AI-ENABLED SOFTWARE-AS-A-SERVICE (SaaS)

The Next Frontier for Global SaaS Start-Ups from India

IN COLLABORATION WITH

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Stellaris VENTURE PARTNERS

IFC International Finance Corporation WORLD BANK GROUP

Creating Markets, Creating Opportunities

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Note to the Reader

This report has been prepared solely for the purpose of information to provide a perspective on the global opportunity for Indian AI software start-ups. Projected market and financial information, analyses, and conclusions contained in this report should not be construed as definitive forecasts or guarantees of future performance or results. Also, IFC's internal data were not used in preparing this report.

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Abbreviations and Acronyms

ACV	Annual Contract Value
AI	Artificial Intelligence
AI4BIZ	Artificial Intelligence for Business
API	Application Programming Interface
ARR	Annual Recurring Revenue
AWS	Amazon Web Services
B2B	Business-to-Business
B2C	Business-to-Consumer
BD2K	Big Data to Knowledge
BPM	Business Process Management
BPO	Business Process Outsourcing
CAC	Customer Acquisition Cost
CADM	Custom Application Development and Maintenance
CAGR	Compounded Annual Growth Rate
CEO	Chief Executive Officer
CMM	Capability Maturity Model
CNN	Convolutional Neural Network
COE-DSAI	Centre of Excellence for Data Science and Artificial Intelligence
CORE	Centre of Research Excellence
CRM	Customer Relationship Management
CT	Computerized Tomography
DARPA	The Defense Advanced Research Projects Agency
DEVOPs	Development Operations
DOE	Department of Energy
EHR	Electronic Health Record
ERP	Enterprise Resource Planning
EV	Enterprise Value
FAQs	Frequently Asked Questions
FMCG	Fast-Moving Consumer Goods
FOS	Feet-On-Street
GCP	Google Cloud Platform
GDP	Gross Domestic Product
GPT	Generative Pre-Trained Transformer
GTM	Go-To-Market
HITL	Human-In-The-Loop
HPC	High-Performance Computing
ICTAI	International Centre of Transformational AI
ID	Identification
IFC	International Finance Corporation
INR	Indian Rupee
IOT	Internet of Things
IP	Intellectual Property
IPO	Initial Public Offering
iSPIRT	Indian Software Product Industry RoundTable
IT	Information Technology
ITeS	Information Technology Enabled Services
KYC	Know-Your-Customer
LiDAR	Light Detection and Ranging
ML	Machine Learning
MLOPs	Machine Learning Operations
MRI	Magnetic Resonance Imaging
NASA	National Aeronautics and Space Agency
NASSCOM	National Association of Software and Service Companies
NEP	National Education Policy
NIH	National Institutes of Health
NITI	National Institution for Transforming India
NLP	Natural Language Processing
NSF	National Science Foundation
OCR	Optical Character Recognition
OTT	Over-The-Top

POC	Proof of Concept
PPP	Public-Private Partnership
R&D	Research and Development
RNN	Recurrent Neural Network
RPA	Robotic Process Automation
SAAS	Software as a Service
SDR	Sales Development Representative
SKU	Stock-Keeping Unit
SMB	Small and Medium Business
SME	Small and Medium Enterprise
SQL	Structured Query Language
STEM	Science, Technology, Engineering, and Mathematics
SVP	Senior Vice President
TCS	Tata Consultancy Services
TFLOPs	Teraflops
TIFR	Tata Institute of Fundamental Research
UI	User Interface
UK	United Kingdom
US	United States
US$	United States Dollar
UX	User Experience
VC	Venture Capital
WB	World Bank
WBG	World Bank Group
YOY	Year-on-Year

Note: All dollar amounts are U.S. dollars unless otherwise indicated

INTRODUCTION

Historically, technological megatrends have had a transformational impact on businesses, industries, and society at large. From electricity and steam power to personal computing and the Internet, these innovations have completely changed how we work, communicate, and live. While it is hard to predict the timing and full extent of megatrends accurately, their early signals provide opportunities for businesses and countries alike to leverage technological innovation to transform entire sectors, while also driving economic growth and improving human welfare.

We at IFC have over six decades of experience in investing in innovative companies in emerging markets. We work with a wide range of industry stakeholders across the entire technology ecosystem, including early-stage start-ups,[1] and seed, venture capital, and growth equity funds. In doing so, we focus on spotting disruptive technology trends at an early stage, and we support such innovation through our investment and advisory work.

Stellaris Venture Partners, an IFC investee fund in the start-ups ecosystem in India, collaborated with us in preparing this report. Stellaris, a leading tech-focused VC fund, invests in early-stage start-ups that leverage technology to provide innovative solutions across three areas—the emerging 500 million transacting Internet consumers in India, the digitization of more than 50 million Indian small and medium-sized businesses, and global enterprise software companies.

Like the many innovations IFC has identified and supported over the years, the increasing adoption of artificial intelligence (AI) in enterprise processes could not only promote business growth, but also offer innovative solutions to complex challenges in emerging markets and beyond. AI shows early promise in addressing a breadth of challenges, ranging from improving agricultural yields and providing credit to people previously excluded from formal financial services, to increasing doctors' capacity to make rapid and accurate diagnoses, and contributing to some of humanity's most ambitious projects such as autonomous transport, space travel, and ground-breaking medical treatments.

In early 2020, IFC and Stellaris started working together to study the role that AI-led software as a service (SaaS) start-ups from India could play in the global market. Looking at the increasing adoption of AI across a wide range of enterprises, we posed two questions:

a. What opportunities does this megatrend present, and what challenges and bottlenecks must be overcome to take advantage of these opportunities?

b. What role can India, which is already a leader in the global software ecosystem, play in an AI-led future?

We began formulating our views by making the following hypotheses:

1. **AI has arrived and it is ready for prime time:**

   A multitude of AI-enabling technologies are reaching inflection points simultaneously and are setting the stage for AI to start delivering on its many promises. These include the availability of enormous amounts of data, storage capacity, and computing power, as well as highly sophisticated algorithms.

2. **The disruption of enterprise processes is inevitable:**

   AI can improve judgment, which leads to smarter, faster, and more consistent decision making, and the resultant gains in both efficiency and productivity are likely to be much greater than the gains previously achieved with computer software. Consequently, most if not all business processes will be rethought and not just automated.

3. **India can be a significant contributor to AI disruption:**

   India is already recognized as a global leader in software development. The country's software services industry has driven massive value creation through companies such as Tata Consultancy Services (TCS), Infosys, Wipro, and HCL, which have a combined market cap of almost $400 billion.[3] India is now becoming the third SaaS global powerhouse, after the United States and Israel. Following the success of Freshworks (and previously Zoho), within a short timeframe India has created thirteen unicorns[4] and at least 50 SaaS companies that are now worth more than $100 million. India also has an enormous trained workforce that can enable the provisioning of human and data support in developing algorithms, and this gives India an advantage in the creation of AI-led applications[5] and the tailoring of these for different markets.

4. **In addition to economic impact, AI presents an unprecedented opportunity to achieve social impact:**

   Emerging economies often lack the resources required to scale critical services such as education, health, finance, logistics, agriculture, and transportation. AI-led software has the potential to augment both physical and human resources to expand reach, affordability, and quality that otherwise would be difficult to achieve.

Much of the work behind this report was completed in 2020 and in the first half of 2021, when IFC and Stellaris conducted a comprehensive market assessment to validate these hypotheses. As we spoke with participants across the software ecosystem—company founders, investors, academics, and government and industry leaders—we grew even more bullish about the AI-led software opportunity, both globally and in India. In 2020, we also organized the AI4Biz Challenge to identify and recognize groundbreaking, early-stage Indian AI SaaS companies. This contest, which is described in the annex, allowed us to interact with over 100 start-ups and have in-depth conversations with the 20 finalists. These interactions gave us valuable insights into the opportunities and challenges that AI SaaS start-ups face in India.

This report combines IFC's and Stellaris's extensive investment experience with the data and lessons learned from our market assessment and the AI4Biz Challenge. Before proceeding further, we would like to point out some methodological limitations, as well as clarify the scope of this report.

We used primary and secondary research, along with our judgment to forecast up to 2030 the evolution of enterprise AI adoption and the associated software market. In producing this report, we focused on identifying trends in AI applications, as well as the challenges and opportunities that Indian start-ups face in targeting global markets, and what they need in order to succeed.

There are several important aspects related to enterprise AI that we did not include in this document.

AI is likely to cause significant social change—for example, AI could lead to job losses due to automation, but it could also generate substantial employment in both the private and public sectors. Furthermore, although AI can be used to invade people's privacy, it can also prevent identity theft and subsequent financial losses. While concerns about both job losses and privacy are extremely important and require extensive analysis and attention, they were not within the scope of this project.

Finally, in this report we presented current policies related to AI from the vantage point of private enterprise. As we recognize that policymakers operate in a complex environment, we did not include any specific policy recommendations.[2]

It is our hope that this document will prove useful for the start-up ecosystem as we approach what is a seminal era for businesses. ■

VOICES FROM THE ECOSYSTEM

The future of software is not SaaS (software as a service), but SaaS (solution as a service). Products are context-agnostic, solutions have context; India can build context-aware solutions by combining machines and people. The Indian information technology (IT) industry today faces the innovator's dilemma in the wake of the AI adoption wave.

—DR. HARRICK VIN, TCS Fellow and Chief Services Innovation Officer, Tata Consultancy Services (TCS)

The hype about creating a General Purpose AI system started in the 195Os and died by 1975. By 2010, following Moore's law, hardware had become significantly cheaper and companies started focusing on Specific Purpose AI systems. By 2035, AI will be as embedded in our digital world as motors and engines are in our physical world today. In doing so, these breakthrough technologies of the past will become commonplace and standardized.

—ALOK AGGARWAL, Chairman, Chief Executive Officer (CEO), and Chief Data Scientist, Scry Analytics

If I could change one thing about all the AI projects I have done in the past, I would choose to be more realistic in my goal setting. AI start-ups should begin by targeting simple problems rather than solving the problems that "sound interesting."

—KAPIL TANDON, VP Product Growth, Tricentis; ex-Global Product Lead for AI-powered Fraud Protection solutions, Microsoft

There are AI-first and AI-second companies; the latter mostly have machine learning (ML)/AI added to the existing functionality, whereas the former will not exist without ML/AI. AI-first software companies may take longer to reach the first million dollars when compared to regular software companies, but the scale-up to the next $99 million may be significantly faster as they tend to disrupt the space they are in. In such companies, the importance of models is often underrated, and that of data is overrated.

—MANISH SINGHAL, Founding Partner, pi Ventures

Research results in AI are focused on controlled conditions and often betray the true complexity of launching the model in a real business environment.

—MANISH GUPTA, Director, Google Research India

Democratizing AI is a massive opportunity, and the market is up for grabs. The India advantage in AI lies in the vast amount of consumer data available for training. Progress in AI will happen once companies start seeing research and development (R&D) through an investment lens, and not a "tax-break" lens. Research funding has to wean itself off the tax incentives and stand on its own merits.

—PRASAD JOSHI, Senior Vice President, Emerging Technology Solutions, Infosys

You are not building an AI company, just as you are not building a Cloud company. These are technologies that help you to solve a business problem and should not be confused with the business itself; AI is a means to an end. Instead, make yourself known as a product/solution for "X" problem.

—DILIP KHANDELWAL, Global CIO and India MD, Deutsche Bank

As an Indian company, you are always tempted to use people rather than automation to solve a repetitive problem, but the world does not want to interact with humans when using their software. There is no faster way to kill your product than bandaging the rough edges with people. If humans already have a 95 percent accuracy in achieving a task, AI systems have to shoot for near-perfect 99 percent to have a reasonable chance of replacing humans.

—NISHITH RASTOGI, Founder and CEO, Locus.sh

Contrary to popular belief, AI innovation in call centers, chat-bots, next-best action, and so on, are far from done and dusted. There is a lot of value yet to be claimed.

—RAJESH RADHAKRISHNAN, Executive Vice President and General Manager, Front Office Automation, Automation Anywhere

AI will become a commodity. In the trade-off between working on building the best AI model versus solving data collection and workflow problems, an AI applications start-up should always optimize for the latter.

—MAYANK KUMAR, CEO, Tangent.ai

In AI, data ownership leads to more adoption, thus leading to even more data accumulation that results in ever larger companies that already own user data; India should architect public data to achieve public good.

—SUCCESSFUL SILICON VALLEY AI ENTREPRENEUR (ANONYMOUS BY REQUEST)

Factors of production have evolved, e.g., deep leverage data is the new opportunity frontier. That implies there is a disproportionate advantage accruing to companies that are already bang in the middle of data pipes and flows as they are sitting on a potential AI goldmine. In certain domains, it is the incumbents who have the ability to deliver the full potential of AI with their ready access to the key pools of data—a huge advantage for an already good customer relationship management (CRM) solution to transform itself into an amazing offering with new AI layered on.

—RAVI GURURAJ, Founder and CEO, QikPod

Increasingly, companies are realizing that AI is not a stand-alone piece of software; it is something that has to work seamlessly with existing systems and their complexities. The risk of the unknown is another significant roadblock in AI buyers' minds—it is not about what AI can handle; it is about what has never been seen before.

Data is an overrated factor when it comes to winning in AI software, whereas in an industry where AI is trying to solve problems, domain expertise is immensely underrated.

—RAGHUNATH R, Chief Revenue Officer, Platform & Technology Group at SAP

There are some things that AI can do better than humans, and there are some things that humans can do better than AI. A lot of my time goes into figuring out where to put machines, and where to have humans in the loop, and advising customers on where to use AI, and where not to.

—ASHWINI ASOKAN, Founder and CEO, Mad Street Den

AI, as machine intelligence, will elevate humans to focus on what really matters. And yet, paradoxically, the idea of intelligent machines will be a pipe dream without humans helping train and retrain the models that will be the underbelly of these machines. This is true symbiosis.

—DHEERAJ PANDEY, Founder, Investor, and then CEO, Nutanix; Board Member, Adobe

EXECUTIVE SUMMARY

AI will drive the next wave of business transformation

Artificial intelligence (AI)—the use of technology to aid human judgment, as opposed to simply automating repetitive tasks—is ready for prime time. Several simultaneous inflection points have created the perfect opportunity for AI adoption: the availability of enormous amounts of data, storage capacity, and computing power, as well as highly sophisticated algorithms. The efficiency and effectiveness gains from the proper use of AI can create value that far exceeds traditional software as a service (SaaS) solutions. Globally, AI applications are mushrooming at a rapid pace, and their use is limited only by our imagination.

AI solutions are fundamentally different from SaaS in their data intensity. What code is to SaaS, data is to AI. In addition to coding skills, which are the primary skills needed for traditional software development, building AI solutions requires deep data management, data science, and modeling skills. There is an inherent separation of data and software in traditional software, whereas with AI that distinction disappears because it is the data that "write" the software. The AI stack and the skill sets required to build AI solutions are very different from those required for traditional SaaS applications. Thus, AI will not just be a "feature" in existing applications, it will help produce a new class of applications and create the next enterprise disruption, which will be akin to the impact of the Cloud at the turn of the 21st Century. Estimates suggest that by 2030, AI infrastructure, applications, and services will become a market worth more than $800 billion.

Adoption of AI will vary across use cases, depending on readiness and risk

For a particular use case, readiness refers to the level of impact that AI can have, the availability of data, and the sophistication of algorithms that justify the case for change. For example, a chatbot used for customer support in banking is an illustration of high readiness for AI, whereas we are not ready yet to engage in unconstrained conversations with machines. Risk is a measure of what can go wrong if a machine makes decisions that have always been made by humans, or through a rule-based system. For example, the recommendation of a search engine is a low-risk use case, whereas a machine serving as a judge in a criminal court would be a high-risk use case. As one would expect, AI use cases with high readiness and low underlying risk will be the first AI use cases we adopt. Conversely, some use cases with low readiness and high risk such as autonomous surgery may never become mainstream, or they will only be used in limited, controlled circumstances.

Across industries and functions, there are already a large number of use cases that have been disrupted through the use of AI, or that are ripe for disruption. As both computing and storage costs continue to decrease exponentially, these improvements, coupled with advances in AI algorithms, mean that we will likely be pleasantly surprised by how quickly we are ready to accept new applications of AI.

India is well positioned to be at the forefront of the AI revolution

India has come a long way in the last decade with regard to building globally successful SaaS companies. Consequently, Indian companies have gained experience in solving complex problems through SaaS, and in executing a variety of go-to-market strategies, from inside sales[6] to feet-on-the-street, and for annual contract values (ACVs) that range from a few thousand dollars to more than a million. India has a large talent pool of developers and strong process expertise, along with a fast-growing pool of niche talent such as designers and data scientists.

The overall ecosystem for early-stage companies is quite mature in India. Also, the country has no shortage of risk capital, with investors increasingly focusing on software investments, and several industry-specific

associations and accelerators to support companies in the early stages of their journey. In addition, a growing number of successful business founders are looking to "give back" by helping younger entrepreneurs.

These, in combination with the increased service intensity inherent to AI, plus the democratization of AI infrastructure through big Cloud companies and open-source software, mean that in comparison to the SaaS wave, India is in a much better position to drive the AI wave.

Through AI disruption, India could create more than $500 billion in value by 2030

With regard to AI, the immediate opportunity for India lies in leveraging the capabilities developed during the information technology (IT) and SaaS waves in order to build global AI applications and services businesses.

AI applications will come in many variations; however, India's advantage will lie in the ones that have a higher intensity of service, those that are more vertical specific, or those that are built on India's unique data sets. India could also be the natural choice as a global destination for a set of services related to data collection, cleaning, and labeling, as well as for implementing services and monitoring results on an ongoing basis. However, we expect AI SaaS companies to be somewhat less capital-efficient than has been the case with the traditional SaaS companies. This is due to the additional costs involved when building the underlying AI models. These costs include data acquisition, processing, and the team of data scientists and machine learning (ML) engineers. At the same time, AI solutions are likely to be "stickier" and they can command better prices given the higher-value unlock potential. Thus, we expect AI SaaS companies to command attractive valuations at scale. By 2030, AI applications and services together have the potential to create additional market capitalization of more than $500 billion for Indian companies (see Chapter 4, sections 4.7 and 4.8 for more detail).

Unleashing the opportunity will require concerted industry and policy interventions

While the opportunity ahead of us is massive, several challenges must be overcome. Currently, the biggest roadblocks facing India are insufficient senior talent, knowledgeable capital, and data and research capabilities.

The size of the AI prize is too large to ignore, and both the government and industry need to act now to mitigate the challenges to AI adoption. Global examples suggest that well-designed policy measures can have a positive impact on a country's competitiveness in AI, which will be measured by metrics such as the number of research papers published, and the start-ups that are created and funded. In this context, national bodies such as the Indian government think tank, NITI Aayog, the National Association of Software and Services Companies (NASSCOM), and the Indian Software Products Industry Round Table (iSPIRT) have proposed sound measures for India, and the government has taken some significant steps. However, speedy execution is crucial for building on this momentum. ■

CHAPTER 1

Enterprise AI—A Massive Disruption

AI: A Brief History[7]

AI is a misused and often misunderstood term. One definition of AI is "the ability of a computer or computer-controlled robot to perform tasks commonly associated with intelligent beings."[8] Ever since computers were invented, machines with general intelligence—common sense, and the ability to perform tasks that involve learning, reasoning, and processing complex information—have been enthusiastically anticipated. In 1965, I.J. Good,[9] a mathematician, when defining the potential for an "intelligence explosion" argued as follows:

> *Let an ultraintelligent machine be defined as a machine that can far surpass all the intellectual activities of any man, however clever. Since the design of machines is one of these intellectual activities, an ultraintelligent machine could design even better machines; there would then unquestionably be an 'intelligence explosion', and the intelligence of man would be left far behind. Thus, the first ultraintelligent machine is the last invention that man need ever make, provided that the machine is docile enough to tell us how to keep it under control.*

Since the mid-1950s, AI has gone through several boom and bust cycles, with periods of intense hope and excitement followed by "AI winters."

- In 1956, 10 scientists gathered at Dartmouth College for a two-month research project funded by the Rockefeller Foundation. The project proposal stated, "An attempt will be made to find [out] how to make machines that use language, form abstractions and concepts, solve the kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully chosen group of scientists work on it together for a summer."
- AI had its first era of excitement in the 1960s and 1970s, when researchers demonstrated the ability of machines to perform specific tasks, albeit in controlled environments—for example, proving mathematical theorems and solving specific types of algebra and calculus problems. However, performing these tasks in an uncontrolled environment led to a combinatorial explosion of possibilities, which the computers of that time could not handle, and this led to the first "AI winter."
- A second era of excitement about AI occurred in the 1980s with the Japanese Fifth Generation Computer Systems Project—a public/private partnership set up to create massive parallel computing infrastructure to serve as a platform for AI projects. This led to a large number of expert systems and computers that could perform only one task. Although the systems worked, the utility of acquiring a computer for solving just one problem was suspect, at best, and led to the next "AI winter."
- A new wave of optimism began in the early 1990s with the introduction of newer types of algorithms that mimic natural systems. One popular type of algorithm here is a neural network, which is inspired by how neurons function in the human brain.

AI: The Status Quo

AI is consistently achieving human-like or superhuman performance levels across a range of tasks.

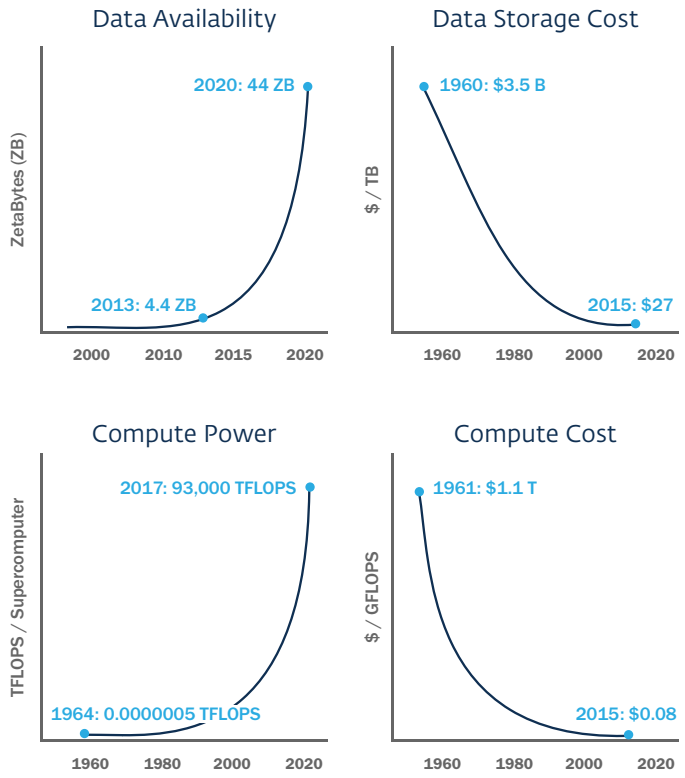
- Convolutional neural networks (CNNs) have led to a dramatic increase in the accuracy of object recognition within images. Error rates for computers have been below human levels since 2016,[10] and computers' image recognition performance is consistently improving.

