Enabling healthcare with technology

March 2023

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Table of contents

1. Preface 4
2. Introduction and overview of artificial intelligence (AI) in healthcare 11
3. Emerging themes for AI in healthcare 15
4. Focus areas of AI in healthcare 18
5. Primary survey analysis 23
6. Maturity levels of AI implementation in healthcare 27
7. Challenges to AI adoption in India 35
8. Opportunities for AI adoption in India 39
9. The road ahead 43

1. Preface

Arnab Basu

It is our pleasure to bring to you our paper on the role of AI in healthcare. In this paper, we have presented our view on the emerging themes and focus areas of AI in healthcare and some of the challenges and opportunities of AI adoption in the Indian healthcare ecosystem.

There is a great potential in adopting AI technology in healthcare in areas such as care delivery, diseases surveillance, patient centricity and research and development (R&D). The implementation of AI, if done correctly, can bring promising results for the healthcare industry.

We have also looked at the challenges for AI adoption in the Indian ecosystem, with compliance risk being a significant impediment in the implementation of this technology. With the government of India (GoI) trying to build a digital health ecosystem to foster healthcare in the country, AI will get more acceptance in the future.

With continuous innovations being implemented across healthcare industry, we believe that AI will bring a positive change in the healthcare sector. It will be interesting to see how this emerging technology will play a role in shaping the future of the Indian healthcare landscape.

Arnab Basu
Advisory Leader
PwC India

Dr. Rana Mehta

AI has the potential to revolutionise healthcare by improving the accuracy and speed of diagnosis, treatment and research.

Emerging themes and broad applications for AI in healthcare include:

1. Patient centricity: Personalised medicine and virtual assistants
2. Care delivery: Medical imaging and predictive analytics
3. Disease surveillance: Real-time monitoring, contact tracing and predictive modeling
4. R&D: Medical research and drug development

The AI in healthcare market has been growing rapidly in the recent years and is expected to continue to grow in the future. The global healthcare AI market size is expected to reach USD 45.2 billion by 2026, growing at a CAGR of 44.9% from 2021 to 2026.

The global AI in healthcare market's growth is driven by factors such as the increasing adoption of AI technology by healthcare providers, policy makers and customers, rising demand for personalised healthcare and the growing amount of healthcare data which needs to be analysed.

For it to succeed, AI needs to gain the trust of the patients. This entails appropriate regulations regarding patient privacy and data security to ensure that AI is safe, effective and used ethically to benefit patients and healthcare providers. AI has the potential to reduce costs, enhance clinical outcomes and revolutionise the delivery of healthcare.

Dr. Rana Mehta
Healthcare Leader
PwC India

Sayantan Chatterjee

As India looks to usher in the new age of development and work towards being an economic superpower, it needs to work on providing three basic services to its citizens – universal healthcare, primary education for all and a stable infrastructural set up. Among these three, the COVID-19 pandemic has made us realise the magnitude of work that is required to be done on providing quality healthcare services to all.

To make healthcare accessible and affordable to all citizens, having a robust digital health infrastructure is of utmost importance. In the context of digital healthcare in India, the Government has taken key initiatives namely under the aegis of Ayushman Bharat Digital Mission (ABDM) to work towards an integrated, interoperable healthcare ecosystem for all its citizens. The key focus is on unique access identifiers, health registries and a unified health interface that will be a game changer in the times to come.

Among the digital technologies that are at the forefront of realising this vision is AI which has the potential to not only enable better and accurate care delivery, but also to help lessen the immense burden on the healthcare providers to cater to the population of the country.

The key aspects to be kept in consideration as we prepare to embrace AI in healthcare would be data privacy and security, and personalised care delivery.

In this paper of, we have tried to look at how AI can have a meaningful impact on the healthcare ecosystem, the challenges to implement AI in healthcare and the opportunities for its adoption in India.

Sayantan Chatterjee
Digital Healthcare Leader
PwC India

Rajarshi Ghosh

In recent times, the dependency on technology has increased exponentially to cater to the growing needs of the consumer. Amidst this wave of technological advancement and adoption, it's important for industries to pave the way for the evolution and growth of technology by exploring the opportunities that new-age technologies can offer.

Industries are riding on this wave of automated business activities for increased efficiency, operational excellence and improved customer experience. Exploring such opportunities, businesses have reaped major benefits of AI by optimising routine functions. The implementation of AI has not only enabled faster data-driven decision-making through cognitive technologies but has also personalised customer experience through insights on predicting customer preferences.

AI has made its way into the global healthcare sector. This had led to the GoI to encourage and facilitate the adoption of AI in the country's healthcare sector which is evident from the initiatives that have been discussed in this paper. With the prevalent challenges in the Indian healthcare sector, the potential of AI can be leveraged to transform the healthcare delivery landscape. We can foresee great improvements in the Indian healthcare ecosystem across the different functions within the industry such as treatment procedures, patient monitoring and diagnosis of diseases, care delivery, disease surveillance, R&D, drug discovery and clinical trials. However, India still needs to overcome challenges such as the lack of technical infrastructure, data privacy policies and the cost of implementation to successfully adopt AI in the healthcare sector and to reap its benefits.

Through this paper, PwC has attempted to talk about some of the difficulties of adopting AI and highlighted the opportunities that it has to offer in the healthcare sector.

Rajarshi Ghosh
Data & Analytics Leader, Pharma & Healthcare
PwC India

Angana Guha Roy Chowdhury

The Bengal Chamber of Commerce and Industry (the chamber) is one of the oldest institutions of its kind tracing its origins back to 1833. It has played a pioneering role as a helmsman, steering the evolution of commerce and industry in India. The Chamber reviewed and commented upon some of the most critical legislations in the country. It was involved in the conceptualisation of the airport in Kolkata and the Howrah Bridge and had lobbied for the creation of the overland trade routes with China through Tibet. The Chamber has helped in the formation of a slew of educational and cultural institutions – Indian Institute of Management (IIM) Calcutta, Indian Institute of Social Welfare and Business Management (IISWBM), Nazrul Manch and the Academy of Fine Arts apart from bringing to Kolkata the son-et-lumiere at the Victoria Memorial.

Today, the Chamber is deeply involved in areas such as healthcare, information technology, education, energy and environment, finance and banking, corporate governance, MSME development, manufacturing, infrastructure and tourism to name a few and has now assumed a multi-faceted role.

The Chamber has a vibrant IT Committee comprising leading developers, consultants, corporates and academia. Startups have also been included in the committee. The focus has always been to communicate and create a bridge between technology users and developers on how the synergy may be enhanced with disruptive innovations. The Chamber's annual signature event Business IT Conclave (BITC) creates a platform for the stakeholders across the technology sector including service providers, users, academia, incubators and startups to network, interact, brainstorm and share the best practices of emerging technologies and their applications.

There is a constant focus of connecting the stakeholders with larger markets through dedicated B2B and B2G meetings in partnerships in embassies and consulates in India, overseas chambers of commerce and similar organisations.

The Chamber has set up Webel-BCC&I Tech Incubation Centre to encourage technology entrepreneurship and provide deserving potential entrepreneurs with a platform to initiate startups which would be a contribution to the startup movement of the State. The startup incubatees are provided mentorship by the mentor group and the Chamber's experts on the domain knowledge and ancillary areas of business like taxation, legal and IPR, and others. The viable businesses are connected with the larger ecosystem for acceleration.

The Chamber's Health Committee has been playing an important role in addressing the critical aspects in the field of healthcare and has been catalytic in bringing about significant corporate consciousness in healthcare management. It has organised health expos, panel discussions, lectures on health issues by leading and iconic personalities in health from the fraternities of doctors, entrepreneurs and policymakers. The committee's activities also include B2B meets with IT companies to discuss the latest offerings relevant to the healthcare sector. Blood donation camp and seminar on deceased organ donation has been organised as a gesture of our responsibility to our society. The committee also engages in policy advocacy.

With the outbreak of the pandemic, the health committee of the Chamber, as a proactive measure, had shared useful information on history, symptoms, treatment and prevention of COVID-19 with all the members and stakeholders of the Chamber.

The health committee of the Chamber has also taken the initiative to connect MSMEs, who manufacture items which are essential to combat the pandemic, with the healthcare service providers. The committee has also asked its members to donate masks and sanitisers.

The Chamber recently organised the International Health and Wellness Expo on 15–16 September 2022 with Mati-ta Wellness and Hospitality in Chittagong, which was inaugurated by MA Latif, Hon'ble Member of Parliament, Bangladesh, Dr. Rajeev Ranjan, Assistant High Commissioner of India and Mr. Mahbubul Alam, President, Chittagong Chamber of Commerce and Industry. The event was also attended by other dignitaries. The Exhibitors from India, Bangladesh and Malaysia and included participants from hospitals, medical equipment startups, air ambulance service providers, medical tourism agencies, wellness resorts, beauty product manufacturers, digital marketing agencies, digital payment platforms and health insurance companies. B2B meetings took place and a few collaborations on medical tourism and medical equipment were also initiated at the event.

Angana Guha Roy Chowdhury
Assistant Director General
The Bengal Chamber of Commerce and Industry

2. Introduction and overview of artificial intelligence (AI) in healthcare

After the COVID-19 pandemic and the challenges it has posed to the healthcare system, AI is becoming a crucial component for healthcare innovation and advancements. The increasingly wide application of technologies like AI would need healthcare providers to adapt to the new ecosystem. Some applications of AI in healthcare are improving healthcare delivery in preventive care, disease diagnosis and prediction, treatment plans, and care delivery and administrative work, thereby benefiting both the overall experience of patients and healthcare providers.

Use of AI in the healthcare sector has numerous benefits such as increase in the accessibility of healthcare services, efficient diagnosis, cost- and time-efficient treatment, and better preventative care services. However, there are a few pitfalls of using AI in healthcare, such as unintended bias, data privacy issues, data security risk and increase in unemployment.

To maximise the opportunities and limit the risks of AI in the domain of healthcare, WHO has proposed six principles:

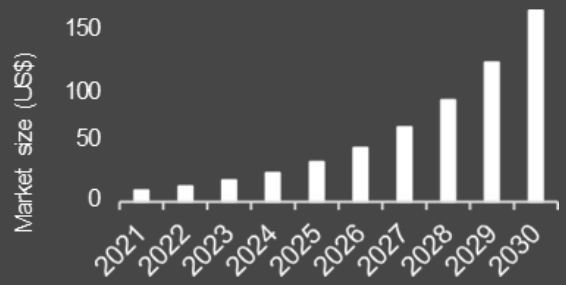
Securing the human autonomy	Ensuring equity and inclusiveness
Fostering accountability and responsibility	Promoting safety and well-being in public interest
Promoting sustainable and responsive AI	Promoting Intelligibility explain ability and transparency

Source: WHO

A growing global market

In 2021, the global artificial intelligence market in healthcare was valued at USD 11 billion and forecasted to reach USD 188 billion by 2030.[1] The increase in investments by both the government and the private sector is driving the healthcare AI market.

Forecasted market size for AI in healthcare worldwide from 2021 to 2030



Source: Press release by Statista on Sept 2022. Retrieved from https://www.statista.com/statistics/1334826/ai-in-healthcare-market-size-worldwide/

As of January 2021, 20 member states of the European Union (EU) have published various policy recommendations and commissioned studies which will build the foundation for National AI Strategy initiatives. The EU has proposed to invest euro seven billion in area of AI in healthcare for the period 2021–2027.[2]

The Government of China is aiming to become an AI innovation centre by 2030. One of the major areas of AI application in China is medical imaging which is predicted to grow at 40% and will reach USD 2.5 billion by 2024.[3]

In South Korea, the market size for the use of AI in healthcare in 2019 was USD 44 million, which is expected to reach USD 194 million by 2023. The major market in South Korea using big data or AI is of medical devices software.[4]

India has witnessed a gradual improvement in the healthcare sector over the years. The patient to doctor ratio in India has improved from 1:1700 to 1:854[5] in 2022, which is significantly better than the WHO recommendation of 1:1000 ratio.[6] However, there is a huge imbalance in this distribution. Almost 70%[7] of the healthcare facilities are situated in urban areas where only 30%[8] of the population resides. Most of the rural population is beyond the reach of modern healthcare facilities. This disparity can be countered by leveraging the power of AI. AI can analyse huge amount of healthcare data to bring about actionable insights and help in improving public health surveillance, emergency response and aid the R&D sector. AI can also be used in other areas of healthcare such as diagnosis, disease surveillance and care delivery. Implementation of AI in India, a state with 1.4 billion people, is a necessity to improve the healthcare system.

