieved March 4, 2018, from **https://www.deccanchronicle.com/nation/current-affairs/200118/ap-aims-for-5b-investments-with-new-cloud-hub-policy.html**

93 Future of jobs and its implications on Indian higher education. Retrieved March 4, 2018, from **http://www.ficci.in/spdocument/20787/FICCI-Indian-Higher-Education.pdf**

94 Telecommunications Sector - Achievements Report. Retrieved March 4, 2018, from **http://www.makeinindia.com/documents/10281/114126/Telecommunications+Sector+-+Achievement+Report.pdf**

95 Nasscom to Set Up Centres of Excellence on Artificial Intelligence, Data Science. Retrieved February 23, 2018, from **http://www.thehindubusinessline.com/info-tech/nasscom-to-set-up-centres-of-excellence-to-better-learn-artificial-intelligence/article9916019.ece**

the Department of Science and Technology[96] have also set up research institutions to further the role of AI in industry. Another association, namely The AI task force[97] aims at drafting effective policy while Niti Aayog[98] is in the final stages of launching a portal for the sharing of practice data sets.

Funders/Investors: The startups working on AI in manufacturing and services in India have been funded by various investors that believe in the potential of AI to improve the manufacturing and services industry. Our study identified twenty-seven investors/funders who have funded various AI startups. These funders included firms such as Kalaari Capital[99], Sequoia[100], Prime Venture Partners[101] and Matrix Partners[102] to name a few, the startups were also funded by Indian companies such as Reliance[103] and Ratan Tata[104] of the Tata Group, startups were also funded by the Incubate Fund India[105] and the Indian Angel Network[106].

Developers: In our attempt to map significant developers of AI solutions in the manufacturing and services industry, we were able to identify eighty-three companies that had developed AI enabled products and services in order to benefit the manufacturing and services industry. Out of the eighty-three companies sixty two companies were from India and twenty-one companies were international companies. Some of these developers/companies also provided products that could be used by consumers, thereby bringing the use of AI into our everyday lives. The focus areas of these companies ranged from analytics to helping in agriculture, to customer insights, virtual assistants to even robots that can be used in factories. Out of the companies, the majority (fifty seven) were in the IT and services sector, followed by six in the field of electronics, three in the field of heavy electricals, six in the field of agriculture seven in automobiles and five that were sector neutral. International companies, such as HCL[107] were found to be the key international players in this sector, the

96 Data Science Research Initiative - Department of Science and Technology. Retrieved March 4, 2018, from **http://dst.gov.in/data-science-research-initiative**

97 Artificial Intelligence Task Force. Retrieved March 4, 2018, from **https://www.aitf.org.in/**

98 Budget 2018: How will Artificial Intelligence fuel the Indian Economy, Amit Dua. Retrieved March 4, 2018, from **https://yourstory.com/2018/02/budget-2018-artificial-intelligence-fuel-indian-economy/**

99 Kalaari Capital. Retrieved March 3, 2018, from **https://www.kalaari.com/**

100 Predictive hiring platform Belong raises Series B funding of $10M led by Sequoia Capital and launches Belong Experts, Sindhu Kashyap. Retrieved March 4, 2018, from **https://yourstory.com/2017/02/belong-funding-2/**

101 Security Management Solution Mygate Raises $2.5 Mn In Funding From Prime Venture Partners, Shweta Modgil, Retrieved March 4, 2018, from **https://inc42.com/buzz/security-management-mygate-prime-venture-partners/**

102 Predictive hiring platform Belong raises Series B funding of $10M led by Sequoia Capital and launches Belong Experts, Sindhu Kashyap. Retrieved March 4, 2018, from **https://yourstory.com/2017/02/belong-funding-2/**

103 Reliance Industries invests $16M in US-based startup NetraDyne, Binu Paul. Retrieved March 4, 2018, from **https://www.vccircle.com/reliance-industries-invest-16-mn-us-startup-netradyne/**

104 Artificial Intelligence App Niki.Ai Raises $2 Mn From SAP, Others, Aparna Mishra. Retrieved March 4, 2018, from **https://inc42.com/buzz/niki-ai-funding-sap/**

105 Exclusive: AI Based HRTech Startup Skillate Raises Funding, Megha Agarwal. Retrieved March 4, 2018, from **https://inc42.com/buzz/ai-hrtech-startup-skillate-funding/**

106 AI startup Staqu raises funding from Indian Angel Network, Priya Prasad. Retrieved March 4, 2018, from **http://techcircle.vccircle.com/2016/06/23/ai-startup-staqu-raises-funding-from-indian-angel-network/**

107 Automation and Orchestration: Cognitive Computing and Robotic Process Automation Solutions. Retrieved March 4, 2018, from **https://www.hcltech.com/autonomics-and-orchestration**

other major player was Wipro[108] that had its own AI system - Wipro Holmes as well as Infosys' Nia[109]. Among the other domestic companies were startups such as NikiAi[110], Greyorange[111], Clay Labs[112], Mad Street Den[113], Arya AI[114], Uncanny vision[115], that were working across sectors and especially in IT services. Companies such as Aibono,[116] Stellapps[117] and TartanSense[118] were also notable, for their work in the field of bringing AI into the Indian agricultural sector.

Conferences: In our attempt to map out the AI and manufacturing and services ecosystem in India, our study attempted to identify relevant AI events and conferences that were held or were slated to be held in India. The mapping identified that in the year 2017 there were eighteen conferences in India that were on topics related to use of AI in the manufacturing and services sector. The organizers of these conferences included government organizations such as CII[119] and NASSCOM[120] as well as state governments such as the Department of IT and BT Government of Karnataka[121]. Three conferences were also conducted by educational institutions, such as IIT Kanpur[122], and IIM Bangalore[123]. In the case of future conferences our study identified twelve conferences that were planned to be conducted in 2018. The topics in the conferences identified included, AI and Deep Learning, AI and Machine Learning, Emerging technologies etc. These conferences had participants and speakers from Indian as well as international companies both in the manufacturing and services sector, academia as well as representatives from the government. Another trend that was identified from the study was that these conferences were mostly held in the metropolitan cities, such as Bangalore, Mumbai, Delhi and Chennai.

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108 Wipro Holmes. Retrieved March 3, 2018, from **http://www.wipro.com/microsite/holmes/**

109 Infosys MANA & NIA - The Next-gen AI Platform for Enterprises, Amit Paul Chowdhury. Retrieved February 23, 2018, from **https://analyticsindiamag.com/infosys-mana-nia-next-gen-ai-platform-enterprises/**

110 Niki - AI Chat Bot to Simplify Your Order Experience. Retrieved March 4, 2018, from **https://niki.ai/**

111 GreyOrange - Intelligent Automation. Retrieved March 4, 2018, from h**ttp://www.greyorange.com/**

112 Clay Labs. Retrieved March 4, 2018, from **http://claylabs.com/**

113 Mad Street Den. Retrieved March 3, 2018, from **https://www.madstreetden.com/about-us**

114 Arya.ai. Retrieved March 4, 2018, from **https://arya.ai/oil-and-gas.php**

115 Uncanny Vision - Accelerating Computer Vision. Retrieved March 4, 2018, from **http://www.uncannyvision.com/**

116 Aibono. Retrieved March 4. 2018, from **http://www.aibono.com/**

117 Dairy Technology Solutions Company - Stellapps. Retrieved March 4, 2018, from **http://www.stellapps.com/index.php/about-stellapps/**

118 TartanSense - Aerial Imagery Solutions, India. Retrieved March 4, 2018, from **http://www.tartansense.com/**

119 ICT East 2017 - CII Eastern Region. Retrieved March 4, 2018, from **https://www.mycii.in/Admin/EventPreview.aspx?CallFrom=CAM&EventId=E000035849**

120 NASSCOM Big Data & Analytics Summit 2017. Retrieved March 4, 2018, from **http://www.nasscom.in/bigdata/**

121 Bengaluru Tech Summit - Ideate Innovate Invent. Retrieved March 4, 2018, from **http://www.bengalurutechsummit.com/**

122 2017 International Conference on Computational Intelligence: Theories, Applications and Future Directions. Retrieved March 4, 2018, from **https://www.iitk.ac.in/idea/ICCI2017/**

123 Machine Learning with Business Applications. Retrieved March 4, 2018, from **http://www.iimb.ac.in/eep/product/270/Machine_Learning_with_Business_Applications?management=Analytics&addurl=S01330&Ref=IIMBsite**

Government Led Initiatives

The Central and State Governments have started to undertake different initiatives to promote, understand, and enable the development and adoption of AI in India. Some of these include Centres of Excellence, Task Forces, strategic partnerships, and joint projects. Some of the initiatives are specific to manufacturing and some of the initiatives broadly relate to AI. For example:

- **Centre of Excellence for Data Science & Artificial Intelligence**
  NASSCOM announced their initiative to set up centres for AI and data science in Bengaluru and Hyderabad in order to map growing technologies and tap opportunities for their deployment.[124] These centres will map resources, encourage startups and look at global best practices for the emerging use of AI in India. It has been recognised by NASSCOM that before regulating the use of AI, it must be allowed to mature and its growth must be promoted.[125] Further, NASSCOM also entered into an agreement with Dalian Municipal People's Government in furtherance of promoting collaboration and the use of IoT in the industrial space. The agreement provides India with the opportunity to delve into China's AI and IoT market.[126]
- **Digital India, Make in India, Skill India Initiatives**
  The Digital India and Make in India initiatives have given a major boost to the use of AI and IoT in the manufacturing and services sector.[127] With these initiatives, India has taken a huge step towards the adoption and development of Industry 4.0 which aims completely digitise the manufacturing sector with the use of IoT, AI and Big Data analytics.[128] Furthermore, the Skill India initiative will help in reskilling workforce towards performing new and high skilled tasks. Presently, the 2015 National Policy for Skills and Entrepreneurship policy does not specifically mention AI, but its general objectives could be used to support skills required in the advent of AI technologies.[129]
- **Digital Agriculture initiative between Government of Karnataka and Microsoft**
  The Government of Karnataka has entered into a Memorandum of Understanding with Microsoft for predictive analysis in agriculture in order to safeguard population from high inflation or avoid harm to farmers from price crash.[130] Microsoft's "multivariate agricultural commodity price forecasting model" estimates crop yields at every stage of farming with help of remote sensing data.[131] This is procured from images captured by geo-stationary satellites. This data along with weather, yielding, production rates, historical sowing area and other relevant datasets are analysed in an "elastic-net

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124 Nasscom to Set Up Centres of Excellence on Artificial Intelligence, Data Science. Retrieved February 23, 2018, from **http://www.thehindubusinessline.com/info-tech/nasscom-to-set-up-centres-of-excellence-to-better-learn-artificial-intelligence/article9916019.ece**

125 Ibid.

126 NASSCOM Signs Agreement with local Chinese Government to Push For AI.Retrieved February 23, 2018, from **https://economictimes.indiatimes.com/tech/software/nasscom-signs-agreement-with-local-chinese-government-to-push-for-ai/articleshow/60767451.cms**

127 Towards Smart Manufacturing: Industry 4.0 and India. Retrieved February 23, 2018, from **http://www.makeinindia.com/article/-/v/towards-smart-manufacturing-industry-4-0-and-india**

128 Ibid.

129 National Policy on Skill Development and Entrepreneurship 2015, Ministry of Skill Development and Entrepreneurship. Retrieved February 23, 2018, from **http://www.skilldevelopment.gov.in/assets/images/Skill%20India/National%20Policy%20on%20Skill%20Development%20and%20Entreprenurship%20Final.pdf**

130 Digital Agriculture: Farmers in India are Using AI to Increase Crop Yields. Retrieved February 23, 2018, from **https://news.microsoft.com/en-in/features/ai-agriculture-icrisat-upl-india/**

131 Ibid.

framework" to forecast the timing when the grains will arrive in the markets and in what quantities.[132] This will in turn help determine the prices of the respective crops. The model is currently being used for predictive analysis for tur and can be expanded to other crops and regions as well.[133]

- **Task Force on Artificial Intelligence**
  The Ministry of Commerce and Industry set up a Task Force on Artificial Intelligence in order to expedite developments in the field of information technology.[134] The task force comprises of 18 members from the industry, researchers, academics and experts in the field. Through this initiative, the government seeks to accelerate the use of technology across various fields which include fintech, agriculture, healthcare, retail and customer engagement among others. The main focus areas of the task force include, enabling the use of AI in tech development, entrepreneurship, product commercialisation, public utility services, and national security.[135]
- **Policy on Cloud Hub and Artificial Intelligence**
  The government of Andhra Pradesh is considering the initiative of setting up a policy on Cloud Hub and AI in furtherance of incentivising IT companies basing their work on these areas to set up their offices in the new state.[136] It is estimated that this policy would result in job growth and add around two lakh jobs in the coming year.