- Recurrent neural networks (RNNs) have led to a similar improvement in computer speech recognition, with error rates for computers falling below human levels since 2017[11] and the performance of computers consistently improving.
- Over time, computers have surpassed humans in playing a number of games[12]—for example, checkers (1994), Othello (1992), chess (1997), Scrabble (2002), Jeopardy (2010), and Go (2016).

Simultaneous inflection points in several underlying technologies have set the stage for the rapid proliferation of AI. These inflection points are exponential growth in the availability of data, data storage, computing power, and AI algorithmic efficiency. Based purely on its computing power and storage capacity, a typical 2020 smartphone would have been considered a supercomputer in 1990. Content consumption has shifted dramatically to mobile devices, which generate significantly more context-related data points such as physical location and type of location (home versus shopping mall versus school) in addition to time and type of action taken. Additionally, there has been a veritable explosion in the number of interconnected devices (popularly called the Internet of Things—IOT), which are constantly sending data points to a central repository—for example, temperature and pressure sensors in a power plant. As a result, there is no lack of data available to train AI's increasingly more sophisticated and data-efficient algorithms. Add to these the continuing effect of Moore's law on storage and computing power and ever-increasing Internet bandwidth, and the problem of "combinatorial explosion" seems a lot less daunting than it did a few decades ago.

The coming of age of AI has led to a combinatorial explosion of a different kind—AI use cases themselves. AI is being applied to a large number of use cases across horizontals (functions) and verticals (industries).

FIGURE 1.1 Simultaneous Confluence of Multiple AI Enablers



Data: Over 70 billion IoT devices worldwide in 2020; to triple in 5 years. Supervised data is the next challenge, which is on track to be solved 50% through automation.

Computing: Next-gen GPUs, TPUs and AI specific chips which can have 1,000s of cores.

Storage: The least limiting factor for AI development; storage costs are manageable because the training data need not be stored indefinitely.

Algorithm: Improvement in algorithmic ability to parallelize training, and allow for training using exponentially larger data sets.

Sources: World Economic Forum, OpenAI, Economist, Seagate

FIGURE 1.2 Applications of AI Are Limited Only by Our Imagination

Industries

Insurance
Assessment of size, location, constructed area, proximity to fire station, roof condition, etc., of individual homes, using satellite images

Manufacturing
Identification of potential breakdown on a shop floor through analysis of the sound signatures of equipment

Education
Use of chatbot as a teaching assistant in school/college education

Financial Services
Fraud detection through keystroke fingerprinting

Functions

Human Resources
Automated chat-based interviews of blue collar workers

Sales
Prediction of best prospects for a B2B company based on hundreds of structured/unstructured parameters and past successes

Supply Chain
Stock capacity planning for new SKUs based on proximity to historical SKUs and past sales data

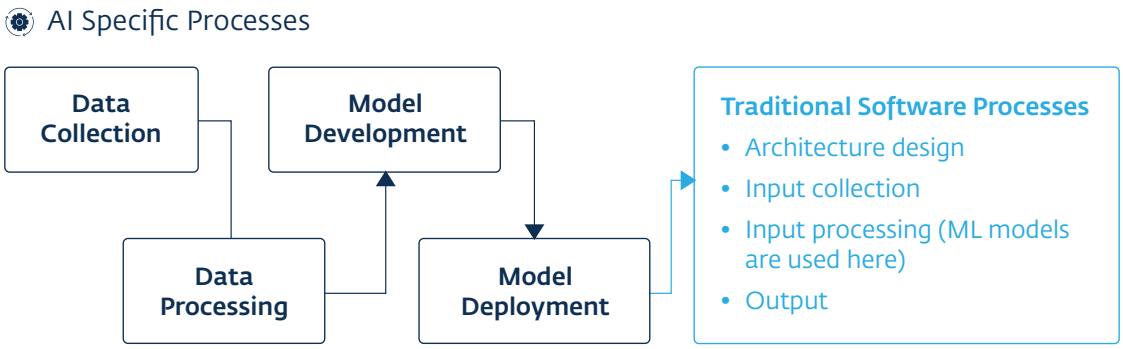
Quality
Video-based continuous monitoring of every item produced, instead of random sampling

A Georgia Tech professor uses AI as a teaching assistant; healthcare start-ups are using AI for online consultations with patients; manufacturing companies are using AI to predict future failures and prevent downtimes; and financial institutions and retailers are using AI to prevent fraud. The breadth of AI use cases is enormous and growing.

Hang on, isn't AI the same as traditional software?

While there are several similarities between AI and traditional software, developing AI software is very different from developing traditional software—this difference is primarily because AI software relies on data and models, in addition to code.

FIGURE 1.3 Data and Models Are Key to Developing AI Software



A typical AI software development cycle involves the deployment of an enterprise-grade, machine learning model before "software" kicks in, which broadly involves the following four steps.

- **Data Collection:** This involves putting in place a process for collecting relevant raw data to train the underlying AI models—for example, a credit-scoring algorithm may reasonably require historical data on borrowers' profiles, loan parameters, and repayment performance. Underlying data sets continuously change as additional data become available. These data sets can come from internal sources such as other enterprise software, or from external sources such as Dun & Bradstreet.
- **Data Processing:** This involves a range of steps to make the data usable for machine learning. Data sets need to be cleaned (removing outliers and extraneous variables) and data need to be made richer and easier for machine consumption through annotation. Often, two or more underlying data sets are combined, which results in a larger and more contextual data set.
- **Model Development:** This involves both model selection, where different types of ML models can lead to varying levels of accuracy for the same problem statement and the same data set,[13] as well as training the actual model with the processed data set.
- **Model Deployment:** The trained model needs to be deployed in a production environment, which requires integration with an enterprise's existing software workflows. This also requires building feedback loops wherein both correct and incorrect outputs of the model can be used to reinforce or modify the model's parameters.

Owing to the presence of both data and models, AI software development is much more dynamic than traditional software development. The same version of an application can lead to differing results due to changes in the underlying training data, even though no change has occurred to the underlying source code. Not only does AI software development need an additional set of specialized skills—chief among which are data engineering and machine learning—the AI stack also looks notably different from the traditional software stack (see Figure 1.4). In particular, AI development is significantly more service intensive—up to three times more intensive—when compared to traditional software, with service requirements across data preparation, model development, deployment, and ongoing maintenance and improvement of the model.

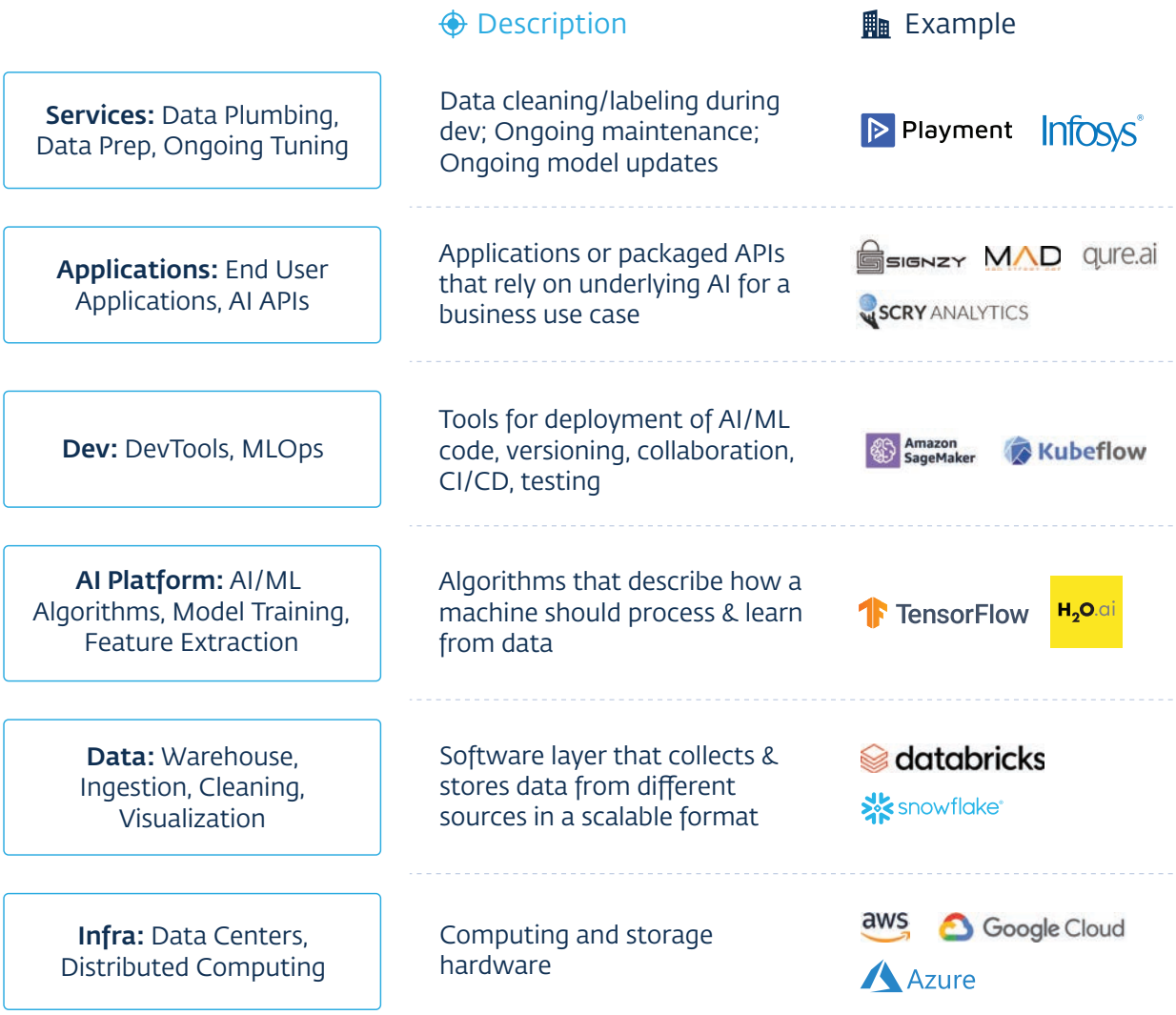
SaaS and AI-SaaS are poles apart; the services-to-software ratio for AI companies is significantly higher than regular SaaS. One of the strongest competitive moats a SaaS-oriented AI company can build is [to] own a workflow that enables a single model across customers, with the ability to regenerate training data, continuously.

—KRISH MANTRIPRAGADA,
Chief Product Officer, Seismic

What this means is that AI will be a different category of software altogether, as opposed to a feature within the existing software workflow. AI is expected to trigger massive disruption because of its ability to fundamentally change the structure, functionality, and efficacy of technology solutions by orders of magnitude that are far beyond what traditional software can do. In our opinion, the last such disruption was the Cloud. While many other trends such as analytics and mobility have occurred since then, they did not necessarily create a massive disruption.

The implications of a disruptive AI wave are significant for the start-up ecosystem. During such waves, the incumbents are incremental in their

FIGURE 1.4 The AI Stack is Very Different from the Software Stack



approach to adopting new technology, whereas insurgents take higher risks, as they start without baggage from the past. Also, they bring different skills and approaches and, in the process, are able to innovate and scale much faster than the incumbents. While SAP had every opportunity to build the first Cloud enterprise resource planning (ERP) software, and Siebel had the same opportunity for Cloud customer relationship management (CRM) software, the winners in these categories were Netsuite and Salesforce. Similarly, the disruption caused by AI could bring forth new winners that could leap ahead of the current incumbents—a phenomenon we are all closely watching for.

Regardless of who wins this race, we believe that over the next decade significant opportunities will be created for all stakeholders—businesses, investors, academics, and governments. By 2030, AI is expected to create an $800 billion market across applications, infrastructure, and services. To put this into perspective, the global cloud infrastructure services market was estimated to be at a revenue run rate of $200 billion as of Q3 2021.[14] ■

FIGURE 1.5 AI is Not a Feature But a New Wave, Leading to Creation of a New Category

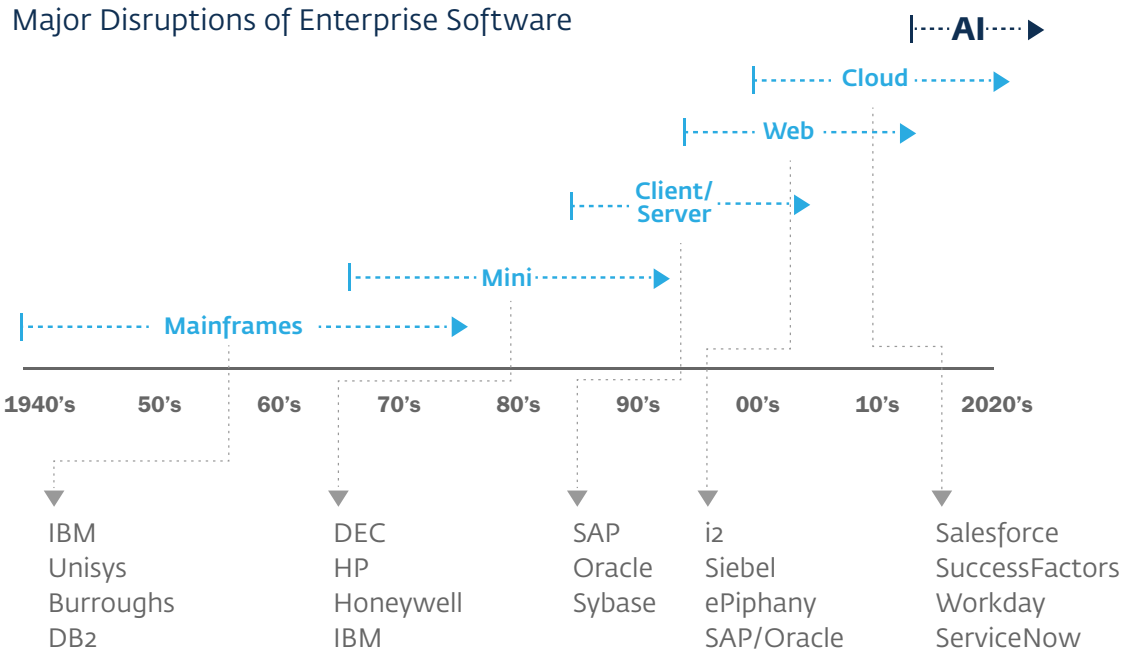
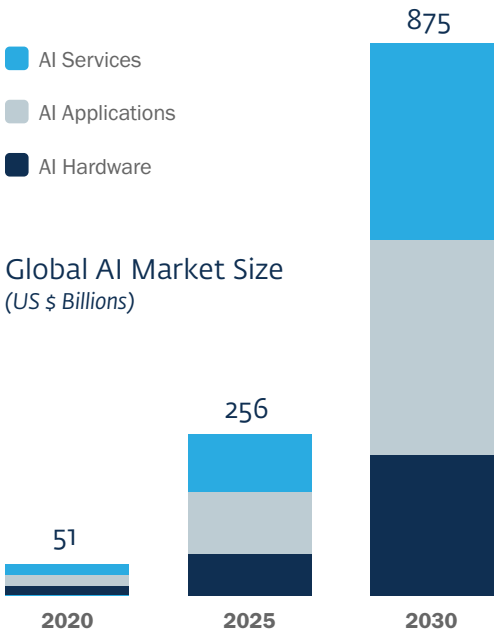


FIGURE 1.6 AI Will Drive > $800 Billion in Annual Revenue Over the Next Decade



- Overall market to clock ~40% annual growth till 2025 and continue to grow at ~30% for the next 5 years.
- Implementing AI tools will be service-intensive, and this segment will capture more than a third of overall value.
- Software to be dominated by enterprise applications, with less than 20% of the software spend on underlying developer platforms.
- Growth in the AI hardware market will be dominated by large incumbents; competition for the next generation of AI processors and memory is on.

Sources: Gartner, IDC, Grandview, SEC filings

CHAPTER 2

Drivers of AI Adoption in Enterprises

As was the case with previous megatrends, the adoption of a new technology, once it begins, is followed by a series of catalytic factors that accelerate the trend through the interplay of several dependent variables. For example, the increasing adoption of AI creates virtuous cycles as the greater availability of data leads to models that are more accurate, which in turn encourage more enterprises to adopt AI. It is also likely that when the benefits of adopting AI are seen, other enterprises will follow. However, it is difficult to predict when specific AI use cases will be adopted.

When forecasting the adoption of AI, conventional wisdom dictates considering AI's impact across different industries (or verticals) and functions (or horizontals). For example, how would AI be adopted in chemical manufacturing versus education, or across a finance function versus a recruitment function? In our view, the inevitable digitization of businesses of all types—big or small, manufacturing or services, new or old—will lead to the unprecedented availability of the underlying data needed to make the adoption of AI a megatrend. In such circumstances, a different lens is necessary to understand AI adoption by businesses—one that focuses on the underlying use case as opposed to the industry or function.

Use cases within an enterprise can be thought of as a combination of problem type and data type. AI is employed to solve a variety of underlying problems—for example, classification, clustering, and recommendations that utilize different types of data as input such as text, audio, images, video, and time-series data that are in either a structured or unstructured form.

For example, tumor detection in healthcare is a classification problem that uses images as inputs. Use cases can also involve multiple problem types. This is the situation with voice assistants that take in audio

FIGURE 2.1 A Wide Range of Problem Types Are Addressed by AI

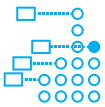
Classification
Categorize new input as belonging to an existing set of categories

Clustering
Create a set of categories in which items have similar features

Continuous Estimation
Estimate next numeric value in a sequence; prediction

Ranking
Order the results of a query/request using pre-set criteria

Recommendation
Provide recommendations based on a specific set of data; a special type of optimization



Anomaly Detection
Given a set of data, determine if specific inputs are abnormal; subset of Classification

Data Generation
Generate appropriately novel set of data based on training data

All Other Optimizations
Create a set of outputs that optimize for an objective function

as input and apply techniques related to classification, clustering, and data generation in order to convert speech to text, make sense of the statements made through voice, and then deliver the system's response back in a spoken fashion.

Readiness and Risk are the primary factors governing whether an enterprise will adopt AI for a particular use case.

- Readiness is essentially driven by performance. To judge readiness, we need to check whether there is tangible evidence that AI will improve factors such as accuracy or costs. These indicate whether the deployment of AI will have a reliably beneficial impact on a business. For sufficient readiness, there must be a large enough pool of underlying data (available continuously and in a manageable format), algorithms that are advanced enough to take care of use-case specific edge cases[15] and other challenges, and a manageable level of process complexity. In general, the higher the number of processes impacted, the lower the level of readiness will be.

  Each use case has a different readiness level, which depends both on the type of problem involved and the available data. For example, image recognition, which requires the classification of visual inputs (still images or video), has reached accuracy levels that surpass human performance, which means that image recognition has reached a high level of readiness. Conversely, using AI for long-term equity investing is much more challenging, and consequently has a low level of readiness.

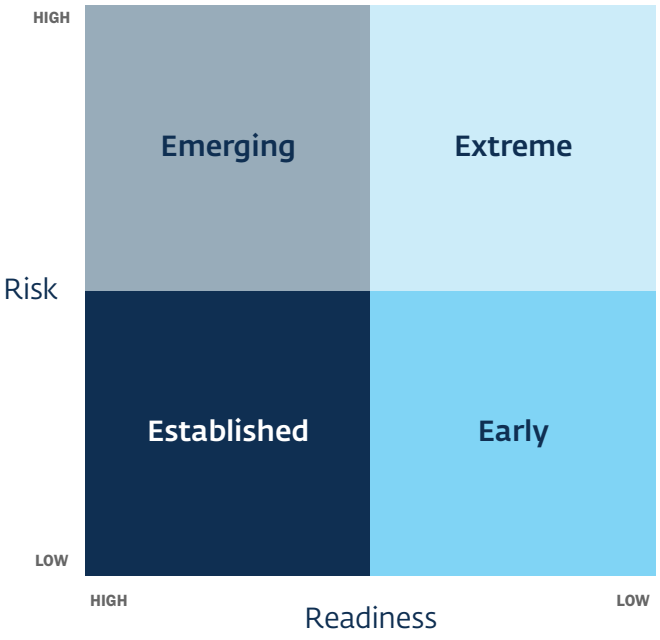
- Risk refers to the consequences if the AI model fails to do its job properly, and there are primarily three types of risk: financial, reputational, and legal. Financial risk is the amount of money at stake if AI malfunctions. For example, a hedge fund that relies on algorithmic trading could lose hundreds of millions of dollars if a misfiring algorithm goes unchecked. Reputational risk is often the intangible cost of damage to a brand. For example, if a chatbot's perceived rudeness or insensitivity when dealing with an irate customer is then widely criticized on social media, this will have negative consequences for the brand of the business using the chatbot. Legal risk is the potential for an adverse legal action arising from an AI malfunction. An example of legal risk is a class-action lawsuit that results when personally identifiable information is leaked through a security breach. A malfunctioning AI system can lead to loss of life as well—for example, if a nuclear power plant goes out of control. Thus, as is the case with Readiness, there are Risks when using AI, and these need to be considered for each use case.

Based on the interplay of readiness and risk, use cases fall into four categories when it comes to the extent of AI adoption (see Figure 2.2).

- **Established—High Readiness, Low Risk**

  These are use cases where the suitability of AI is obvious. Examples include document processing through robotic process automation (RPA), and recommendation engines such as those that suggest the next-best purchase option on an e-commerce website or the next movie to watch on a video streaming service. Given the early stage of AI adoption, globally, it is worth pointing out that even with established use cases, penetration levels within an industry are likely to be low, which indicates significant room for growth.