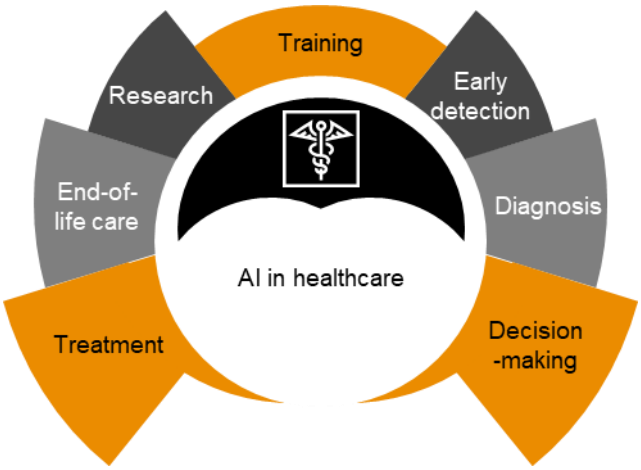
To achieve the aim of making healthcare affordable and accessible to the 1.4 billion people in India, the use of AI in healthcare is a necessity.

Investment in AI in India's healthcare sector

AI expenditure in India increased by over **108%** in 2018 to reach **USD 665 million** and is expected to reach **USD 11.78** billion by the end of 2025. By 2035, AI expenditure is expected to contribute **USD 1 trillion** to the Indian economy.[9]

India, being the founding member of the Global Partnership on AI (GPAI) alliance 2022–23, has so far adopted a measured approach for the integration of AI. AI is already being integrated into the diagnostic algorithms for screening of diseases ranging from cancer, diabetic retinopathy to cardiovascular diseases. Healthcare is one of the most dynamic yet challenging sectors in India which faces challenges of quality, accessibility and affordability for a large section of population. Integration of AI technologies in healthcare helps in improving the access to healthcare in remote areas by providing point-of-care diagnostics, teleconsultation and e-prescription capabilities.

Areas of AI implementation in the healthcare sector



Recent examples of AI implementation in India's healthcare sector

COPD diagnosis and management

AI-based solutions have been developed to aid in the diagnosis of COPD. These include early warning systems that use specialised spirometer along with advanced analytical tools to identify symptoms and provide insights about COPD. An AI-powered inhaler is one of the solutions to track the patient's compliance to the prescribed medication and to monitor the correct drug delivery technique. Advanced Computational Fluid Dynamics tools are also being used to visualise lung parameters.[10]

Tuberculosis (TB) diagnosis

The Central TB Division of the MoHFW is exploring opportunities in applying AI for the country's fight against tuberculosis. The national TB program, which is intended to be AI-ready, aims to support the identification of disease clusters/hotspots and vulnerability mapping through cluster analysis, devise newer methods of diagnosis and screening, providing decision support to caregivers, etc.[11]

Recent examples of AI implementation in India's healthcare sector

Cancer screening

With around one million new cases being diagnosed every year, India is expected to witness the challenge of a shortage of experienced oncopathologists. In future, AI could assist pathologists in making quality diagnosis. However, this would require high quality pathology datasets. A national-level repository of curated pathology is being developed by the NITI Aayog. Another initiative to develop a cancer imaging biobank based on AI-based radiomics principles is also being discussed.[12]

Public health surveillance

Remote monitoring systems like the Indore 311 mobile app launched by Madhya Pradesh has been used to track asymptomatic patients and generate alerts when suspected patients break home isolation regulations.

Milagrow Sanbot ELF Humanoid Robot has been deployed in AIIMS, New Delhi, which enables doctors to monitor patients without in-person contact. Monal 2020 monitoring by the state of Uttarakhand is another remote monitoring wearable that captures and displays patients' vitals to doctors across any location. LiFi (light fidelity) technology, an innovative radiation-free communication network has been implemented in hospitals in Ahmedabad and is used to effectively capture patients' vitals through devices connected across hospital without the need of the internet.[13]

Putting the patient first

Conversational AI technology has been adopted to engage with and generate awareness among the citizens during the pandemic.. MyGov is the world's largest citizen engagement platform which provides awareness and real-time updates about COVID-19 and answers queries related to COVID-19 via the chatbot.[14]

Automating the essentials

States governments have led several initiatives such as the Milagrow iMap 9 – a robotic disinfection solution for sanitisation purposes. State government of Kerala has deployed robots (KARMI-Bot and Nightingale-19) for serving food and medicines to patients, cleaning up waste and disinfecting isolation wards.[15]

The vibrant AI ecosystem

India and the other GPAI member countries are currently trying to leverage AI capabilities to meet the needs of public health. They have made progress in developing recommendations for the international community to create an environment of open AI research. It will speed up the drug discovery process and help in cost reduction of the overall expenditure associated with the drug discovery process and may help in decreasing the failure rates of drug candidates. Since AI tools are re-usable, they help in allocating resources in other aspects of research.[16]

GoI's increasing focus on AI adoption

India has witnessed a fragmented journey in the development and implications of AI. Under the umbrella of Digital India Initiative, the GoI has taken numerous initiatives envisioning India to become one of the leaders in AI-rich economies by embedding political and legal processes to accelerate the deployment of AI technologies. India aims to draft a concrete set of recommendations for the next 5-years focusing on specific industry and research programs as part of its mission to encourage AI adoption in the country. FinTech, agriculture/food processing education, retail/customer engagement and healthcare are the primary focus areas of AI adoption in India. For the healthcare sector, GoI has laid down numerous regulations to fast-track AI implementation in healthcare. Some of the regulations are:

- The IT Act, 2000, and the Information Technology Rules, 2011, mandates the continuous exchange of information between patients and service providers with the use of latest technologies.[17]
- National eHealth Authority (NeHA), 2015 aims at the expansion of the integrated health information system within India.[18]
- India Science and Technology Endowment Fund's collaboration with the United States, 2009, is aiding entrepreneurs from both countries to encourage building healthcare improving solutions by harnessing the power of artificial intelligence.[19]
- As per the Integrated Health Information Program (IHIP), 2018 the aim to equip all citizens of India with Electronic Health Records (EHR) and increase interoperability within existing EHR/EMRs.[20]

3. Emerging themes for AI in healthcare

AI has the potential to transform the healthcare value chain. The domains where AI plays an integral part in the healthcare ecosystem are patient centricity, care delivery, disease surveillance and research and development.

Patient centricity[21,22,23]

Patient centricity involves prioritising the patients' needs and achieving the best possible care delivery experience for them. As disease management continues to become more complex, there is a need for personalised, novel patient-centric approaches in the healthcare industry.

A comprehensive and effective disease management plan comprises strict adherence to both medication and nonmedication-based treatment. With increasing complexities in patient care treatment, these plans become increasingly complex for the patient and the care giver. Hence, doctors and healthcare institutions continue to be concerned about adherence to such plans, and more importantly, the impact it has on a patient's health in cases of partial or non-adherence. Further, the approach to creating disease management plans has evolved and become more personalised with the implementation of technology in the plans. As a result, additional layers of security and governance are required to ensure the ethical use of patient data. Hence, personalised care through digital solutions now plays an indispensable role in disease management.

Recent developments in disease management and the increasing requirement of providing personalised care to patients has resulted in the integration of advanced emerging technologies (including AI) with the digital solutions implemented by healthcare organisations. Fine-tuned AI models help to sieve relevant information from the vast multitude of data and enable informed decision-making which leads to better patient experiences and results. In a study[24], researchers were able to identify men with heightened risk of erectile dysfunction (ED) for precision medicine and targeted therapies, by comparing natural clusters of male characteristics per country with quantified ED dynamics in these profiles. Such techniques, used to derive deeper insights, enhances the ability of healthcare providers to gain a holistic understanding of a patient's health and tailor the treatment plan accordingly.

Care delivery[25,26]

With AI-infused systems, healthcare providers are presented with a myriad of possibilities to re-imagine care delivery by adding value at each stage of the patient's journey. By pairing it with the required infrastructure and creating strategic alliances with technology providers, AI systems can be used to enhance the care delivery process.

As the complexities in care delivery keep evolving – primarily in the domains of administration, decision support, monitoring and intervention – AI-enabled processes can help in supplementing the existing systems and enhancing the care delivery value chain.

AI-enabled systems can be used to reduce the burden on healthcare providers for routine and repetitive administrative tasks and can increase their availability for meaningful interactions with the patients. A research study has identified that 33% of tasks performed by healthcare practitioners and technicians can be automated. Further, customised AI and machine learning algorithms, coupled with data mining techniques can be leveraged to draw deep insights, recognise patterns and re-affirm decisions taken by healthcare providers. This can enable them to promptly take corrective actions, increase care delivery efficacy and minimise errors.

Disease surveillance[27,28,29]

Legacy methods for disease surveillance are dependent on statistical techniques. Complementing them with AI models and deep learning algorithms may help in developing finer early detection systems in the field of disease surveillance. It could also enable regulatory bodies to take prompt actions and issue care guidelines.

The increase in the application of AI in disease surveillance and the availability of a large amount of data has enabled care providers to focus on new initiatives like epidemic intelligence for disease prevention. Epidemic intelligence enhances traditional disease surveillance by incorporating information from public sources. Data from these multiple sources is collated and the insights are leveraged to trigger early warnings to relevant regulatory bodies.

R&D[30,31,32]

In the healthcare industry, AI-enabled processes have fuelled an exponential growth in the rate of advancement in R&D activities. A recent research has identified that the pipeline for drug discovery at biotech firms with an AI-first approach is growing at an approximate annual rate of 40%. Researchers have leveraged AI to discover new streams, proliferate the accuracy of existing technologies and optimise operating costs in healthcare. With the accelerated adoption of EHRs by healthcare providers, researchers mine data through AI-embedded processes, such as natural language processing (NLP) and deep learning algorithms to derive meaningful insights.

With the potential to redesign the traditional value chain in fields like drug discovery and repurposing, AI is being used by researchers and pharmaceutical firms to improve individual steps and expedite experiment turnaround times. Real world evidence (RWE) data generated from EHRs, insurance claims, smart wearables, clinical imaging, etc. are leveraged by researchers to design clinical trials. The efficacy and safety of drugs used in trials are analysed through AI models to gain deeper insights and enable quicker availability of the drugs to patients. Regulatory bodies leverage RWE data to monitor disease outbreaks and take administrative decisions.

Advancements in analytical and predictive capabilities of AI-embedded systems have enabled research professionals to build models that can be used for accurate and early identification of at-risk demographics for diseases. Insights drawn from these models are used by healthcare providers and regulatory bodies to take preventive steps to manage the severity of these diseases.

4. Focus areas of AI in healthcare

Modern healthcare systems are equipped to cure diseases, not just at a rapid pace but also with greater accuracy for improving the quality-of-care delivery through technological advancements. AI is increasingly getting more adept at doing what humans do more swiftly with greater efficiency and at a lower cost. The potential for both AI and robotics in healthcare is vast. Like many other aspects of our everyday lives, AI and robotics are increasingly becoming a part of our healthcare ecosystem.

Powered with efficiency and accessibility, AI can bring about a revolution in healthcare. By accelerating the processes, AI can transform the way we use technology to make better decisions.

However, to unleash the potential, there is a need to assess the priorities and capabilities of the healthcare sector to plan for the future.

The Integral focus areas for AI would be machine learning (ML), deep learning, natural language, data engineering, simulation, automated ML, embodied AI and responsible AI. These areas would help in making the processes and systems more patient-centric and enhance care delivery by improving the quality of life through enhancements in treatment procedures and diagnostics processes, strengthening the disease surveillance mechanism which would enable faster diagnosis and help to enhance the drug discovery process.

Patient centricity	• AI-based precision medicine to offer enhanced personalised treatment	
Care delivery	• AI-aided clinical decision-making for disease management for physicians • AI-based diagnostic image enhancement to assist in accurate diagnosis	
Disease surveillance	• AI-aided public health surveillance and contact tracing • AI-based population health improvement of a group of population to create care pathways	
Research and development	• Population health simulator using AI and AR • Accelerating the drug discovery process using biology-based AI	

Patient centricity

Patient engagement and empowerment

Improvement in the health of the patient and his/her satisfaction with the services offered is a priority for any healthcare organisation, thereby making patients the most important factor responsible for their growth. In a world driven by technology, AI in healthcare has immense potential to improve the efficiency of the healthcare sector. AI can be used in administrative processes, supply chain and clinical procedures. AI-based processes could increase the patient retention rate and improve the patient's relationship with the healthcare service providers. Such engagements could also empower patients by giving them the autonomy to choose and make informed decisions. Given below are some examples of how AI can help improve the patient experience and research in the healthcare sector:

- By using AI, an organisation can develop ML algorithms to forecast the demand of services at peak intervals to ensure optimum utilisation, allocation and management of beds based on need and availability. By automating such processes and enabling convenient mechanisms, the providers can not only improve the quality of the services but also, reduce the wait time which would improve patient satisfaction.
- Involving patients as a stakeholder to understand their perspective on the services and experiences would help in conducting relevant studies.

ML and NLP enabled models can be constructed to perform feedback analytics, sentiment analysis, and automatic grouping by ML to add more meaning to the feedback received from patients and caregivers to generate insights to improve service delivery and patient satisfaction. Such value-based, patient-centric care delivery models would ensure better healthcare outcomes, improved patient retention and increase a patient's trust in the healthcare system in the long-run.