Legal and Ethical Considerations and Policy Landscape

The use of AI in manufacturing processes and products can raise a number of legal and ethical questions. How can various kinds of liability be determined? How does AI impact employment contracts? How is privacy impacted? etc. The below section outlines legal and ethical questions that arise in the context of using AI in manufacturing processes and products and maps policy and legislation in India that would (potentially) be applicable.

Security and Safety

AI technologies and systems are driven by data collected from public and private domains. This means that they require access to large data centres in order to perform efficiently and produce accurate results. However, such large data centres can be "honeypots" for cyber attacks and AI technologies can be exploited to get access to sensitive and private information, thus jeopardising the security of vital information.[137] The vulnerability of these data centres increases if data is shared across organizations. There also exists the risk of Machine Learning algorithms being misused by actors and harmful autonomous techniques being developed.[138] It is critical that AI technologies and solutions are developed with security by design and are implemented in a secure manner. For example, AI is dependent,

132 Government of Karnataka Inks MoU With Microsoft to use AI for Digital Agriculture, Jasmeen Nagpal. Retrieved February 23, 2018, from **https://news.microsoft.com/en-in/government-karnataka-inks-mou-microsoft-use-ai-digital-agriculture/**

133 Digital Agriculture: Farmers in India are Using AI to Increase Crop Yields. Retrieved February 23, 2018, from **https://news.microsoft.com/en-in/features/ai-agriculture-icrisat-upl-india/**

134 A Look at India's Unique Initiative on Artificial Intelligence Task Force, Richa Bhatia. Retrieved February 23, 2018, from **https://analyticsindiamag.com/a-look-india-unique-initiative-artificial-intelligence-task-force/**

135 Ibid.

136 Ibid.

137 Artificial Intelligence and Robotics, 2017 - Leveraging Artificial Intelligence and Robotics for Sustainable Growth, PWC. Retrieved February 23, 2018, from **https://www.pwc.in/assets/pdfs/publications/2017/artificial-intelligence-and-robotics-2017.pdf**

138 Ibid.

reacts, and learns from its environment and needs to be trained to account for possible attacks or manipulation. This includes having organizational level security protocols and processes in place that account for the use of AI technologies. For example, AI technologies may be more susceptible to certain kinds of cyber attacks such as adversarial learning attacks.[139]

Relevant policy in India includes:

- ***NCIIPC CII Guidelines***: NCIIPC has developed a security framework for CII in India.[140] This framework may need to be assessed for its applicability to AI technologies and solutions.
- ***Sectoral Safety Standards***: The Bureau of Indian Standards offers localized standardisation for electronic commodities. For example, keeping in view the safety of Indian consumers, and to curb the inflow of substandard electronic products, the "Electronics and Information Technology Goods (Requirements for Compulsory Registration) Order, 2012" was notified on 3rd October 2012, by MeitY under the provision of Compulsory Registration Scheme of the Bureau of Indian Standards (BIS) Act, 1986. The Order prohibits the manufacturing or selling of a product within the scope of the Order, unless the good has been tested to Indian Safety Standards, registered with BIS and displays the registration logo (Standard Mark).[141]

Privacy

Privacy concerns over the use of AI across sectors have been raised particularly in light of a lack of comprehensive data protection laws in India.[142] The use and functioning of AI across domains is dependent on the collection of data and analytics to arrive at solutions. This has resulted in the AI technology accessing large sets of data including Personally Identifiable Information (PII). AI systems and technologies now have the ability to track behavioural patterns, individual interests, location and everyday movements of a person. In manufacturing, the collection of PI or SPDI depends on the way in which the technology is used. For example, it is less likely that PI or SPDI will be collected in an AI driven system used for detecting plant growth abnormalities or disease as opposed to an AI driven autonomous car. There are situations where the collection of PI and SPI is less clear - for example an AI driven platform that monitors production and operation of a factory- potentially would be collecting the personal data of employees.

Relevant policy and legislation in India includes:

- ***K.S.Puttaswamy v UOI***: In light of the recognition of privacy as a fundamental right under the Constitution of India in K.S.Puttaswamy v UOI, these concerns become even more prominent and need immediate remedies.[143] The Supreme Court in this case also recognised the growing use of emerging technologies and stated that there is an immediate necessity to come up with a data protection framework in light of technological developments.

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139 Berkeley Experts on How to Build More Secure, Faster AI Systems, Brett Israel. Retrieved February 23, 2018, from **http://news.berkeley.edu/2017/10/16/berkeley-experts-on-how-to-build-faster-safer-and-more-secure-ai-systems/**

140 Guidelines for Protection of Critical Information Infrastructure, National Critical Information Infrastructure Protection Centre. Retrieved February 23, 2018, from **http://nciipc.gov.in/documents/NCIIPC_Guidelines_V2.pdf**

141 List of items notified under the 'Electronics and Information Technology Goods (Requirements for Compulsory Registration) Order, 2012'. Retrieved March 4, 2018, from **http://electronicstds.gov.in/CREITG/app_srv/tdc/gl/jsp/AboutUs.jsp**

142 Artificial Intelligence Could be a Game-changer, but Privacy Concerns Remain. Retrieved February 23, 2018, from **https://economictimes.indiatimes.com/magazines/panache/artificial-intelligence-could-be-a-game-changer-but-privacy-concerns-remain/articleshow/61965806.cms**

143 Puttaswamy v. Union of India, Writ Petition (Civil) No. 494/2012

- ***Section 43A and associated Rules***: The Rules mandated under Section 43-A of the IT Act create a quasi data protection framework and make it compulsory for the body corporate to inform the data provider as to the reason for collecting the said data after taking his/her consent for the same. The data provider should also be notified as to further recipients of the data along with details as to retention of information collected.[144] These Rules would have clear applicability to AI driven systems collecting and using the PI and SPDI of consumers and users, but their applicability is less clear in the situation of the collection and use of PI and SPI of employees.
- **Srikrishna Committee White Paper**: With the development of technologies like artificial intelligence and Internet of Things, the Srikrishna Committee in its White Paper on Data Protection has mentioned the importance of formulating comprehensive data protection laws in order to effectively address issues of privacy which will inevitably arise in an AI driven ecosystem. It has further been recommended by the Committee that the data protection laws should cover both manual and automated processing and the word processing should be broadly defined to leave room for incorporation in the future by way of interpretation.[145]

Access and Ownership of Data and Technology and Competition

Companies with access/ownership of data and AI technologies have the potential to be more successful than other players in the field. For example, a Gartner Report notes that companies incorporating cognitive ergonomics and system design into artificial intelligence will be four times as successful as competitors.[146] The same Report notes that it is not only the large companies that will succeed, predicting that by 2019 startups will overtake google, Amazon, Facebook etc. in driving the AI economy.[147] Ownership of data and technologies are key to facilitating domestic innovation, sector growth, and equal playing fields.

Relevant policy around access and ownership of data and technology in India include:

- ***National Data Sharing and Accessibility Policy***: The National Data Sharing and Accessibility Policy (NDSAP) was developed by the Ministry of Science and Technology with the Ministry of Electronics and Information Technology (MeitY) which implements the policy.[148] In furtherance of this policy, the MeitY established the Open Government Data Platform which provides access to data collected and available with various Ministries and departments of the Government of India.[149] The main objectives of this platform include creating an enabling mechanism to provide open access to data held by the government and to increase transparency, accountability and better governance among other things.

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144 Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011

145 White Paper of the Committee of Experts on a Data Protection Framework for India. Retrieved March 4, 2018, from **http://www.meity.gov.in/writereaddata/files/white_paper_on_data_protection_in_india_171127_final_v2.pdf**

146 The Road to Enterprise AI. Retrieved February 23, 2018, from **https://www.gartner.com/imagesrv/media-products/pdf/rage_frameworks/rage-frameworks-1-34JHQ0K.pdf**

147 Ibid.

148 Open Data, Ministry of Electronics and Information Technology. Retrieved February 23, 2018, from **http://meity.gov.in/open-data**

149 Open Government Data (OGD) Platform India - An Overview, Ministry of Electronics and Information Technology. Retrieved February 23, 2018, from **http://meity.gov.in/writereaddata/files/OGD_Overview%20v_2.pdf**

The Open Government Data Platform offers quantitative data across many sectors on a state and national level. Specific to the sectors discussed in this report, the Electronics and IT Services sector has data regarding yearly and decade specific data on national and state production and exports.[150] They also have data regarding cases filed under the IT Act concerning cyber crimes,[151] lists of approved[152] and currently authorised[153] software technology parks of India and a list of copyrights developed under DeitY.[154]

The Automobile industry has data regarding production across different time spans both as a collective whole and also broken down into specific categories.[155] They also have data regarding tax exempted vehicles,[156] motor transport statistics,[157] state wise data on motor vehicle accidents[158] and total revenue derived from motor vehicle tax and fees.[159] On the other hand, the Agricultural industry has data regarding crop yield,[160] wholesale

150 Electronics and IT Exports. Retrieved March 8, 2018, from **https://data.gov.in/catalog/electronics-and-it-exports**; Electronic and IT Production (Financial Years) India 2000 to 2011, Annual Report on Electronics and IT Production for 2012-2013. Retrieved March 8, 2018, from **https://data.gov.in/catalog/electronics-and-it-production;**

151 Cases Registered Under IT Act of Cyber crime during 2013, Cases registered under IT Act of Cyber crime during 2012. Retrieved March 8, 2018, from **https://data.gov.in/catalog/cases-registered-under-it-act-cyber-crime**

152 State-wise list of approved new Software Technology Parks of India (STPI) centres (in reply to unstarred question on 09-12-2016)(From:Ministry of Electronics & Information Technology). Retrieved March 8, 2018, from **https://data.gov.in/resources/state-wise-list-approved-new-software-technology-parks-india-stpi-centres-reply-unstarred**

153 State-wise list of existing Software Technology Parks of India (STPI) centres (in reply to unstarred question on 09-12-2016)(From:Ministry of Electronics & Information Technology). Retrieved March 8, 2018, from **https://data.gov.in/resources/state-wise-list-existing-software-technology-parks-india-stpi-centres-reply-unstarred**

154 Copyrights for Softwares Developed under DeitY Funding. Retrieved March 8, 2018, from **https://data.gov.in/catalog/copyrights-softwares-developed-under-deity-funding**

155 Category-Wise Automobile Production. Retrieved March 8, 2018, from **https://data.gov.in/catalog/category-wise-automobile-production**

156 All India And State-wise Number Of Taxed And Tax-Exempted Motor Vehicles Registered In India. Retrieved March 8, 2018, from **https://data.gov.in/catalog/all-india-and-state-wise-number-taxed-and-tax-exempted-motor-vehicles-registered-india**

157 Motor Transport Statistics. Retrieved March 8, 2018, from **https://data.gov.in/catalog/motor-transport-statistics-1970-71**

158 State Wise Data on Motor Vehicle Accidents. Retrieved March 8, 2018, from **https://data.gov.in/search/site?query=State+Wise+Motor+Vehicle+Accidents**

159 State/UT Wise Revenue Realized From Motor Vehicle Tax, Commercial Vehicle And Other Fees, Passenger Tax, Goods Tax And Fines. Retrieved March 8, 2018, from **https://data.gov.in/catalog/stateut-wise-revenue-realized-motor-vehicle-tax-commercial-vehicle-and-other-fees-passenger**

160 Average Area, Production and yield of Different Crop Groups in Triennium Ending (TE) and Percentage Increase in yield during TE 2009-10 and TE 2014-15 (From:Ministry of Agriculture and Farmers Welfare). Retrieved March 8, 2018, from **https://data.gov.in/resources/average-area-production-and-yield-different-crop-groups-triennium-ending-te-and-percentage**

price index,[161] suicide rates,[162] FDI inflow,[163] state wise agricultural GDP share[164] and other similar data sets.