FIGURE 2.2 Readiness and Risk Will Define the Extent of AI Adoption



- **Emerging—High Readiness, High Risk**

  These use cases rank second with regard to their degree of AI adoption. Although readiness is high, risk is significant too. For example, an automated know-your-customer (KYC) process used for financial transactions cuts staff costs, but at the potential risk of approving customers without the necessary documentation, or with fraudulent documentation. In these use cases, despite the risk, the benefits of AI are large enough for businesses to adopt AI solutions. Also, the risk can often be mitigated by a human-in-the-loop (HITL) mechanism that augments the AI system with constant human monitoring to deal with a high-risk edge case if it occurs.

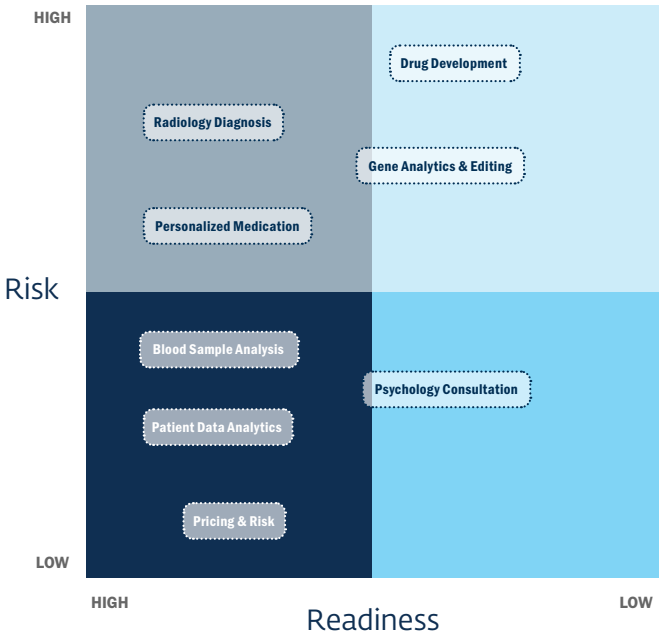
- **Early—Low Readiness, Low Risk**

  In low-risk circumstances, unproven technologies are often adopted by businesses that face workforce problems due to cost or lack of personnel. Examples of such AI applications include advanced chatbots that help shoppers when they are considering online purchases. Most of the chatbots used by enterprises today provide responses to simple questions, much like the kind of assistance provided through a list of frequently asked questions (FAQs). These chatbots offer very limited value if a customer is making an expensive and complex purchase such as a home theatre system. In these situations, what matters is the contextual awareness of the chatbot, and its ability to personalize responses based on the conversation's history. A chatbot is likely to be deployed when there are not enough staff to deal with each customer. Therefore, as long as the chatbot can deliver some positive results (the customer makes a purchase) and some intermediate results (the chatbot recognizes that failure is imminent, and a human is alerted to take over), there is relatively little risk of a bad outcome such as an unsatisfactory conversation.

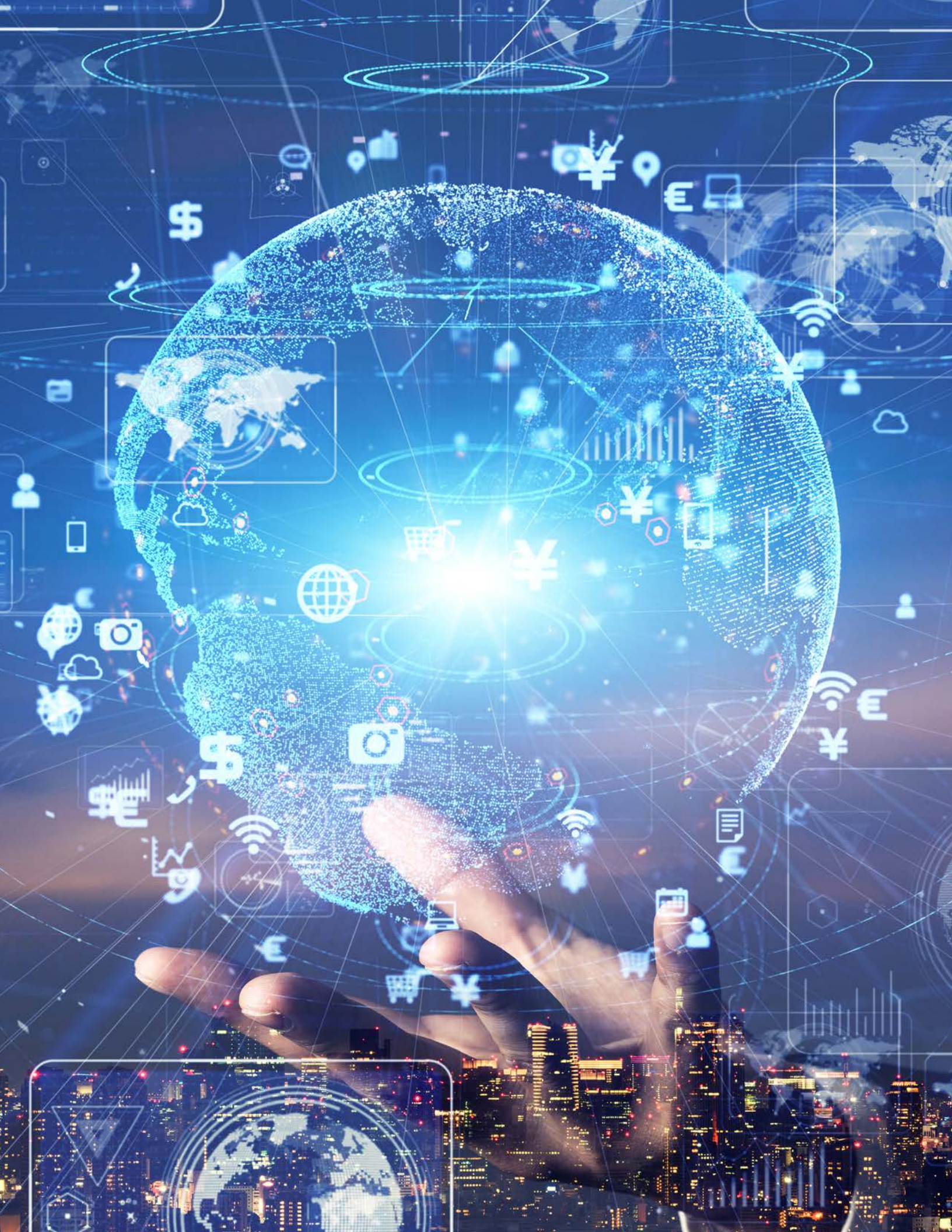
- **Extreme—Low Readiness, High Risk**

  These scenarios, which are best described as "moonshots," often imply that there is no clear prospect of commercial adoption. Often, the extremely high underlying risk of failure leads to exceptionally high-performance benchmarks that AI must meet, which in turn leads to challenges with regard to adoption. An example of this is fully automated robotic surgery. It is worth pointing out, however, that failing to meet goals should not deter researchers from undertaking moonshot projects, as these often develop extremely beneficial technology. For example, light detection and ranging (LiDAR) performance has improved enormously in recent times. While the relationship is hard to quantify, much of this improvement in LiDAR is a result of existing firms and start-ups conducting research and experiments to create autonomous vehicles. While the widespread use of autonomous vehicles is still some years away, LiDAR improvements have been immediately applicable in other use cases such as better estimation of ore deposits in mining.

FIGURE 2.3 Readiness and Risk Levels for Healthcare Use Cases



With this framework in mind, adoption of AI will happen in a non-uniform fashion across use cases within industries. For example, while analytics of patient data is a fairly well-established use case within healthcare, using AI to develop drugs has yet to become mainstream. With regard to the latter, the technology is not mature enough yet, and negative consequences such as unintended side effects could be extremely severe. ■



CHAPTER 3

India—Primed to Create Value in an AI-Driven Future

To understand how Indian companies can capture value in the AI megatrend, it is important to understand the developments that have shaped the talent pool and business ecosystem in India. Two major enterprise software trends in India serve as the precursors to the AI software wave we are seeing today.

The first is the IT service boom of the late 1960s that eventually matured in the first five years after 2000, with India's dominance in business process outsourcing (BPO). Much of India's technical talent ecosystem and software product legacy can be attributed to this multi-decade wave. It is worth noting that significant talent has also come from the Indian offices of large tech companies such as Microsoft, SAP, Oracle, and Symantec.

The second is the software as a service (SaaS) wave that started in the early-2000s and has created significant business value since then. This wave, which is the more recent phenomenon, has significantly shaped India's preparedness to participate in the next wave of enterprise software development—artificial intelligence.

The Making of an IT Service Juggernaut

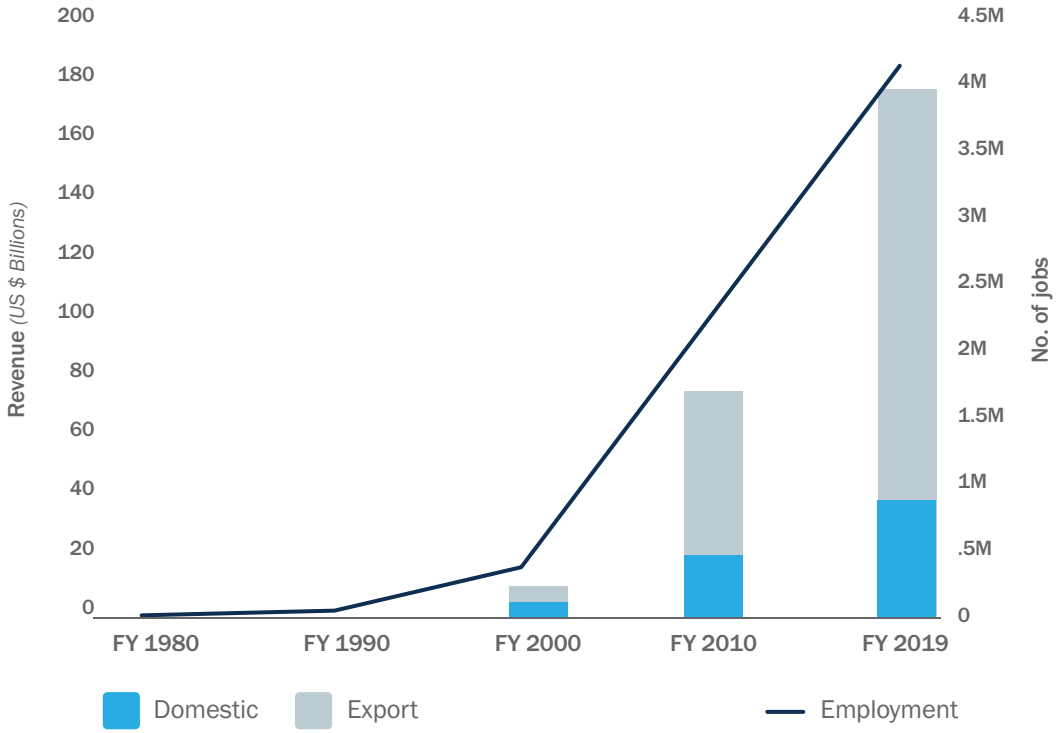
India's journey in the world of computing began in 1955 with the installation of HEC-2M (a computer designed in England) at the Indian Statistical Institute in Calcutta (now Kolkata).[16] Also in 1955, a team at the Tata Institute of Fundamental Research (TIFR) in Bombay (now Mumbai) started designing and fabricating a computer. From a handful of people in India who knew about computers in the 1950s, India's information technology workforce grew to over 4.7 million by 2020.[17] As indicated in Figure 3.1, India has come a long way over the past few decades.

The first wave of Indian IT services companies emerged in the late 1960s and early 1970s. These companies operated primarily as data entry providers for domestic companies that had just started to digitize their books and records. Toward the latter half of the 1970s, Indian IT services companies began to participate frequently in international onsite projects, most of which were billed based on time and materials, and which involved low-level code development and the maintenance of custom applications.

A small company, Tata Consultancy Services (TCS), was established in these early days without much fanfare, but it had large ambitions. As a part of a much larger conglomerate, the Tata Group, TCS stood out among Tata's largely traditional industries such as steel and motor vehicle production.

> *Many years ago, there was an industrial revolution; we missed it for reasons beyond our control. Today, there is a new revolution—a revolution in information technology, which requires neither mechanical bias nor mechanical temperament. Primarily, it requires the ability to think clearly. This we have in abundance. We have an opportunity to participate in this revolution on an equal basis; we have an opportunity even to assume leadership in this revolution.*
>
> —F C KOHLI, TCS Deputy Chairman, 1975
> Speech to the Computer Society of India

FIGURE 3.1 Information Technology BPM Revenue and Employment Growth in India



Sources: Nasscom, McKinsey, Gartner, Fujitsu

In 1980, the Indian IT services industry had only 25 firms and employed just 2,000 people. By then, early success in IT services exports had begun and the industry's combined export value was $30 million.[18]

Based on high-quality and consistently reliable service delivery, toward the end of the 1980s, Indian IT services firms started enjoying higher project ownership and accountability. As a result, a great deal of onshore work started coming back to India. By 1990, the percentage of revenue earned from on-site coding had dropped from 90 percent to 80 percent, but it remained high. By this time, software services exports had quadrupled to reach $128 million, but this still accounted for only 0.05 percent of India's gross domestic product (GDP).

The steady growth of India's IT services in the 1970s and 1980s reached hyper speed in the 1990s, and this has continued into the 2000s. In 2007, the IT services' and BPO industry's revenue was $23.5 billion (including $18 billion from exports).[19] This phenomenal growth was a direct result of the shift toward the offshoring model, and India's preparedness to capture the lion's share of this trend. The IT industry itself did exceedingly well to master the evolving standards of offshoring, as measured by its capability maturity model (CMM)[20] assessments. During this period, offshoring moved beyond just traditional custom application development and maintenance (CADM) into higher value addition services such as systems integration and consulting. For example, in 1993, Motorola's software development center in Bangalore was the first commercial software development center in the world to achieve CMM level 5. By 2003, 75 percent of the world's CMM level 5 software centers were in India.[21]

This excellence in process standardization and quality was in no small measure attributable to the early establishment of captive development centers in India by some of the world's leading software companies. Notable among the other reasons were: a)

the significant depreciation of the Indian rupee against the dollar (depreciating roughly 17 percent in real terms[22] [adjusted for inflation from 1991–1999]); b) relatively liberal foreign investment regulations in the software industry; c) strengthened telecommunications infrastructure; and d) establishment of software technology parks equipped with satellite communication and tax incentives for exports.

Besides the policy impetus and favorable macro-factors, another development around this time that supported the industry's growth was the establishment of the National Association of Software and Services Companies (NASSCOM) in 1988. Over the years, the role of NASSCOM in putting the industry's concerns in front of policymakers and in pushing for reforms cannot be overstated—NASSCOM has been a great champion of the IT industry.

The Indian IT industry achieved a seminal milestone on October 8, 2020[23] when TCS became the most valuable IT services company globally, which made India's dominance in IT services official. The success of India's IT services sector and its emergence as the preferred software partner across the world has paved the way for the next wave of SaaS products from India.

Dawn of the SaaS Era

While the SaaS wave started in the United States in the late 1990s, India did not have its first SaaS companies until the mid-2000s. Most early SaaS companies were in fact new avatars (incarnations) of legacy software businesses that were sold as on-premises installations. Zoho, a company that offers online productivity tools for businesses, is a classic example of this. Zoho, a current poster child of India's SaaS success story, started in 1996 as AdventNet, a network management company, and only pivoted to become a SaaS product suite in 2005.[24]

Between 2005 and 2010, India's first SaaS companies were launched and they had several characteristics in common. Many of the companies were started by engineers who had worked in the technology teams of global companies in the United States, or in the Indian software development centers of these global companies. Most of these companies sold their services to the Indian market, and they did not have well-defined playbooks for product development, customer success, or inside sales.[6] Also, these early SaaS companies' revenues were skewed toward services revenue more than recurring product revenue.

As the first batch of SaaS companies grew in size between 2010 and 2015, their capabilities evolved. A better understanding of product user interface (UI) design, user experience (UX) design, and inside sales practices was established. Indian SaaS revenue started to come increasingly from global customers and revenue became more recurring.

In 2020, 75 percent of India's SaaS revenue came from global markets, and we have seen this trend continue to accelerate in 2021.[25] This also led to a fresh crop of entrepreneurs who had firsthand experience of scaling product teams, as well as engineering and sales, due to their work in the previous generation of successful SaaS companies. These entrepreneurs achieved faster product development and go-to-market results, as they had learned from the mistakes of their predecessors.

In parallel, India's fast-growing business-to-consumer (B2C) start-ups provided the impetus for the development of the SaaS ecosystem. By 2015, B2C start-ups such as Flipkart, Paytm, Myntra, Zomato, and others had grown rapidly; they served as fertile ground for new product ideas; and they were also early adopters of the SaaS products that were built to solve their problems.

As of 2020, Indian SaaS companies had firmly established themselves on the global map, and India's SaaS revenue was $3.5 billion,[26] which represented 3.4 percent of global SaaS revenue, up from 1.5 percent in 2015. At this rate, India's SaaS revenue is expected to reach $13 to $15 billion by 2025, when it will represent 6 to 7 percent of global SaaS revenue.[27] Other estimates suggest Indian SaaS companies are set to generate $30 billion revenue by 2025.[28] This revenue will place India firmly in the top five SaaS countries in the world. However, given the massive size of the global SaaS market, India's share is still small, which presents a significant opportunity for further growth.

As of January 2022, India has thirteen SaaS unicorns and the list is growing rapidly, with six entrants in 2021 alone. In addition, more than 50 companies have valuations of over $l00 million.

FIGURE 3.2 India is Already a Notable Participant in the Global SaaS Wave

*representative, non-exhaustive list

Making Way for AI-First SaaS Companies

While Indian SaaS companies have grown faster than their global counterparts since 2015, it could be argued that, overall, India has been a late entrant in the SaaS wave. Most new SaaS categories have been created in the United States first, and their Indian SaaS companies have been launched three to five years later. We believe that the time lag has narrowed since 2015, and this narrowing is more evident in AI SaaS companies. Several AI-first SaaS companies have launched in India at the same time as their global counterparts, and they are competing for the same global business. They are also significantly more prepared to compete with their global counterparts than was the case with the first crop of Indian SaaS companies that launched around 2005. This change can largely be attributed to the groundwork laid by India's IT services companies and, more recently, to the SaaS companies, as well as key market developments:

- **Global Go-to-market (GTM) Expertise:** Go-to-market expertise is a combination of sales, demand generation, and product marketing skills that enable a business to sell in a particular market. This requires a deep understanding of the buyer persona, buying behavior, cultural nuances, ability to customize for buyers' unique requirements, and effective sales methods that can predictably create revenue in the target market. Over the decade since 2010, Indian SaaS companies have made successful forays into both the European and U.S. markets. Through several trials and errors, a playbook has emerged for different go-to-market approaches that include inside sales, feet-on-street enterprise sales, product-led growth, and open-source. There have been encouraging success stories in companies such as Mindtickle, Whatfix, Freshworks, Moengage, Vymo, and Chargebee that have created differentiated positioning and built strong demand generation functions.

  The expertise gained is further distributed across the start-up ecosystem when employees from successful organizations join younger start-ups or launch new businesses and deploy tried-and-tested playbooks that succeed in global markets.

