ASSESSMENT OF OPPORTUNITIES FOR SKILLS DEVELOPMENT FOR THE ARTIFICIAL INTELLIGENCE DRIVEN AGE

Final Report for

11ʰ of May, 2020

TABLE OF CONTENTS

ACRONYMS & DEFINITIONS

ACRONYMS

1	ABAP	Advanced Business Application Programming
2	AHDL	Altera Hardware Description Language
3	AI	Artificial Intelligence
4	ASIC	Application Specific Integrated Chip
5	COBOL	Common Business-Oriented Language
6	CPU	Central Processing Unit
7	CUDA	Compute Unified Device Architecture
8	DMA	Direct Memory Access
9	FPGA	Field Programmable Gate Array
10	GCC	Global Capability Centers
11	GPU	Graphics Processing Unit
12	IT/ BA	Information Technology/ Building Automation

13	MATLAB	Matrix Laboratory
14	ML	Machine Learning
15	MNC	Multi National Companies
16	NN	Neural Networks
17	ODM	Original Device Manufacturer
18	PCB	Printed Circuit Board
19	RAM	Random Access Memory
20	RPA	Robotic Process Automation
21	TPU	Tensor Processing Unit
22	VB	Visual Basic
23	VHDL	Very High-Speed Integrated Circuit Hardware Description Language

DEFINITIONS

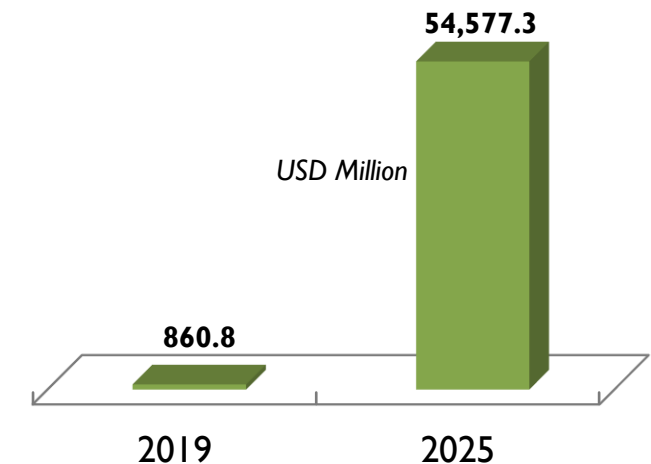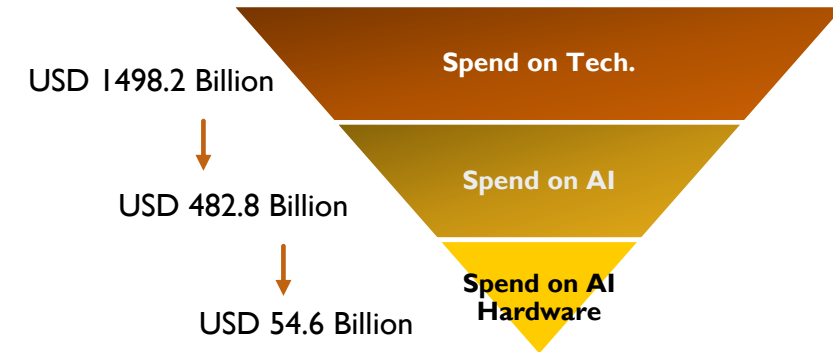|		
1	AI Hardware	AI hardware refers to certain type of AI accelerators — a class of microprocessors, designed to enable faster processing of AI applications, especially in machine learning, neural networks and computer vision. Associated hardware considered are Memory and Networking.
2	AI Software	A software that is capable of intelligent behavior - in creating intelligent software, this involves simulating a number of capabilities, including reasoning, learning, problem solving, perception, knowledge representation.
3	Artificial Intelligence	The ability of a digital computer to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience.
4	CPU	A CPU is the central processor of a computer is the electronic circuitry that executes instructions of a computer program. It performs basic arithmetic, logic, controlling, and input/output operations specified by the instructions.
5	Fabless Companies	Fabless chip makers are companies that produce semiconductors for use in various types of electronics. The term "fabless" means that the company designs and sells the hardware and semiconductor chips but does not manufacture the silicon wafers, or chips, instead, it outsources the fabrication to a manufacturing plant or foundry.
6	GPU	A GPU is a specialized electronic circuit designed to rapidly manipulate and alter memory to accelerate the creation of images in a frame buffer intended for output to a display device. They are used in embedded systems, mobile phones, personal computers, workstations, and game consoles.