- ***Indian Patents Act***: Sections 1 and 2 of the Patents Act provide for the eligibility and definitions with respect to application for a patent for an invention. On a plain reading of these sections, it can be inferred that there is no requirement for an inventor applying for a patent to be a natural person.[165] Since the advancement of technology and use of AI is a new phenomenon, it must be kept in mind that these provisions in their general practice and understanding have always applied only to natural persons. Further, any wider interpretation of such laws would also only extend to juristic persons, and it is unlikely at this point such legal personality status may be accorded to AI systems.
- ***Industrial Designs Act 2000***: The Industrial Designs Act 2000 provides intellectual property rights to the design and aesthetics of a product. These rights are valid for ten years and apply if a product is novel and original, applicable to a functional article, visible on a finished article, is non-obvious, and there is no prior publication or disclosure of the design.[166] As AI is used in more and more creative capacities, the questions of whether or not a design by AI could fall under the Industrial Designs Act is raised.
- ***Indian Copyright Act 1957***: It has been recognised that Indian Copyright Laws might not effectively cover situations where the work is question has been created by an AI.[167] Section 2(d) of the Copyright Act provides the definition of an "author" which might not cover the possibility of an AI being the creator or a contributor and is only limited to a legal or natural person. The applicability of the legal framework around copyright in India to AI is a grey area, particularly with AI increasingly playing a key role in in creating new work.[168]

Labor and Workers Rights

The impact of manufacturing and services on jobs is not entirely clear and appears to be a mixture of job loss, increase in opportunities or a shift in tasks and responsibilities. Reports studying the impact of automation and AI on jobs in the marketplace have found that an AI driven environment has the potential to create more high skilled jobs that do

161 Wholesale Price Index. Retrieved March 8, 2018, from **https://data.gov.in/catalog/wholesale-price-index-0**

162 Farmers Suicide Data for the Period from 2011 to 2014 (Ministry of Agriculture and Farmers Welfare). Retrieved March 8, 2018, from **https://data.gov.in/resources/farmers-suicide-data-period-2011-2014-ministry-agriculture-and-farmers-welfare**

163 Total FDI inflows in agriculture sector from 2013-14 to 2016-17 (Apr- Sep)(From:Ministry of Agriculture & Farmers Welfare). Retrieved March 8, 2018, from **https://data.gov.in/resources/total-fdi-inflows-agriculture-sector-2013-14-2016-17-apr-sepfromministry-agriculture**

164 State-wise India's GDP from Agriculture on yearly basis. Retrieved March 8, 2018, from **https://data.gov.in/resources/state-wise-indias-gdp-agriculture-yearly-basis**

165 The Future is Here: Artificial Intelligence and Robotics, Nishith Desai Associates. Retrieved February 23, 2018, from **http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/Artificial_Intelligence_and_Robotics.pdf**

166 What is Industrial Design Protection and How Can One Protect Their Designs?, Gaurav Singhal. Retrieved February 23, 2018, from **https://yourstory.com/2015/07/what-is-industrial-design-protectiontheir-designs/**

167 The Future is Here: Artificial Intelligence and Robotics, Nishith Desai Associates. Retrieved February 23, 2018, from **http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/Artificial_Intelligence_and_Robotics.pdf**

168 Ibid.

not exist today.[169] Furthermore, people can be employed in performing tasks which require completely different skill sets from what they currently possess.[170] It has also been estimated that employment opportunities will increase from 38 million to 46-48 million by 2022 in the organised manufacturing and services sector with the rise in AI technologies.[171] The use of AI for augmentation also makes it possible for AI and humans to thrive in the same workspace and complement each other, without the former displacing the latter.[172] At the sametime, though the use of AI in any sector raises concerns about job displacement and workers rights, in our research, we found these concerns to be acute in the manufacturing and services sector. Unlike in the health sector, where our research showed AI as being used to primarily augment the role of a doctor[173], in manufacturing reports show AI displacing jobs or reducing the tasks in a job.[174] Reports more generally on the impact of technology on jobs have highlighted, with concern, the independent but growing trend of contract work in India in the sharing economy and sectors such as logistics, tech platforms for services etc.[175] Contract work falls outside of the scope of some labor laws in India - leaving workers more vulnerable in terms of lower pay and ease in hiring and firing. The introduction of AI into a workplace could potentially exacerbate this trend and the vulnerability of workers through rapid and new forms of automation. Furthermore, the use of AI in the workplaces raises questions about the relationship between AI, employees, and employers.

Relevant policy around job displacement and workers rights in India include:

- **Industrial Disputes Act**: The Industrial Disputes Act provides for the procedure to be followed for retrenchment of workforce by giving prior notice and compensation for such retrenchment. This provision could potentially be resorted to for the purposes of reducing an existing workforce on the factory floor who will be replaced by automated methods driven by artificial intelligence.[176]
- **National Manufacturing Policy**: The Ministry of Commerce and Industry along with the Department of Industrial Policy and Promotion came up with the National Manufacturing Policy. This policy, aimed at increasing manufacturing growth rate, generating jobs and supporting skill development programmes, has been defined as the most

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169 Future of Jobs in India: A 2022 Perspective. Retrieved February 23, 2018, from **http://www.ey.com/Publication/vwLUAssets/ey-future-of-jobs-in-india/$FILE/ey-future-of-jobs-in-india.pdf**; Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Automation, 96. Retrieved February 23, 2018, from **https://www.mckinsey.com/~/media/McKinsey/Global%20Themes/Future%20of%20Organizations/What%20the%20future%20of%20work%20will%20mean%20for%20jobs%20skills%20and%20wages/MGI-Jobs-Lost-Jobs-Gained-Report-December-6-2017.ashx**

170 Ibid.

171 Ibid.

172 Gartner Says By 2020, Artificial Intelligence Will Create More Jobs Than it Eliminates. Retrieved February 23, 2018, from **https://www.gartner.com/newsroom/id/3837763**

173 Y. Paul, Centre for Internet and Society (2018, January 26). Artificial Intelligence and the Healthcare Industry in India. Retrieved February 23, 2018, from **https://cis-india.org/internet-governance/blog/artificial-intelligence-and-the-healthcare-industry-in-india**

174 India and the Artificial Intelligence Revolution, Shashi Shekhar Vempati. Retrieved February 23, 2018, from **http://carnegieindia.org/2016/08/11/india-and-artificial-intelligence-revolution-pub-64299**

175 R. Kapoor, Working Paper 313: Technology, Jobs and Inequality Evidence from India's Manufacturing Sector, (February 2016). Retrieved February 23, 2018, from **http://icrier.org/pdf/Working_Paper_313.pdf**

176 Industrial Automaton and Robot Law in India, Arya Tripathy. Retrieved February 23, 2018, from **http://www.mondaq.com/india/x/612028/new+technology/Industrial+Automation+And+Robot+Law+In+India**

"comprehensive and significant policy initiative".[177] One of the major objectives of this policy is to implement industrial training and skill upgradation methods. In the age of AI, reskilling and upskilling of existing workforce becomes crucial as an AI driven ecosystem is bound to create opportunities for employment which will require potential workers to perform high skilled tasks. Existing workforce will be shifted to jobs that will require them to possess higher knowledge and skill sets as a result of AI performing a majority of the tasks. Therefore, policy measures furthering skill upgradation and reskilling will help create a conducive human workforce for an AI environment.

- **Electronic Contracts - Section 10-A IT Act**: Section 10-A of the IT Act provides for the validity of electronic contracts which can be entered into through electronic means if they satisfy the general conditions of a valid paper contract provided for in the Indian Contracts Act. However, the Indian Contracts Act provides that a contract can be entered into between "legal persons" who are competent to enter into a contract. This raises concerns in an AI ecosystem where the question of the nature of an AI in unclear. AI has not been given "personhood" and does not qualify as a legal or natural person under the existing Indian laws. This raises questions of how the relationship between robots driven by AI and employers in a manufacturing unit should be structured in the absence of a valid contract? With the advent of technology, automation and AI, there is a need to rework existing contract frameworks in order to accommodate a regulated existence of AI. Contract frameworks also need to establish liability regimes and clarify the validity of smart contracts.[178]

Liability, Negligence, and Standards of Care Regime

With AI replacing the tasks performed by humans across the manufacturing and services sector, there is a need to rework and establish a liability regime. In the instance of damage, inaccurate, or misinformed decisions, legal considerations arise with respect to attributing liability in an AI driven ecosystem. There has been a significant debate around whether robots or autonomous systems should be attributed a legal personality and if they qualify as legal persons in order to be held liable in themselves.[179] Furthermore, the structure of a liability framework for AI needs to be clarified - for example, does liability change depending on the criticality of a situation - autonomous vehicles versus an AI driven virtual assistant.

Presently, in India the standards of strict product liability law apply, which holds the manufacturer liable if the product malfunctions.[180] Individuals can also hold a company responsible for negligence if there exists a specific duty of care to the individual. Existing liability regimes in other contexts hold that the AI technology or the robots in themselves cannot be held for damages caused and instead impose liability on the manufacturer. For example, the EU Directive holds the manufacturer of the robot liable only in cases where manufacturing defects have led to foreseeable damage.[181] Similarly, in the case of United States of America v Athlone Industries, the court held that robots cannot be sued.[182] However, this legal framework needs to reconsidered in light of highly intelligent technologies which

177 Point of View: National Manufacturing Policy, PWC. Retrieved February 23, 2018, from **https://www.pwc.in/assets/pdfs/industries/industrial-manufacturing/national-manufacturing-policy-pov.pdf**

178 The Future is Here: Artificial Intelligence and Robotics, Nishith Desai Associates. Retrieved February 23, 2018, from **http://www.nishithdesai.com/fileadmin/user_upload/pdfs/Research_Papers/Artificial_Intelligence_and_Robotics.pdf**

179 Ibid.

180 Ibid.

181 Directive 85/374/EEC on the Approximation of the Laws, Regulations, and Administrative Provisions of the Member States Concerning Liability for Defective Products

182 United States v. Athlone, 746 F.2d 977, 979 (3d Cir. 1984)

learn and adapt to their surroundings in ways which are not foreseeable.[183] In India, the tort law standard of care requires that there must exist a duty of care towards the injured party, and the breach of such duty must cause a legal damage to her. The law on negligence covers those kinds of harms which are reasonably foreseeable, which poses interesting questions when AI is used. How should liability be determined in cases where both human and machine decision making is involved which eventually leads to the harm caused. The standard of reasonable foreseeability will need to be examined by the courts to see how they may be applied in cases involving algorithmic decision making. Globally, the courts have shown reluctance in relying upon the principle of negligence where software products are involved, and prefer to invoke product liability rules.[184] It is important to note that product liability principles govern the liability of manufacturers, distributors and vendors in cases of legal injury due to defective products in India laws.[185] However, regardless of the legal principle in questions, both will involve looking at issues around causation. It remains to be seen how standards such as 'proximate cause' and 'causation in fact'[186] work in the context of complex processing systems.