- **Services Expertise and Advantage:** As discussed earlier, firms' development of AI SaaS solutions requires much higher human involvement than was the case with traditional

FIGURE 3.3 Indian Companies Can Sell Products Across the ACV Spectrum

Distinct advantage in remote go-to-market for small and medium businesses

freshworks, VWO, SLINTEL, Chargebee

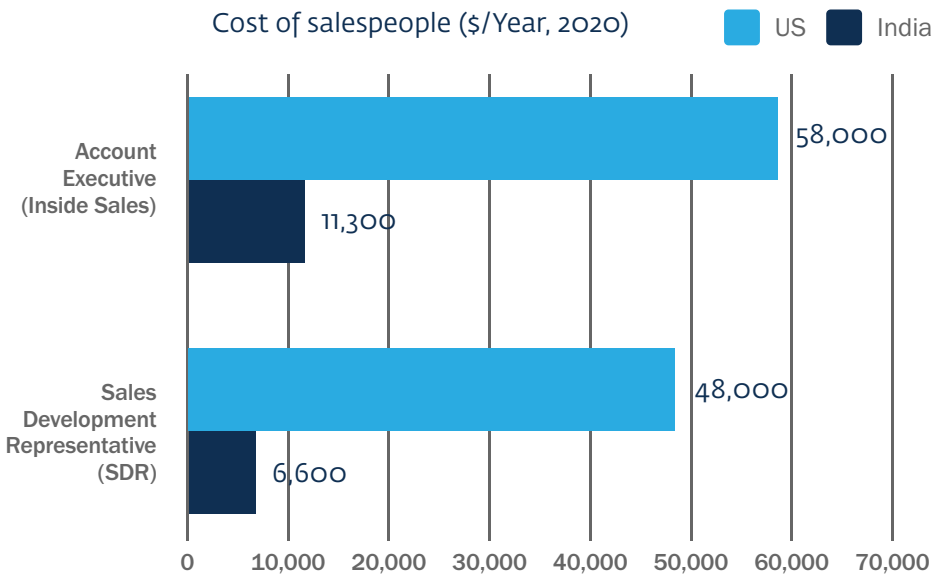
- Proven playbook with demand generation, lead qualification, and inside sales capabilities
- ACVs up to $50K sold remotely
- Can onboard sub-$5000 ACV accounts with human support

Significant experience in enterprise sales

mindtickle, Icertis, whatfix, LOCUS, MAD Mad Street Den

- $100K and above contracts sold with feet-on-street (FoS) sales in USA and Europe
- FoS enterprise sales team supported by lead geneneration and qualification team in India
- Cost-effective services contract a differentiator in large SaaS deals

FIGURE 3.4 India-Based Sales Teams Lead to Highly Capital Efficient GTM



Sources: Salary.com, Indeed.com, Glassdoor.com

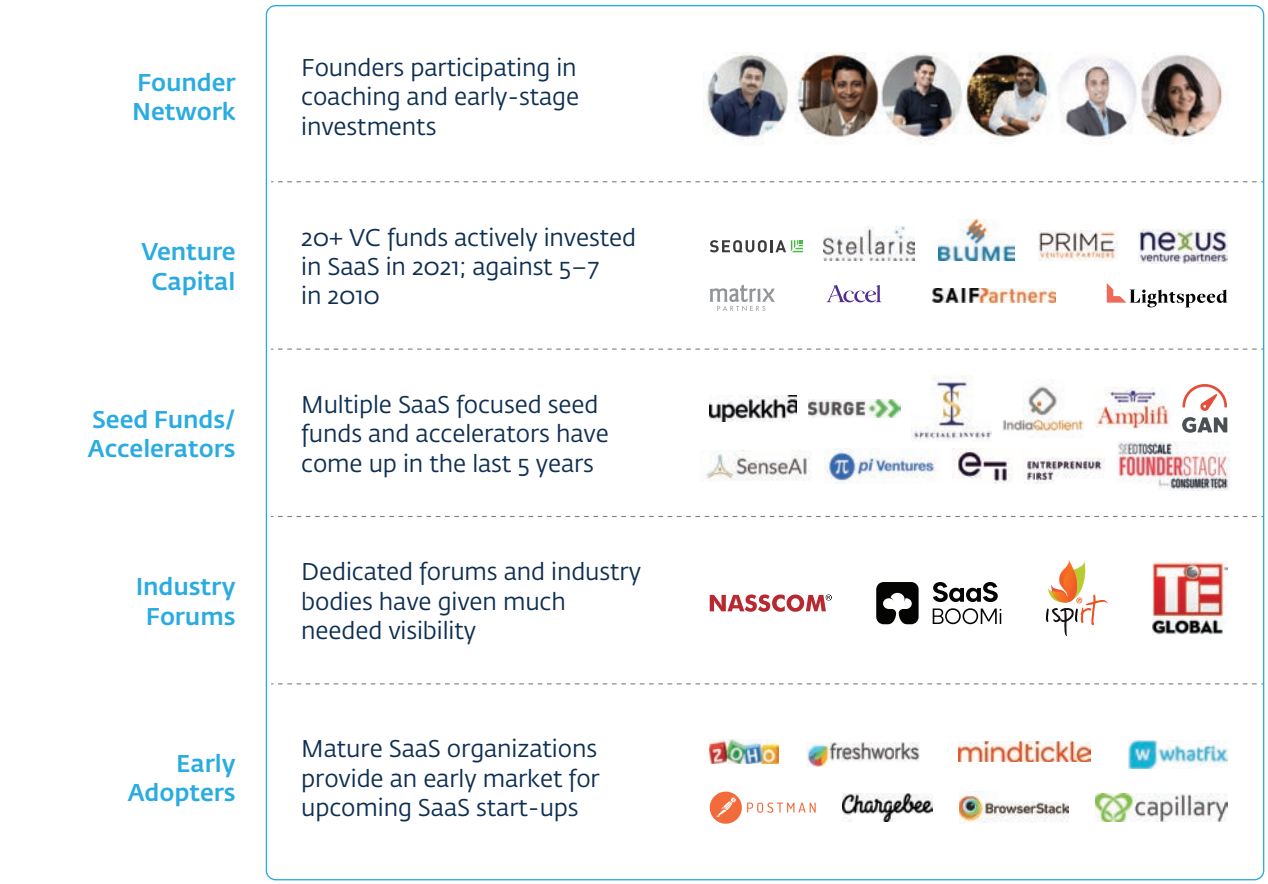
SaaS. This is primarily due to requirements such as cleaning, collecting, and preparing data, as well as the HITL requirements for handling edge cases in high-risk situations. These are also the reasons why India is better prepared to capture value in the AI wave. In addition to having a large base of trained personnel, Indian companies have their proven ability to manage large-scale services projects. IT services companies such as TCS and Infosys solve some of the largest and most complex technology process challenges for Fortune 1000 companies. As a result, India has a whole generation of managers and technical leaders who are uniquely trained and skilled to manage large-scale IT projects for multinational corporations; they thus have skills that are highly useful in service-heavy AI software development and deployment.

- **Maturing Ecosystem:** The success of India's SaaS start-ups has resulted in advantageous second-order effects for the next generation of AI-first software businesses. These businesses can learn from the product building, go-to-market, and fundraising expertise of the successful entrepreneurs who are actively supporting the start-up ecosystem. Given their appetite for trying new things and supporting start-ups early in their journey, these successful later-stage start-ups have acted as early adopters of AI-first software. This creates a virtuous cycle and enables early-stage start-ups to find initial traction. Additionally, a lot more risk capital is available for AI software start-ups in 2022 than was the case in 2010, and this capital is available both at the early/seed stage as well as in the growth stage of start-ups. Over 20 venture capital (VC) funds were active investors in SaaS in 2021, as opposed to only five to seven funds in 2010. Good start-ups are now "spoiled for choice," with more than two dozen high-quality seed funds and accelerators offering financing. Lastly, industry bodies such as SaaSBOOMi and NASSCOM have played an integral role in identifying and showcasing promising AI start-ups, as well as helping them to gain much needed credibility during the early stages of their journey.
- **Talent Pool:** According to LinkedIn, India had over one million software developers at the end of 2021, and by 2023 India is set to overtake the United States as the country with the highest number of developers.[29] While India's developer talent pool has been one of the more obvious results of the IT services boom during the late 1990s and early 2000s, the SaaS boom since 2010 has resulted in the development of the niche talent that is required to successfully launch global product businesses, and especially highly specialized AI software businesses. Most notable among these skills is data science, followed by user interface/user experience (UI/UX) design. Analytics services companies such as MuSigma, Fractal, Axtria, and many others have contributed significantly to creating a vast pool of data-related talent in India. India's advantage lies not only in the availability of talent, but also in the cost of talent. Sales, engineering, and services talent in India cost 75–90 percent less than the equivalent talent in the United States, which makes Indian start-ups significantly more capital efficient.

In the AI value chain, most lower-level processes such as data management are dominated by open source, and this trend is slowly making its way upstream in the creation of AI models. Creating an open-source AI company is a tricky process—it requires a skillful combination of horizontal open-source technologies with proprietary knowledge and understanding of the business problems being addressed.

—JISHNU BHATACHARJEE, Managing Director, Nexus Venture Partners

FIGURE 3.5 Strong Second-Order Effects of the SaaS Wave in India



- **Democratization of AI Infrastructure:** In the 1960s and 1970s, only IBM could develop applications on top of IBM mainframes, as the underlying stack was proprietary, which gave IBM an unfair advantage. Two things have happened over the last few decades: (1) architectures have become open—for example, anyone can develop an application on Microsoft SQL or Oracle Database; and (2) the core intellectual property (IP) of infrastructure layers has become open-source. The concept of open source is not new—it has existed since Unix/Linux was developed, but the number of different open-source projects and their adoption has dramatically changed. Open source is a norm for today's software developers.

Github, the world's de facto developer collaboration platform with over 56 million developers, recorded a 40 percent year-on-year increase in open-source project creation in 2020.[30] A large number of open-source projects are related to AI. This includes TensorFlow from Google, Neo-AI by AWS, H2O, and the Microsoft Cognitive Toolkit, among others.

Even though not open-source, the one project that has captured the most attention recently is Generative Pre-trained Transformer 3 (GPT-3). This is a language prediction model created by OpenAI, an AI research lab based in San Francisco, in the United States. GPT-3's full version has been trained on 175 billion parameters.[31] Introduced in May 2020, GPT-3 is part of a trend in natural language processing (NLP) systems of pretrained language representations. Before the release of GPT-3, the largest language model was Microsoft's Turing NLG, which was introduced in February 2020. The capabilities of such systems are available to developers globally, including developers in India, which reduces the competitive advantage of a few large players. ■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CHAPTER 4

Opportunities for Indian AI SaaS Start-Ups

India has a unique opportunity to capitalize on the growing global AI market. As discussed in the previous chapter, India's vast experience and its advantages in services, the skills gained in building global SaaS companies since 2010, and a level playing field created through Cloud infrastructure players and open-source software, have created the right enablers for India's success. However, as we de-layer the AI stack, there are areas where we expect that India will have distinct advantages, and areas where it will not.

In this chapter, we explore where the advantages lie for Indian companies and the reasons for these, including some early evidence of success with attractive opportunities. It is important to note, however, that the AI landscape will rapidly evolve, and so will India's capabilities. Therefore, we would not be surprised

FIGURE 4.1 Within the AI Stack, India Has an Advantage Across Three Layers

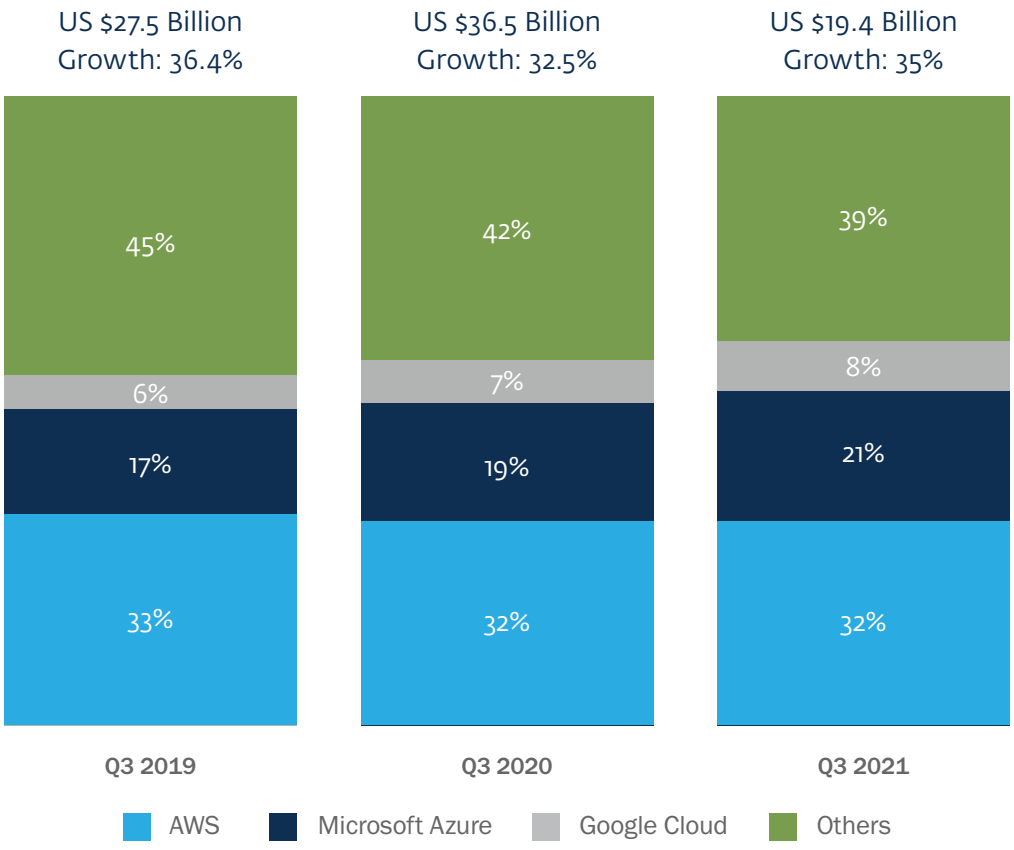
if our predictions are either too conservative or too aggressive, even in the medium term.

We believe that India's AI opportunities will broadly be in the upper part of the AI stack—that is, closer to applications and services. As is explained in the sections to follow, India has fewer competitive advantages in the lower parts of the stack—the infrastructure, data, and platform layers.

4.1 Infrastructure Layer—Limited Opportunity

The business of data centers and distributed computing infrastructure is highly capital intensive and has significant scale advantages. As a result, over the last decade, the infrastructure layer has largely become a three-horse race between Amazon Web Services (AWS), Microsoft Azure, and the Google Cloud Platform (GCP). AWS is the pioneer and market leader in this category, and it has its roots in the internal requirements for computing and storage for Amazon's e-commerce business. Similarly, GCP has emerged from Google's internal requirements. Azure, even though it launched later than the other two, has grown very rapidly on the back of Microsoft's deep enterprise relationships, and its own Cloud application portfolio, such as what it provides for Office 365. In a relatively rapid time, the criteria for success have shifted from providing just servers to providing the application components that developers need for front end, back end, and analytics. The pace of innovation and scale has made it very hard to penetrate this market. Although other large companies including IBM, Oracle, and SAP have attempted to break into this market, they have not had much success. The three top players controlled 61 percent of market share in 2021, with a year-on-year increase of three percentage points, as seen in Figure 4.2.[32,33]

FIGURE 4.2 Worldwide Cloud Infrastructure Services Spending



We believe that as data privacy and data localization policies become more stringent, pressure will increase for service providers to keep the data, and therefore the computing resources, in India. However, given the growing size of the Indian market, we also expect that the leading global companies will set up local data centers in India and, in fact, AWS has already done so. The chances are slim that Indian data center start-ups will achieve scale before the major global companies set up their own competing data centers in India.

Along with the issue of achieving scale, the technical depth required to build such platforms is substantial, and catching up on these technical capabilities will be hard for Indian players. As Figure 4.2 shows, despite their considerable resources and their distribution reach, even Microsoft and Google have had a tough time making a dent in AWS's dominance in this market. In Jeff Bezos's words:

> *AWS had the unusual advantage of a seven-year head start before facing like-minded competition. As a result, the AWS services are by far the most evolved and most functionality-rich.*

It is important to note that infrastructure is a critical and foundational component for AI to take off, and we believe that infrastructure provision is a large and growing market. However, for the reasons we just discussed, the opportunities for Indian start-ups in this market are likely to be limited.

4.2 Data Layer—Limited Opportunity

Data infrastructure such as data warehouses, ingestion technologies, data cleansing platforms, and data visualization software have matured significantly in the United States and Europe since 2010. The development of these technologies has correlated highly with the data complexity and requirements of industry and academia in these countries. The requirements of advertising technology (adtech), IoT, e-commerce, and government/defense applications have driven innovation in the data stack. Therefore, the West naturally innovated ahead of India.

Examples of these technologies include NoSQL databases such as MongoDB, Cloud data warehousing technologies such as Snowflake, data science platforms such as Databricks, and data cleansing software such as Tamr and Trifecta. A host of such innovations have happened since 2010, and several such as Hadoop have even come into prominence, and then faded away.

Pushing the boundaries of the data stack requires fundamental technical innovation, which has been dominated by top-tier doctoral degree (PhD) scientists and software engineers in Silicon Valley in the United States. Currently, such talent is not abundantly available in India, and, consequently, Indian success stories in this category have been rare and sporadic. The best-known Indian company in the data layer has been Qubole, but it has not been able to become a global leader. Recent exceptions are Hevodata, which has developed a leading data ingestion and transformation tool, Atlan, a data governance platform, and Acceldata, which has seen early success with its data observability platform. These companies stand out not just because of their tech-differentiation, but also because they are exceptions rather than the rule in the Indian landscape of innovations within the data layer.

However, we do expect the availability of talent in India to consistently improve, and it will be driven by Indian engineers' exposure to the latest technologies, and the greater proportion of research and development (R&D) for global technology companies that is being carried out in India.

4.3 AI Platforms Layer—Limited Opportunity

The complexity of building AI applications today has been significantly lowered by the underlying AI platforms, which make various AI algorithms and model training infrastructure available. This infrastructure leverages the research undertaken by universities as well as companies, and it is generating newer algorithms at an unimaginable pace. Most of the AI algorithms are open-source and therefore also offered by Cloud infrastructure players. For these players, the primary monetization mechanism lies in their computing and storage infrastructure, and they are able to offer the platform at negligible costs. It is no surprise, therefore, that this market is dominated by the big three Cloud infrastructure providers—AWS, Azure, and GCP. IBM, with its Watson initiative, and many others have also built sophisticated AI platforms, but they have found it hard to compete, given the massive reach achieved by the big three Cloud infrastructure players.

The development of many of these platforms has been driven by the needs of large technology companies such as Amazon, Microsoft, and Google. Each of these has hundreds of millions of customers, and customers' increasing expectations, as well as the need for differentiation, has led them to use sophisticated AI algorithms for their core businesses. As an example, consider how much AI is used to autocomplete sentences in email and in search engines. Much like AWS was spun out of Amazon's eCommerce requirements, the AI infrastructure initiatives of these giants have also taken advantage of internal needs. The situation in China is very similar, with Alibaba Cloud being a leading AI platform.

Despite the presence of giants, some start-ups in the United States have shown signs of success. Notable among these is H20, an open-source AI platform that provides application programming interfaces (APIs) and application components (for example, fraud detection) across a variety of industries and functions. Similarly, Clarif.ai has created an AI platform specifically for computer vision applications. However, for the most part, much like data and infrastructure, this layer is dominated by the large incumbents, which are unlikely to be easily dethroned.

4.4 MLOps Layer—Potential Opportunity

In the era of on-premises software, the codes were clunky and took forever to integrate, test, and deploy. The update frequency was very low and new releases could take as long as six months. Low update frequency was primarily due to on-premises deployment of software, as any change in code had to be upgraded across every instance of every customer. This was particularly difficult, as customers often had different versions and customized code on top of their instances. However, this changed with the arrival of Cloud applications where all customers are served with the same instance and, therefore, they have a single base code. Cloud-based SaaS companies made it easier and faster to do updates, and engineering teams have moved faster than ever before.

This has led to different development paradigms—for example, the Waterfall[34] methodology has been replaced by the Agile[35] methodology. Multiple tools that automated one or more steps of committing a code to production emerged, and eventually this led to the advent of the DevOps category that has enabled teams to release updates much more frequently.

FIGURE 4.3 DevOps is a Large Software Category on Its Own

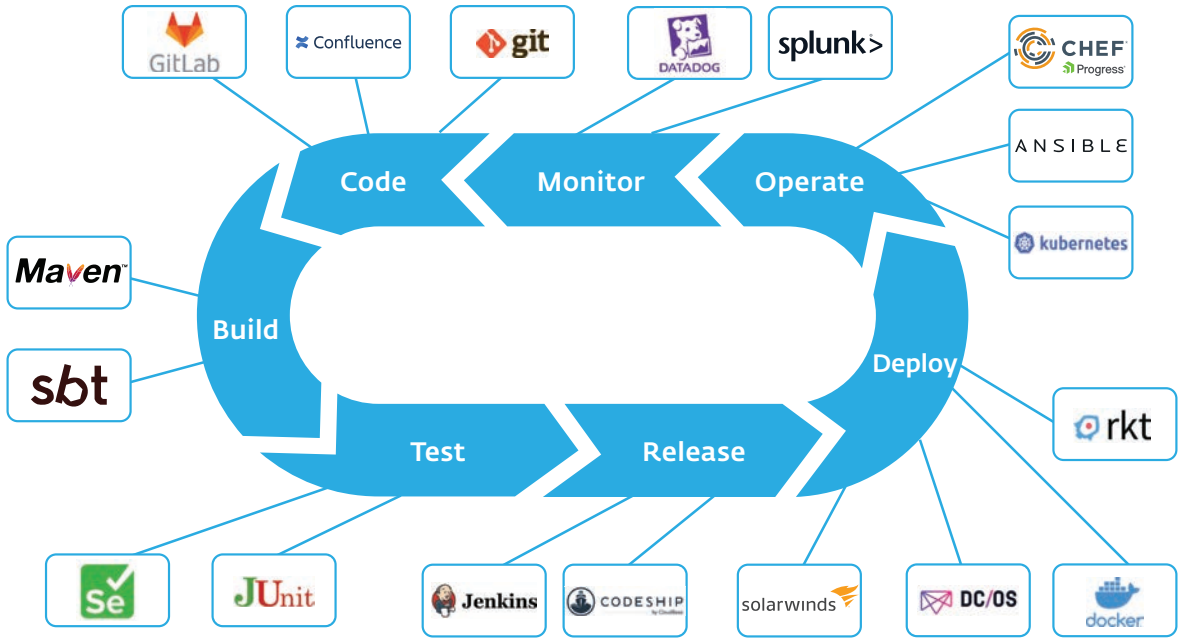


FIGURE 4.4 Two Break-Out Winners in DevOps: Postman and BrowserStack

- A collaborative platform for API development, automated testing, version control, and continuous monitoring and documentation
- Valued at $5.6 billion+ in 2021—only six years after inception
- Raised $430M so far from Nexus, Insight Partners, and CRV
- Counts global giants like Microsoft, PayPal, Cisco, and Shopify as its clients

- A cloud-based testing platform that enables developers to test applications across platforms (browsers, operating systems, and mobiles) without the need of installation
- Raised $200M at a valuation of $4 billion from Accel, BOND, and Insight Partners
- Powers 2 million tests every day and provides instant access to 2000+ real mobile devices and browsers
- Counts global giants like Microsoft, Twitter, RBS, and Expedia as its clients

DevOps as a separate category began emerging, globally in 2008. However, until 2010 there was little notable activity in this space from Indian start-ups. But as the software ecosystem matured in India, the country's developers started following the best engineering practices, and these developers became available as a fertile testing ground for locally created developer tools. Despite being a late entrant in the space, India has created two winners in DevOps since 2015—POSTMAN and BrowserStack.

4.4.1 *MLOps—An Emerging Category to Support AI-First Start-Ups*

While the popular DevOps tools of today enable developers to deploy production-grade code at scale, they cannot cater to the added complexities of data and model management, both of which are essential for AI systems. As AI rapidly moves from being a scientific discipline to an engineering one, and from research/experimentation to deploying AI in businesses, the challenges of implementing commercial AI systems have become clear. As of December 2019, only 22 percent of companies using AI for commercial use had been able to successfully deploy machine learning models, which actually constitute the "intelligence" of AI systems.[36] Moreover, in companies with dedicated data science teams, data scientists were spending at least 25 percent of their time just on deployment efforts.[37] The unique complexities associated with developing ML models have led to the emergence of a new set of practices called MLOps (machine learning operations).

An MLOps framework must cover everything that a DevOps framework does because it is essentially still based on collaborative code development. However, MLOps extends far beyond DevOps because a typical AI system contains two more dynamic components: data and ML models. The interplay of data and models on top of the code in AI systems leads to additional requirements such as statistically validating data, handling continuous data updates, building a complex pipeline of individual ML models that feed into each other, experimenting with multiple slices of datasets/model parameters, deploying resource-heavy models with reliability built in, constantly monitoring the model's performance with live data, and so on.