Avanteum
DISCOVER FUTURE

DEFINITIONS

7	Global Capability Centers	The offshore centers created by global organizations that hold repository for internal IT or operations functions. They drive processes and productivity improvements for global operations besides creating new capabilities, drive innovation and lead cross functional efforts. They are primarily built on a cost arbitrage model.
8	Large Corporates	Large diversified business houses which full fledged operations in India spanning innovation, design, development and manufacturing.
9	Machine Learning	Machine learning is an application of AI that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.
10	Neural Networks	A neural network is a network or circuit of neurons, an artificial neural network, composed of nodes. It can be a biological neural network or an artificial neural network, for solving AI problems.
11	PCB	A PCB mechanically supports and electrically connects electrical or electronic components using conductive tracks, pads and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate.
12	Start-up	A startup is a company or project initiated by an entrepreneur to seek, effectively develop, and validate a scalable business model.
13	TPU	A TPU is a proprietary processor designed by Google in 2016 for use with neural networks and in machine learning applications

Avanteum
DISCOVER FUTURE

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

- AI technology is set to define businesses and economic activities in India. The AI industry is set to grow to USD 482.8 billion by 2025.

- AI hardware industry spending is likely to double every year till 2025 to reach USD 54.6 billion.

- Multitude of industry segments and India specific needs to be the cornerstone of AI industry growth in India. Currently 1700 AI oriented start-ups operate in India.

- While the AI industry will leverage India's existing software capabilities, but hardware expertise is an emerging opportunity. Appreciation of India's engineering expertise reflected in global companies setting up India centers for AI. India has the 9th largest pool of AI specialists in the world and ranks 3rd in the number of research publications.

- AI hardware is in its nascent stage since semiconductor chip development has limited presence in India. Nevertheless, emergence of fabless companies and outsourced hardware jobs portend good potential.

USD 1498.2 Billion

Spend on Tech.

USD 482.8 Billion

Spend on AI

USD 54.6 Billion

Spend on AI Hardware

54,577.3

USD Million

860.8

2019   2025

Avanteum
DISCOVER FUTURE
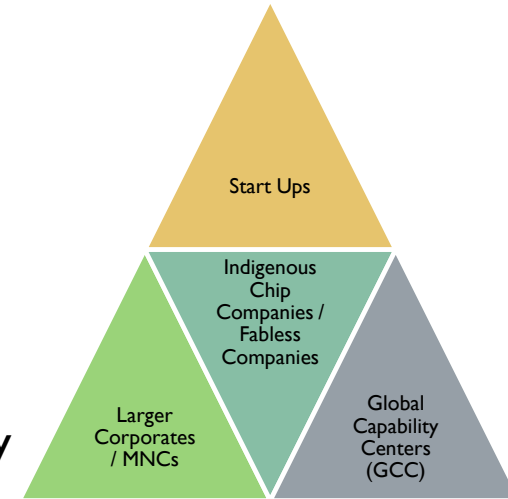
EXECUTIVE SUMMARY

- Annual demand for AI hardware professionals is expected to be 16,888 in 2020 and is likely to reach a size of 434,967 by 2025, thus growing at a rate of 92% during the forecast period. Hardware professionals currently constitute 10-14% of total AI professionals and this proportion is expected to increase by 2025.

- Global capability centers with 54% will lead the demand for AI hardware workforce by 2025 followed by large corporates at 25% and start-ups with 20%.