Virtual care

In recent times, the shortage of workforce has magnified the problem of deteriorating healthcare quality. Factors such as limited movement, fear of contracting the virus, lack of resources and lack of available beds in hospitals have made the world realise the importance of contactless care delivery after the COVID-19 pandemic. The unprecedented times have also highlighted the importance of telehealth where people can find their solutions from the comfort of their homes. The use of AI in telehealth can enable physicians to undertake better data-driven decisions, derive real-time insights of the patients' health, provide clinical decision support to combat drug-allergy, drug-to-drug or any other type of clinical interactions, thereby enhancing the quality of care. AI combined with the data gathered from the Internet of Medical Things (IoMT) sensors can being used in ambulances to track the vitals of a patient which can be shared with the healthcare staff and physicians who can analyse and plan the treatment accordingly. This mechanism can also be extended to home-based monitoring wherein wearables and sensors like light sensors, sound sensors supplemented with computer vision and deep learning techniques can help in faster, real-time monitoring of critical patients.

Care delivery

Preventive care

Preventive care is a pivotal element of healthcare. It represents a proactive approach from an individual's end to combat illnesses. However, some preventive measures are beyond the scope of human tracking and control. AI-powered technologies can be beneficial in providing better patient outcomes and aid in disease prevention. Predictive models can be used to evaluate the social determinants of health to foresee and detect imminent disease progression.

Amidst the big data boom, the demand for AI and ML-led models to accelerate the diagnosis of diseases has grown exponentially. To expedite the process of early diagnosis of cancer, advanced technologies such as thermal image sensing is being utilised instead of the traditional self-examination models.

Another area where AI can be seen spreading its roots is towards the development of AI-based image algorithms is for detecting symptoms of diabetes-related eye problems. Diabetes-related eye problems go undetected till the time the patients are very close to losing their vision. This is where AI's image processing algorithm convolutional neural network (CNN) can bring about a difference by scanning and examining large amount of retinal examination data for various diabetes patients to deduce patterns and share valuable insights related to the diagnosis to prevent blindness.

Curative care

The post-diagnosis treatment planning is a labour-intensive and time-consuming process. ML techniques in AI can be implemented at various steps to optimise the process. Firstly, it can help in identifying patients who need a particular treatment based on their symptoms. This classification can be done by comparing a patient's data with the data of the classified patients in the database. The treatment plan can then be personalised based on the patient's needs by building on the his/her data. Such AI-led interventions could minimise the process of planning and can also help physicians in curating new treatment modalities for other critical patients. For example, cancer patients usually receive detailed imaging diagnostics during their treatment procedures and checkups which can act as sources for data to train the AI model to analyse the medical imaging data for better diagnosis and prognosis of the disease since the treatment of cancer requires an individualised approach in a timely manner.

Palliative care

It is an extremely arduous task to understand, address and incorporate palliative care for patients due to shortage of resources, facilities, and the very nature of rehabilitation services for terminally-ill patients. AI can be instrumental in providing care for palliative care patients. AI-based algorithms can be used to identify and classify patients who might need palliative care services and to streamline the electronic health records. Technology such as conversational AI can also be helpful in having sensitive conversations with terminally-ill patients which might be difficult in the presence of another human being. Emotional support can be extremely helpful in keeping the physicians and family members up-to-date with the patient's health in real-time and enable them to deliver proper care to the patient.

Disease surveillance

Passive surveillance

A new disease is not discovered in one go. Health officials need to process a great amount of information from various sources like news articles and publications, broadcasts, social media, etc. This real-time information needs to be validated, researched, realised, stored and broadcasted within a short span of time. This is where AI can help reduce the turnaround time for information processing and broadcasting by churning out a large amount of data within a few minutes. AI's search algorithms can validate any heterogeneous open-source data to identify new diseases or abnormal symptoms at an early stage within a population. AI powered diagnostic engines are being explored to detect breast cancer lesions at early stages, and have demonstrated a 27% increased accuracy in the diagnosis in comparison to traditional mammography.[33] AI can harness real-time data across the world at once, point out anomalies and spikes, assist in designing a rapid action plan and suggest the way ahead to the health professionals.

Active surveillance

Sometimes critical patient-level indicators like physical movements, visual cues, gestures, etc. may get missed due to absence of medical expertise at hand. Pervasive AI-enabled system can take inputs from a stream of sources like cameras, wearable devices, noise sensors, motion sensors, etc. to detect any abnormalities in the patient's health. As reports[34] suggest, 70% of diabetic patients do not take insulin in the prescribed format. To detect such self-administration errors, radio wave-enabled wireless sensing technology has been developed when the patient administers insulin via an inhaler or a pen. This uses AI to interpret modulated radio waves and has not only been successful in identifying 96% insulin uses and 99% inhaler uses, but also helped in flagging anomalies and assisted in correctly administering the medicine. AI integration can also provide notifications to the physicians to inform them about the patient's health to ensure that timely medical assistance can be administered to the patient.

Research and development

Drug discovery

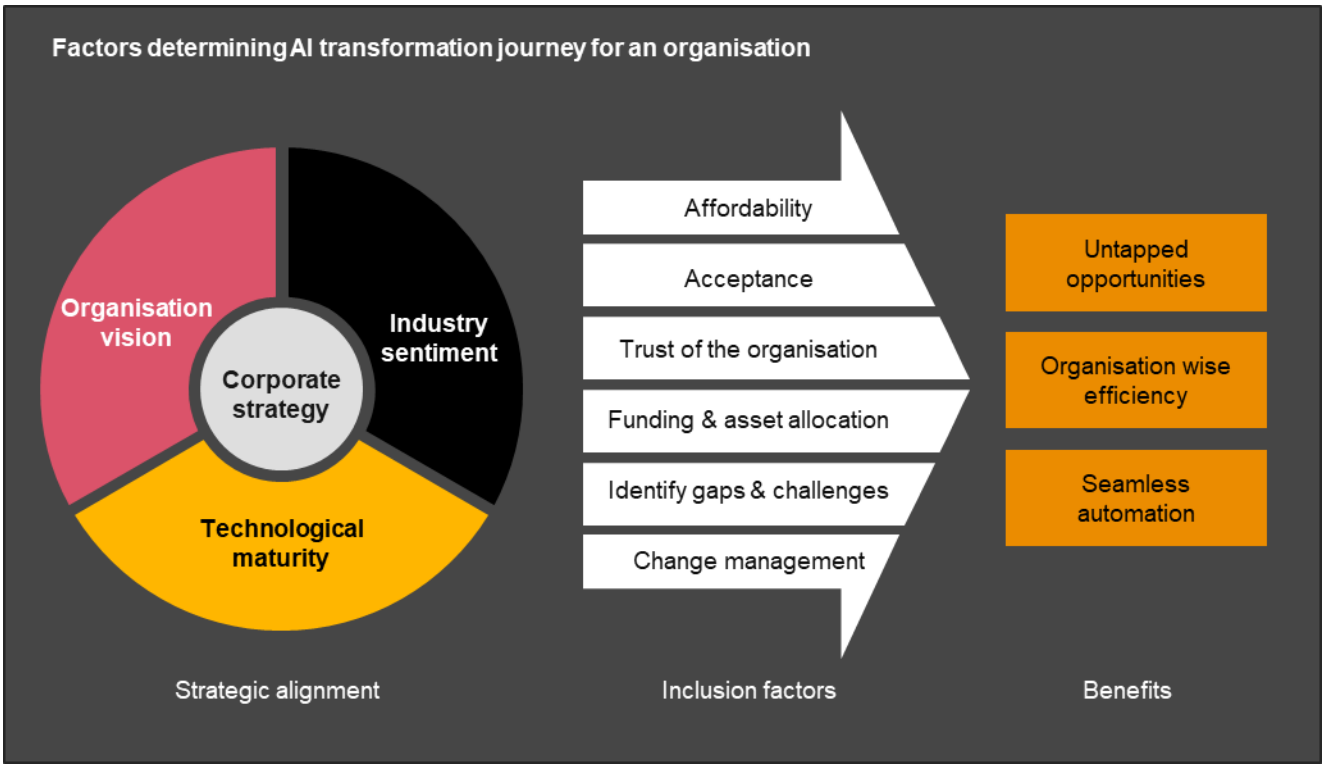
In an era of transition where we are moving away from target-based approaches, the application of AI is now an absolute necessity to support the healthcare ecosystem. AI, with its capability to achieve high predictability, can help in attaining higher accuracy and streamline the drug discovery process by reducing drug discovery time and can even aid in the development drugs for certain rare conditions. NLP can make the processes effective by improving data mining which will be the stepping-stone in establishing models than can predict the effectiveness of potential treatments. A research[35] suggests that the drug discovery costs can be brought down by USD 70 billion in the next 5 years. AI-led drug discovery industry is expected to flourish at a CAGR of 40.5% in the market, from 2020 to 2027 reaching a worth of USD 3932 million by 2027. Healthcare AI startups have bagged more than USD two billion in 2020 by using AI to streamline the drug manufacturing process.[36]

Clinical trials

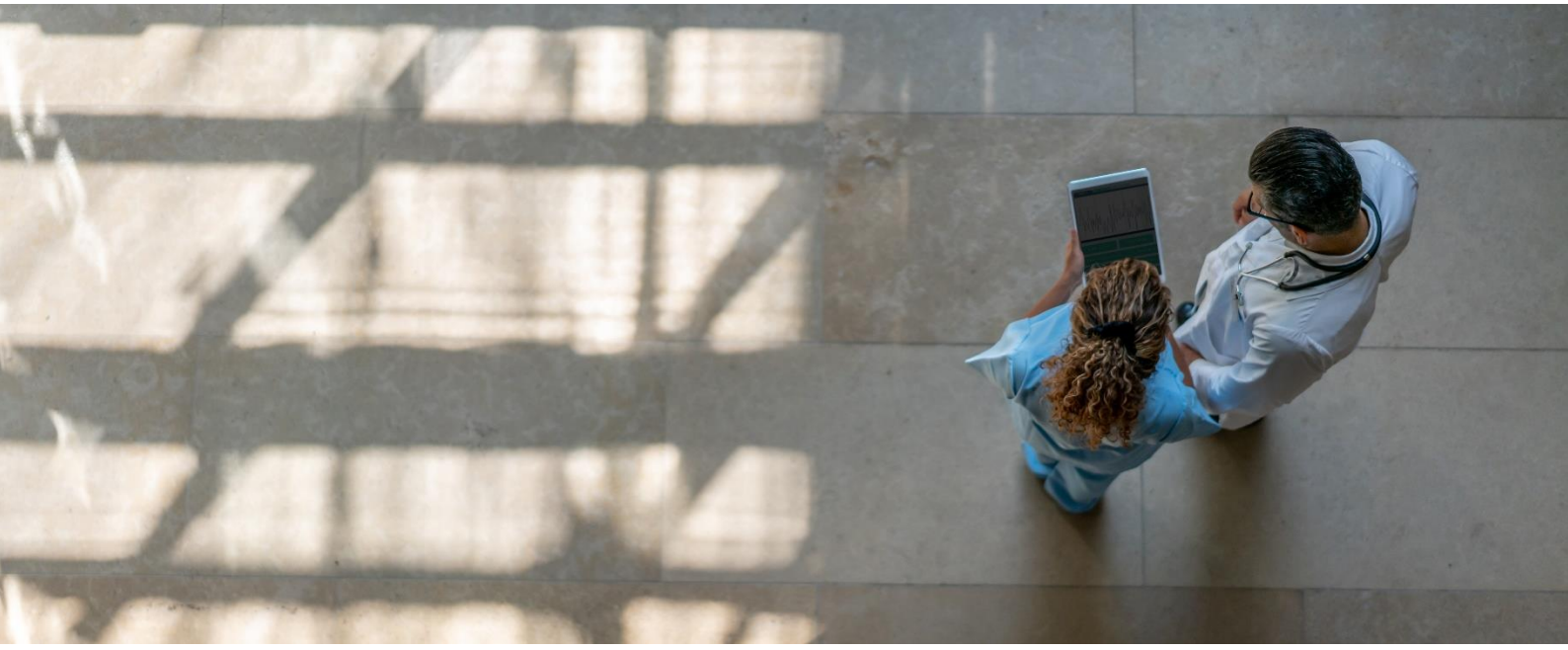
In the context of clinical research, the most vital step in clinical trials is the selection of the right patient population for testing the drug. Patient recruitment activities which is a major expense to the pharma industry, costs over USD 5.9 billion annually.[37] Incorrect sampling can lead to wastage of time, resources, capital and opportunity. Phase III trials have a 32% failure rate due to issues with patient recruitment and is considered to be one of the most serious flaws in clinical trial design. Thus, trials that have high demand for patients are most adversely affected by ineffective patient recruitment methods. AI and ML can aid in patient recruitment and help to improve the composition of patient cohorts[38] and in furnishing effective samples so that the selected population is the best fit for the trail. Predictive AI models can prevent redundancies in the patient recruitment process.