> *The space of MLOps is in the early stage of infancy, but there is plenty of scope; just as it was with SaaS products 7–8 years back.*
>
> —MANEESH SHARMA, Country Manager, India, Github

FIGURE 4.5 MLOps Surpasses the Complexity of DevOps

Practice	DevOps	MLOps
Version Control	Code version control	Code version control + Data versioning + Model version control
Data Validation	N/A	Statistical validation
Model Pipeline	N/A	Training ML pipeline + Serving ML pipeline
Validation	Unit tests	Unit tests + Model validations
Continuous Integration/ Continuous Deployment	Deploy code to production	Deploy code to production + Deploy trained models
Ongoing Monitoring	Service level objectives-based	Service level objectives-based + Differential monitoring + Statistical sliced monitoring

A complete MLOps infrastructure that can help with the tasks just listed will comprise parts that are considerably more complex when stacked against analogues from the DevOps world (Figure 4.5).

In 2019, more than 200 MLOps tools were available, globally and earning over $350 million in revenue. MLOps continues to grow rapidly and is poised to reach a global market size of $4 billion by 2025.[38] While most of today's MLOps tools are provided by specialized players that offer solutions for one or two parts of the value chain (data preparation/model development/experimentation/ deployment/monitoring), there has also been a recent surge in end-to-end MLOps platforms. Given the complex and customized nature of AI use cases, the wide applicability of such generic end-to-end MLOps platforms is still uncertain. A chart depicting the popular categories, as well as the end-to-end MLOps tools, is shown in Figure 4.6. Going forward, by 2025 we expect more MLOps tools that target a specific use case (for example, NLP or an entity classification) to come to market.

FIGURE 4.6 MLOps is a Fast-Growing Software Category

4.4.2 *MLOps from India—Opportunities and Challenges*[39]

While MLOps is certainly a promising new category, it is still unclear if India will be able to capture a meaningful market share. India's strategic advantages in producing winners in MLOps comprise (a) having a large talent pool of developers and data scientists that can act as beta users/early adopters; and (b) having a rapidly evolving tech start-up ecosystem wherein large tech start-ups that aspire to follow globally benchmarked engineering best practices could be codevelopment partners. However, Indian developers have traditionally lagged behind their global counterparts in adopting engineering best practices. This is due to a combination of India's deep services "DNA" and the fact that Indian product start-ups have only recently become large enough to see the benefits of following best practices. For India's large pool of developers to become a material advantage for Indian MLOps companies, that trend will need a quick reversal.

It is a bit early to predict how successful India will be as a source of global MLOps companies. However, there are a few promising start-ups. For example, Segmind is a start-up focused on a unified MLOps platform for computer vision applications; Waterdip.ai is creating an observability solution for assessing model drift; and True Foundry is creating a platform for end-to-end flow for deployment and monitoring of ML applications.

4.5 Application Layer—Significant Opportunity

While AI applications could be sold either through the traditional licensing-based model or through the software as a service (SaaS) model, in this and the following sections we use the terms AI applications and AI-led SaaS interchangeably, since we believe that over the next decade SaaS will become the preeminent business model for Indian AI companies.

Since 2010, India's SaaS industry has seen breakout companies across different industries, functions, and customer types. However, India has had the most success within the small and medium enterprise (SME) space, where annual contract values (ACVs) are low and unit economics are not easy to make work with U.S.-based sales costs. Remote inside sales from India dramatically lowers the customer acquisition cost (CAC), and Indian SaaS companies have been very successful in targeting the North American SME market. Zoho and Freshworks are the two best-known companies.

We believe that India's success in AI-led SaaS will also have some dominant themes. In Chapter 1 we discussed how "AI software" is different from traditional SaaS in terms of service intensity, which is the case not just during development but also during and after implementation. India's edge in supplying talent, as well as its cost arbitrage with regard to services, provide a unique competitive advantage for India's AI start-ups. The higher the services intensity, the greater India's advantage will be.

AI-applications can be divided into four categories, based on the increasing level of their training and service complexity, and therefore their increasing attractiveness for Indian AI start-ups (see Figure 4.7).

1. **No/Little Training:** Think of an application that uses Google's speech-to-text API as part of a video conferencing application for the transcription of notes. Technically, this is an AI application; however, the application provider is not investing in any training in this scenario—instead it is relying on Google to train the API, and it simply uses the API as it is, with no modifications. Such software is no different from any traditional SaaS application using an external API. We classify such applications as AI-enabled, and we believe that India has no special advantage above and beyond what it has with traditional SaaS.
2. **Train Once, Deploy Everywhere:** Many AI applications do not require separate training for each customer, but instead utilize the same model (and therefore the same underlying training) for each customer. Signzy, which provides onboarding solutions for financial services institutions, is one such example. One of the steps in customer onboarding is know-your-customer (KYC), which involves matching people's faces across multiple IDs/documents, and ensuring the consistency of text that is extracted from multiple documents using optical character recognition (OCR). While underlying models for face matching and OCR need to be developed for the KYC use case, they do not need to be trained differently for different customers. Case Study 4.1 shows two examples of Signzy's capabilities that do not require customer-specific training.

FIGURE 4.7 India Has a Greater Advantage Where Service Intensity is Higher

	Type	What it means	India's advantage
AI-Enabled	**I. No/Little Training**	• Uses 3rd party APIs inside other workflows with little/no additional training • Use of AI is just a feature	• Similar to regular SaaS
	II. Train Once, Deploy Everywhere	• Application uses 3rd-party or open-source algorithms/partially trained algorithms, but need to supplement with own data training. Does not require any customer specific training	• Access to the right training data is important • Companies like Skit and Inspektlabs have solved it in creative ways
AI-First	**III. Customer-Specific Training**	• AI needs training with every customer as data and underlying patterns are unique to every customer	• Longer implementation cycles • Higher data-related services
	IV. Human in the Loop (HITL) AI	• Customer needs full solution to a problem and inaccuracies of AI are not acceptable—e.g., medical diagnostics, where human backup is required	• Can be combined with BPOs at a later stage, but AI app providers will need to do this in early stages.

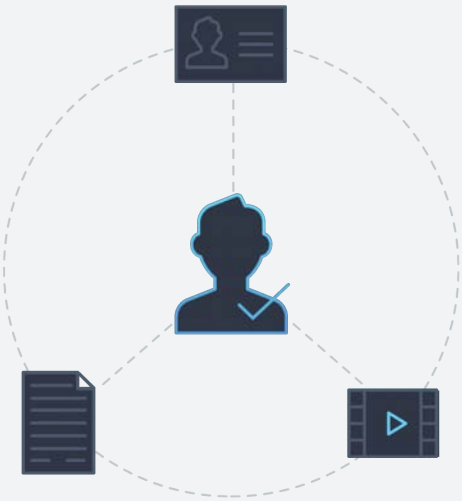
Increasing advantage for India

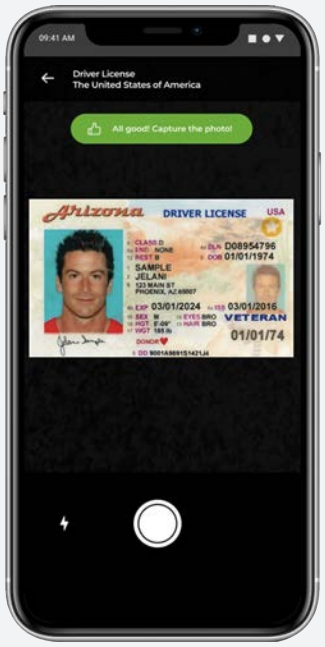
CASE STUDY 4.1 Signzy: Examples of AI Applications That Do Not Require Customer-Specific Training

SIGNZY

Industry: Financial Services
Function: Customer Onboarding
Location: India/US/Middle East

- Real-time ID verification against established databases
- Matching face on ID with face in video (with % confidence score)





3. **Customer-Specific Training:** A large number of AI applications will need customer-specific training—for example, demand forecasting. Machine learning models for demand forecasting are dependent on historical demand data for each specific company. Thus, while the technique used for forecasting may be the same across different fast-moving consumer goods (FMCG) companies, the actual model that is deployed is likely to be very different, and even more so across customers from different industries. Limechat.ai is a conversational AI start-up that is targeting this category of problem. The training complexity for these kinds of applications is naturally higher than that of the previous two categories, described above.
4. **Human-in-the-Loop (HITL) AI:** Unlike the demand forecasting example just discussed, for many AI-applications achieving 100 percent accuracy is necessary. As discussed in Chapter 2, examples of high-risk applications include robotic surgery and AI for diagnosis of complex diseases. Since AI has deficiencies, and in many cases it cannot provide sufficiently accurate output, human backup is required. Sometimes this can be provided by the customers themselves, and in other cases the application's provider delivers this service. In such cases, the boundary between product and services begins to blur. For example, Synapsica's technology can read through MRI/CT scans to identify and measure relevant biomarkers; however, since a mistake could be fatal, the company has a remote radiologist who checks the machine's diagnosis.

4.5.1 *Micro-Verticalization—India's Edge in AI-Applications*

Memorial Sloan Kettering Hospital in New York is regarded as one of the best cancer hospitals in the world. One of the reasons for this is the hospital's level of specialization. Even within onco-surgery, there are different surgeons for ovarian cancer and breast cancer. This is important because a surgeon who only performs ovarian cancer surgeries is able to identify patterns and nuances that a general onco-surgeon might not be able to. AI models are no different. The more specific you make them (while, of course, providing sufficient data), the better they become.

Google's Dialogflow was designed to be a booking assistant that could be used by a variety of small businesses such as spas, beauty salons, and dental practices. However, making Dialogflow work for a specific application such as a spa is not easy.

CASE STUDY 4.2 Synapsica: Marketplace and AI-Assistant for Efficient Radiology

Synapsica
BETTER RADIOLOGY

Industry: Healthcare
Function: Diagnostics
Location: India/US

Problem

- Margin pressures, as 85% of the radio-diagnostic market is fragmented, and 24x7 radiologist cover is costly
- Wasted time and earning opportunities due to the tedious work of adding objective evidence to a report
- Opaque reports without objective evidence lead to subpar medical assistance

Solution

- Automatically detecting case information, e.g., body part, orientation, etc., to determine reporting needs
- Automated detection and characterization of the biomarkers of pathologies in patients' scans
- Combining AI findings with NLP to auto-generate relevant text/table/images in radiology report

Impact

- Improve margins through workflow automation and accessing a flexible pool of radiologists via an Uber-like model
- Save time with automated reports and diagnostic assistance. Create access to geographically distributed earning opportunities
- Generate better quality reports and visibility in medical care

Dialogflow does not understand the nuances of a spa appointment, and the buyer, in this case a spa, needs technology that is trained for its specific use case. Interpreting the vocabulary, intent, and grammar for dentists is very different from that required for spas. If someone wants to come in for a hairstyling appointment, perhaps the booking assistant should ask if the customer also needs a shampoo, hair coloring, and other related services. The assistant must also know the amount of time required for each of a small business's services, understand the availability and skills sets of different service team members, and be able to schedule appointments accordingly. If the assistant is integrated into the customer relationship management (CRM) software, the system should know that the customer has a teenage daughter, and ask if the daughter also needs an appointment at the same time. These specificities of spas will make the application very different from what is required for a similar front office solution for dentists. True Lark is one example of a product for the front office of a spa (see Figure 4.8).

In working with AI companies, we believe that greater specialization is often necessary for both the accuracy of AI as well as the overall value proposition of the software because specific workflows and integrations are required across different verticals (industries).

It is not surprising, therefore, that AI start-ups are specializing aggressively and targeting micro-verticals across industries. Since 2010, a great many start-ups have launched within the industrial IoT space. At the core of all of these is a common value proposition—they collect data that is continuously emitted from a vast number of machines and sensors on shop floors, and they utilize the data to predict faults and prevent downtime. In theory, if this works for one business, it should work for all. However, in practice, it does not. An automotive plant and its equipment are very different from a specialty chemical plant, and two specialty chemical plants are very different from each other. Two brands of pumps have different technical specifications and, often, two pumps from the same

FIGURE 4.8 Micro-Verticalization Will Play to India's Advantage

truelark

- Front-desk assistant that handles inbound customer queries over text
- Sharp focus on beauty and wellness, fitness centers, and dental clinics
- Understands the service portfolio of these micro-verticals as well as the inbound customer's context for product enquiries, and booking
- Integrates with standard booking software that SMBs use—Acuity, Booker, etc.

Google

- Dialogflow provides an end-to-end "build once, deploy anywhere" development suite for chatbots
- Requires a developer to build the chatbot using Dialogflow, which is an expensive proposition for most SMEs
- Will require training on the salon-specific data to understand the customer's booking intent, service catalogue, etc.
- No out-of-the-box integrations

manufacturer have different normal/abnormal signals in different situations.

Start-ups in general, and those in India in particular, have a unique advantage as big software companies such as Google and SAP will find it hard to justify investing in specialized use cases; they would rather create platforms, on top of which others can build specific applications.

4.5.2 *The API Opportunity*

Much like Twilio, many SaaS companies do not build full-fledged applications. Instead, they provide APIs that are repeatedly used across many different applications. Such examples are abundant within the AI stack as well; the Google speech-to-text API is a very popular API service. In addition to applications, Indian companies will also find opportunities to create AI-APIs where they have a data collection advantage over global alternatives.

We are already seeing examples of such companies in India. Inspektlabs has built APIs that assess damage to cars based on uploaded photos of the cars. Given India's bad traffic conditions, cars have a much higher incidence of dents, scratches, and other damage, which provide rich data for training. Within a few months, Inspektlabs collected millions of photographs at a very low cost. Today, the company's APIs are being used by insurance providers to assess vehicle damage with no need for a visit by a company inspector.

We believe India could be a provider of many such APIs, particularly in areas where India is data rich. Other examples of APIs could lie in healthcare (for example, assessing x-rays and MRI scans), financial services (for example, OCR of structured financial data) and identification (ID) matching (for example, of driving licenses).

4.5.3 *Unit Economics and Capital Requirements for Building AI-Application Companies*

Given the sizable global SaaS opportunity for companies from India, VC funding in Indian SaaS companies has grown rapidly since 2010, as shown in Figure 4.9.[40] In 2019, VC funding of $1 billion was raised by Indian SaaS companies, which was more than twice the amount raised in 2018. In 2021, Indian SaaS companies attracted $4.5 billion of fresh capital, a 170 percent increase over 2020.[41] Freshworks alone had raised over $300 million. Almost every major VC fund in India invests in SaaS today, and many specialist SaaS funds have been created—for example, Exfinity, Avataar, and Together.

The success of SaaS investing will drive capital toward AI-application companies, as well. However, we believe that in comparison to the traditional SaaS companies, creating AI-application companies will require more capital for the following reasons:

- Higher initial costs in data acquisition and training to reach a minimum viable product;

CASE STUDY 4.3 Inspektlabs: Computer Vision for Asset Inspection

Inspekt labs

Industry: Automotive, Insurance, Mobility
Function: Asset Inspection
Location: India/Global

Problem

- Every time a vehicle changes hands, there is a need to perform inspection on the asset for any damages.
- Current process for inspections is completely manual and slow—taking up to 10 days, expensive—up to INR 1000 per inspection, and rife with fraud (5–15%).

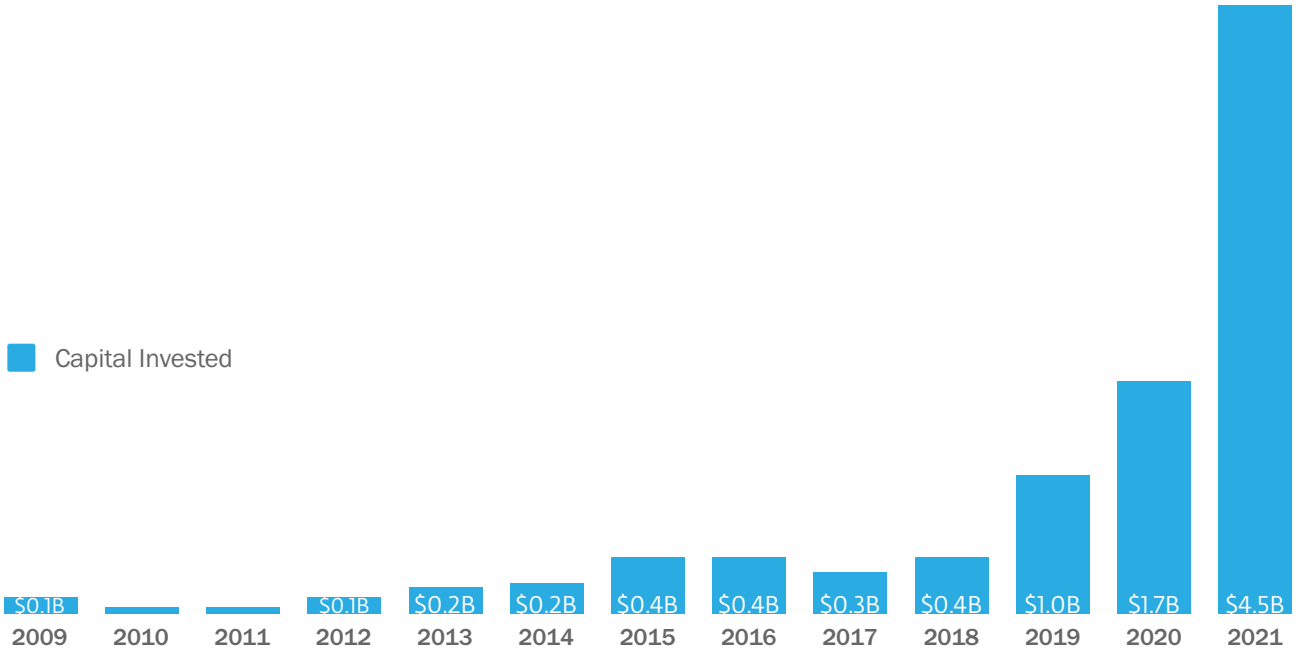
Solution

- Customer takes a 360° video of the asset which is shared with Inspektlabs' pretrained damage detection models via APIs for real-time quality scores.
- The model has been trained on 5Mn+ videos/images for accurate detection of dents, scratches, etc.

Impact

- Automates car inspections for motor insurance and sharing economy (e.g., car rental players).

FIGURE 4.9 Venture Capital Investment in Indian SaaS Companies



- Longer sales cycles—many deployments will require custom proofs of concept (POCs);
- Longer implementation cycles where customer-specific training is required;
- Higher Cloud infrastructure costs for data storage as well as training;
- Higher research and development (R&D) team costs because, in addition to those with regular software skills, data architects, data scientists, and machine learning engineers will be needed.

Some of these costs will be offset by some advantages that AI-applications will have over regular SaaS:

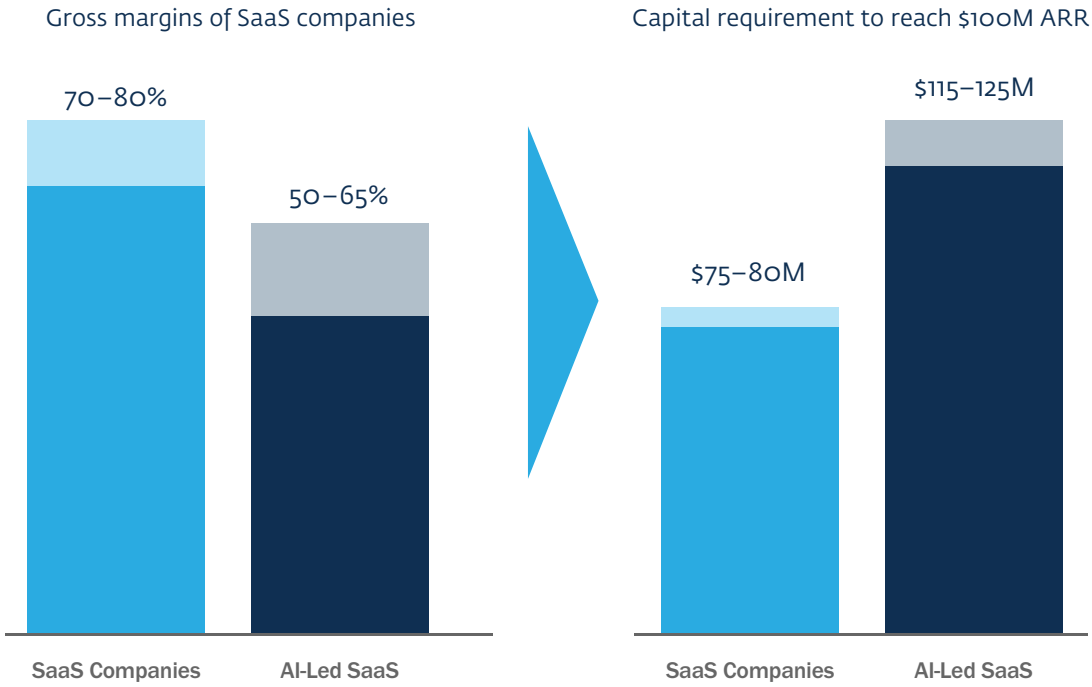
- Given the deeper integration and learning of models over time, lower customer churn and higher customer stickiness is likely;
- Given the higher value of solutions, higher ACVs can be expected;
- In many businesses, there will be data network effects. More customers ==> more data ==> higher accuracy ==> higher value ==> higher number of customers;
- The increasing availability of open source components and APIs can reduce development costs.

When selling AI SaaS, keep your POCs quick; longer POCs can be a death knell for an AI SaaS start-up.

—RAJESH RADHAKRISHNAN, EVP and General Manager, Front Office Automation, Automation Anywhere

Our research and experience suggest that AI-application companies will take longer to create a minimum viable product, they will typically have lower gross margins in their initial years, and they will take longer to scale due to more complex sales cycles. Gross margins for AI-application companies will typically start at 50–65 percent, compared to 70–80 percent for traditional SaaS companies. In the long run, these margins should move toward those of traditional SaaS companies owing to lower churn (loss of customers), and better pricing once value has been demonstrated. In conclusion, to achieve an annual recurring revenue (ARR) of $100 million, we conservatively estimate that an AI-application company will require ~$120 million in capital compared to ~$75 million for a traditional SaaS company, and could also take a year longer to achieve ARR of $100 million.