Number of Professionals

2020	2021	2024	2025
16,888	39,351	3,78,759	4,34,967
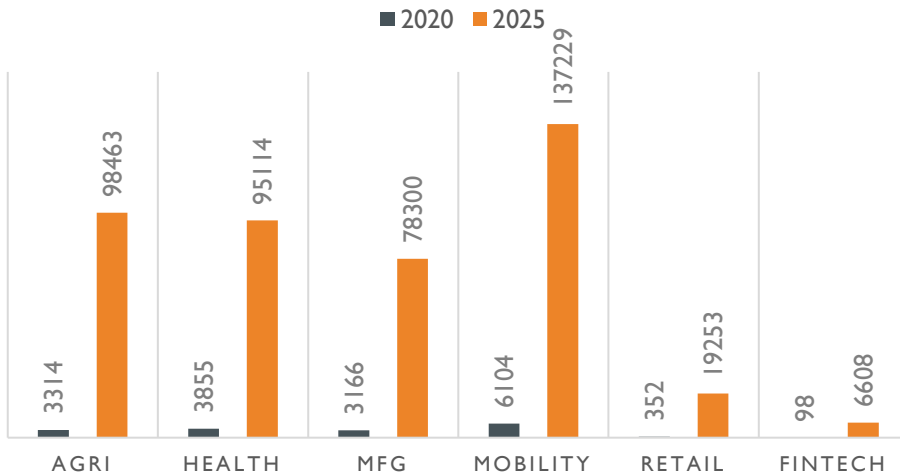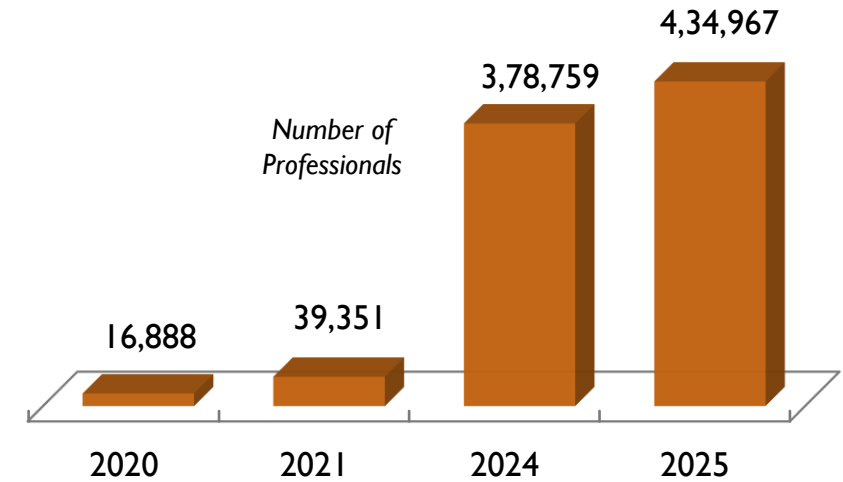
- Mobility to be the leader in AI skills demand generation for hardware with Autonomous Vehicles, Fleet Management and Urban Mobility solutions driving innovation.

- Precision Farming, Drones, Increased automation and precision in food processing, Insurance are the key application areas within agriculture and food tech, the second largest contributor of skills by 2025. Healthcare with the third major sector while manufacturing too will offer fair share to the skills demand.

2020 **2025**

	AGRI	HEALTH	MFG	MOBILITY	RETAIL	FINTECH
2020	3314	3855	3166	6104	352	98
2025	98463	95114	78300	137229	19253	6608

Avanteum
DISCOVER FUTURE

EXECUTIVE SUMMARY

- AI industry hiring varies by size of organizations and also the stage of its financial maturity. Global companies with capability centers hire large number of fresh graduates and fill senior positions with experienced hands. Start-ups with limited financial resources tend to optimize workforce budget by investing more on experienced professionals. Larger corporates/MNCs hire experienced professionals as well as recruit fresh engineers who are then trained in house for the next 6 months to a year.

- Preference for Electronics, Instrumentation, Computer Science and Electrical Engineers is largely witnessed. Primary hardware functions executed are board design, system assembly and test, and integration of hardware with software. Hardware design and integration skills are a pre-requisite while working knowledge of major AI hardware platforms is desired.

- Electronics systems design and manufacturing is also expected to be positively influenced by the AI industry growth. As the need for local IP and local production witness an increase, traditional skills related to design, manufacturing and services will get renewed support.

Start Ups

Indigenous Chip Companies / Fabless Companies

Larger Corporates / MNCs

Global Capability Centers (GCC)

STRATEGIC RECOMMENDATIONS

CURRICULUM

- Courses/programs that ESSCI is recommended to commence training on.
- Topics to be covered initially and advanced programs to be added later.