The questions of liability also arise in the context of proceedings under the civil law legislations such as the Code of Civil Procedure, 1908 and Consumer Protection Act, 1986. In order to seek redressal, it must be demonstrated that there was a legal damage caused. The issues of liability are complicated where the services are provided by a separate entity than the one involved in creating the AI system. This poses questions of the extent to which services and manufacturing companies creating AI systems may be able to exclude their liability contractually.

Governance and Design

- **The Element of Morality**: Most of human actions are not just determined my rational thought but also the morality of the action itself.[187] It is widely agreed that the current AI systems lack a moral status due to the absence of two important criteria; Sentience and Sapience.[188] Keeping in mind Asimov's laws of Robotics, it is still difficult to teach ethics and moral values to an AI system as they are not something that can be transplanted through algorithms.[189] Moral values are highly subjective and cannot be conveyed to a computer system in measurable metrics.[190] However, scholars have suggested that future AI systems can have a moral status and play a social role if the designs sufficiently fulfil the requirements of predictability and transparency.[191] Crowdsourcing of morality and

183 Robot Rights: At What Point Should an Intelligent Machine be Considered a 'Person'?, Kyle Bowyer. Retrieved February 23, 2018, from **http://theconversation.com/robot-rights-at-what-point-should-an-intelligent-machine-be-considered-a-person-72410**

184 Gerstner, M. E. (1993). Liability issues with artificial intelligence software. Santa Clara L. Rev., 33, 239.

185 This is demonstrated across laws under the Consumer Protection Act, 1986, the Sale of Goods Act, 1930 and Competition Act, 1986.

186 Both standards are used in Indian laws such as Consumer Protection Act, 1986 and Tort Law.

187 The Ethics of Artificial Intelligence, Nick Bostrom. Retrieved February 23, 2018, from **https://intelligence.org/files/EthicsofAI.pdf**

188 Ibid.

189 Will Artificial Intelligence Have a Moral Compass?, Vyacheslav Polonski. Retrieved February 23, 2018, from **https://m.dailyhunt.in/news/india/english/the+indian+economist-epaper-indecono/will+artificial+intelligence+have+a+moral+compass-newsid-77000079**

190 Ibid.

191 The Ethics of Artificial Intelligence, Nick Bostrom. Retrieved February 23, 2018, from **https://intelligence.org/files/EthicsofAI.pdf**

defining what "ethics and moral values" stand for could also help embed the AI systems with an element of morality.[192] India, as of now, has not taken a clear stance on the question of the morality of AI.

- **Algorithmic Bias and Accuracy**: Experts have voiced concerns about AI mimicking human prejudices due to the biases present in the Machine Learning algorithms.[193] Scientists have revealed through their research that machine learning algorithms can imbibe gender and racial prejudices which are ingrained in language patterns.[194] Since AI and machine algorithms are data driven, they arrive at results and solutions based on available and historical data. When this data itself is biased, the solutions presented by the AI will also be biased.[195] While this is inherently discriminatory, scientists have provided solutions to rectify these biases which can occur at various stages by introducing a counter bias at another stage.[196] It has also been suggested that data samples should be shaped in such a manner so as to minimise the chances of algorithmic bias.[197] When used in the process of manufacturing or to provide business guidance, algorithmic bias in the manufacturing and services sector might not necessarily directly impact a human as it might in the banking or health sector, but it can result in inaccurate guidance, forecasts, predictions, etc. that can significantly impact a business. On the other hand, an inaccurate decision taken by an autonomous vehicle could place individual lives at risk.
- **Control**: To what extent should AI be autonomous? Should a 'kill switch'' be built into each AI system? What other mechanisms that can ensure human control over AI? These questions have not been addressed by policy or law in India, but should be considered - particularly in contexts where the use of AI can significantly impact a human or put human life at risk.

Challenges to Development and Adoption of AI

While the Indian manufacturing and services industry has shown a strong inclination to implement AI, there are several global prerequisites that are essential to ensure successful utilisation of AI. Due to India's unique socio-economic conditions, there exist several challenges that come in the way of fulfilling these prerequisites. These challenges are:

- **Lack of robust indigenous infrastructure**: Though there are initiatives to develop domestic infrastructure that will enable industry 4.0, such as IndiaStack[198], Experts have

192 Will Artificial Intelligence Have a Moral Compass?, Vyacheslav Polonski. Retrieved February 23, 2018, from **https://m.dailyhunt.in/news/india/english/the+indian+economist-epaper-indecono/will+artificial+intelligence+have+a+moral+compass-newsid-77000079**

193 Forget Killer Robots - Bias is the Real AI Danger, Will Knight. Retrieved February 23, 2018, from **https://www.technologyreview.com/s/608986/forget-killer-robotsbias-is-the-real-ai-danger/**

194 AI programs exhibit racial and gender biases, research reveals, Hannah Devlin. Retrieved March 4, 2018, from **https://www.theguardian.com/technology/2017/apr/13/ai-programs-exhibit-racist-and-sexist-biases-research-reveals**; Algorithms might be everywhere, but like us, they're flawed and biased, Jonathan Albright. Retrieved March 4, 2018, from **https://scroll.in/article/819639/algorithms-might-be-everywhere-but-like-us-theyre-flawed-and-biased**

195 Ibid.

196 Algorithmic Bias in Autonomous Systems, David Banks. Retrieved February 23, 2018, from **https://www.cmu.edu/dietrich/philosophy/docs/london/IJCAI17-AlgorithmicBias-Distrib.pdf**

197 Controlling Machine Learning Algorithms and their Biases, Tobias Baer. Retrieved February 23, 2018, from **https://www.mckinsey.com/business-functions/risk/our-insights/controlling-machine-learning-algorithms-and-their-biases**

198 The Indian Manufacturing Industry Needs to Get 'Smart', Sudip Singh. Retrieved February 23, 2018, from **https://www.infosys.com/insights/digital-future/Pages/the-indian-manufacturing-industry-needs-to-get-smart.aspx**

noted that cloud computing infrastructure which is capable of storing massive quantities of data and computing power, which is required by AI, exists in servers beyond the Indian borders.[199] All online tools and services such as Google machine learning and Amazon Web Services (AWS) which make the use of AI accessible to the Indian business community, depend on this infrastructure outside India.[200] There's been a delay in investment in cloud computing infrastructure which has significantly impacted the pace at which AI is deployed in various sectors in India. Startup initiatives have preferred to establish themselves outside India where there is availability of infrastructure which facilitates the use of AI in their business activities.[201] Furthermore, the absence of such native infrastructure makes the use of AI and cloud computing services expensive for the private sector, thus disincentivizing them from investing in cutting edge technologies and automation.[202]

- **Lack of emphasis and investment in research and development of AI policy, technology and infrastructure**: It has been widely recognised and criticised that India lacks a dearth of R&D investments in the arena of AI when compared to other countries which heavily spend on implementation of policies that encourage work around AI systems, technologies, and infrastructure.[203] India is lacking not just physical infrastructure but also the cultural infrastructure required to create an environment that fosters the growth and use of AI systems.[204] While there are a significant number of startups creating fierce competition in the AI market, a major portion of the investors hesitate from investing their capital in the AI arena either due to the fear of failure or a lack of understanding of the AI systems and functioning itself.[205]
- **Data**: The challenge of data is three fold in India 1. *Access to public and private data*: Though India has an open data policy, this has not been fully implemented and there still exists government data that has not been digitized. Private sector companies have not implemented policies and programmes to enable access or use of their data sets. 2. *Data Accumulation*: Large companies, often foreign, collect and hold large amounts of data. In a economy where data is gold and data enables innovation, this creates an uneven playing field. 3. *Usability and Interoperability*: Though data may be digitized - it is not necessarily clean, accurate, and interoperable.[206]
- **AI Skill, Education, and Training**: A move towards an AI powered factory floor can provide manufacturers with the opportunity and need to reskill their existing labour and also amend their requirements for future employment.[207] The manual workforce will now be required to perform tasks which will help develop, build, and train AI systems. Similarly,

199 India and the Artificial Intelligence Revolution, Shashi Shekhar Vempati. Retrieved February 23, 2018, from **http://carnegieendowment.org/files/CP283_Vempati_final.pdf**

200 Ibid.

201 Ibid.

202 Ibid.

203 Why India Needs an AI Policy. Retrieved February 23, 2018, from **http://www.livemint.com/Politics/bEcUIEcRE25IIfxv8OiXtO/Why-India-needs-an-AI-policy.html**

204 Ibid.

205 Top 5 Challenges That are Holding Back AI Startups to Scale Fast, Srishti Deoras. Retrieved February 23, 2018, from **https://analyticsindiamag.com/top-5-challenges-holding-back-ai-startups-scale-fast/**

206 S. Mohandas, Centre for Internet and Society (2018, February 13). AI and Manufacturing and Services in India: Looking Forward. Retrieved February 23, 2018, from **https://cis-india.org/internet-governance/blog/ai-and-manufacturing-and-services-in-india-looking-forward**

207 Ibid.

in the IT services, employees will now be required to fully comprehend the functioning of AI systems and its subsets such as neural networks, natural language processing and data analytics.[208] Companies like Tata Consultancy Services are beginning to fill this requirement by launching skilling programmes in AI and IoT for employees.[209] Similarly, in a move towards skill upgradation and training for an AI ecosystem, Intel, under its 'AI Developer Education Program', has decided to host 60 courses for students, scientists, engineers and developers in India.[210] These courses will train a range of people on how to better adopt AI for research, designing products and testing through making them understand deep learning and ML. Through collaborations with stakeholders from across sectors, Intel also seeks to help democratise AI by reducing barriers for small scale startups, students and developers.[211] Similarly, organisations like IBM and HCL have collaborated with researchers from different universities (IITs, IISc, etc), for the development of AI. While the universities develop programs to serve a broad purpose, the companies fine-tune them and apply them in their product/service. Companies also have collaborated with these institutes to obtain interns/employees with the required set of skills for AI development/application. This is noteworthy, because it has proven difficult to find and recruit sufficiently skilled professionals possessing the required level of competence. Quality checking on an institutional level, which is then verified over internships also benefits the professionals themselves, by providing them motivation to innovate and perform.[212] One of the identified barriers to appropriate skill development is the need for engineering colleges in India to revamp their existing curriculum to suit current technological developments.[213] The Indian Government, towards training students in AI and other advanced technologies, has announced the setting up of an AI Institute at University of Mumbai in collaboration with Wadhwani Institute for Artificial Intelligence. This research institute seeks to promote education, research and create jobs in the field of AI.[214]

- **Contextual Challenges**: The adoption and use of a technology is defined by the context it is used in. The production and use of AI technologies could face contextual challenges ranging from cultural acceptance to infrastructure and environment. For example, autonomous vehicles will still face challenges in navigating the roads and traffic in India.[215]

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208 4 Indian Institutes That Need Immediate Reskilling in the Era of AI, Vishal Krishna. Retrieved February 23, 2018, from **https://yourstory.com/2017/10/4-indian-industries-immediate-reskilling-ai/**

209 Blockchain, Data Science and Other Fields Techies Need to Skill Themselves in to Survive the IT Bust, Sushma UN.Retrieved February 23, 2018, from **https://scroll.in/article/863516/ai-data-science-and-other-fields-indian-techies-can-skill-themselves-in-to-survive-the-it-bust**