FIGURE 4.10 AI-SaaS Will Need More Capital Than Traditional SaaS Companies

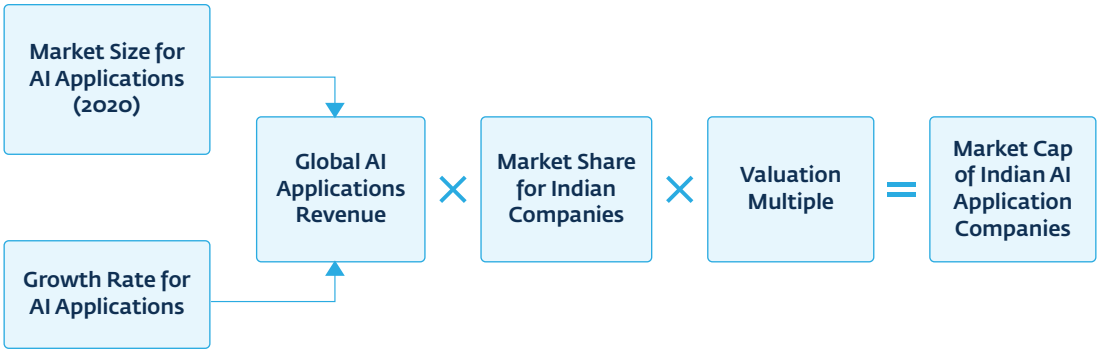


However, this does not mean that AI-led applications are not an attractive opportunity. In fact, quite the contrary. We believe that many cost components will decline over time. Also, in the early years, valuation premiums will be high, as leaders will be created in different categories, and the scarcity of similar assets will drive investors to pay high valuations for the emerging winners.

4.5.4 *Sizing the Opportunity for AI Applications*

To estimate the size of the opportunity available for AI applications from India, we estimated the aggregate revenue for Indian AI applications companies, and applied a valuation multiple in order to arrive at the market capitalization that these companies could create. We used a decade-long forecast interval that allows sufficient time for the category to display signs of maturity.

FIGURE 4.11 Methodology: Sizing the AI Applications Opportunity for India



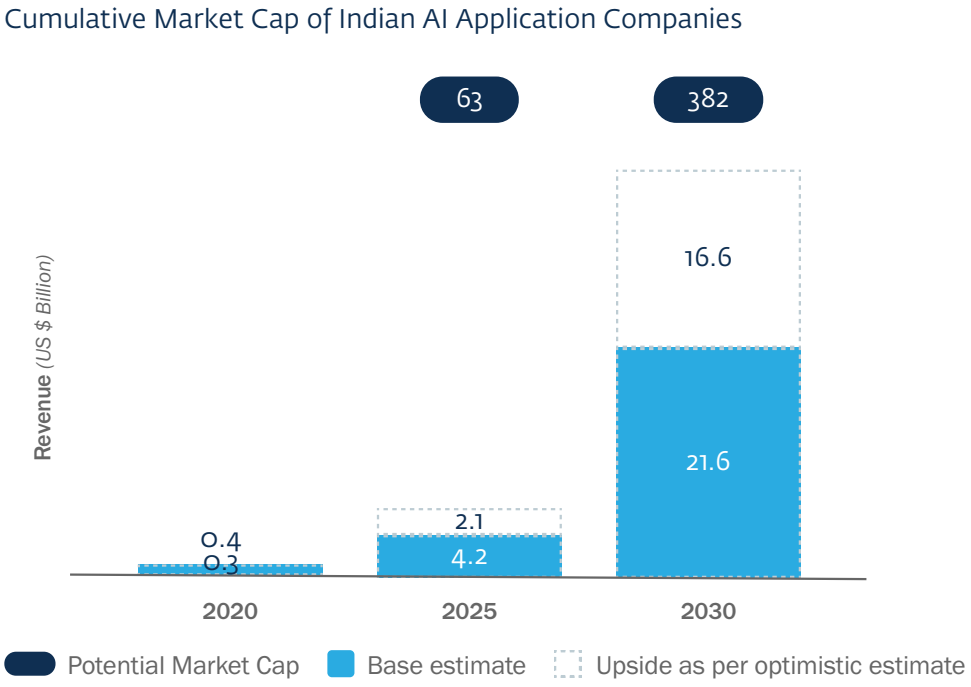
Notes:
1. Market growth rate benchmarked against growth rate for Cloud applications in early stage of maturity.
2. Market share for AI applications benchmarked against market share for SaaS players from India.
3. Valuation multiple estimates based on late-stage private and public market data.

Between 2010 and 2020, the global revenue of SaaS companies—the last major wave of significance in the global software industry—grew by more than 10 times, from $9.2 billion in 2010[42] to $104 billion in 2020,[43] and this revenue is expected to reach $479 billion by 2030.[44] As of 2020, AI applications revenue, including both SaaS and licensed models, was estimated to be around $20 billion.[45] However, this segment is expected to grow rapidly, with healthy growth rates of between 25 percent and 40 percent between now and 2030, and it is likely to constitute a significant proportion (over $300 billion) of an estimated $1.3 trillion in global software spending by 2030.[46]

As discussed in earlier chapters, India is likely to enjoy some unique advantages in developing AI applications due to: the country's decades of global leadership in traditional software services; a large workforce with technology and data management skills; experience in remote sales of software products to international SaaS customers; significantly lower labor costs; and the development of a vibrant start-up ecosystem, with diverse sources of capital and know-how available to young start-ups.

Since several of these strategic advantages are either the same as or similar to those for traditional SaaS, we expect that the trajectory of India's market share in AI applications is likely to closely mirror that of India's traditional SaaS market share. Moreover, we assume that SaaS will be the predominant business model for the new AI applications companies coming out of India and, therefore, that Indian AI applications companies will, for all practical purposes, be AI SaaS businesses. Within the traditional SaaS market, India's revenue share has risen from practically nothing in 2010 to

FIGURE 4.12 AI Application Companies Can Create ~$400 Billion Market Cap by 2030



1. Base market growth rate of 35% until 2025 and 25% for 2025–30, benchmarked against cloud growth since 2008.
2. Optimistic market growth rate of 40% until 2025 and 30% for 2025–30, consensus estimates.
3. India's share in global SaaS ~6% and 10% in 2025 and 2030, respectively; our scenarios assume that AI apps will either command a similar share from 2025 onwards, or will take two years longer to reach similar market shares.
4. At maturity, assumed EV/ARR multiple to be 10.

Sources: Gartner, NASSCOM, IDC, Grandview, SEC filings

3.4 percent[47] in 2020, and it is expected to continue to outperform the market and reach 9.5 percent[48] by 2030. We have assumed that by 2030, India's AI-SaaS market share will lag behind India's SaaS market share by zero to two years.

In the previous section on unit economics, we compared the economics of AI-SaaS businesses to that of traditional SaaS businesses. In our view, AI companies are likely to be less capital efficient than traditional SaaS companies, with a slightly slower growth trajectory to achieve similar outcomes. However, for the foreseeable future, these businesses are likely to have "stickier" customers and revenues, command higher pricing over time, and present opportunities for category leadership. On balance, the longer-term average valuation multiples for traditional SaaS businesses—an Enterprise Value (EV)/ARR of ~10 for a representative sample of listed companies—are the best proxy for the future valuation multiples of AI-SaaS companies.[49]

Based on these assumptions, we believe that Indian AI application start-ups could create a market capitalization of anywhere from $200–$400 billion by 2030.

4.6 Services Layer—Significant Opportunity

Since 1980, India has developed significant capacity to operate services-oriented businesses, and the country is now a preferred destination for outsourcing various services such as technical support, technical implementation, customer support, lead generation, data entry, and many other back-office business processes. What makes India the number one choice is its large pool of skilled English-speaking, tech savvy, affordable professionals, and a proven track record for managing large and complex projects.

As discussed earlier in this report, the primacy of data and models results in significantly higher service intensity in the AI software development and deployment process. Service requirements are unavoidable, and are found at all the key stages of the process—from data preparation, model development and deployment, to ongoing support. This has created an entirely new area of opportunity for AI-focused services. Figure 4.13 lists the different kinds of AI-related services where Indian companies have opportunities.

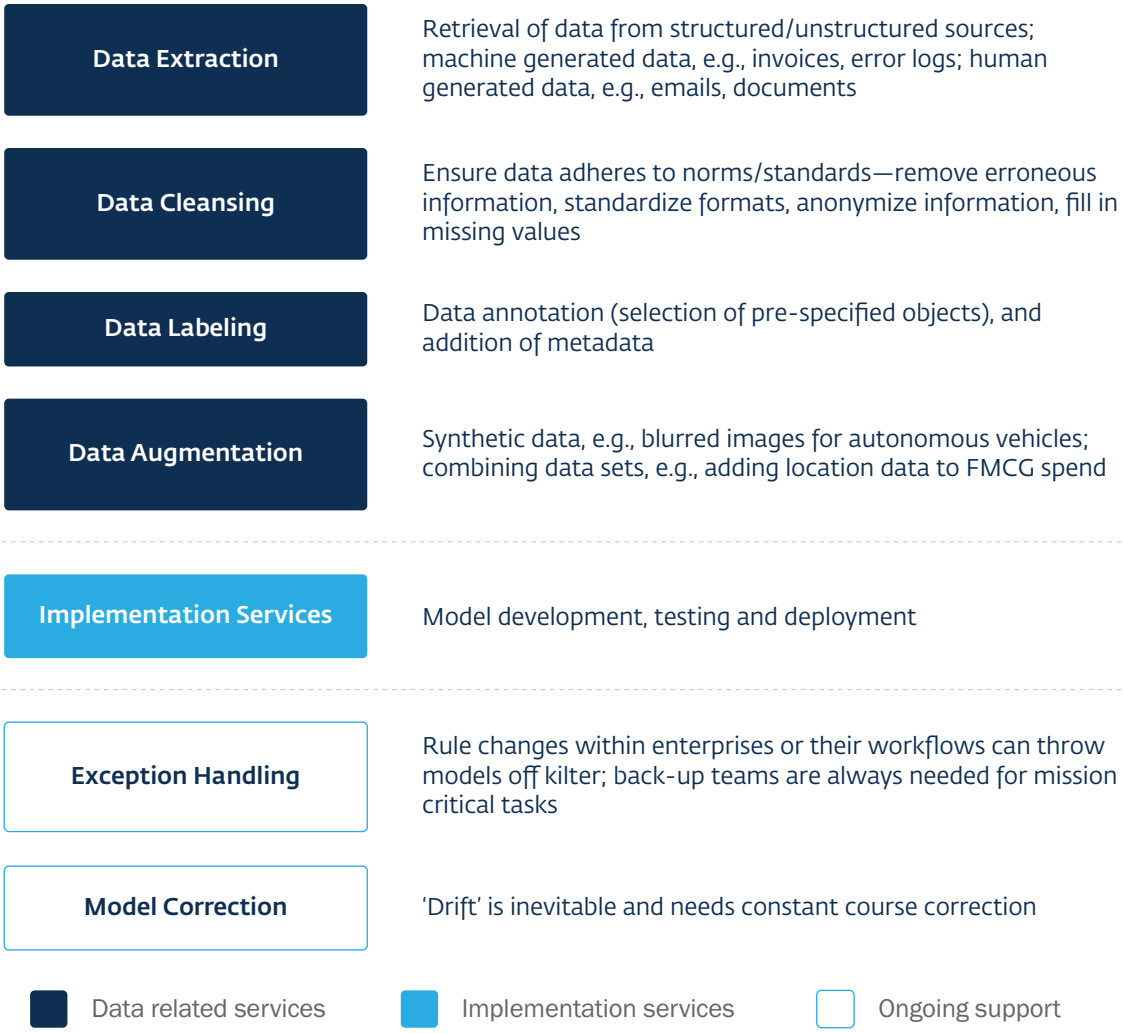
Unlike applications, where significant value will be captured by start-ups, we believe that a significant part of the value in services will be captured by the incumbents. With regard to expertise, we believe that skills will transfer more easily across services or, in many cases, that AI services will not be as difficult to build as applications. Incumbents' existing client relationships will also make it easier for them to capture opportunities, as opposed to start-ups, which will take a long time to build their client bases. However, some opportunities are being captured by start-ups, several of which are discussed in the following section.

Data-Related Services

A large quantity of data must go through multiple different steps before it can be used to train AI models with reasonable accuracy. The first step is data extraction, which involves accurately picking data from structured or unstructured sources that can be either human or machine generated. Examples include invoices, emails, documents, images, and videos. The next step is data cleansing, which ensures that the data adhere to underlying norms such as anonymization of information, removing erroneous information, and standardizing formats—for example, across locations. Once data have been cleaned, they are often sent for labeling to add richness to the data; this can involve the selection of pre-specified objects within the data, as well as the addition of specific metadata—for example, identifying different elements in a traffic image for training self-driving car algorithms. Finally, training data can also be augmented to add robustness such as through the generation of synthetic data, which are used when real-world training data are either unavailable or too costly to generate—for example, in the case of Waymo One,[50] a self-driving taxi service launched in China by Alphabet. Augmentation can also occur through combining multiple data sets into a larger data set that has greater context.

Depending on the requirements of the model being generated, and the nature of the underlying data, data preparation services can vary substantially. Taskmonk and Playment are two such examples. Both provide tools and services for data labeling, and they also automate parts of the labeling process.

FIGURE 4.13 India Could be the Natural Destination for AI Services



CASE STUDY 4.4 Taskmonk: Making Data Labeling More Efficient

Taskmonk

Industry: Horizontal
Function: Data Ops
Location: India/US/SEA

Problem

- Enterprise-grade AI solutions need massive amounts of labeled data for training.
- Up to 25% time in a typical enterprise AI project is spent on data labeling.

Solution

- Taskmonk's unified data labeling platform contains active-AI (pre-labeling with existing standard algorithms) built in.

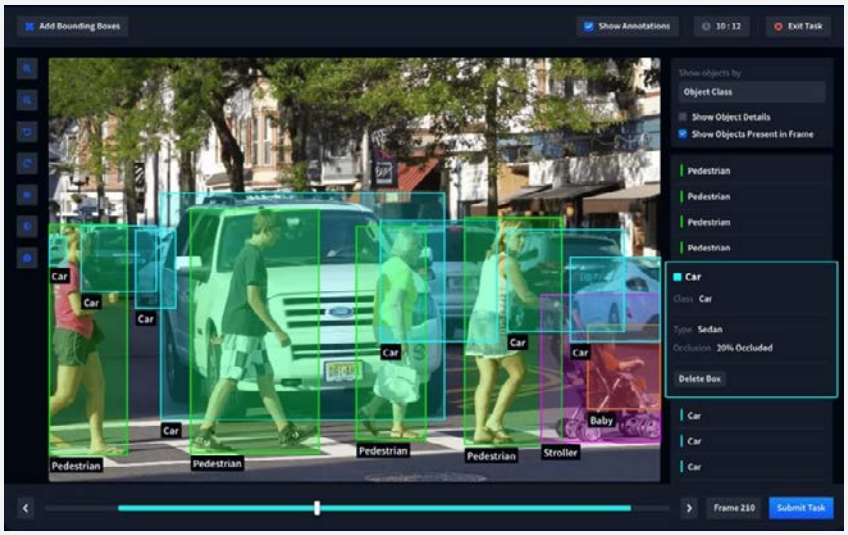
Impact

- Effective auto-AI decreases human labeling time by up to 60%.
- Unified data labeling platform upgrades employment-intensive small BPOs, enabling them to win large enterprise projects.

CASE STUDY 4.5 Playment: Data Prep Entails Unique Business Opportunities

Playment

- Provides both tools and services for data labeling.
- Has built tools to automate parts of the labeling process.
- Crowdsources data labelers to create a flexible capacity model.
- Started with a focus on autonomous driving that requires high accuracy and needs massive amounts of data to be labeled.
- Data labeler costs in India can be as low as $200 per month.



Implementation Services: Model Development and Deployment

As enterprises adopt AI, they often require a tailored approach to make an AI system work with their unique data and existing processes. Model development requires dedicated intervention by highly skilled machine learning engineers and data scientists. Additionally, deployment often needs customized efforts—for example, integrating with legacy IT systems that have been custom developed and therefore do not have standard APIs. Most traditional enterprises do not have highly skilled in-house AI talent and prefer to outsource the model development, testing, and deployment process. This is creating an opportunity for companies like SCRY Analytics (see Figure 4.15), which works closely with each customer and implements a custom-fit AI solution from its wide suite of use case-based product lines.

Ongoing Support

Most AI applications require regular, ongoing support. In general, support requirements are for two types of use cases. The first are the high-risk use cases, with very high costs if they fail—for example, medical diagnosis, which requires a human-in-the-loop (HITL). The second case is "model drift," which essentially is a change in the relationship between a model's input and output variables. Model drift is a natural consequence of the dynamic nature of AI, and it can occur over time as a result of regime changes in a model's underlying data set(s). Consider the case of a manufacturing plant that collects data from a variety of sensors and uses predictive modelling to forecast machine failures before they occur. When equipment in the plant is upgraded to collect data

There is a trade-off between cost and returns in getting from 80 percent to 99 percent accuracy for AI; more often than not, it makes sense to stay at 80 percent, and use human aid to make up the difference. India's advantage in AI services stems from its proven expertise in handling large-scale software services projects.

—SIDDHARTH MALL, Co-founder and CEO, Playment

CASE STUDY 4.6 Scry Analytics: Turnkey AI Solutions Companies—Solution as a Service

SCRY ANALYTICS

What: Collection of AI-enabled enterprise applications across different industries and functions

How: Work closely with each customer, using a service heavy approach, and implement a custom fit AI solution from their wide suite of use-case based product lines

Why: As enterprises adopt AI, they require a tailored approach to making the system work with their unique data, and existing processes

Location: India/US

Collatio

Ingesting, harmonizing, and reconciling data

Risc

Predicting financial and business risks for financial, pharma, and service industries

Anomalia

Identifying potential fraud risk, conflict, and noncompliance in financial and legal transactions

Medsocial

Community and platform for insights from global medical conversations

Data Collection | Data Processing | Integrations | Decision Workflows | Human-in-the-loop | 'Drift' Improvement | User-training

from more points and with higher accuracy, the plant's previous predictive model may not be as effective and the model will need to be retrained with the new sets of data coming from the upgraded equipment. As a consequence, machine learning models need regular maintenance services so that they continue functioning as optimally as possible.

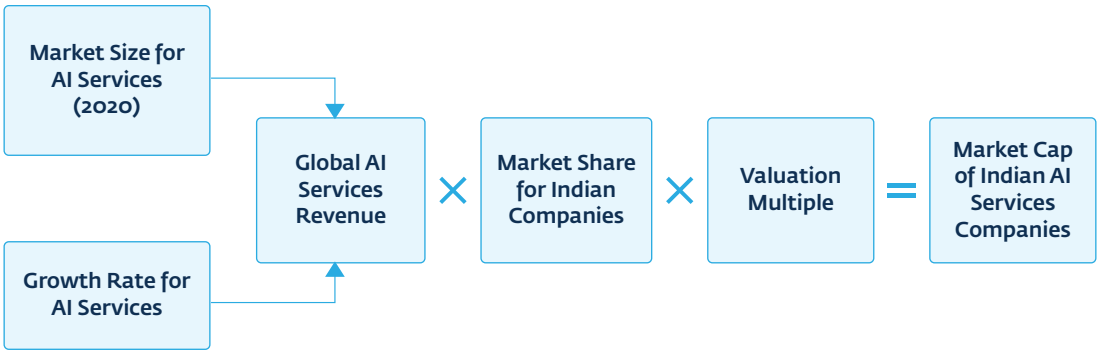
It is worth pointing out that the market for AI services is one where skilled employees would be needed to succeed, and as a corollary, labor cost arbitrage, while useful, is an insufficient competitive advantage. Companies that provide AI services—be this data preparation or model development/deployment/maintenance—use sophisticated technology and employ highly qualified and trained personnel to run their operations. The most important skills needed for success are (a) technical capabilities and (b) managing large delivery projects at scale. India is well placed on both counts, as it has a large population of software developers, an increasing number of data scientists, and decades of experience managing highly complex IT delivery projects.

4.6.1 Sizing the Opportunity for AI Services

To estimate the market size for AI services from India, we used a similar approach to the one we used for AI applications. We divided AI services into two broad categories: (1) IT Services (services such as model testing and deployment, which are already being performed by Indian IT services companies), and (2) business services (such as data labeling and HITL services), which are being provided by Indian business process outsourcing (BPO) companies. We then forecast the aggregate revenue of India's AI services by 2030, and subsequently applied a valuation multiple to arrive at the estimated market capitalization while using a conservative estimate for long-term valuation multiples.

> *AI Services will generate more revenue than AI Applications themselves.*
>
> —SUMIT GUPTA, Head of Product Management, Google

FIGURE 4.14 Methodology: Sizing the AI Services Opportunity for India



Notes:
1. Market growth rate for services assumed to be same as AI applications.
2. Market share for AI services benchmarked against market share for ITeS players from India.
3. Valuation multiples estimated based on data from top 4 publicly listed Indian players.

To estimate the revenue accruing to Indian AI services companies, we estimated the global size of the AI services market, as well as India's market share.

The total global AI services market in 2020 was about $18.4 billion,[51] of which AI IT services accounted for an 80 percent share, and business services accounted for the rest. Similar to AI applications, AI services are also expected to grow by 25 to 40 percent between now and 2030.

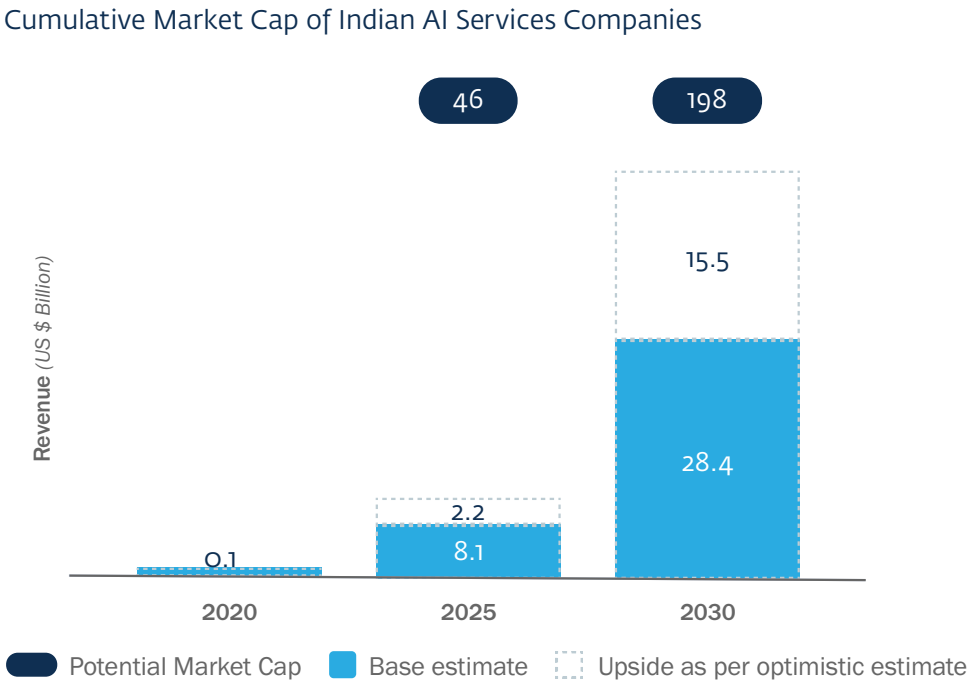
We expect that India's market share for AI IT and business services will follow a similar trajectory as that of traditional IT services and BPO industries, respectively. India is a leading destination, globally, for both IT services (~$1 trillion[52] global market) and BPO services ($166 billion[53] global market), with a market share in 2020 of 10 percent,[54] and 25 percent,[55] respectively. With a conservative assumption of a 6 percent compound annual growth rate (CAGR) for Indian services until 2030, versus a ~3 percent global growth rate until 2030, India's market share in IT and BPO services would be 13 percent and 33 percent, respectively. However, the traditional IT/BPO services industry is fairly mature in India, so with regard to global market share, it is likely that AI services from India will lag behind by up to two years.