Drug resistance

The widespread use and abuse of antibiotics has led to a significant rise in antimicrobial resistance (AMR). AMR is antagonistic to antibiotic therapeutic efficacy, i.e. it reduces the effect of the antibiotics to the bacterial strain and increases the risk of the spread of disease in a patient. To prevent AMR, the logical approach is to enable mechanisms that can help in early diagnosis of infectious diseases, understand and manipulate the spread of AMR and make quick decisions to implement the right set of therapies. Shortcomings in antibiotic therapeutic efficacies can be dealt by AI-led ML models which can study the resistance patterns and trends of the microbes. AMR prediction models can be used with the available genomic and clinical data to make synergistic drugs that can reverse the effect of AMR.



For an organization's AI transformation journey, the management should be abreast of the organisational vision, technological maturity & industry sentiments so that they are aligned with the corporate strategy required to bolster revenues and achieve the set goals by leveraging AI. Along with that, these organizations must look at the inclusion parameters like affordability, acceptance and trust of the organization which would pave the way for a better adoption of AI. Through this transformation, the businesses can ensure maximum organization-wide efficiency & process automation without impacting BAU.



5. Primary survey analysis

In order to understand the perspective towards adoption of advanced technologies (such as AI) in the healthcare industry, a survey of the general population was conducted along with interviews with CXOs of healthcare and information technology institutions. This online survey was conducted in February 2023 and 156 responses were captured across India.

The following sections discuss the significant insights from the survey.

General population survey

Insight I:

Patients feel that advanced emerging technologies (including AI) will help them in getting a better understanding of their health and will aid care providers.

In our survey of 150 respondents from the general population, we observed that 97% of the respondents feel that advanced technologies (such as AI) will help them in getting a better understanding of their health. AI has multiple use-cases for enhancing patient-centric approaches and augmenting the care delivery value chain as outlined in the preceding sections. Further, an analysis of the general population responses to the survey revealed that 88% of the people are of the opinion that these advanced technologies will aid care providers in multiple domains such as, expediting turnaround times, improving operations of healthcare institutions and generating meaningful insights to enable quicker data-driven decision-making.

Insight II:

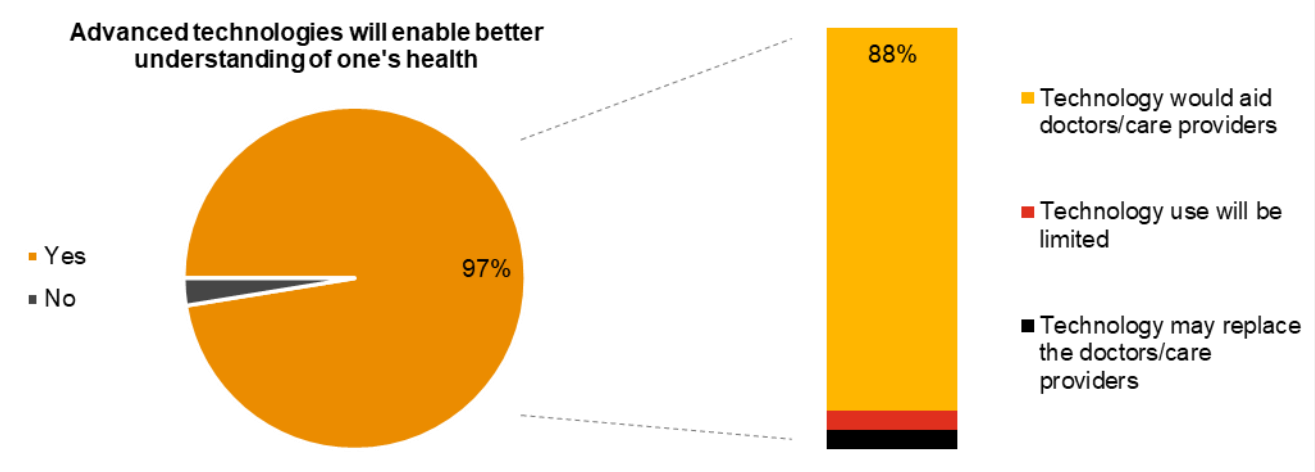
85% of respondents feel that incorporation of advanced emerging technologies (including AI) by healthcare organisations will help care providers and are interested in AI-enabled, patient-centric solutions, such as sharing customised treatment plans for autonomous disease detection and aiding prevention/cure.

Insight III:

Patients prefer specialised doctors while selecting care institutions.

When selecting a care institution (hospitals, nursing homes, etc.), the driving factor for patients and their families is the availability of specialised doctors.

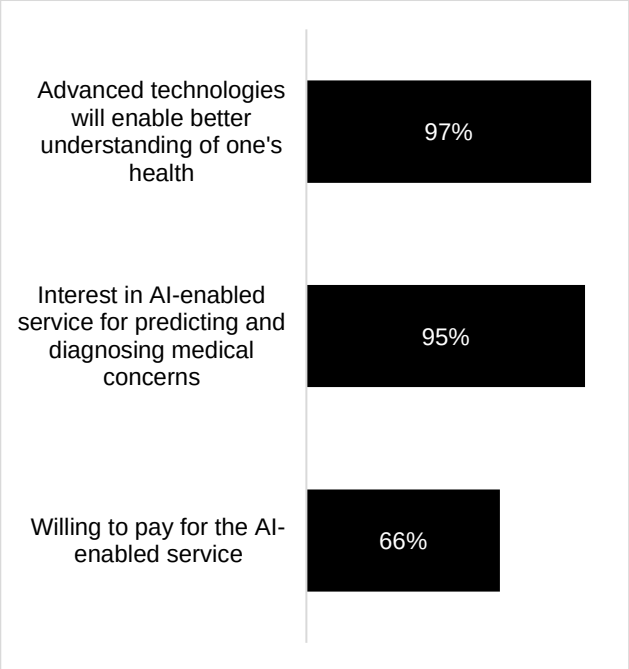
In India, access to specialised doctors is limited largely due to the varying density of population. Integrating advanced emerging technologies (including AI) in the existing ecosystem can help in addressing this limitation. For example, AI-infused ML models can help in reducing the diagnosis time through radiological image and pathological report analysis where skilled technicians are not readily available. This can potentially help in saving lives through timely intervention. With scale and maturity of AI-integration, healthcare will become more reliable and accessible to patients and soon the availability of advanced technologies will become the driving factor when choosing care institutions.



Insight IV:

Approximately 65% of the patients are interested and willing to pay for a service for a disease or a medical concern that can be predicted using AI.

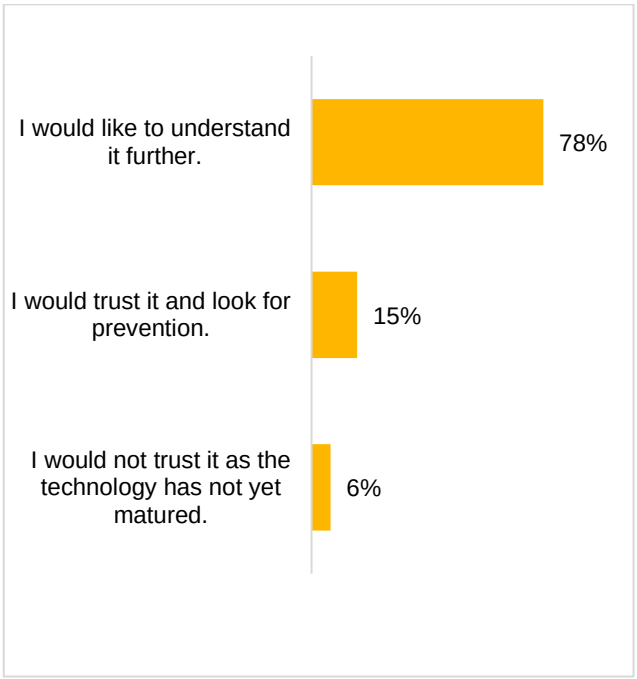
In our survey of 150 respondents, we observed that 97% feel advanced technologies (such as, AI) will help them in getting a better understanding of their health. Out of this cohort, 95% of the population has expressed their interest in a service where a disease or a medical condition can be accurately predicted or diagnosed using AI and advanced analytics. A further analysis of data has shown that 66% of the interested respondents are willing to pay for this service.



Insight V:

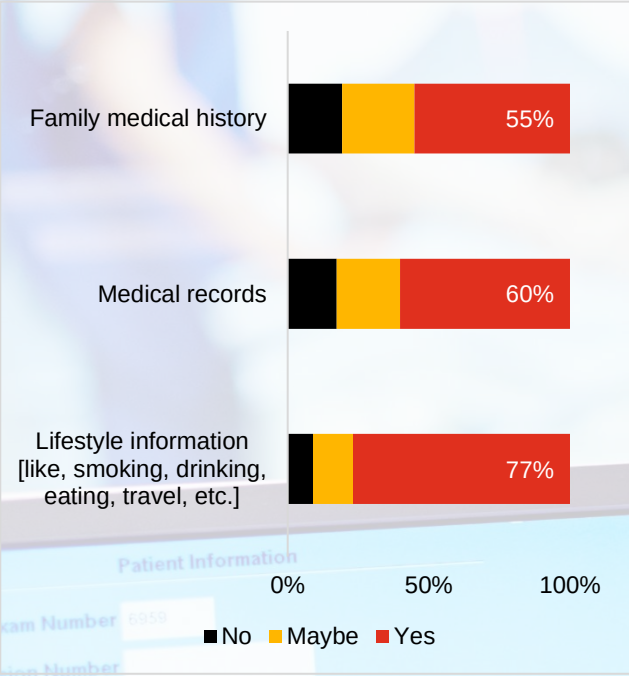
More than 90% of the respondents feel that AI-generated diagnosis is trustworthy and would like to discuss it further with their healthcare providers.

15% of the total respondents trust the outcome of the AI- generated diagnosis results, while 78% of the population wants to further investigate it And discuss it with the doctors. This shows that there is high interest in the patient fraternity for AI-generated diagnosis.



Insight VI:

More than 60% of the people are willing to share their medical data, such as lifestyle information, medical records and family history for creating a centralised repository to aid community disease management.