210 Intel bets on artificial intelligence, to train 15,000 people in India, Alnoor Peermohamed. Retrieved March 4, 2018, from **http://www.business-standard.com/article/companies/intel-bets-on-artificial-intelligence-to-train-15-000-people-in-india-117040400847_1.html**

211 How Intel Aims to Leverage AI and Engage With 15k AI Techies, Harshith Mallya. Retrieved February 23, 2018, from **https://yourstory.com/2017/04/intel-indias-ai/**

212 M. Sachidanand. (HCL) Personal Interview.

213 Can India's AI Talent Gap Be Stemmed With Government Initiatives?, Richa Bhatia. Retrieved March 4, 2018, from **https://analyticsindiamag.com/can-indias-ai-talent-gap-stemmed-government-initiatives/**

214 Can India's AI Talent Gap Be Stemmed With Government Initiatives?, Richa Bhatia. Retrieved March 4, 2018, from **https://analyticsindiamag.com/can-indias-ai-talent-gap-stemmed-government-initiatives/**

215 Driverless Cars Face Unique Challenges on India's Chaotic Roads. Retrieved February 23, 2018, from **https://economictimes.indiatimes.com/industry/auto/driverless-cars-face-unique-challenges-on-indias-chaotic-roads/articleshow/59379769.cms**

- **Urbanization**: The current government's emphasis on the 'Make in India' movement has helped bring FDI into India. Yet, this growth must be understood by taking into account the changing landscape of manufacturing, which is increasingly laying more emphasis on automation and AI, and the growing working class that may potentially suffer as a consequence. As noted above, automation and AI in the industrial sector may render certain jobs redundant in a time when an increasing number of Indians are migrating to urban areas seeking employment. The Central and state level governments face a daunting challenge in balancing the free market with citizen welfare.[216]

Learnings from Other Contexts

Artificial Intelligence is in a nascent state in India, and is yet to be implemented to the extent where significant legal challenges become imminent. However, the types of challenges that may exist can be reasonably predicted, by looking at other jurisdictions where AI is already being utilised and regulated. We are looking at the jurisdictions of the USA, China, and Japan, which have evolved laws to deal with issues unique to Artificial Intelligence *inter alia* in the areas of motor vehicles and traffic laws, insurance law, human resources and labour law, and law concerning privacy, data protection and surveillance. Studying the effectiveness of these policies and their intricacies can enable Indian policy makers to preemptively solve problems, and also guide them in developing policies that are more effective and less problematic.

United States of America[217]

The 'Federal Automated Vehicles Policy', published in September 2016, is a comprehensive roadmap for how regulatory bodies ought to go about handling 'Highly Automated Vehicles' (HAV's). The Department of Transportation, through the National Highway Traffic Safety Administration (NHTSA) aims to harness the innovation in the HAV sector with the goal to reduce vehicular fatalities. The primary goal of the policy is to preserve the simplicity a driver enjoys across state lines as one travels, while also ensuring the safety of an HUV. The NHTSA uses SAE International's standard for HAV classification which categorizes cars based on degree of their of automation. The intent of the policy is not to over regulate but instead, to create a safe environment in which companies may partake in their experimentation, all in furtherance of a more competitive market.

The NHTSA, as part of its 'Safety Assessment' initiative, would require manufacturers to give the NHTSA details regarding data recording and sharing, privacy, system safety and twelve other criteria. Being a software oriented service, the policy also accounts for software updates, and requires the manufacturer to provide all relevant information regarding the update if they affect the fifteen parameters which form the basis of the safety assessment.

While the policy delves into a lot of technical details regarding the information and test data that manufacturers must share with the NHTSA, one key theme that remains prevalent throughout the policy is its desire to be comprehensive. This desire comes partly for the need for safety but is also equally inspired by the need to achieve universal acceptance. I say need because the drafters worry that too many varying policies amongst the states may only hamper company compliance and put ordinary citizens at risk. Their model policy delves into the definitions of key stakeholders. This is followed up with hierarchies to deal with certification, information collection and other important services which each state will have to provide in order to accommodate increasingly sophisticated HAV's.

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216 Can India's factories keep up with digital disruption?, Johan Aurik. Retrieved March 4, 2018, from **https://www.weforum.org/agenda/2016/10/india-factories-digital-disruption-manufacturing/**

217 Federal Automated Vehicles Policy - September 2016. Retrieved March 4, 2018, from **https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016**

The policy also lays down guidelines for how the states ought go about regulating insurance with due regard being given to the degree of autonomy of the vehicle. The policy also deals with the potential for NHTSA interpretations and how manufacturers may clarify their doubts by following the procedures laid down for the same.

The policy concludes by considering the need to set up other specialised agencies to deal with nuanced need of the HAV sector and how certain manufacturers may be granted exemption from safety compliance if they can justify their needs for economic or technological factors.

China[218]

On July 21st 2017, the State Council of the People's Republic of China announced its strategy to achieve AI world leadership by 2030. The policy laid down is very broad and ambitious as it attempts to outline the course of action for almost conceivable course of development AI may take over the coming decades. The policy begins by highlighting the achievements that China has already achieved in the field of AI with regard to patents and publications. This is followed by an acknowledgement of shortcomings in the countries AI development up till then. The policy seeks to remedy these shortcomings by first achieving theoretical supremacy in the various subfields of AI, as the country views itself as lacking when compared to other developing countries. Following this, the policy address each individual AI application and makes brief statements about how the governments plans to address the shortcomings in that sector. The policy recognises the potential disruptive capabilities of AI with regard to employment but balances this threat by highlighting how AI may also improve social welfare, governance and judicial efficiency. The policy also recognises the potential of open source AI development and aims to complement this by setting up the necessary infrastructure to facilitate the same. Towards the end of the policy, the State Council discusses the need to improve human resources by incorporating lifelong learning as a means to combat the disruptive tendencies of AI in the field of employment and to leverage media as a means to promote the countries achievements in AI.

Japan[219]

The Ministry of Economy, Trade and Industry in Japan aims to promote further research into AI by setting up the 'Artificial Intelligence Research Center'. The underlying idea being the bringing together of leading researchers and technology from both within and outside Japan to foster a conducive environment for innovation.

Recommendations

- **Develop a flexible and agreed upon definition of AI**
  Before regulating the application of AI, it is essential for legislators to decide upon a clear, accurate, and uniform definition of Artificial Intelligence. Presently, the manufacturing and services industry sees several definitions of AI, and an appropriate legal definition through consultation with experts and stakeholders, weighing the legal and technical implications of the legislation, will be required.[220] This definition must be flexible to accommodate innovation. Incorrectly defining AI, or failing to maintain an updated legal definition could potentially hinder innovation within the industry, and also serve as an obstacle to the efficient development of AI.

218 Notice of the State Council on Printing and Distributing a New Generation of Artificial Intelligence Development Plan. Retrieved March 4, 2018, **http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm**

219 Ministry of Economy, Trade and Industry - Artificial Intelligence. Retrieved March 4, 2018, from **http://www.meti.go.jp/english/policy/economy/research_development/index.html**

220 M. Sachidanand. (HCL) Personal Interview.

- **Comprehensive National AI Plan, multi-stakeholder partnerships and including AI in PM initiatives**
  The first step towards steady growth of AI in India is through adopting a national plan for AI which will provide for a "long-term vision and road-map for AI in the country's economic development".[221] The government has already come up with a seven-point strategy that will go on to form the framework based on which AI will be used in India.[222] The national plan for India can reflect the one adopted by China which has set out targets for the development and use of AI in phases.[223] Clear milestones should be set in order to ensure a streamlined growth. Furthermore, it is crucial for the stakeholders involved to enter into partnerships which will help arrive at answers and solutions from all spheres to develop best practices and guidelines for the national plan.[224]
- **Strengthening India's AI research and development wing**
  - **Increase investment**: The government could sufficiently increase its investment in the research and development of AI in order to enable access to technology and incentive to innovate. This will encourage smaller startups and companies to deploy AI in their day-to-day process and also develop their own platforms. Investment in R&D will also incentivise academics and research talent pool to work towards the potential uses and development of AI in India which will add to the improvement of AI technologies. Sufficient investment should also ensure access to technologies available in other countries which will help with the indigenous growth of AI.
  - **Relax trade barriers**: The government could relax regulations and trade barriers as a part of the Make in India initiative to encourage manufacturers to build design and research labs along with investing in automation research within the country.[225] This will also incentivise them to develop strong links in robotics and manufacturing automation between start-ups and universities in India.[226] Such incentives in the Make in India initiative will also be in furtherance of making India a "global hub for machine intelligence".[227]
  - **Improve infrastructure**: Further, the Digital India program should be reworked towards building large-scale data centres and cloud infrastructure within India to bridge the existing infrastructure gap.[228]
  - **Encourage Innovation**: The government should also allow experimentation by start-ups of new business models in order to ensure the development of AI in the

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221 Rewire for Growth, Rekha M. Menon. Retrieved March 4, 2018, from **https://www.accenture.com/t20171220T030619Z__w__/in-en/_acnmedia/PDF-68/Accenture-ReWire-For-Growth-POV-19-12-Final.pdf**

222 Govt Sets Up Expert Group for Suggestions on Artificial Intelligence Policy, P Suchetana Ray. Retrieved February 23, 2018, from **https://www.hindustantimes.com/india-news/govt-sets-up-expert-group-for-suggestions-on-artificial-intelligence-policy/story-R4VnrCufgm7xhh1fVlz9IL.html**

223 China Has a New Three-Year Plan to Rule AI. Retrieved February 23, 2018 **https://www.technologyreview.com/the-download/609791/china-has-a-new-three-year-plan-to-rule-ai/**

224 Rewire for Growth, Rekha M. Menon. Retrieved March 4, 2018, from **https://www.accenture.com/t20171220T030619Z__w__/in-en/_acnmedia/PDF-68/Accenture-ReWire-For-Growth-POV-19-12-Final.pdf**

225 India and the Artificial Intelligence Revolution, Shashi Shekhar Vempati. Retrieved February 23, 2018, from **http://carnegieendowment.org/files/CP283_Vempati_final.pdf**

226 Ibid.

227 Ibid.

228 Ibid.

country.[229] Unnecessary regulations on these businesses will discourage small scale units from innovating and developing AI business models.