The enterprise value (EV)/revenue multiple for India's IT and BPO services businesses averages around 4.5.[56] While the talent cost of servicing AI requirements would be higher than for traditional IT/BPO services, we believe that automation will reduce operations and process costs. Furthermore, AI service vendors can command higher pricing, and would be harder to replace due to sensitivities regarding data sharing. Therefore, on balance, we have assumed a similar EV/revenue multiple for AI services as well. Based on these assumptions, over the next decade, we estimate that for AI services, India could create market capitalization of somewhere between $130 billion and $200 billion.

4.7 The Global AI Opportunity

To conclude, in terms of financial impact, India's participation in the global AI opportunity could create $500 billion worth of market value by 2030,[57] which could add an estimated 900,000 new white-collar jobs, and more than 3.6 million indirect jobs.[58] To put things in perspective, in 2020, the total market capitalization of IT services companies in the "Nifty 50" (India's 50 largest traded companies), was approximately $420 billion; there were only about 12.5 million white-collar employees in India;[59] and the overall net employment growth rate was well below one million jobs per year.

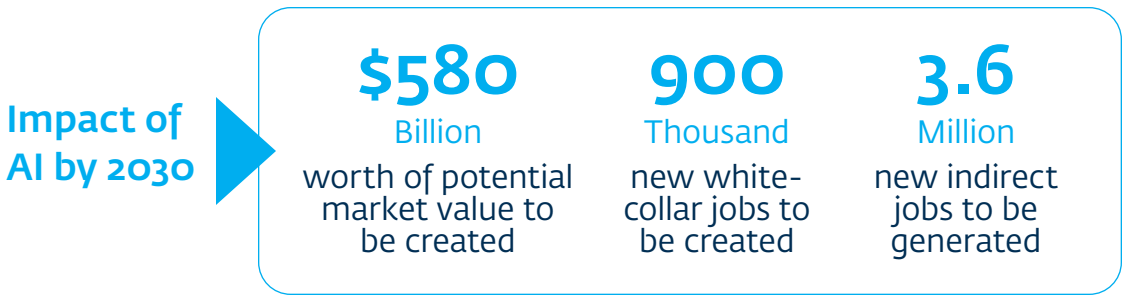
FIGURE 4.15 AI Services Companies Can Create ~$200 Billion Market Cap by 2030



1. Base market growth rate of 35% until 2025 and 25% from 2025–30, assumed to be at same pace as AI Apps & benchmarked against 2000–05 growth in Indian IT companies.
2. Optimistic market growth rate of 40% until 2025 and 30% from 2025–30, same as AI Apps.
3. India's share of global ITeS ~10% and 12% in 2025 and 2030 respectively. Our scenarios assume that AI services will either command similar share from 2025 onwards, or will take two years longer to reach similiar market shares.
4. At maturity, assumed EV/revenue multiple to be 4.5.

Sources: Gartner, NASSCOM, IDC, Grandview, SEC filings

FIGURE 4.16 Impact of India's Play in the Global AI Market



4.8 The Domestic AI Opportunity

India's AI Potential

So far in this report, we have discussed the massive opportunity for Indian companies to create value as a direct result of global AI adoption. While that has been the primary focus of this report, we must also offer our views on the potential for AI adoption in India.

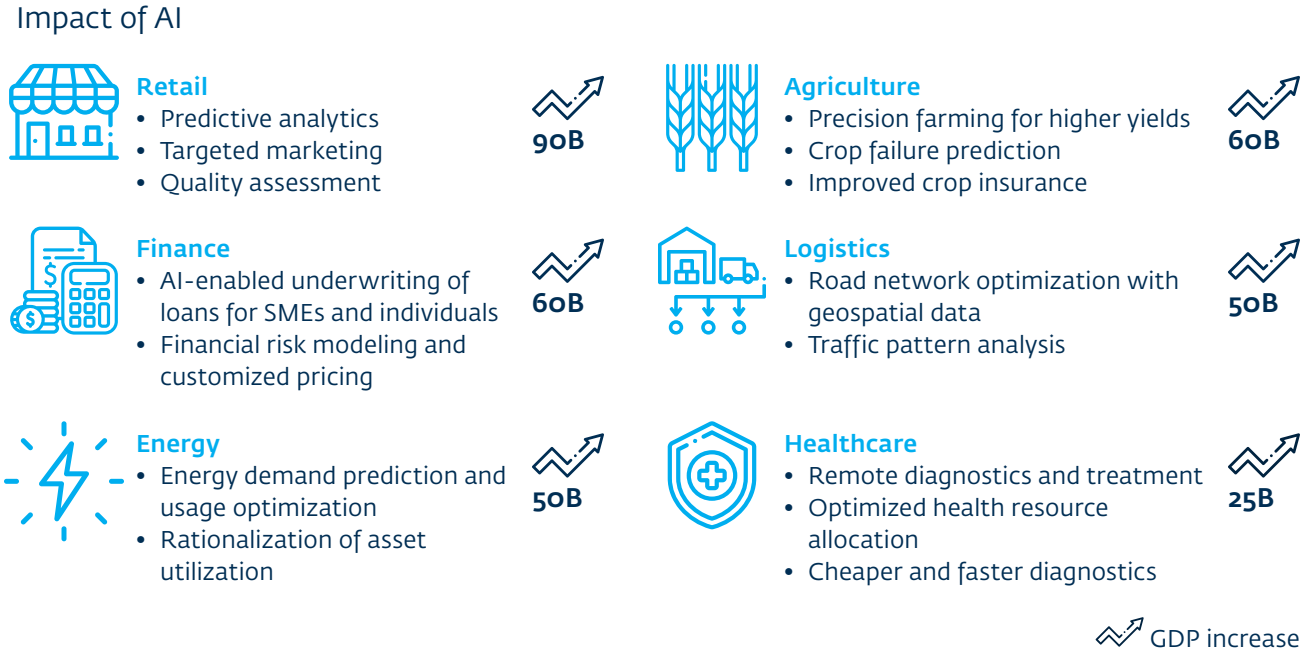
Within India, immense value could be created and captured through AI, not just by for-profit enterprises, but also by the government and society at large. However, so far, the adoption of AI in large sectors in India such as education, healthcare, agriculture, financial services, and retail has been quite limited.

The scale of operations required in India cannot be solved solely through physical and human resources. Indian highways are often choked at tollbooths, hospitals are overwhelmed with incoming patients, and banks are overloaded with know-your-customer (KYC) processes that lead to significant delays. As a result, the economic cost of delays is greater than the cost of investment in AI technology. Therefore, what is pushing AI adoption in India is not the explicit cost of getting the job done by humans, but the implicit cost of delays and inefficiencies.

> *AI start-ups will be pleasantly surprised by the vibrancy and size of the domestic opportunity.*
>
> —C. N. RAGHUPATHI, SVP and Head of India Business, Infosys

AI has already made inroads into the everyday lives of millions of Indians without much fanfare or notice. Banks have embraced digital KYC processes to reduce the customer onboarding time from a few days to a few hours. Tax collection and assessment is now being aided by ML algorithms to identify tax evasion and payout errors.[60] These are not just isolated examples, but are part of a larger push toward a more efficient system of work across India.

FIGURE 4.17 AI Could Add $500 Billion to India's GDP by 2025



Sources: NASSCOM. 2020. "Unlocking Value from Data & AI: The India Opportunity."

On the domestic front, by 2025, $500 billion could be added to India's economy through leveraging AI,[61] spread across key sectors such as agriculture, healthcare, logistics, energy, and finance. For clarification, this is the impact on GDP, as opposed to market capitalization. For example, agricultural yield in India is among the lowest in the world. India's paddy rice yield in 2018 was 3.8 tons per hectare compared to 8.6 tons per hectare in the United States and 7 tons per hectare in China,[62] and this productivity gap cannot be bridged by infrastructure development alone. AI can play a big role by helping farmers directly through precision agriculture, crop failure prediction, pest control, and so on, and indirectly through improved crop insurance and financing. AI-led improvements in sectors such as insurance and financing will also have incremental second-order effects on industries that heavily depend on them such as agriculture, retail, and pharmaceuticals.

In addition to AI's contribution to India's gross domestic product (GDP), there is massive potential for India to create social impact through AI. We are already seeing signs of AI start-ups creating social impact by solving problems unique to India. For example, Niramai is able to provide highly accurate breast cancer detection in a noninvasive manner, which has enabled many more women to come forth for screening. This in turn enables early diagnosis, which significantly improves a patient's chances of survival. Another company, Plantix, helps farmers by providing them with a highly accurate diagnosis of plant diseases within a few hours, and is already used by more than one million Indian farmers.

Other application areas of AI are equally promising. For example, companies today use AI-driven models to assess the creditworthiness of individuals who do not have a financial history, and this is increasing financial inclusion. On the healthcare front, mFine, a medical consultation start-up, is using AI to increase doctors' patient screening capacity by three to four times. This productivity improvement has immense value in a country where the doctor/patient ratio is 1 to 1,445.[63] Accessing medical specialists is one of the biggest bottlenecks in healthcare in India. We are also optimistic and confident about AI's role in helping to improve the quality of life of Indian citizens, and it is this potential that excites us the most when we think about what AI could achieve by 2030. ■

FIGURE 4.18 AI Start-Ups Have Started to Show Impact Across Sectors

Niramai

- Breast cancer is the most common form of cancer among women and kills over 600,000 women each year.
- Indian women with breast cancer have only a 50% chance of survival.
- Niramai's AI-based diagnostics software detects cancer earlier than traditional methods in a noninvasive, radiation-free, and painless manner.
- The technique has shown >90% sensitivity and is 27% more accurate than mammography. Now 32% more women walk into hospitals for breast screening.

plantix

- Farmers need to deal with a variety of problems such as pests and disease during the growing cycle. Problems are often new, with the potential to spread rapidly. Given small landholdings, delays in solving the problem often lead to massive income shocks for Indian farmers.
- The current solution involves visiting local retailers/large farmers, which takes significant time. These inputs are prone to error.
- Plantix takes images of infected crops—which farmers upload through the Plantix app—and, within a few hours, provides a diagnosis along with recommended solutions. It is currently used by >1 million farmers in the country.

CHAPTER 5

Risks and Considerations

5.1 Challenges Ahead

India's path to capitalizing on the AI opportunity, both globally and domestically, is not without challenges. A good way to understand these challenges is to look at the fundamental building blocks of AI software businesses:

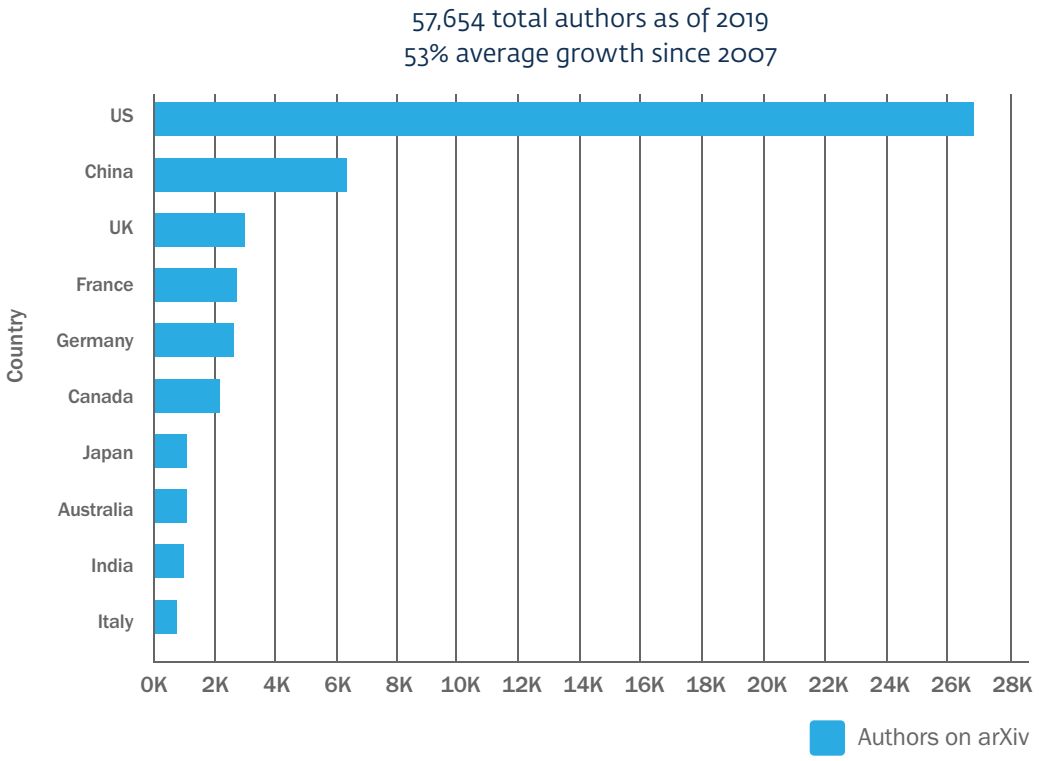
1. **Research:** Research is at the core of designing advanced algorithms and AI models that can push the boundaries of what is commercially viable and create a competitive edge. Moreover, research also improves the viability of AI solutions with respect to their accuracy, cost of training, and the data appetite of models.
2. **Data:** Data is the lifeblood of AI. The continuous and economical availability of usable data is critical for all good AI models.
3. **Capital/Infrastructure:** AI software businesses are more capital intensive than regular software businesses due to the cost of collection and processing of large datasets, model development, and continuous training. As a result, the risk capital required to properly fund AI software start-ups must be both large and patient.
4. **Talent:** Creating AI software solutions requires more than just coding skills. It requires skillful application of data science and mathematics to create, iterate, and improve AI models.

Today, India faces systemic challenges across these four building blocks. According to the Global AI Talent Report 2020,[64] India ranks ninth, globally, with 1,008 AI authors on the open access research-sharing platform, arXiv, compared to 26,818 from the United States and 6,401 from China. Also, according to the same 2020 report,[65] out of 4,149 self-reported AI researchers whose contact information was available on the Internet, only 313 were in India. It has been estimated[66] that the computer science departments of the top 20 Indian engineering universities produce approximately 500–600 PhDs per year, and of these, only about 100 PhDs are in the AI/ML field. However, several leading academic institutions are taking measures to increase the strength and quality of AI researchers in India, and much of this may be done in partnership with government and industry.

> *There is a sore need to fund research projects in cutting edge AI. A thousand such AI projects, challenged with at least a million dollars each in funding, will surely deliver a vastly greater and longer-lasting impact for those at the bottom of the pyramid than the same billion dollars handed out as a subsidy.*
>
> —RAVI GURURAJ, Founder and CEO, QikPod

> *India could have done better as an IT industry powerhouse to establish its leadership in AI; we now need to catch up with heavy government/industry investments in basic AI research, and the creation of open datasets.*
>
> —MANISH GUPTA, Director, Google Research India

FIGURE 5.1 Top 10 Countries: Number of AI Authors on arXiv



India does not fare too well with regard to data availability. Large public data sets are usually the domain of government, and a great deal of public data are still offline in unconnected "silos." For the data that are online, a coherent effort is required to aggregate the data—for example, across state governments—with a plan to make data accessible to AI practitioners in a regulated fashion, with the requisite safeguards to ensure data privacy. For example, while India has adopted an electronic health record (EHR) policy, the sharing of data among hospitals is still at an early stage since different hospital chains have interpreted records' digitization differently.

For AI start-ups to flourish, the government should make more data public, and public data more accessible.

—A WELL-KNOWN INDIAN AI ENTREPRENEUR, identity protected

There is encouraging mindshare on AI development from the government today, and it only bodes well for the industry going forward. Data availability is a better long-term incentive than cash to help AI start-ups succeed.

—PRAVIN RAO, President and Board Member, Infosys Ltd

The availability of infrastructure and capital requirements for AI start-ups go hand in hand. The computing costs required to train world-class AI models are extremely high—some estimates predict that it took approximately $10–12 million to run each epoch for GPT-3 (in ML, an epoch is one complete pass of the training data through the neural network). Experts believe that a well-trained model such as GPT-

3 will require between 10 and 100 epochs—which is, at minimum, an infrastructure bill of over $100 million. This is a significant cost for start-ups, as well as for larger companies. Also, most of India's high-performance computing (HPC) infrastructure is not built for the AI workload. In a list of the world's top 500 supercomputers, which was released in November 2020, only three were in India: Param Siddhi, Mihir, and Pratyush. Of these, the latter two are purpose-built for the specific, non-AI tasks of meteorology and weather forecasting. Moreover, most of India's supercomputers are only available to a few premium educational institutions and government agencies and, hence, unavailable to businesses, including start-ups.

On the talent front, India fares reasonably well, with most estimates of AI talent supply placing India second only to the United States. However, it is possible that China may have a bigger talent pool, as most reports on the topic use LinkedIn for their research, and LinkedIn is not widely used in China. The Global AI Talent Report divides AI roles[67] (barring research) into the following categories: data engineering and architecture, AI/ML engineering, and AI/data productization. The report estimates that of over 470,000 professionals in these roles, globally, India has 75,900, placing the country second only to the United States, which has 186,700 professionals. China's numbers are not reliable because of the underreporting issue mentioned above.

On their own, these numbers paint a good picture. However, India's higher education curriculum has not traditionally encouraged the mingling of arts and science subjects, which means that engineers do not learn about the softer aspects of decision making, and arts students typically do not take courses focused on computational skills. To put this in perspective, a 2019 employability survey by Aspiring Minds, an Indian skill testing company, revealed that 80 percent of Indian engineers are not trained for a job in the knowledge economy, and only 2.5 percent possess the AI skills that industry requires.

Although this is a challenge, it also an opportunity across multiple areas. We believe that the growing demand for AI/data professionals across the spectrum will create opportunities for new education companies. In the last few years, we have seen significant growth in the companies teaching coding to children. We believe that many more Indian companies will be created to target AI education, and some will also target upskilling/reskilling of workers displaced by automation. There will be second-order opportunity effects as well—for example, lending for tech-enabled education aimed at people who want to develop the skills required in the AI age. Similarly, we believe that there will be targeted recruitment portals/companies catering to the demand and supply pools for AI skills.

5.2 Policy—Learnings From the World

The challenges mentioned in the previous section are not unique to India. To varying degrees, every country in the world faces similar challenges. While private enterprises are expected to step in and capture the value from AI adoption, they need policymakers to remove or blunt the challenges under each of the four pillars of data, talent, research, and capital/infrastructure. Policymakers must ensure that: the requisite supporting infrastructure/capital is in place for promising businesses; data are readily and affordably available; training capacity is expanded to ensure a ready supply of quality AI talent; and there is a flourishing research ecosystem for developing local expertise and transferring technology from research to industry.

> *To leapfrog into the future, we will have to re-skill every engineer to be an ML engineer and every employee to be an AI-native. The best thing that the government can do is train the future generation of kids in machine learning, the way they are trained in math or science, making it part of basic literacy.*
>
> —ASHWINI ASOKAN, Founder & CEO, Mad Street Den

FIGURE 5.2 AI Policy Initiatives by Frontrunners

	China	UK	Singapore	US
Research	Govt. selected 'AI national Champions', e.g., Baidu for autonomous driving; and Tencent for computer vision and medical diagnosis	16 new centers for doctoral studies, graduating 1,000 PhDs in 5 years, and govt. skills and talent package such as Turing AI Fellowships	Expedited granting of patents for AI inventions to as fast as six months	Eight strategic priorities areas for federal R&D investment; NSF invests $0.5 billion/year on fundamental research
Capital	Local cities sponsoring AI funds for integrating AI solutions in city infrastructure, e.g., City of Tianjin to establish $16 billion fund for AI development	'Industrial Strategy Challenge Fund' allocates £725 million to tackle grand AI challenges; British Business Bank allocates £2.5 billion 'patient capital'	'100 Experiments' program supports companies in deploying AI in a co-investment model	Department of Medicine, Department of Defence, Food & Drug Administration, and National Institutes of Health develop own AI research and investment policy
Talent	400 new university majors related to AI and big data; lucrative research grants to bring back foreign PhD scholars of Chinese origin	Increasing the number of Tier 1 (Exceptional Talent) Visa up to 2000/year; and industry sponsors for new AI master's degrees in UK universities	AI Apprenticeship Program, TechSkills Accelerator, and joint curriculum with IBM to help citizens	2018, five-year strategy for STEM with AI focus; agency fellowships; and training funding from DARPA, NASA, DOE, NIH, USDA
Data	Public data made available to businesses that partner with the government in facial recognition, healthcare, etc.	Three pilot projects under the 'data-trust' framework for safe, secure, and equitable data transfer; and making high quality public data available	'Trusted data sharing framework' and 'model AI governance framework' for data partnerships and AI deployment	City-level regulations on the use of citizens' data, and defining privacy statutes; Big Data to Knowledge (BD2K) to support data accessibility in biomedical research

Sources: Secondary research, news

Across the globe, some countries are already reaping the benefits of coherent design and implementation of AI-enabling policies. Among these countries, China has been the most notable. With a clear and ambitious target from the central government, and its development of a "new generation AI plan 2030" to attain global leadership in AI, local governments, departments, and universities in China have taken further initiatives to ensure effective implementation. Leading Chinese universities such as Tsinghua University have been forging AI research collaborations with leading foreign universities, and especially with those in the United States.[68] China's researchers have gained critical insights from their exchanges with foreign universities, and they have brought back knowledge to share with other academics in China. This initiative, which started in the early 2000s, has now begun to yield results. As shown in a study[69] of academic AI research papers published up to the end of 2018, by 2025 China should produce the top 1 percent of the most-cited AI research papers. China has created several generous research grants to bring back AI talent that has migrated to other countries. There has also been a tremendous push to develop AI education in

China. Four hundred new university majors in the field of AI and big data were launched in 2019.[70]

City administrations in China are also offering funds for the development of private AI solutions that can be integrated into the city's administrative infrastructure. For example, the City of Tianjin has pledged to establish a $16 billion fund for AI, alone.[71] Meanwhile, the central government has created a specific program for "AI national champions," which are companies playing a key role in developing cutting-edge AI technology that can solve local problems, but also be adopted globally and establish China's leadership in AI development. A few prominent "AI national champions"[72] are Baidu (for autonomous driving) and Tencent (for computer vision and medical diagnosis). Besides regulatory support, these companies get preferential access to large government-owned data sets, which they can use to create increasingly better AI models.