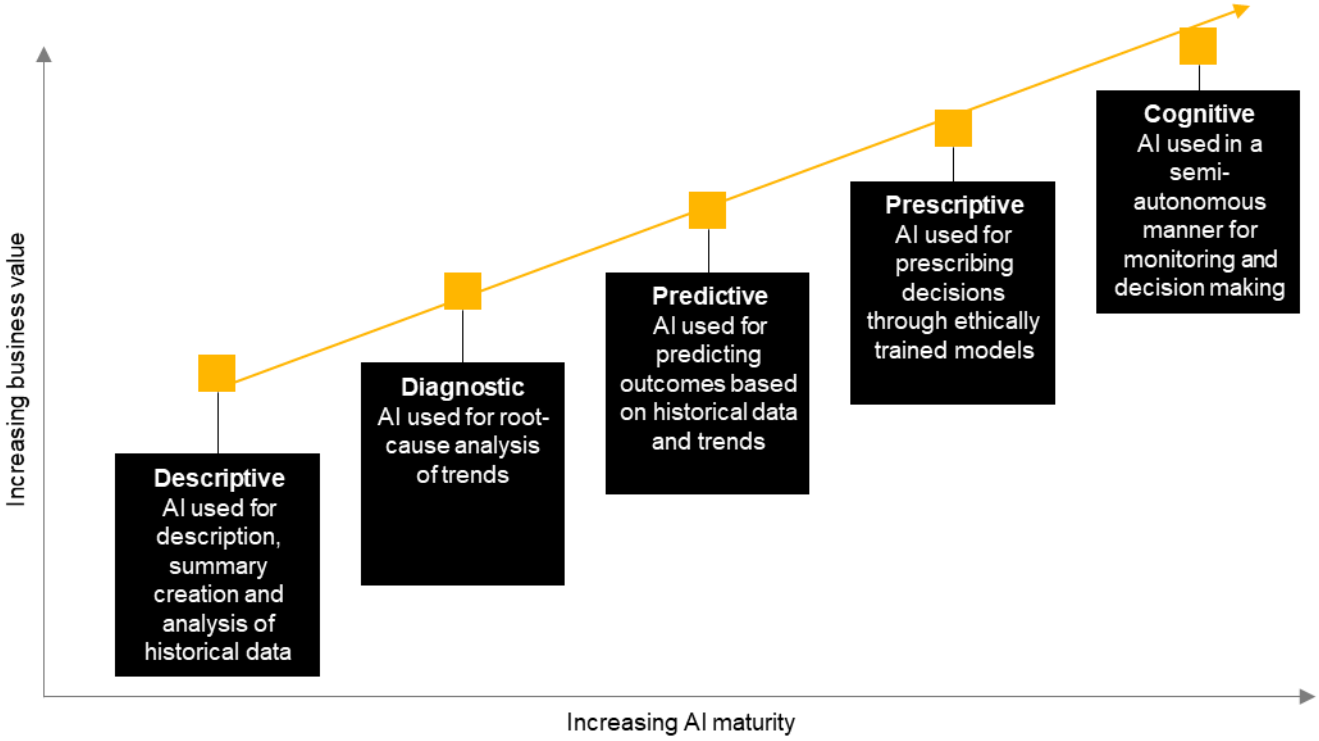


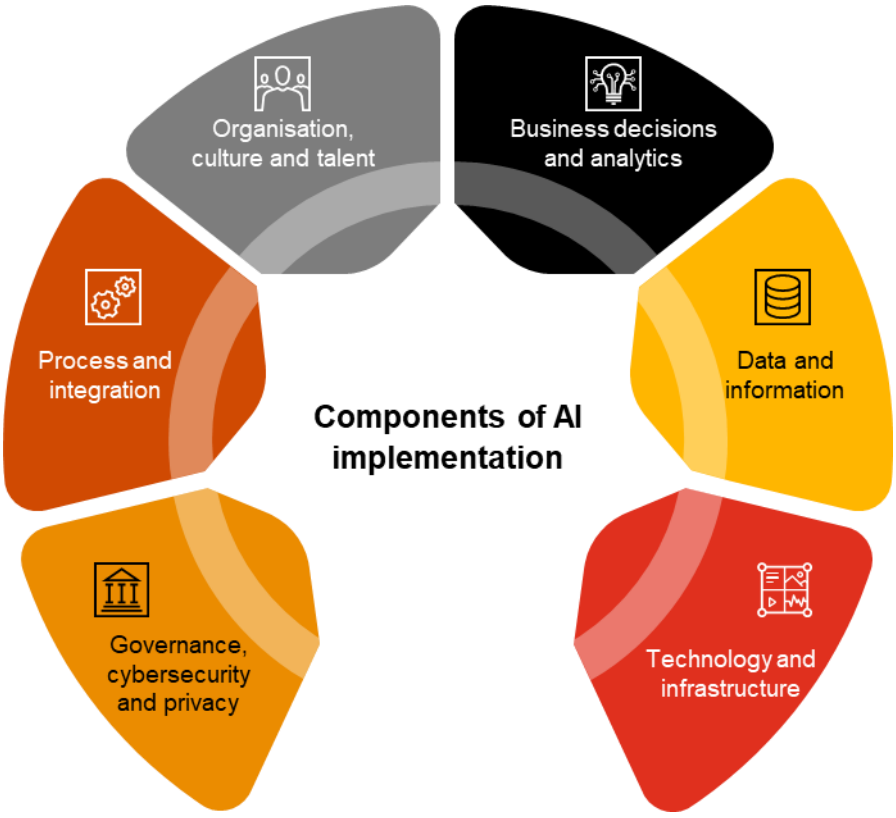
6. Maturity levels of AI implementation in healthcare

As AI implementations in the healthcare industry mature, the value delivered by these AI-infused systems to business processes will increase. The trajectory of the maturity of AI can be split into five stages, with the 'descriptive' stage being the nascent implementation of AI and the 'cognitive' stage being the most mature. This forms the maturity model for AI implementations.

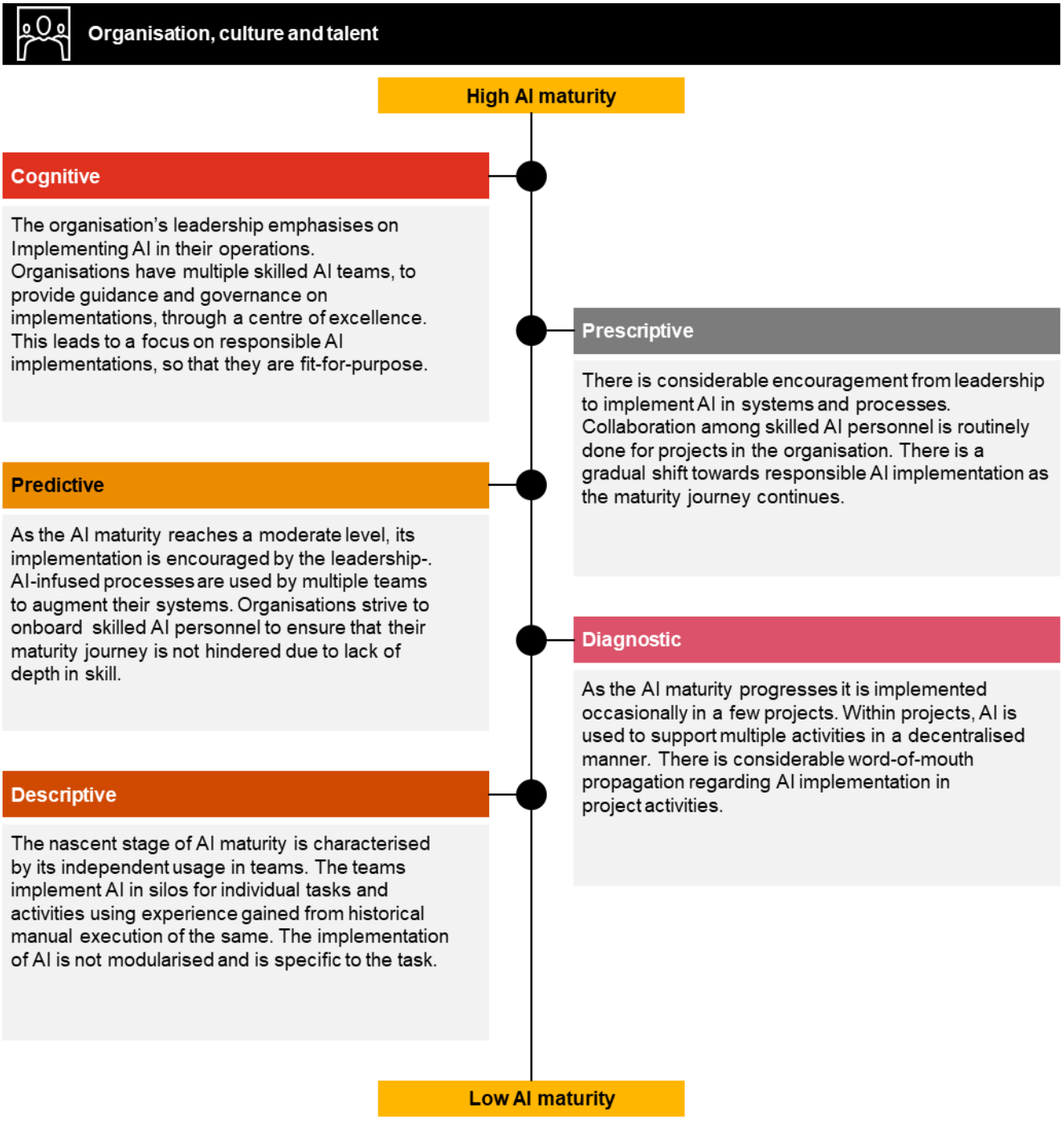
In order to facilitate a phased transition to a mature AI ecosystem which is more complex, organisations can leverage the components below. These components go beyond modelling, techniques and technologies, and focus on six dimensions which help in ensuring that an organisation is capable of meeting the needs of this mature ecosystem.