- **International Engagement**: Engagement of professionals and researchers in India in key initiatives related to AI at the international level could help in building competencies, facilitate knowledge exchange and collaboration across borders, and ensure that India is represented in key international forums related to AI.[230]

- **Improve access to data**
  - **Open Government Data**: The performance and development of AI depends on large quantities of data which will help utilise these technologies to their full potential. AI technologies require widely accessible data in order to deployed at a large scale. The government can play a key role in providing access to datasets that will help the functioning and performance of AI technologies. The Indian government has already made a move towards accessible datasets through the Open Government Data Platform which provides access to a range of data collected by various ministries. Telangana has developed its own Open Data Policy which has stood out for its transparency and the quality of data collected and helps build AI based solutions.[231]
  - **Open Standards**: There is also need for scientific research units and universities to make their findings and research widely accessible in order to further collaboration and support the development of AI solutions. Opening access to large datasets is of significant importance in a growing AI environment as small organisations do not have the ability to access data unlike large corporations, thus discouraging them from innovating and adding to the AI ecosystem. However, access to data must be balanced with privacy concerns that will inevitably arise out of throwing open large quantities of public data.
  - **Enabling Access to Private Sector Data**: The private sector is the gatekeeper to large amounts of data. This data is often considered as a company asset and not shared with other stakeholders. Yet, this data is essential in enabling innovation in AI. A solution could be federated access, with companies allowing access to researchers and developers to encrypted data without sharing the actual data.[232] Another solution that has been proposed is 'watermarking' data sets.[233]
- **Addressing impact on jobs and preparing a high-skilled workforce to manage AI**
  - **Curriculum**: Moving into an AI led environment will only mean the requirement of workforce to perform extremely high-skilled tasks to manage and maintain the AI technologies and systems. This will necessitate the training of current and potential workforce to be skilled with performing higher level tasks. It has been recognised that there is an immediate need for reskilling with the growing risk of mass job

229 Ibid.

230 S. Mohandas, Centre for Internet and Society (2018, February 13). AI and Manufacturing and Services in India: Looking Forward. Retrieved February 23, 2018, from **https://cis-india.org/internet-governance/blog/ai-and-manufacturing-and-services-in-india-looking-forward**

231 KTR Pitches for Telangana's Open Data Policy. Retrieved February 23, 2018, from **http://www.thehindu.com/news/cities/Hyderabad/ktr-pitches-for-telanganas-open-data-policy/article22538055.ece**

232 Intel Recommends Public Policy Principle for Artificial Intelligence, Naveen Rao. Retrieved February 23, 2018, from **https://blogs.intel.com/policy/2017/10/18/naveen-rao-announces-intel-ai-public-policy/**

233 Data Management and Use: Governance in the 21st Century. Retrieved February 23, 2018, from **https://royalsociety.org/~/media/policy/projects/data-governance/data-management-governance.pdf**

displacement due to "technological disruptions".[234] Manufacturing and IT services will take a hit with the rapid deployment of AI and will only require workforce that can train AI in comprehending data. they require people to be trained with Deep Learning, Machine Learning and the functioning of Neural Networks.[235] Therefore, a steep barrier that persists in India for the deployment of AI is the lack of skill sets and capabilities among the workforce to develop and manage AI technologies. This can be overcome by implementing training programs which should undoubtedly extend to disadvantaged groups and minorities of all forms.[236] Presently, most engineering programs across the country involve student projects that aim to solve problems that are nearly a decade old. This could be replaced with projects that involve the application of AI to modern problems in India.[237] This would help with domestic innovation, as well as building motivation and skill for future professionals.[238]

- **Re-skilling**: There are a number of actors that can play an important role in ensuring that the workforce has the skills needed to thrive in an AI environment. This includes government, universities, companies developing and employing AI solutions, and civil society. Re-skilling efforts need to be targeted at all sectors of the society and should be embedded in efforts to educate the public about AI. It has been suggested that the Skill India initiative should be amended in order to accommodate training and skilling programs that will help the current and future workforce survive in an AI led ecosystem.[239]
- **Levying a "robot" Tax**: As a means to address potential job loss, a 'robot' tax could apply to companies that leverage AI in a way that replaces human jobs.[240] For example, South Korea has introduced a policy that will limit available tax incentives for companies that invest in automated machines.[241] A similar approach has also been considered in the UK,[242] and has been supported by Bill Gates.[243]
- **Universal Basic Income**: A full-scale or even semi deployment of AI and automation would inevitably result in job displacement with machines taking over and simplifying the jobs of humans. Consequently, this will cut the supply of income to

234 Reskilling Revolution Needed for the Millions of Jobs at Risk Due to Technological Disruption, Oliver Cann. Retrieved March 4, 2018, from **https://www.weforum.org/press/2018/01/reskilling-revolution-needed-for-the-millions-of-jobs-at-risk-due-to-technological-disruption/**

235 4 Indian Industries That Need Immediate Reskilling in the Era of AI, Vishal Krishna. Retrieved February 23, 2018, from **https://yourstory.com/2017/10/4-indian-industries-immediate-reskilling-ai**

236 Accelerating India's Economic Growth With Artificial Intelligence, Accenture (2017), Retrieved March 5, 2018, from **https://www.accenture.com/t20171220T030619Z__w__/in-en/_acnmedia/PDF-68/Accenture-ReWire-For-Growth-POV-19-12-Final.pdf**.

237 S. Mohandas, Centre for Internet and Society (2018, February 13). AI and Manufacturing and Services in India: Looking Forward. Retrieved February 23, 2018, from **https://cis-india.org/internet-governance/blog/ai-and-manufacturing-and-services-in-india-looking-forward**

238 P. Talukdar, (IISc). Personal Interview.

239 Ibid.

240 Ibid.

241 South Korea Introduces World's First Robot Tax, Cara McGoogan. Retrieved February 23, 2018, from **http://www.telegraph.co.uk/technology/2017/08/09/south-korea-introduces-worlds-first-robot-tax/**

242 Return of the Luddites: Why a Robot Tax Could Never Work, Anna Isaac. Retrieved February 23, 2018 **http://www.telegraph.co.uk/business/2017/09/27/return-luddites-robot-tax-could-never-work/**

243 Here's how Bill Gates' plan to tax robots could actually happen, Malcolm James. Retrieved March 5, 2018, from **http://www.businessinsider.com/bill-gates-robot-tax-brighter-future-2017-3?IR=T**

people employed in those jobs. Universal Basic Income (UBI) has been proposed as a possible solution to the problem of loss of income due to job displacement.[244] Though this is a broad solution, the discussion around UBI has taken place in part in the context of job loss in low paying jobs and transport, manufacturing, and retail.[245] A number of countries, including Finland, Germany, the UK, the Netherlands, the US, and Canada, are already considering different variations of a UBI to counteract the side effects of automation. Such variations include monthly payments to eligible individuals as seen in Finland,[246] and Canada,[247] and the creation of a fund that can be applied to as is being considered in the UK[248]

- **Create an Environment of Accountable AI**
    - **Evaluate algorithms**: To mitigate harms arising out of decisions taken by AI solutions it is important that training data and algorithms are evaluated for accuracy and fairness. To facilitate this, reliable and comprehensive synthetic datasets can be created specifically for this purpose during the development of an AI solution and regularly throughout its implementation. Suggested aspects of accuracy that algorithms can potentially be evaluated for include statistical validity, statistical rationality, and feedback loops.[249]
    - **Appropriate mechanisms for transparency**: The level and method of transparency, explainability, traceability, and scrutability of AI driven decisions and actions necessary to bring accountability differs depending on the service and the stakeholder. Appropriate mechanisms and levels of transparency should be considered.
    - **India specific use norms**: The impact of a technology is shaped by the context that it is used in. Developing India specific use norms will be important in ensuring that harms specific to the Indian context are considered and addressed. While formulating these norms, international standards and best practices should also be kept in mind to ensure interoperability.

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244 Schiller, B. (2015). A Universal basic income is the bipartisan solution to poverty we've been waiting for *Fast Coexist*; McKinsey Report Identifies Basic Income as a Potential Response to Automation, Micah Kaats. Retrieved February 23, 2018, from **http://basicincome.org/news/2018/01/international-mckinsey-report-identifies-basic-income-potential-response-automation/**; Let the Robots Take Our Jobs and Pay for a Universal Basic Income, Aaron Berger. Retrieved February 23, 2018, from **https://qz.com/1034358/ubi-and-automation-could-be-the-symbiotic-solution-for-displaced-workers/**; Universal Basic Income: The Answer to Automation?. Retrieved February 23, 2018, from **https://futurism.com/images/universal-basic-income-answer-automation/**; Richard Branson Calls for Universal Basic Income Because Robots are Tking People's Jobs, Benjamin Kentish. Retrieved February 23, 2018, from **http://www.independent.co.uk/news/business/news/richard-branson-universal-basic-income-robots-taking-jobs-automation-threat-a7993006.html**

245 Universal Basic Income Could be Used to Protect People From Robots Taking Their Jobs, Billy Bambrough. Retrieved February 23, 2018, from **https://www.verdict.co.uk/universal-basic-income-robots-taking-jobs/**

246 Richard Branson Calls for Universal Basic Income Because Robots are Taking People's Jobs, Benjamin Kentish. Retrieved February 23, 2018, from **http://www.independent.co.uk/news/business/news/richard-branson-universal-basic-income-robots-taking-jobs-automation-threat-a7993006.html**

247 Ontario Plans to Launch Universal Basic Income Trial This Summer, Ashifa Kassim. Retrieved February 23, 2018, from **https://www.theguardian.com/world/2017/apr/24/canada-basic-income-trial-ontario-summer**

248 Universal Basic Income Could be Used to Protect People From Robots Taking Their Jobs, Billy Bambrough. Retrieved February 23, 2018, from **https://www.verdict.co.uk/universal-basic-income-robots-taking-jobs/**

249 Éthique, algorithmes et intelligence artificielle: Quelles sont nos obligations de rendre des comptes?, Dominic Martin. Retrieved March 4, 2018, from **http://www.isaca-quebec.ca/assets/presentations/2017-10-02-DominicMartin_Algorithmic%20accountability.pdf**

- **Clarify responsibility, liability, and accountability**: As AI is deployed in manufacturing and services processes and end products, it is important that responsibility, liability, and accountability for inputs or decisions taken or provided by the AI is claried.[250]
- **Registration, certification and license**[251]: Companies developing and using AI technologies could be required to register and certify the use of the technology in order to create a record of what AI is being used where. Suggested details of registration by some experts have been intended use, training data, sensors, algorithms, process graphs, model features, user interfaces, actuators/outputs, and optimization.[252] As another mechanism for accountability, the EU has proposed a Charter on Robotics which includes a code of ethical conduct for robotic engineers, a code of research ethics and committee, and a 'licence' for designers and a license for users of AI and robotics.
- **Defining safety critical AI**: The implications of AI differs according to use. Some countries, such as the EU, are beginning to define sectors where AI should play the role of augmenting jobs as opposed to functioning autonomously.[253] Global bodies researching the impact of AI have termed sectors where AI tools supplement or replace human decision making in areas such as health and transportation as 'safety critical AI' and are researching best practices for application of AI in these areas.[254]

Conclusion

This research was an initial attempt to map the landscape and understand key trends in use, actors, challenges, ethical and legal considerations, and regulation of AI in the manufacturing and services sector in India. Below is a summary of high level learnings from the research and key questions for future research.

- ***Use***: From an initial analysis of the sub-sectors employing AI, it can be observed that the IT and services industry has taken a leap in its day-to-day activities through the adoption of AI. IT service giants in India have built their own AI platforms and virtual assistants for process management and to perform maintenance tasks and produce business solutions with greater accuracy and efficiency. Customer analysis, performance indicators, and chatbots that understand customer preferences are other key uses of AI in the sector. Automobiles, electronics, and heavy electrical production units have also progressed in deploying AI, both in the process of manufacturing - including through smart factories, and the end product. The most controversial of these products is autonomous cars, due to the ethical concerns that arise. The agricultural sector has also benefited from the use

250 The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, General Principles. Retrieved February 23, 2018, from **https://standards.ieee.org/develop/indconn/ec/ead_general_principles_v2.pdf**

251 European Parliament Resolution on 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)). Retrieved February 23, 2018, from **http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2017-0051+0+DOC+PDF+V0//EN**

252 The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, General Principles. Retrieved February 23, 2018, from **https://standards.ieee.org/develop/indconn/ec/ead_general_principles_v2.pdf**

253 European Parliament Resolution on 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)). Retrieved February 23, 2018, from **http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2017-0051+0+DOC+PDF+V0//EN**

254 Partnership on AI to Benefit People and Society. Retrieved February 23, 2018, from **https://www.partnershiponai.org/**

of AI in tracking crop growth and predicting crop failure. Across all sub-sectors studied - larger national and multinational companies and startups have contributed to the growth of AI in this field.