Among the other countries that have done exceptionally well in providing support to AI businesses are the United Kingdom and Canada. Both have focused on attracting top research talent through a mix of research grants, tax incentives, and favorable visa policies.

5.3 India's AI Policy Approach—Laying a Robust Foundation

Despite the challenges, it is encouraging to see that India's concerted push toward AI aligns with the rest of the world's timeline. Most countries announced dedicated AI policies between 2015 and 2020. In 2018, NITI Aayog (India's policy think tank) came up with a comprehensive policy report on AI.[73] This report is a first step in acknowledging India's challenges and suggesting several policy measures to address them.

First, among the key challenges that NITI Aayog has identified facing the development of India's AI capabilities are:

- The lack of broad-based expertise in research and the applications of AI;
- The absence of enabling data ecosystems, and lack of access to intelligent data;
- The high cost of resources and low awareness of the benefits of AI;
- Privacy and security concerns, including the lack of formal regulations about the anonymization of data; and
- The absence of a collaborative approach to the adoption and application of AI.

NITI Aayog has also highlighted the long-term challenges concerning privacy, security, and collaboration that affect the sustainability of the AI technology ecosystem in India.

Second, on the research front, NITI Aayog proposes setting up organizations that draw inspiration from global best practices:

- The Centre of Research Excellence (CORE) in AI, which would focus on developing a better understanding of the current research on AI. This would also emphasize the development of infrastructure tools for the application of basic research.
- The International Centre of Transformational AI (ICTAI), which would focus on providing the ecosystem for application-based technology development and deployment. This would be an industry-led initiative that would take up high-level AI challenges, or inter-ministerial projects focusing on AI-based solutions. The initiative would also focus on the commercialization of early-stage AI technologies and prototypes.

In addition to NITI Aayog, prominent industry bodies such as NASSCOM and iSPIRT have their own recommendations, and have contributed their expertise in laying the groundwork for AI-capability development in India.

Some of NASSCOM's key recommendations include:

- Creating a nodal agency within government for development and diffusion of AI in order to nudge government departments to develop their capabilities to adopt AI;
- Creating a collaborative framework for engagement between government, industry, and academia (public-private partnerships—PPPs) to support start-ups and promote innovative localized solutions;
- Developing an all-encompassing data strategy, integrating public data, and evaluating alternative data-sharing models;

- Addressing skill gaps, revising curricula, creating a marketplace for skilled AI professionals, attracting skilled foreign talent, and including private players in STEM (science, technology, engineering and mathematics) training for citizens; and
- Addressing governance challenges in AI, adopting elements of algorithmic impact assessment, and recommending AI specifications for explainability, robustness, and safety.

In addition to these, NASSCOM has undertaken several other initiatives. For example, NASSCOM has partnered with the Government of Karnataka to set up a center of excellence for data science and AI (CoE-DSAI), based on a PPP model. The goal is to catalyze innovation by providing technology and infrastructure know-how to innovators and start-ups, in partnership with private players such as IBM, Intel, Nvidia, Microsoft, and Digital Ocean.

Similarly, iSPIRT has made recommendations about data availability and privacy, including a framework for "data laws" with principles based on the merits of data democracy, the creation of a level playing field for Indian companies, and a design to enable compliance and convenience.

Implementation of these policy recommendations is still a "work in progress." The government has made commendable efforts to bridge the talent gap by making the development of future-ready talent, and especially talent in the field of AI, a key feature of its recent revision of the National Education Policy (NEP). However, the results of such changes, especially when it comes to developing human capital, will take time, and the NEP's benefits are only likely after 2025. The groundwork for creating the national digital health blueprint, which will create a national public database of citizens' health records, is also underway. This should be a boon for healthcare companies that aim to use machine learning to understand and identify disease patterns and early signals, and enhance drug efficacy.

Similarly, several local governments and administrations have adopted AI-based solutions to solve local needs. The traffic police of Goa is evaluating a computer vision-based street monitoring system, and Chennai police have experimented with a somewhat controversial facial recognition technology system to identify public offenders.

Several efforts of public and private institutions and government bodies are praiseworthy for their focus on building long-term AI capacity. Foremost among these is the Indian Institute of Technology Delhi's School of Artificial Intelligence. Started in 2021, this institution offers PhDs in the field of ML/ AI, and is rolling out postgraduate courses in 2022.[74]

APPENDIX

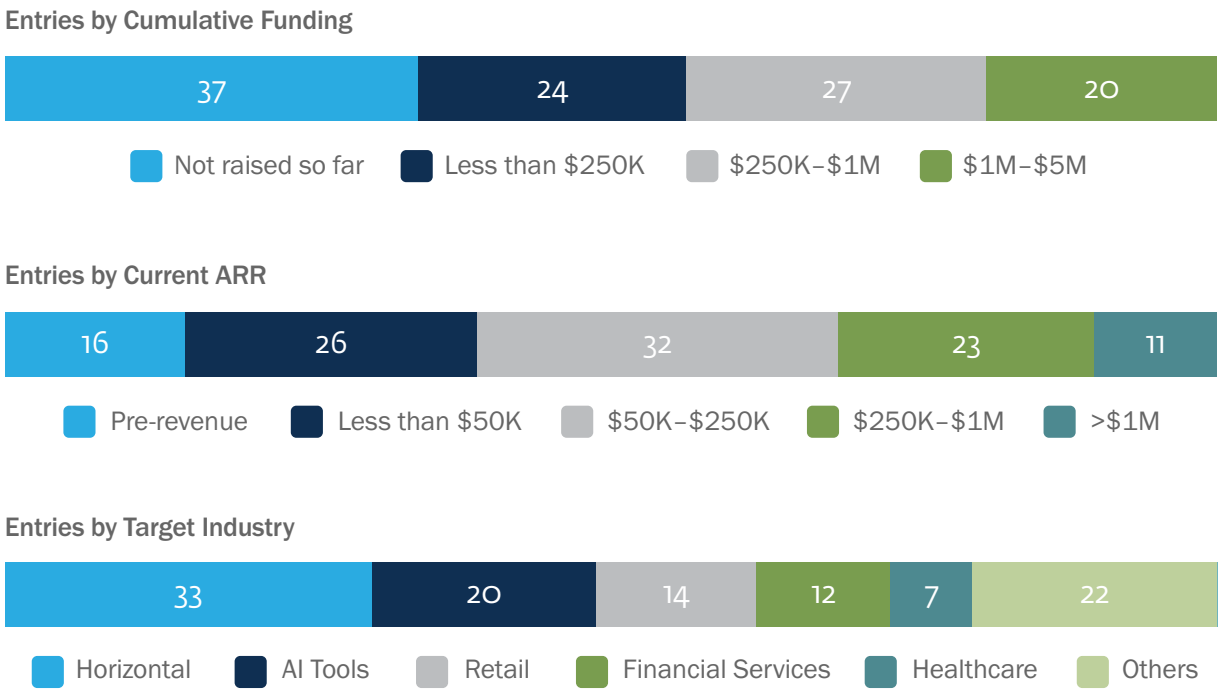
The AI4Biz Challenge

As part of our larger goal to understand the opportunities for Indian AI SaaS start-ups, we conducted a competition to identify the best early-stage AI SaaS start-ups in the country. We undertook this competition, which began in September 2020, in collaboration with Infosys, Cisco, AWS, Github, and Freshworks, and we announced the winners in December 2020.

We received a total of 108 applications from a range of start-ups that, by design, were mostly early-stage. More than 60 percent of the companies had either raised no capital or less than $250,000 in external funding. Two-thirds of the companies, which comprised a broad range of industries and applications, had annualized recurring revenue (ARR) of less than $250,000. In reviewing the applications, we were positively surprised to see some high-quality MLOps and AI platform companies.

In total, 20 short-listed start-ups pitched to a jury comprised of seasoned investors, academics, start-up founders, and industry leaders from the United States and India. Each start-up had 30 minutes to present and field questions from the jury, and then the top 10 finalists were chosen.

FIGURE A.1 108 Diverse, High Quality Applications



A Highly Qualified Jury Supported the Selection of Competitors


ALOK GOYAL, Partner, Stellaris Venture Partners


C.N RAGHUPATHI, Sr. Vice-President & Head of the India Business, Infosys


DILIP KHANDELWAL, Global CIO and India MD, Deutsche Bank


KRISH MANTRIPRAGADA, Chief Product Officer, Seismic


LANA GRAF, Principal Industry Specialist, Artificial Intelligence/Machine Learning, IFC


MANEESH SHARMA, Country Manager, India, Github


PANKAJ MITRA, Director & India Head, Cisco Investments & Acquisitions


PRASAD JOSHI, Senior Vice President, Emerging Technology Solutions, Infosys


RAHUL GARG, Professor of Computer Science, IIT Delhi


RAHUL PANGAM, Vice President, Paypal


RUCHIRA SHUKLA, Regional Lead, South Asia, Disruptive Technologies—Direct Equity & VC Funds, Global HealthTech Sector Lead, IFC


VISHAL GOENKA, Founder, CEO of Stealth Mode AI Startup

Each of the finalists was eligible for generous support, which was made possible through the industry leaders who supported us in this initiative. It is worth pointing out that Stellaris made an investment in one of the 10 winners in the final cohort. Also, IFC has chosen to pilot the AI-powered human resources assistant, Amber, which is offered by inFeedo, another start-up among the top 10 winners.

A brief overview of each of the final 20 start-ups, several of which have been discussed in this report, is presented in Figures A.3 and A.4.

FIGURE A.2 Generous Support for Cohort Members from Industry Leaders

FIGURE A.3 AI4Biz: Top 10 Winners

Company	Description
Blue Sky Analytics	Data intelligence start-up leveraging satellite data+AI to generate environmental datasets across a range of air, land and water parameters.
inFeedo	Empowers HR leaders to identify gaps in culture and employee experience through human-like chat bot.
Inspekt labs	Computer vision platform focused on automation of physical asset inspections (such as cars) using photos/videos.
LimeChat	Shopify for chat; provides a personalized shopping experience for D2C companies on chat platforms using L3 conversational AI.
Myelin Foundry Everything AI, Anything Creative	Uses AI on video and voice to enhance resolution on edge devices with low bandwidth; target use cases include media consumption among rural India and moving vehicles.
Predible	Helps pulmonologists reduce misdiagnosis and improve follow-up care through accurate analysis of chest CT imaging by using AI.
Prescinto	SaaS platform, applies AI in solar power plants to identify causes for underperformance and suggests work orders to plant crew.
SAMATA.AI	Enables balanced decision-making through techniques that identify and remove human biases in AI training datasets.[75]
Segmind	MLOps platform to help teams collaborate on their machine learning products.
Synapsica BETTER RADIOLOGY	Improves efficiency and decision making in radiology. Offerings include a cloud marketplace of radiologists for diagnostic centers as well as an AI-driven PACS radiology workflow solution.

FIGURE A.4 AI4Biz: Additional Finalists

Company	Description
Attentive	Leverages insights from geospatial data to help outdoor service professionals—lawn care, pest control, landscaping, etc.—better manage their businesses.
B2Brain	Provides contextual intelligence for target accounts for salespeople and integrates deeply with underlying CRM systems.
ENTHIRE	Leverages AI to create the equivalent of a credit score for talent. Automates and crowdsources candidates' technical skills (acquired by InfoEdge).
factors.ai	Analytics platform that enables B2B marketers to make better decisions through goal-driven, automatically 'surfaced' insights from data.
Mate Labs	Demand forecasting solution for supply chains in the CPG/Retail sector; Reduces waste and stockouts.
solvio	Computer vision and NLU solution that understands, analyzes, and auto-grades free-form student responses (digital and handwritten).
Taskmonk	Enterprise data labeling platform for data science teams developing production-level AI.
UPTIME AI ELIMINATE SURPRISES	Operationalizes AI for factories, enabling them to improve equipment reliability and process efficiency.
Vaultedge	By automating document processing with AI, helps mortgage lenders and servicers reduce the time and cost to close mortgages.
Wobot.ai	AI-powered video analytics platform that helps businesses monitor internal and external process compliance.

ENDNOTES

1 For the purpose of this report, a start-up is defined as any company or project that is created by an entrepreneur to develop and validate a business model. Please note that there are several definitions for this term. The definition used by the Indian government is available at the following link: https://www.startupindia.gov.in/content/sih/en/startup-scheme.html

2 It is worth noting that the government of India has already implemented several policies with a view to developing an Indian AI ecosystem, e.g., the India Semiconductor Mission and the Hyperscale Data Centre Policy.

3 As of January 15, 2022.

4 In the financial world, a unicorn is a privately owned start-up with a valuation greater than $1 billion.

5 Throughout this document, wording such as "AI-led applications," "AI applications," "AI software," and "AI SaaS" have been used interchangeably.

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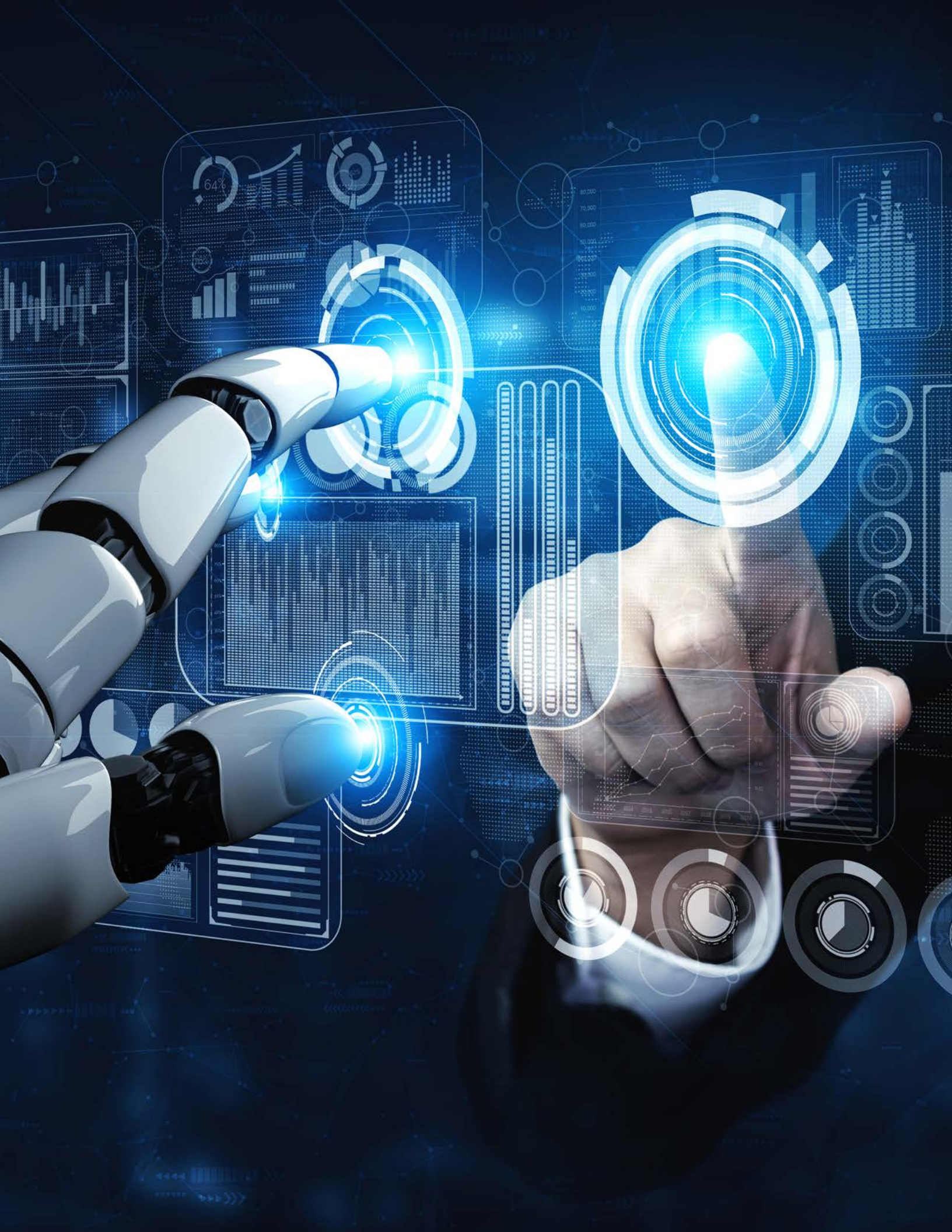
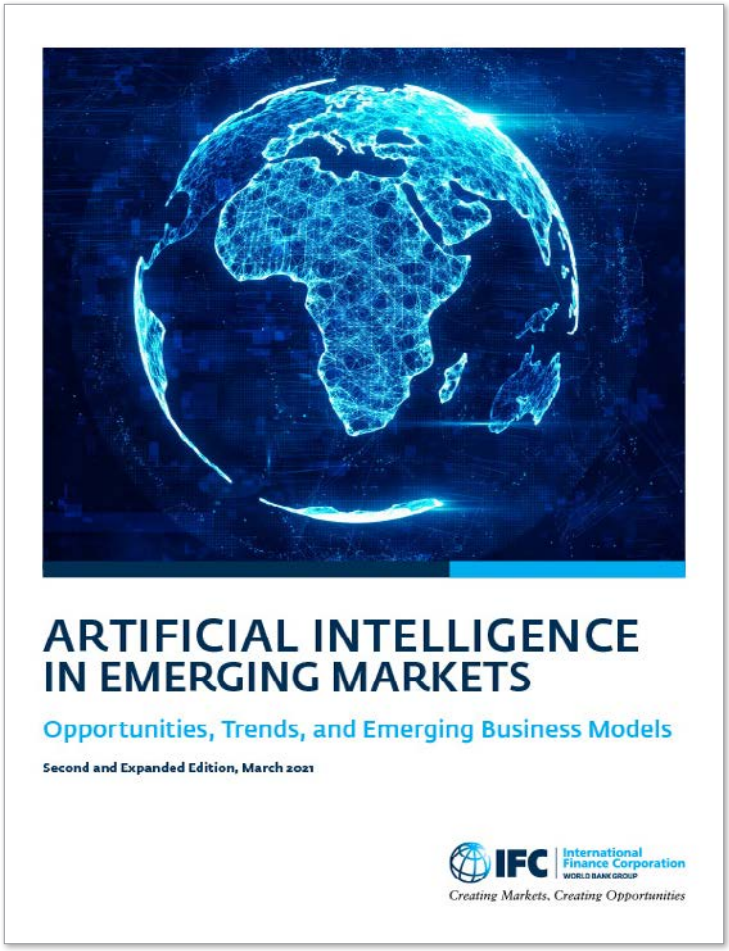


FURTHER READING

Additional reports about investing in challenging markets and the role of technology in emerging markets, as well as a list of EM Compass Notes published by IFC Thought Leadership. Visit http://ifc.org/thoughtleadership.



Artificial Intelligence in Emerging Markets: Opportunities, Trends, and Emerging Business Models

March 2021, Second and Expanded Edition—148 pages

Artificial intelligence (AI)—the science of making machines act in rational, intelligent ways—is rapidly making inroads into business operations and society. AI is already being applied in many areas of our lives, with high penetration in financial services followed by e-commerce, healthcare, post-secondary learning, agriculture, and manufacturing.

Emerging markets can benefit significantly from AI: Its applications are providing new ways to leapfrog infrastructure gaps and solve pressing development challenges in critical sectors.

This report explores the latest AI applications and trends in emerging markets and includes several examples of how AI is expanding opportunities and contributing to the achievement of the Sustainable Development Goals. It also sheds light on how investors, clients, and governments can harness its full potential while minimizing its risks—when managed effectively and with safeguards in place, AI can facilitate private investment to reduce poverty and improve lives at a pace inconceivable only a decade ago.

Reinventing Business Through Disruptive Technologies: Sector Trends and Investment Opportunities for Firms in Emerging Markets

March 2019—108 pages

Technology disrupts and transforms. And disruptive technologies are critical to achieving the Sustainable Development Goals, many of which can be advanced and accelerated through technological innovations.

For a comprehensive examination of the ways these innovations alter private sector business models in emerging markets, IFC conducted a tour of the technology horizon in eight selected sectors—power, transport, water and sanitation, digital infrastructure, manufacturing, agribusiness, education, and financial services—and six selected themes, from gender and climate-smart cities to e-logistics and personal identification, among others.

This report examines each of these sectors and themes in terms of what true disruption looks like, which technologies are most likely to have a dramatic impact, and the specific opportunities they offer. It also identifies the challenges and constraints that will need to be surmounted if the private sector is to seize these opportunities. Lastly, it presents how IFC supports companies and investors in their efforts to enter into or expand in emerging markets.

Blockchain: Opportunities for Private Enterprises in Emerging Markets

January 2019, Second and Expanded Edition—88 pages

Over the course of two years, IFC worked with key influencers and experts in the worlds of distributed ledgers and digital finance to create a series of nine papers examining the potential and perils of blockchain. An initial report with six chapters was published October 2017. Since then, three additional in-depth notes have been added to broaden and deepen our understanding of this burgeoning technology, its enormous potential, and its many challenges. These documents collectively examine the general contours and technology underlying blockchain and its implications for emerging markets.

Specifically, this report provides an examination of blockchain implementation in financial services and global supply chains; a regional analysis of blockchain developments in emerging markets; a new focus on blockchain's ability to facilitate low-carbon energy solutions; and a discussion of the legal and governance issues associated with the technology's adoption.

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