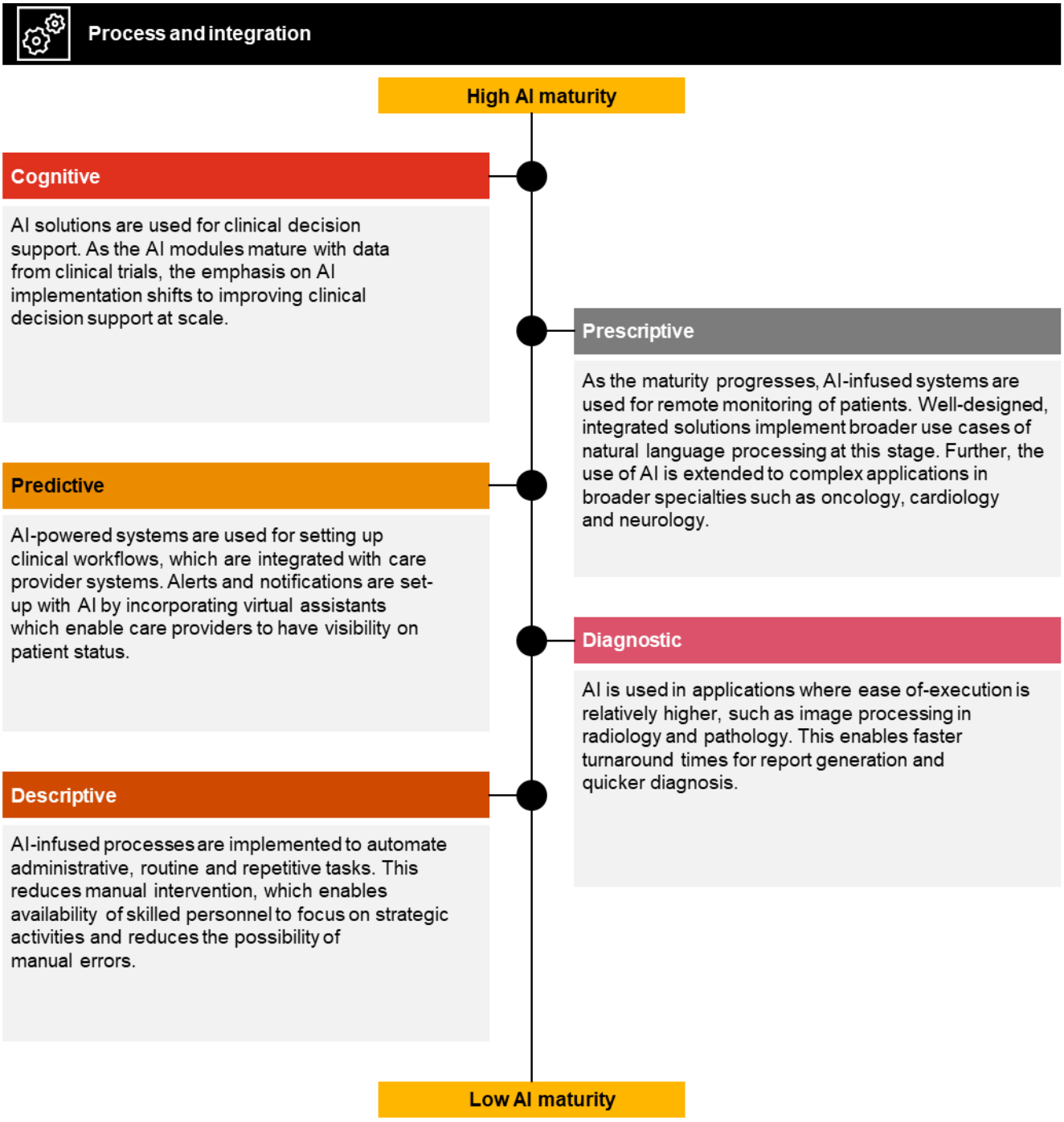
Components of AI implementations

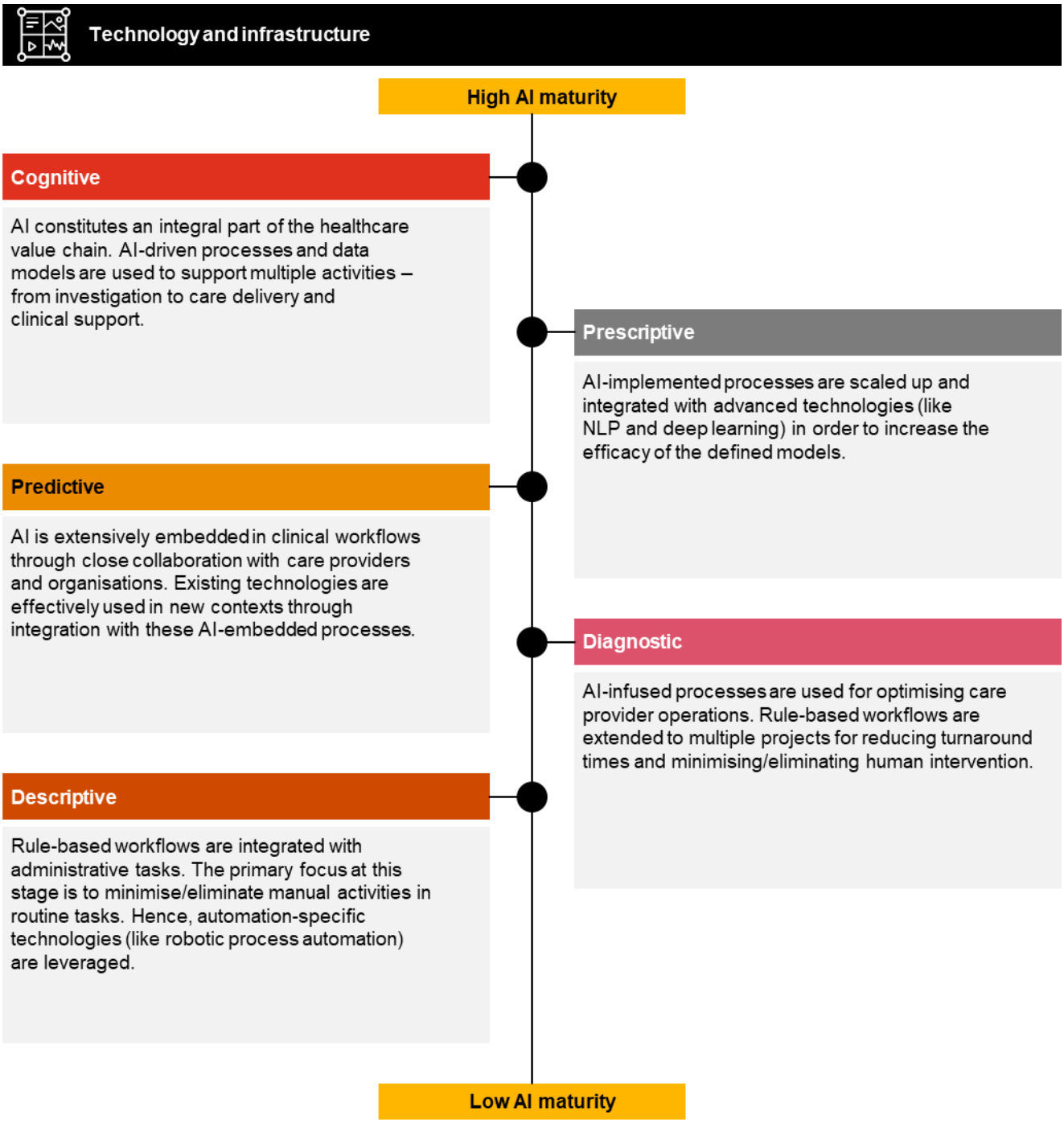


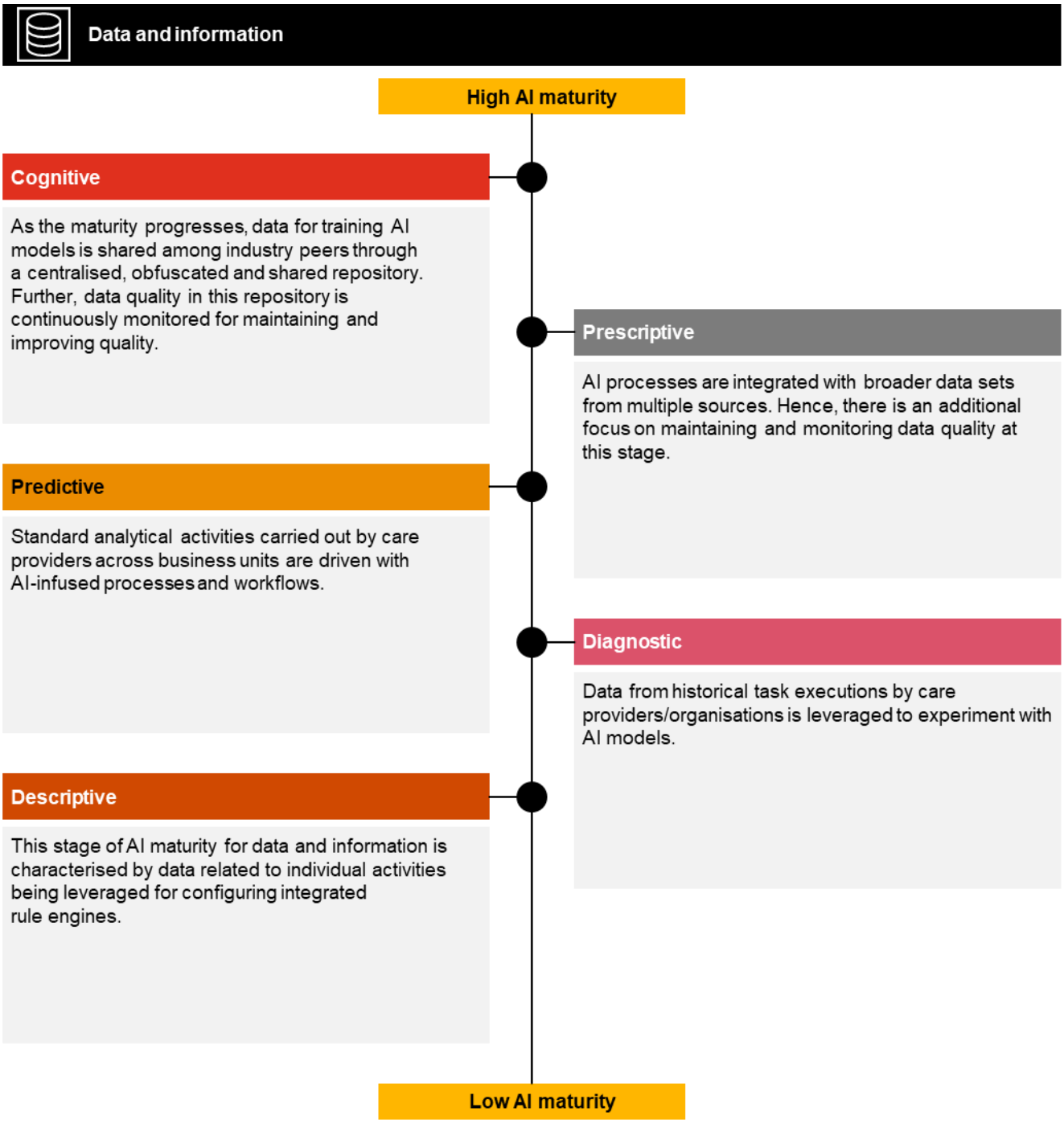


A healthcare perspective on the components of AI implementations at different maturity levels

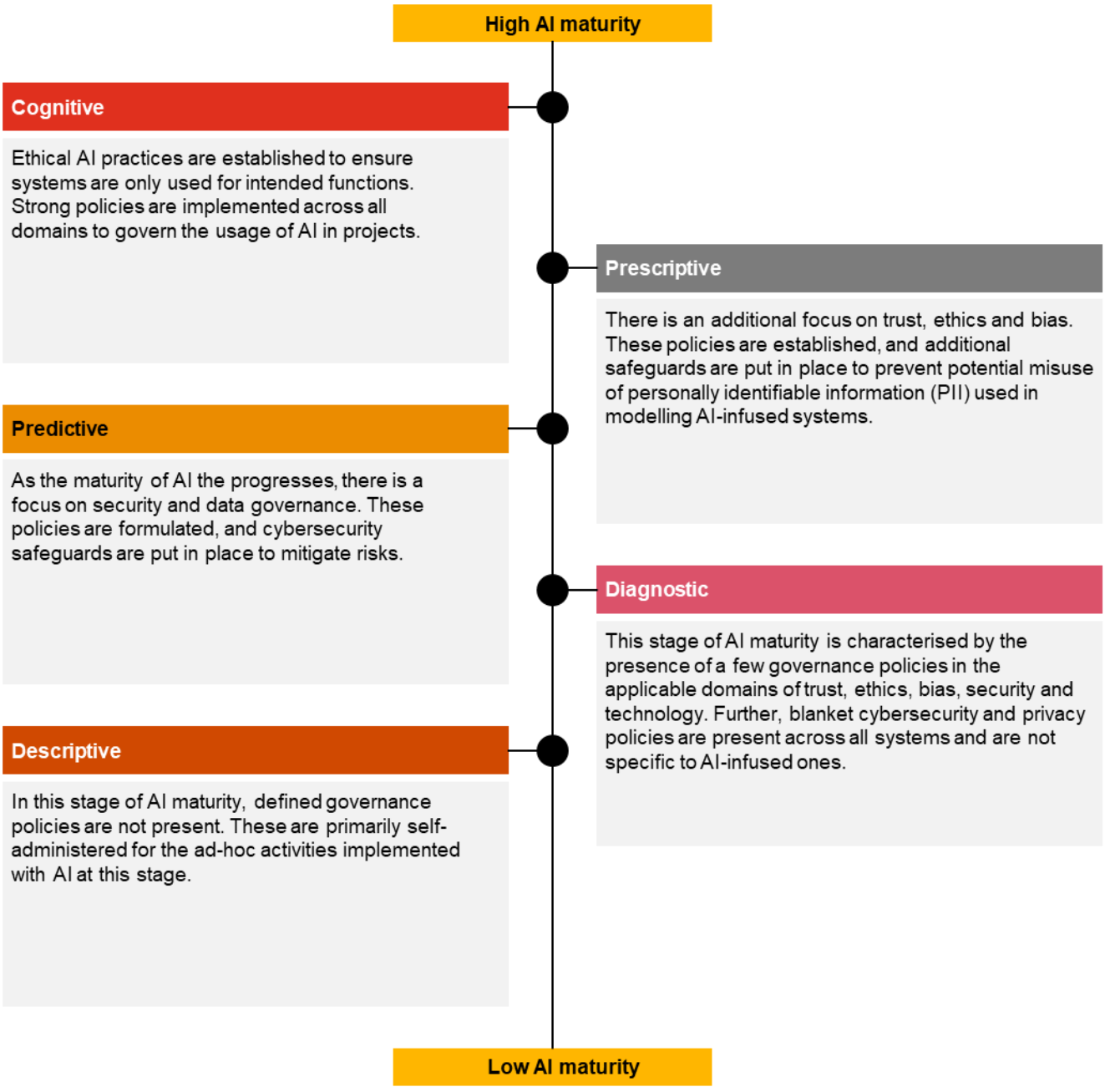


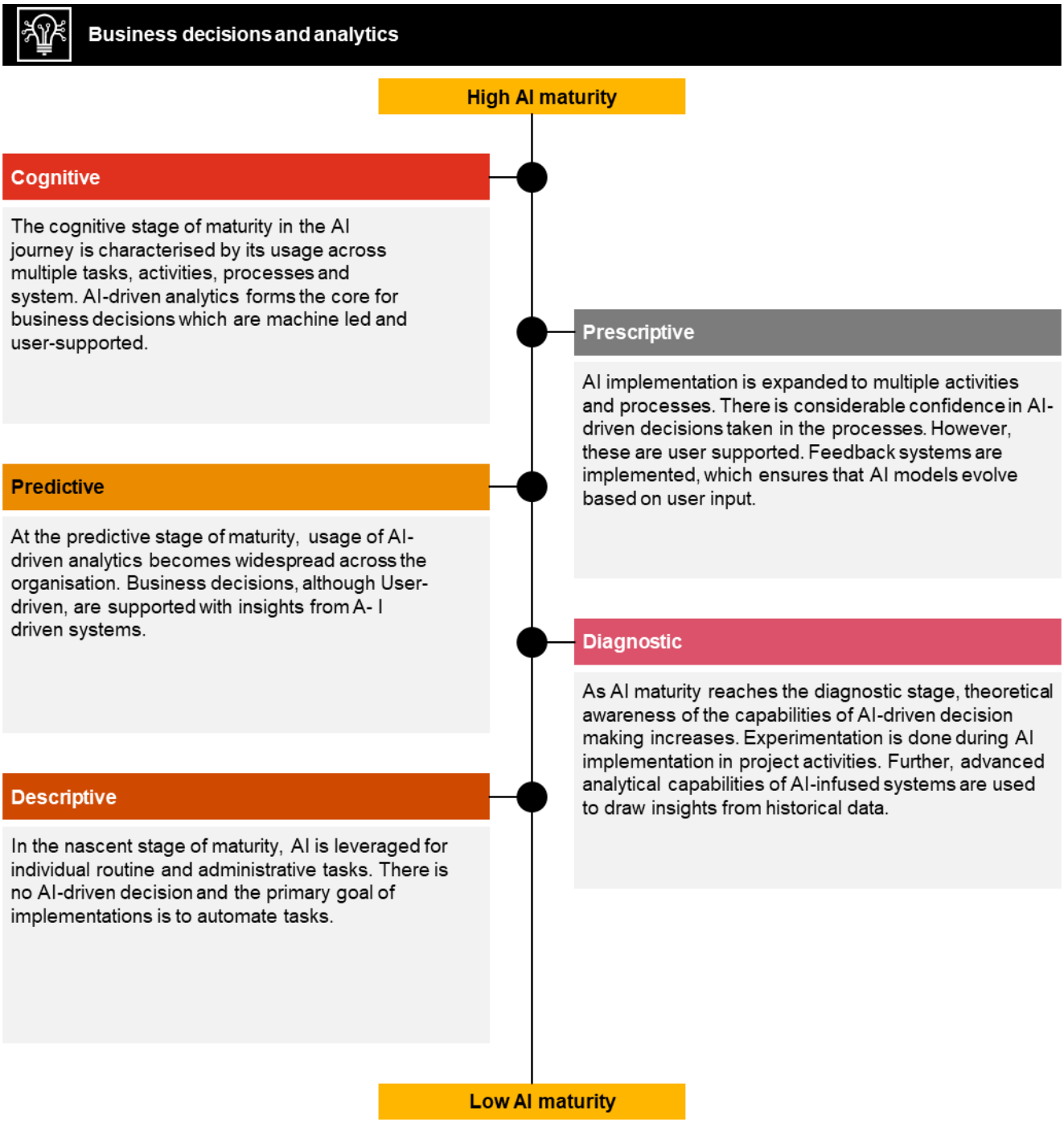

Process and integration
High AI maturity
Cognitive
AI solutions are used for clinical decision support. As the AI modules mature with data from clinical trials, the emphasis on AI implementation shifts to improving clinical decision support at scale.
Prescriptive
As the maturity progresses, AI-infused systems are used for remote monitoring of patients. Well-designed, integrated solutions implement broader use cases of natural language processing at this stage. Further, the use of AI is extended to complex applications in broader specialties such as oncology, cardiology and neurology.
Predictive
AI-powered systems are used for setting up clinical workflows, which are integrated with care provider systems. Alerts and notifications are set-up with AI by incorporating virtual assistants which enable care providers to have visibility on patient status.
Diagnostic
AI is used in applications where ease of-execution is relatively higher, such as image processing in radiology and pathology. This enables faster turnaround times for report generation and quicker diagnosis.
Descriptive
AI-infused processes are implemented to automate administrative, routine and repetitive tasks. This reduces manual intervention, which enables availability of skilled personnel to focus on strategic activities and reduces the possibility of manual errors.
Low AI maturity