Towards promoting use and integration of AI, the Government of India has taken significant steps towards embracing AI into various sectors of economy. Initiatives such as Make in India, Skill India, Digital India and a push towards Industry 4.0 has boosted the use of IoT, AI and Big Data. Not only in terms of market use, but government lead initiatives also include promoting research and development in the field in order to foster a technologically advanced education curriculum to shape the current and potential workforce with higher skills to perform complex tasks. However, despite the above factors, compared to economies leading the developments in AI, the progress has been slow. Unlike the more mature digital economies, there is lack of access to data for Indian companies, and as opposed to the US and China, sustainable government capital backing is absent.[255]

As opposed to the health sector, where AI is being seen strictly as a tool for augmentation, there are significant concerns about the adoption of AI resulting in job loss in the manufacturing and services sector. However, the concern of job displacement, as suggested by experts, could also be countered by the large scale deployment of AI creating more jobs which require the current workforce to perform complex tasks with higher knowledge and skills in the areas of machine learning, natural language processing and related AI technologies.

- ***Actors***: Broadly the ecosystem of key actors includes government, developers, practitioners, researchers, and funders/investors. Practitioners consisted of companies and were both domestic and international companies. There are also a number of institutes undertaking research into AI in the context of manufacturing including IITs and IIMs to industry bodies such as PricewaterhouseCoopers (PWC) and Ernst & Young (EY). Some of these reports have been developed in coordination with Indian industry bodies Federation of Indian Chambers of Commerce and Industry (FICCI) and NASSCOM. International Labour Organization(ILO) was also noted to have published significantly on the effect of AI in the labour market. The research found trends in collaborations between State State level governments and the private sector. Indian start-ups in the sector are receiving support and investment from a number of companies, investors, and government departments.
- ***Impact*:** The impact of AI on the human in the industry ranges - with AI as a tool in the process of manufacturing having less of a direct impact as opposed to autonomous cars which have human lives at stake. There are benefits for the adoption of AI in the manufacturing sector in India - AI can facilitate reliability, accuracy, precision, optimization, personalization, and efficiency in processes. AI can also help to ensure worker safety and user safety. At the sametime, adoption of AI will require re-skilling efforts - something that large IT companies have noted and are taking steps towards addressing through collaborations with universities and launching inhouse re-skilling programmes. During the period of transition, research shows that the IT companies are likely to see some impact on their workforce, and rethink hiring strategies to continue to compete globally. Adoption of AI into business processes could potentially also give companies a greater competitive edge going forward.
- ***Regulation***: There are a number of existing policies in India will need to be considered in light of AI. This includes policy that is relevant to security and safety, liability, negligence, consumer protection, workers rights, and privacy. Where India needs to develop new policy and standards around is in the governance and design of AI. What is important to keep in mind while discussing regulation of AI is that given its broad sweep of impact and use-cases, there will have to be a multi-pronged approach with different sectoral laws,

255 Here's why India is likely to lose the AI race, Sriram Sharma. Retrieved March 4, 2018, from **https://factordaily.com/artificial-intelligence-india/**

technological standards and norms that will have to regulate it. It is however, clear that various regulations and laws may need updation with time in order to either address and cover AI based systems within their scope, and also, in some cases, need to reconfigure in order to accommodate AI. There is considerable discussion within the government to articulate an AI policy. However, it will be key while regulating to look at specific applications of AI, what their impact is, and then address regulatory issues surrounding them, instead of looking at a general and holistic AI policy.

- ***Challenges***: In spite of the massive development and use of AI in India, there continues to exist steep barriers in the field. These include the lack of indigenous infrastructure, skill development, education and training in the field of AI, and restricted access to data. The functioning and complete development of AI depends on these key issues which need to be addressed while moving towards a successful AI environment. This can be ensured with the support of the Government and the private sector with both ensuring adequate training and education in AI, reskilling of existing labour or workforce and maintaining a transparent data sets which act as fuel for AI systems. Making data sets more accessible will not only ensure better functioning of AI systems but will also promote and encourage small scale startups to benefit from such esoteric resources which might otherwise prove to be an expensive affair. Also, compared to other key economies that looking to leverage the use of AI, there is an absence of sustained funding in India, which will play a key role in the rate at which this sector grows.

Annex 1
AI in Manufacturing and Services: Stakeholder Mapping

FICCI

FICCI is an industry body that has been researching the impact of AI and re-skilling efforts needed. For example, this article analyzes how employment shall drastically change over the coming decades. The article largely attributes the cause of these changes to AI, deep learning algorithms and other automation based startups. The authors then go on to recommend changes to educational institutions. They recommend emphasising lifelong learning, MOOC integration and other more sustainable forms of learning to ensure that the population has the skills necessary to provide for themselves.

Further Reading

NASSCOM

The industry body NASSCOM is setting up Centers of Excellence on AI and Data Sciences in Bengaluru and Hyderabad. These could potentially contribute to the growing number of start-ups and also help shape the vacuum that currently exists with regard to AI regulation.

Further Reading

Digital India

The Digital India initiative has allocated funds towards creating a favorable regulatory environment to increase the use of Artificial Intelligence.

Further Reading

AI task force

Consists of members specialising in AI from different fields including industry and academia. Creation of policy and legal framework to accelerate deployment of AI technologies

Further Reading

Ministry of Electronics and Information Technology

The Expert Committee set up by the Ministry is intended to inform the government's policy on AI. The government has reportedly also decided on a 7 point strategy when dealing with matters concerning AI. The strategy includes developing methods for human machine interactions; ensuring safety and security of AI systems; creating a competent workforce in line with AI and R&D needs, understanding and addressing the ethical, legal and societal implications of AI, measuring and evaluating AI technologies through standards and benchmarks, among others.

Further Reading

Government Authorities

Niti Ayog

Niti Aayog, the National Institute for Transforming India, is in the advanced stages of launching a National Data and Analytics Portal to facilitate training and dataset sharing between different organisations for AI-related applications.

Further Reading

Government of Karnataka - IT and BT

The Government of Karnataka has launched a Centre of Excellence for data science and Artificial Intelligence (CoE-DS&AI). The CoE aims to position Karnataka as one amongst the top five global innovation centers in AI over the next five years.

Further Reading

Centre of Excellence for data science and Artificial Intelligence (CoE-DS&AI)

Setup by the government of Karnataka the Centre of Excellence will provide impetus to growth of AI, by encouraging partnership with enterprises, government, academic and startups.

Further Reading

Department of Science and Technology Government of India

Set up the Data Science Research Initiative, the main areas of research is machine learning, AI and other applications of data science.

Further Reading

Make In India

The Make in India initiative acknowledges 'Artificial Intelligence' as the catalyst which shall drive future innovation. Reports have recognised the contribution of AI to voice based applications like Apple's Siri and Amazon's Alexa and attributes increased data coordination to innovation in AI.

Further Reading

Government of Andhra Pradesh

The IT ministry has prepared a Cloud Hub policy to promote advanced testing facilities, such as driverless vehicles, drones and to act as an anchor and co-location host for SAARC countries and beyond, the policy has suggested some measures. The Cloud Hub policy has offered incentives, such as power subsidy and fibre connectivity. Power supply from two grids and subsidy of Rs 2/kVAh, for two years from the start of commercial operations is one of the salient features. AI Research and Development, AI workforce, AI testing and AI regulation are the policy enablers.

Further Reading

Government of Karnataka

Microsoft with guidance from 'Karnataka Agricultural Price Commission' is attempting to develop a multi-variant agricultural commodity price forecasting model considering the following datasets – historical sowing area, production, yield, weather datasets and other related datasets as relevant. The MoU is also aimed at using digital tools that have the potential to deliver cutting edge innovations and artificial intelligence to help farmers get higher crop yields in the state.