LOCATION

- Includes recommendations on locations to be considered for the practical labs for the courses recommended.
- Reason by choice of centers and the partnerships to be explored are detailed.
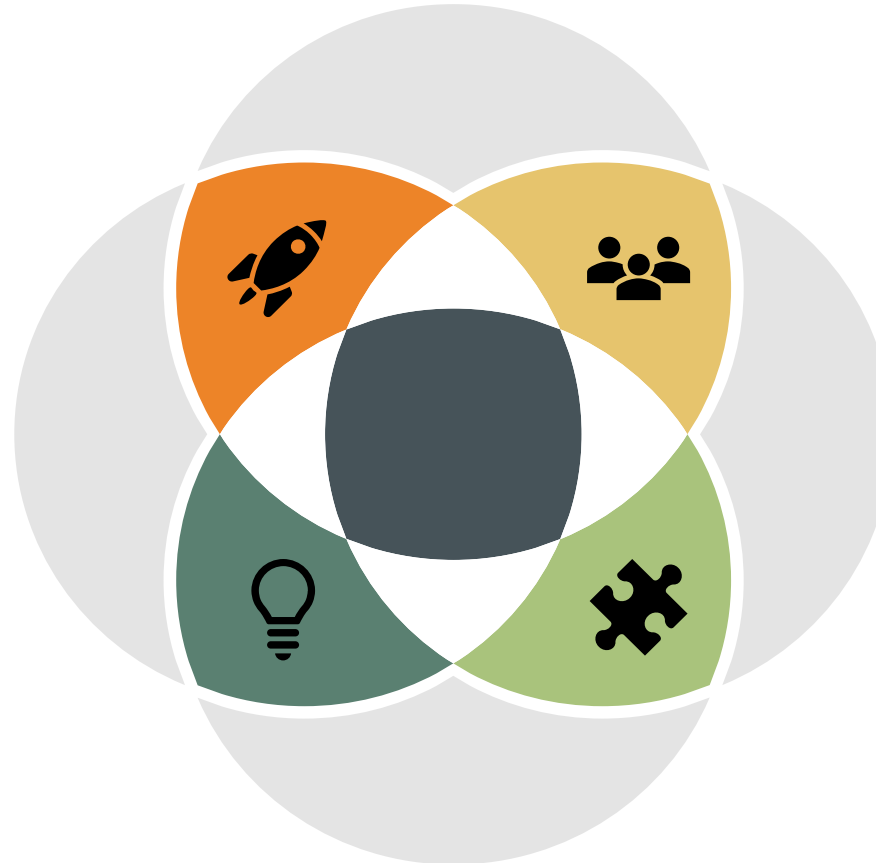
DELIVERY

- Best suited delivery models are recommended
- Delivery partners are suggested.
- Recommendations on trainers are also covered.

MARKETING

- Branding and awareness creation for the ESSCI AI course is recommended.
- Avenues for marketing to the trainess and potential hiring companies are detailed.

RECOMMENDED STRATEGIC PARTNERS FOR ESSCI'S AI HARDWARE TRAINING INITIATIVE

Academia

ESSCI needs to actively engage with the Academia, esp institutes that have faculty with vast experience in AI for the following:
- Understanding the existing need gaps in engineering curicula.
- Design and finalize the topics / coverage for the propsoed training.
- Enrol professors as faculty and mentors.
- Ideate and get feedback on delivery models.
- Promotion for the program through faculty.

Accreditation/Approval Agencies

ESSCI is recommended to seek accreditation and approval for the program/courses from recognized partners such as AICTE, NABET etc which would lend greater credibility to the program and improve patronage
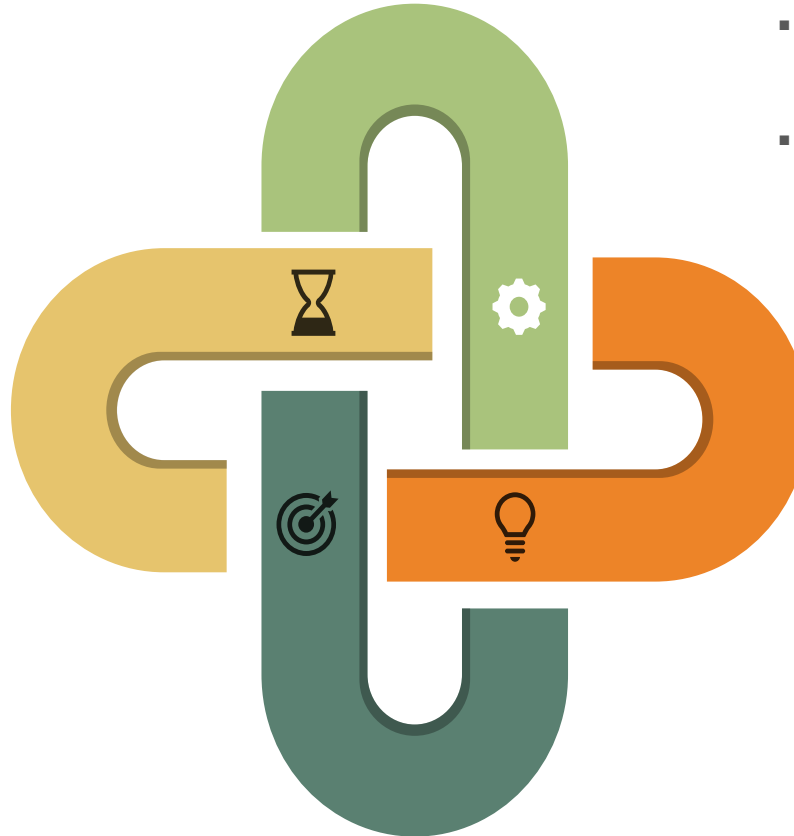
MeitY