Technology and infrastructure
High AI maturity
Cognitive
AI constitutes an integral part of the healthcare value chain. AI-driven processes and data models are used to support multiple activities – from investigation to care delivery and clinical support.
Prescriptive
AI-implemented processes are scaled up and integrated with advanced technologies (like NLP and deep learning) in order to increase the efficacy of the defined models.
Predictive
AI is extensively embedded in clinical workflows through close collaboration with care providers and organisations. Existing technologies are effectively used in new contexts through integration with these AI-embedded processes.
Diagnostic
AI-infused processes are used for optimising care provider operations. Rule-based workflows are extended to multiple projects for reducing turnaround times and minimising/eliminating human intervention.
Descriptive
Rule-based workflows are integrated with administrative tasks. The primary focus at this stage is to minimise/eliminate manual activities in routine tasks. Hence, automation-specific technologies (like robotic process automation) are leveraged.
Low AI maturity


Data and information
High AI maturity
Cognitive
As the maturity progresses, data for training AI models is shared among industry peers through a centralised, obfuscated and shared repository. Further, data quality in this repository is continuously monitored for maintaining and improving quality.
Prescriptive
AI processes are integrated with broader data sets from multiple sources. Hence, there is an additional focus on maintaining and monitoring data quality at this stage.
Predictive
Standard analytical activities carried out by care providers across business units are driven with AI-infused processes and workflows.
Diagnostic
Data from historical task executions by care providers/organisations is leveraged to experiment with AI models.
Descriptive
This stage of AI maturity for data and information is characterised by data related to individual activities being leveraged for configuring integrated rule engines.
Low AI maturity

Governance, cybersecurity and privacy




Business decisions and analytics
High AI maturity
Cognitive
The cognitive stage of maturity in the AI journey is characterised by its usage across multiple tasks, activities, processes and system. AI-driven analytics forms the core for business decisions which are machine led and user-supported.
Prescriptive
AI implementation is expanded to multiple activities and processes. There is considerable confidence in AI-driven decisions taken in the processes. However, these are user supported. Feedback systems are implemented, which ensures that AI models evolve based on user input.
Predictive
At the predictive stage of maturity, usage of AI-driven analytics becomes widespread across the organisation. Business decisions, although User-driven, are supported with insights from A- I driven systems.
Diagnostic
As AI maturity reaches the diagnostic stage, theoretical awareness of the capabilities of AI-driven decision making increases. Experimentation is done during AI implementation in project activities. Further, advanced analytical capabilities of AI-infused systems are used to draw insights from historical data.
Descriptive
In the nascent stage of maturity, AI is leveraged for individual routine and administrative tasks. There is no AI-driven decision and the primary goal of implementations is to automate tasks.
Low AI maturity

7. Challenges to AI adoption in India

According to PwC India's 2020 survey[39] of C-level executives and decision makers in the healthcare and pharmaceutical industries, compliance and control risks were identified as major challenges when it comes to adopting AI. Specifically, 53% of respondents identified compliance risk – which refers to the potential for AI systems to be in violation of laws and regulations related to patient privacy, data security and clinical decision making – as a significant challenge. Control risk was identified as a significant challenge by 50% of respondents. It involves the detection of rogue AI systems and unintended consequences, as well as lack of human oversight in the decision-making process.

In order to make AI more effective and realise its full potential in healthcare, India needs to overcome several challenges. Given the limited academic literature on AI use cases in both developed and developing countries, there is plenty of room to explore specific applications of AI in healthcare.

AI adoption challenges in the Indian healthcare industry

Loss of employment and inadequate skill	Data protection and privacy
Data management	Policies and regulations
Low intensity of AI research	Pricing model

Loss of employment and inadequate skills

A. Worker replacement

One of the main reasons for not adopting AI/ML is the perception that automation will reduce job opportunities and result in job losses. India has a population of 1.4 billion and 522 million[40] people are estimated to be employed all over the country. So, the perception of diminishing job opportunities is hindering the adoption of AI in India.

B. Lack of a skilled workforce

The successful implementation of AI in healthcare requires a skilled healthcare workforce that has received specialised training. Handling sensitive health information and operating smart machines require specific knowledge and expertise. In some cases, analysts may not possess the necessary skills to fully support the use of AI systems, which can lead to a lack of accountability and hinder the ability to achieve optimal results. Lack of trained AI professionals[41] is a common barrier to the use of AI in healthcare. India's manufacturing sector faces a similar issue. To effectively integrate AI into healthcare, it is critical that healthcare organisations invest in training and developing the skills of their staff.

Data protection and privacy

There are increasing concerns around the protection of sensitive healthcare data in India. The lack of comprehensive privacy laws in India to ensure the confidentiality and lack of resources and policies is hindering the adoption of AI in India.

A. Consent

Considering the importance and sensitivity of health data, there are concerns about the misuse and/or unwarranted use of this data by companies. India took an important step towards personal health data protection with the introduction of the Digital Personal Data Protection Bill.[42] With such policies in place, the Indian population can leverage AI capabilities to access services and protect their data from being exploited for commercial purposes. Responsible AI integration calls for data access based on informed consent and strict confidentiality norms. In India, particularly in rural areas, there is a shortage of doctors, which gives patients limited time with their physicians.

To address this issue, it is important for patients in these areas to be informed about how their health data will be used to train AI models.

B. Cybersecurity

The healthcare industry is highly vulnerable to cyberthreats due to the sensitive nature of patient information. The consequences of a breach in patient data could be severe. As a result, healthcare organisations must take proactive and robust measures to protect patient data and prevent unauthorised access by implementing strong cybersecurity measures.

A ransomware attack on a large Indian hospital in 2022[43] highlighted the vulnerability of India's healthcare sector. These incidents have been increasing over the years and obstruct the digitisation and integration of AI in healthcare.

Data management

Medical data, if not collected and documented properly, could be a major barrier in the process of AI adoption. Even though data is available, its usability is questionable. India has relied on manual documentation for decades, leading to considerable inconsistencies and gaps. Also, most of the available data is collected from different areas and is usually fragmented. Such incomplete datasets could lead to inaccurate decisions, such as anomalies in a specific diagnosis or treatment plan.

Huge amounts of unstructured data, such as medical device printouts, doctor records, lab results, imaging reports, medical correspondence, clinical data, and financial data, are generated on a regular basis. This data has to be available and accessible for use. However, India lacks a structured regime and data infrastructure that are necessary for the collection, computation, storage and sharing of health-related data. For start-ups, this process of gathering healthcare information is slightly more complex and challenging that it is for their larger counterparts.

Therefore, some of these companies may turn to using publicly available data from other countries, which may not accurately reflect the demographics of the Indian population. Others may not even attempt to use such data due to strict data protection laws preventing interoperability. In the European Union, countries like Spain and Ireland have more than 90% of their data available as open data, whereas such statistics are not available for India.[44] Given the lack of access to public data and the costs associated with available data, many Indian start-ups are registering from outside India due to easier access to infrastructure and technology. The lack of technological infrastructure has made it difficult to develop applications based on deep learning techniques. This poses a major challenge for developing AI capacities across different languages, which is an imperative to cater to the diversity in India. There are a few limited examples of open-source data specific to India, such as Tamil Nadu Cancer Registry and the National Cancer Registry, but they are not sufficient to fully support AI development in the healthcare sector. Therefore, it is important to resolve this issue and ensure that relevant data is available.

Policies and regulations

The implementation and adoption of AI in India's healthcare ecosystem has been slow due to the lack of a policy and regulatory framework.

While India does not have mature AI policies and regulations for healthcare, there have been efforts to address this gap. In 2018 NITI Aayog, the policy think tank of the GoI was given the responsibility of formulating the national strategy on AI and other emerging technologies. Later, in 2018, NITI Aayog released the 'National Strategy for Artificial Intelligence' (NSAI) discussion paper.[45] The strategy adopted by NITI Aayog is 'AI for all' (#AIforAll) and focuses on five sectors, including healthcare.

In 2021, the NSAI published another approach paper under its 'Towards responsible AI for all' strategy[46] which focuses on laying a foundation of broad ethical principles for designing, developing and deploying AI in India. The paper also highlights the need for specific laws and regulations for AI development and usage given that health is a high-risk sector.

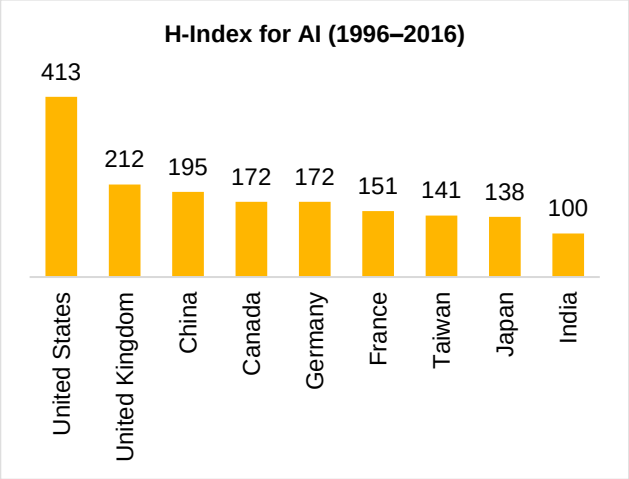
To ensure reliability of AI in healthcare, the National Digital Health Mission (NDHM), in its strategy overview document, mentioned the need for laying down guidelines and standards on AI applications.[47]

Incorporation of AI into public service delivery depends on the collaboration of the public and private sectors, with a balance between the data and resources of the public sector and the expertise of businesses, along with collaborations among data science centres of excellence. With a strong policy framework in place, the benefits of cross-sectoral collaboration can be reaped to improve performance and combat the risk of data breaches.

Low intensity of AI research

India lags behind other countries in AI research quantitatively (ranking 5th globally)[48] as well as qualitatively (low impact of research produced). The research community is confined to a small number of academic institutions.

Moreover, the contribution of the private sector towards AI research is meagre. According to the H-index [49] (a metric that measures a country's scientific productivity and impact produced), India ranks 19 globally. Although India has been producing a significant amount of research, its utility has been low.



Source: Press release by National Strategy for Artificial Intelligence on Jun 2018. Retrieved from https://niti.gov.in/sites/default/files/2019-01/NationalStrategy-for-AI-Discussion-Paper.pdf

Source: NITI Aayog paper on National Strategy for AI (2018)

Companies face a lack of good quality data due to low-quality research, which leads to challenges in AI implementation. This also results in misrepresentation and biases, further leading to anomalies in the output of ML algorithms.

Pricing model

Technological advancements and evolving policies contribute to the ever-evolving landscape of AI which impacts AI investment and adoption strategies for many organisation. Businesses often consider the following options for AI adoption:

1. Repurposing existing hardware which works only as a short-term option.
2. Buying a one-off AI solution which has the potential risk of becoming outdated.[50]
3. Outsourcing can prove to be costly for businesses that lack the required skills and resources.
4. While volume-based pricing is affordable, it is difficult to predict long-term volumes for a multi-year contract.