Further Reading

myGate
IT Services
Surveillance

Greyorange
Sector Neutral
Robotics

Aspiring minds
IT Services
Language Processing and Recruitment

ASIMOV Robotics Pvt Ltd
Electronics and Heavy Electricals
Robotics

Multicore ware
IT Services
Language Processing

DiFACTO
Electronics
Robotics

Gridbots
Electronics
Robotics

Systemantics
Heavy Electricals
Robotics

NikiAi
IT Services
Virtual Assistant

Gade Autonomous Systems
IT Services
Robotics

Helpforsure
Electronics
Virtual Assistant

Sastra Robotics
Electronics
Robotics

Experis IT ManpowerGroup India
IT Services
Language Processing

ObserveAI
IT Services
Language Processing

Fugen
IT Services
Process Management

Bloom Reach
IT Services
Process Management

Artivatic's Technology
IT Services
Customer Analytics

Iken Personics
IT Services
Customer Analytics

Locus
IT Services
Process Management

Xurmo
IT Services
Customer Analytics

Algo Analytics
IT Services
Customer Analytics

Wipro Limited
IT Services
Process Management

Haptik
IT Services
Virtual Assistant

Infosys
IT Services
Process Management

Clay Labs
IT Services
Process Management

Belong
IT Services
Process Management

Botworx
IT Services
Virtual Assistant

Good Work Labs
IT Services
Process Management

Skymet
Agriculture
Analytics

Stella apps
Agriculture
Analytics

Tata Consultancy Services
IT Services
Process Management

Tartansense
Agriculture
Analytics

Abzooba
IT Services
Analytics

Genpact
IT Services
Analytics

Thoughtworks
IT Services
Process Management

Arya AI
IT Services
Process Management

Developers

NVIDIA
Sector Neutral
Process Management

Supertext
IT Services
Process Management

FuGenX
IT Services
Process Management

Flutura
Sector Neutral
Process Management

Netradyne
Automobiles
Decision-Making

Formcept
IT Services
Analytics

Mad Street Den
IT Services
Customer Analytics

vPhrase
IT Services
Analytics

Uncanny Vision
Sector Neutral
Surveillance

Staqu
IT Services
Process Management

AirCTO
IT Services
Recruitment

Vernacular
IT Services
Language Processing

DataVal Analytics
IT Services
Analytics

Glider
IT Services
Recruitment

Wudi
IT Services
Process Management

Skillate
IT Services
Recruitment

Halli Labs
IT Services
Process Management

MintM
IT Services
Process Management

Quenext
Agriculture
Analytics

Cuddle
IT Services
Analytics

Marax
IT Services
Customer Analytics

LightMetrics
Automobiles
Analytics

Morph
IT Services
Customer Analytics

Senseforth
IT Services
Language Processing

EdGe Networks
IT Services
Recruitment

Ayasdi
IT Services
Analytics

Reifier
IT Services
Process Management

Zylotech
IT Services
Customer Analytics

Realbox
IT Services
Process Management

Liv
IT Services
Language Processing

Analytic Edge
IT Services
Process Management

CropIn
Agriculture
Analytics

Gyan Data
IT Services
Analytics

RazorThink
IT Services
Process Management

Trendence
IT Services
Analytics

Covasis
Sector neutral
Process Management

Braina
IT Services
Virtual Assistant

TYPE OF COMPANY
International
Domestic

Tech Mahindra (AQT)
Heavy Electricals
Process Management

HCL
IT Services
Process Management

Aibono
Agriculture
Analytics

Fluid AI
IT Services
Customer Analytics

Renesas
IT Services
Process Management

Hi Tech Robotic Systemz
Automobiles
Robotics

IIT Bombay's Innovation Cell
Automobiles
Robotics

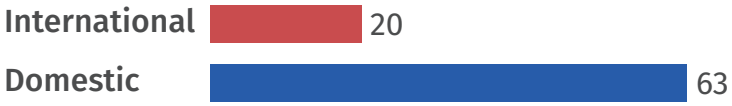
Fisheyebox
Automobiles
Robotics

ATImotors
Automobiles
Robotics

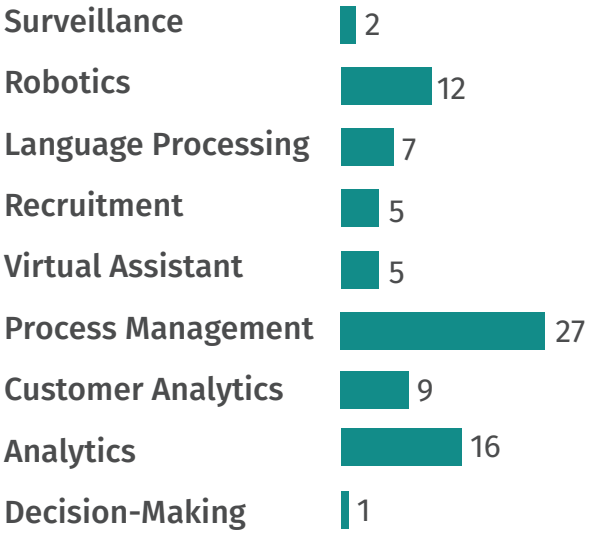
Swaayatt Robots
Automobiles
Robotics

Distribution of Developers Based on Type, Sector and Focus Area

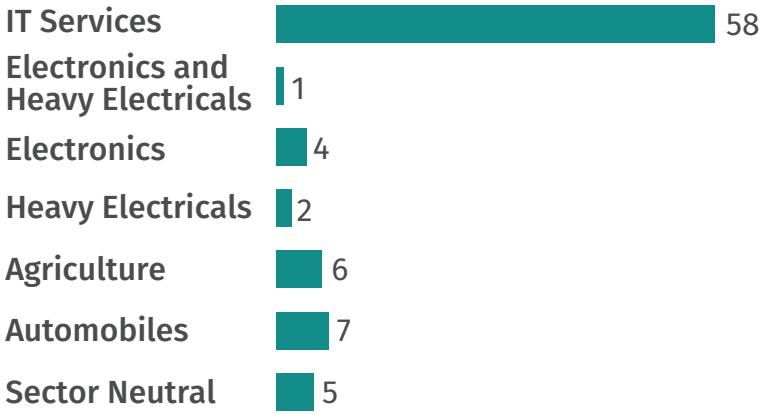
TYPE OF COMPANY



FOCUS AREA



SECTOR



Practitioners

TeachForIndia
Uses **Botworx's chatbot**

Blush
Uses **Botworx's chatbot**

Change.org
Uses **Botworx's chatbot**

Telangana Today
Uses **Botworx's chatbot**

Media Post
Uses **Botworx's chatbot**

Zee Media
Uses **Botworx's chatbot**

News Mobile
Uses **Botworx's chatbot**

Akshaya Patra Foundation
Uses **Botworx's chatbot**

Flipkart
Uses **Greyorange**

gojavas
Uses **Greyorange**

Mahindra
Uses **Greyorange**

Jabong
Uses **Greyorange**

Pepperfry
Uses **Greyorange**

Myntra
Uses **Greyorange**
Has **adopted technologies such as artificial intelligence (AI) and augmented reality**.

DTDC
Uses **Greyorange**

Hindustan Unilever
Uses **Locus**

Quikr
Uses **Locus**

Urban Ladder
Uses **Locus**

Lenskart
Uses **Locus**

Henkel
Flutura

Hitachi
Flutura

GTT
Flutura

Stewart & Stevenson
Flutura

Sodexo
Flutura

Panasonic
Uses **Staqu's**

Faballey
Uses **Staqu's**

Yepme
Uses **Staqu's**

Roposo
Uses **Staqu's**

Tradeindia
Uses **Staqu's**

Intex
Uses **Staqu's**

Lava
Uses **Staqu's**

E-poolers
Uses **Staqu's**

Karbonn
Uses **Staqu's**

Infosys
Infosys **Nia**

HCL
DRYiCE

Wipro
HOLMES

TCS
Ignio

Tata Motors
Tata Motors has **partnered** with TCS

ILO Decent Work Team for South Asia and Country Office for India

The puzzles and contradictions of the Indian labour market: What will the future of work look like?

(Seminar) Technology and the future of work in India: an exploration of the likely (or unlikely) impact of automation in developing countries

Indian Institute of Management, Kozhikode

Technological change and employment relations in india

Artificial Intelligence Marketing: An application of a novel Lightly Trained Support Vector Data Description

IIM Bangalore

Machine Learning Algorithms to Drive CRM in the Online E-commerce Site at VMWare (IMB 621)

IIM Calcutta

Study of Migration of Customers of Mobile Services Using Fuzzy Clustering (Ongoing Project)

A fuzzy logic based approach to assess sustainable development of the mining and minerals sector

IIT Bombay

A Hybrid Intelligent Systems Approach for Die Design in Sheet Metal Forming

IIT Kanpur

A fuzzy logic based approach to assess sustainable development of the mining and minerals sector

TCS Research

Tata Consultancy Services Global Trend Study

Robert Bosch Centre for Data Science and AI at IITM

Conducting Applied Research on Manufacturing Analytics

IISC

Speeding up Reinforcement Learning-based Information Extraction Training using Asynchronous Methods

IIT Delhi

Human Intelligence Needs Artificial Intelligence.

Coordination in supply chains: an evaluation using fuzzy logic

IIT Kharagpur

Artificial Intelligence (AI) Applications in Manufacturing

(Seminar) Use of Artificial Neural Networks for Process Planning of Cylindrical Machined Components

Requirements for and Impacts of ICT Based Advanced Manufacturing With Special Reference to an Indian Context

National Institute of Technology, Agartala

Selection of best intelligent manufacturing system (ims) under fuzzy moora conflicting mcdm environment

Researchers

IIIT B

Demonstration of automatic data partitioning techniques for parallelizing compilers on multicomputers

(Conference) Neural Machine Translation of Indian Languages

Department of Production Engineering, Jadavpur University

Selection of Best Intelligent Manufacturing System (IMS) Under Fuzzy Moora Conflicting MCDM Environment

Analyticsindiamag.com

In the age of automation, will the future of workforce be man vs machine or man + machine?

Future Of Getting Dressed: A Look At How India's Fashion Retailers Are Leveraging AI As Personal Stylists

Putting AI To Work Is The Biggest Challenge For Businesses In 2018

State of AI in India

Pranjal Sharma

Kranti Nation

Central Mechanical Engineering Research Institute Durgapur

Development of autonomous mobile robot with manipulator for manufacturing environment

Ernst & Young LLP

Future of jobs in India
A 2022 perspective

Price Water Coopers India

Workforce of the Future

Report on AI and Robotics in India

FICCI

Future of jobs in India
A 2022 perspective

Accenture

Rewire for Growth - Accelerating India's economic growth with artificial intelligence

NASSCOM

Future of jobs in India
A 2022 perspective

Carnegie India

India and the Artificial Intelligence Revolution

KPMG

The Intelligent Economy - Leveraging technology for the new era

Confederation of Indian Industries

The Intelligent Economy - Leveraging technology for the new era

Conferences and Exhibitions

ASSOCHAM International Conference, Artificial Intelligence & Robotics– 2017 Leveraging AI for Sustainable Growth
Organiser: **ASSOCHAM**
9th March, 2017
New Delhi

Smart Manufacturing Summit
Organiser: **Meity**
21st and 22nd March, 2018
Chennai

The Machine Conference 2018
Organiser: **Analytics India Magazine**
11th May, 2018
Mumbai

Microsoft Academic Research Summit 2018
Organiser: **IIIT-Hyderabad**
24th and 25th Jan, 2018
Hyderabad

National Meet on Grassroot Informatics -- VIVID: Weaving a Digital India
Organiser: **NIC**
8th to 10th Feb, 2018
New Delhi

AI & IoT Summit, 2018
Organiser: **HICC Hyderabad**
18th and 19th Jan, 2018
Hyderabad

ICIADM 2018
Organiser: **WASET**
22nd and 23rd Feb, 2018
Mumbai

Bengaluru Tech Summit
Organiser: **Department of IT and BT Government of Karnataka**
16th to 18th Nov, 2017
Bangalore

Artificial Intelligence for Next Generation HR Leaders
Organiser: **Bombay Chamber of Commerce**
28th July, 2017
Mumbai

AI and Machine Learning Summit 2017
Organiser: **UNICOM**
10th Nov, 2017
Bangalore

AI & Deep Learning Transforming Enterprise Decision Making
Organiser: **NASSCOM**
22nd and 23rd June, 2017
Hyderabad

AICC 2018
Organiser: **MLR Institute of Technology**
2nd and 3rd Feb, 2018
Hyderabad

ICT East - Smarter World – A New Normal
Organiser: **CII**
16th and 17th Sept, 2017
Kolkata

International Conference on Artificial Intelligence, Soft Computing and Application
Organiser: **Academy & Industry Collaboration Centre**
30th and 31st Dec, 2017
Chennai

3rd International Conference on Artificial Intelligence and Applications
Organiser: **AI 2017**
30th and 31st Dec, 2017
Chennai

DataHack Summit 2017
Organiser: **Analytics Vidhya**
9th to 11th Nov, 2017
Bangalore

International Conference on Intelligent Systems Design and Applications
Organiser: **South Asian University**
14th to 16th Dec, 2017
Delhi

Data Science Congress 2018
Organiser: **Aegis School of Business**
29th May to 1st June, 2018
Mumbai

Intel AI Day
Organiser: **Intel**
4th April, 2017

Automationshift_
Organiser: **TWB**
15th Sept, 2017
Bangalore

Conference on Computational Intelligence and Big Data Analysis 2017
Organiser: **IBCB, India**
15th to 17th Dec, 2017
Visakhapatnam

CYPHER 2018
Organiser: **Analytics India Magazine**
26th to 28th Sept, 2018
Bangalore

Gartner Data & Analytics Summit 2018
Organiser: **Gartner**
6th to 8th June, 2018
Mumbai

The AIR Summit
Organiser: **OUT WIT OUT PLAY**
10th to 12th Oct, 2017
Hyderabad

ICCI 2017
Organiser: **IIT Kanpur**
6th to 8th Dec, 2017
Kanpur

Artificial Intelligence - Opportunities and Challenges
Organiser: **IIM, Bangalore**
18th Feb, 2017
Bangalore

The Fifth Elephant 2018
Organiser: **HasGeek**
26th and 27th July, 2018
Bangalore

Emerging Technologies Summit 2018
Organiser: **Mindivik**
1st Feb, 2018
Bangalore

International Conference on Emerging Technologies in Data Mining and Information Technology 2018
Organiser: **School of Information Technology, India**
23rd to 25th Feb, 2018
Kolkata

International Conference on Machine Learning and Data Science
Organiser: **Bennett University**
14th and 15th Dec, 2018
Noida

Investors/ Funders

Ratan Tata
Niki AI

Unilazer Ventures
Niki AI

Kalari Capital
Active.ai

IDG Ventures India
Active.ai

Sequoia
Belong, Mad street den

Matrix Partners
Belong

Blume Ventures
Belong

Sachin and Binny Bansal from Flipkart
Grey Orange

Bikky Khosla
Staqu

Ventureast
EdGe Networks

Times Internet
Haptik
MintM

Omidyar Network
i2e1

Reliance
NetraDyne

Exfinity Ventures
Mad street den

growX Ventures
Mad street den

Indian Angel Network
Staqu

Venture Partners (IVP)
Ayasdi

GE Ventures
Ayasdi

Citi Ventures
Ayasdi

Prime Venture Partners
MyGate

Incubate Fund India
Skillate

Vertex Ventures
Flutura

Nandan Nilekani
Systemantics

Acel Partners
Systemantics

Gujarat Venture Finance Ltd).
FORMCEPT

Venture Catalysts
vPhrase

Karnataka Government
LightMetrics

Hyderabad Angels
Realbox