Risk-based contracting proves challenging when KPIs for evaluating the vendor are not defined. This is likely to happen as most health providers do not have robust systems in place for measuring KPIs. Expensive smart technologies demand equally costly maintenance in addition to the cost incurred on acquiring training data models

8. Opportunities for AI adoption in India

Given the increasing burden of disease (both communicable and non-communicable) and limited medical resources, the introduction of AI in healthcare has become a necessity. Ensuring healthy lives and promoting wellbeing for all at all ages is one of the Sustainable Development Goals (SDGs) and the Government and healthcare sector are making efforts to achieve this goal. In India, NITI Aayog is entrusted with the task of coordinating the SDGs, mapping schemes related to goals, and identifying the lead and support ministries targeting the specific goals.

India's National Health Policy, 2017, aims to achieve the 'highest possible level of health and wellbeing for all at all ages' through preventive and promotive healthcare and universal access to good quality health services. This can be accomplished by expanding access, improving quality and bringing down the cost of healthcare delivery.

AI has the potential to transform patient experience, clinical decision making and accessibility to healthcare services.

The National Health Policy recognises the role of technology in healthcare delivery. It states that a National Digital Health Authority will be set up to deploy digital health. This policy supports the establishment of federated national health information architecture, to roll out and link systems across public and private health providers at the state and national levels in line with the Metadata and Data Standards (MDDS) and Electronic Health Record (EHR).[51] The key strategies of the national health information architecture are the creation of patient/provider/disease registries, development of a health information exchange platform, and use of an optical fibre network and real-time patient data through smartphones.

Monitoring the current needs and trends in the Indian healthcare ecosystem will help in identifying opportunities for AI adoption.

Needs and trends driving AI adoption in Indian healthcare

When defining the ease of incorporation of AI-enabled solutions in the healthcare industry, greenfield implementations have higher feasibility and will pave the way forward as they will be built on the foundation of structured data.

Mr. Girish Koppar

GM-IT, Wockhardt Hospitals Limited

Technology advancement

Healthcare and pharma was one of the sectors that faced significant disruption due to COVID-19 and embraced AI in a more definitive manner, as it was more of a business necessity than a good-to-have solution. The current technology trends are resulting in huge amounts of accumulated medical information for processing and analysis. In turn, the processing of such data with advancements in technology is bringing about a paradigm shift in the level of AI adoption and its impact in the sector.

5G in healthcare

The pandemic led to a 39% increase in 5G network infrastructure worldwide[52] in 2021, which demonstrates the willingness to accept digital solutions with rapid technological advancements. 5G was launched in India on 1 October 2022, and 5G services are currently available in 50 towns across 14 states.[53] This is one of the key factors driving digital transformation in the entire healthcare and medical device industry. AI enables accurate analysis of data and physician diagnosis. To accelerate the flow of information, healthcare facilities need to consider transforming their existing network infrastructure to support 5G and edge computing. This opens up a whole new world of possibilities for next-generation AI by leveraging its full potential to improve performance, reduce latency and activate near-real time data processing.

Metaverse

In 2021, it was estimated that the global metaverse market size stood at USD 38.85 billion. In 2022, this is expected to rise to USD 47.48 billion before surging to USD 678.8 billion by 2030[54]. While the metaverse is evolving, it presents new potential for combining AI with technologies like virtual reality and augmented reality and thus providing a new direction to healthcare. Simulations can be run using real-world data to create a digital twin of any object and learn more about it. With the increased use of telehealth and virtual care, the metaverse can have a huge impact on healthcare by eliminating physical boundaries of space and location with the ability to consult with specialists across different geographies, helping not only in consultation but also in the field of clinical care, medical training and mental health.

Cloud computing

The use of cloud computing in healthcare has resulted in a significant change in how medical data is consumed, stored and shared. It now forms an essential component of healthcare organisations by offering cutting-edge alternatives for security, cost savings and automation. Cloud-based services are a viable option for storing massive amounts of data. Along with cloud adoption, 94% of healthcare providers stated AI could assist in meeting the sector's current business objectives, including lowering wasteful spending, enhancing quality and increasing patient experiences.[55] The use of AI algorithms on cloud-stored patient data can advance medical research. Processing huge datasets is now more practical because of the cloud's strong processing capacity. AI takes users' electronic health records from the cloud using machine learning and provides insights for healthcare providers to make better clinical decisions.

Quantum computing

The Indian Government acknowledged the importance of quantum technologies through its National Quantum Mission. In 2020, the Ministry of Finance allocated the National Mission on Quantum Technologies and Applications a total of INR 8,000 crore for five years to strengthen the quantum industry in the country.[56] Quantum computing uses qubits which can exist as both zero or one or zero and one simultaneously, and this enables quantum computers to perform numerous calculations at the same time, granting them tremendous computational processing power. As a result, they can be used to build algorithms in programs that involve large and different set of variables. Quantum computing can learn from past experience to become progressively better at finding patterns in data. It can be used in the analysis of medical images through edge detection and image matching. Quantum computing offers better insights to expedite drug discovery and personalisation of medicines. The potential areas of its application are the core areas in healthcare which require the use of AI. Thus, the use of quantum computing opens the door for AI adoption opportunities for better health outcomes.

Government focus

Schemes promoting the adoption of AI solutions

AI adoption in India's healthcare sector is expected to grow with a push from Government and private sector initiatives for maximum coverage and quality of health services. The Ayushman Bharat Digital Mission (ABDM) was launched under the National Health Authority on 27 September 2021. Within a year, this scheme could provide equitable healthcare through its digital pathways by bringing together all the stakeholders in the digital health ecosystem. With the **Ayushman Bharat Health account** (ABHA) and personal health record app, users can share, store and link their health records to avail healthcare services with autonomy and consent. ABDM will enable the core infrastructure and capabilities required for health records standardisation and interoperability. Health records standardisation and sharing between various organisations will boost AI use cases by making more structured data available for modelling and analysis. Thus, Government-based initiatives focusing on digital health have opened up many opportunities for AI-based services. **BharatNet** is another Government project that aims to provide digital connectivity in rural areas of the country at affordable costs. Internet connectivity could drive the AI ecosystem in the country.

The **National Quantum Mission** aims to cater to the technological requirements of the society and considers the various trends and roadmaps followed by leading countries for developing next-generation technologies. AI will be a key contributor in this mission of a quantum-based economy.

The issue of accessibility of health services in remote areas can be overcome through **telemedicine** which is a boon to the remote and tribal and hilly areas of the country. India marked an important milestone in its digital transformation journey by completing a total of 170,000 teleconsultations in one day through the Government's telemedicine service called **eSanjeevani**. Such initiatives can help in harnessing AI and improving healthcare delivery.

MyGov Help Desk, an AI-enabled chatbot helpdesk launched by the Government in March 2020 to provide information related to COVID and vaccination services, is another example of the country's rapidly expanding digital health ecosystem. This highlights the progressive implementation of AI-based services in India through the Government's support.

There is no dearth of examples of the use of AI in healthcare. However, AI is taking time in its rollout in the sector as there is zero tolerance for errors in healthcare. Like in last decade, where enterprises developed solutions with a mobile-first approach for better UX, an AI-first approach approach has to be considered for AI solutions in healthcare.

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Industry focus

Emerging technologies like AI, analytics and the internet of things have most potential in healthcare. India's HealthTech market is expected to reach around USD 5 billion by 2023, growing at a CAGR of 39%.[57]

67% of firms in the Indian healthcare and pharma sector are already deploying or planning to enhance the role of AI in **clinical trial and drug discovery.**

35% **of firms in the healthcare and pharma sector are exploring AI-enabled demand forecasting and inventory management.**

Source: PwC's AI: An opportunity amidst a crisis report (2020)

Private players are focusing on the need to deploy AI-enabled solutions in inventory management in hospitals, which can transform the Indian medical supply chain segments and help to cut costs and bring in financial efficiency. Communication technologies are also being leveraged to promote network connectivity across the country, thus fostering growth of AI. The Indian healthcare market has grown from USD 110 billion in 2016 to USD 372 billion in 2022, accelerated by rising investments in leading edge healthcare technologies.[58]

The current conditions are encouraging the industry to leverage AI to meet the growing demand for customer-centric and personalised solutions by moving towards the service/subscription fee model, customer-oriented functions such as chatbot guidance systems and hyper-personalisation of patient care through customer insights. This creates a massive opportunity to drive investments and adoption of AI to stimulate equitable growth.

India's healthcare system has undergone tremendous change over the past decade. However, there is still room for improvement in **some** aspects **of healthcare**, such as trained staff, **accessibility**, diagnostic **errors**, and **doctor-to-patient ratios**. This is where technologies **like** AI **are very useful and** can be **used** to solve **countless problems.**

India AI research report (Nov 2022)

Retrieved from: https://indiaai.gov.in/research-reports/artificialintelligence-in-healthcare-sector

9. The road ahead

The healthcare industry is seeing constant innovation, with new technologies being implemented across multiple domains. Given the GoI's push to make healthcare more accessible and reliable, it is essential for both care providers and technology providers to follow a systematic approach for developing solutions that are fit for purpose.

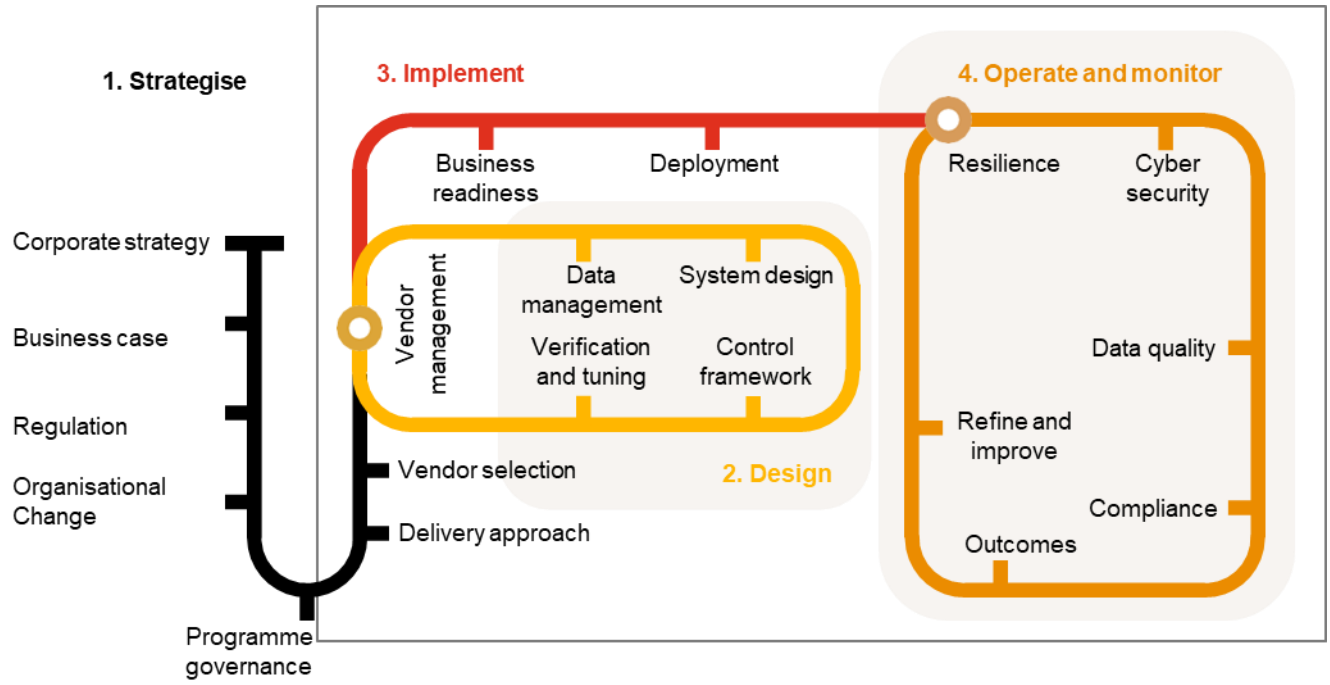
Adoption of technologies such as AI in the healthcare industry can accelerate disease surveillance. By implementing these technologies, healthcare institutions can enable regulatory bodies to take pre-emptive action. Following the COVID-19 pandemic, healthcare technology providers have been able to showcase the potential of emerging technologies in the ecosystem. Through AI, they have been able to forecast the spread pattern of coronavirus and indicate the criticality of the situation earlier than official announcements by regulatory bodies.[59]

Disease surveillance is one among many success stories in the adoption of emerging technologies by the healthcare industry. There are multiple other domains where these technologies can aid in augmenting the healthcare value chain. An indicative plan for adopting emerging technologies has been detailed below. It can be leveraged by the industry to design holistic solutions based on IT maturity, capability of partners, and internal and external factors (e.g. applicability of use cases, ethical considerations, compliance with regulations).

AI can augment the ability of healthcare providers to improve patient care, provide accurate diagnoses, optimize treatment plans, support pandemic preparedness and response, inform the decisions of health policy-makers or allocate resources within health systems.

World Health Organization[60]

An indicative plan for emerging technology adoption[61]



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