- ESSCI is recommended to seek funding from MeitY for the practical labs under the larger AI initiatives of MeitY.
- Opportunities for fee sponsorship by MeitY for eligible trainees from poor backgrounds to also be explored.

Industry

- ESSCI needs to engage with AI industry partners – platform developers, chipset companies, AI systems companies, GCC etc for the following:
  - Ideating and finalizing the content for curriculum.
  - Engaging industry experts for delivery of training and supporting as mentors.
  - Forge agreements for placement assurance of trainees.
  - Sponsorship of reference boards and kits required for the trainees.

Avanteum
DISCOVER FUTURE

CURRICULUM STRATEGY AND RECOMMENDATIONS

Basics of Hardware Design & Artificial Intelligence Hardware

01 Level I

This level shall cover the theoretical basics of hardware / board design and AI hardware. Topics covered to include:

- Architecture and Design of multilayer PCB and Embedded Systems, EDA
- Multicore, multiprocessor, GPU, FPGA based hardware design
- Hardware prototype development and testing
- Product certification and compliance
- Low volume manufacturing / value engineering
- Component benchmarking / selection / obsolescence management
- Transfer to production
- Neural networks – RNN, CNN
- Parallel Computing, Edge Computing,
- GPU Acceleration, FPGA accelerator systems, SoC AI systems
- Neural network processing units (NNPU)
- GPGPU Architecture
- Analog and Digital design basics
- In memory computing

AI Hardware Platforms & AI System Integration

02 Level II

This level shall train the trainees on the most common AI hardware platforms currently in the market. Some of the common platforms to be covered include:

- Intel Xeon Phi, Intel Arria FPGA, Intel Movidius MyraidX VPU,
- NVIDIA Jetson/Jetson Nano/Jetson X2/Jetson Xavier
- Google TPU / Coral
- FPGA based AI platforms
- Hardware and facilities planning, including servers, networking, storage, management, power, and cooling
- Introduction to working on futuristic AI hardware – memory, accelerator

H/W S/W Integration; Hardware Application

03 Level III

- Machine vision in AI use case – Autonomous vehicles/precision agriculture
- Image processing in AI use case – med tech application, autonomous vehicles
- Implementation of ML/DL algorithms on hardware
- Understanding the integration of AI hardware and software
- Understanding of AI relevant Technologies - TensorFlow, PaddlePaddle, MXNet, Caffe, Digits, Pytorch, NVIDIA Tensor RT, Horovod, Keras, Torch, CNN, CFCM (coarse-to-fine context memory), Generative Adversarial Networks (GAN), CUDA, Numba, NumPY, OpenACC, ML Algorithms such as XGBoost, cuGRAPH, cuML, RAPIDS.

RECOMMENDED DURATION AND COURSE COMPONENTS

	01 Level I	02 Level II	03 Level III
Course Components	Theoretical sessions Demonstration sessions through AV Practical lab sessions Project 1 – Board design for a hardware design	Mostly practical sessions Hands on design of AI system (only hardware) using different AI hardware platforms Project 2 – Design of a AI hardware system for specified use case	Combination of theoretical and practical sessions Design and development of complete AI system including software integration Testing of hardware and software Project 3 – Design and implementation of complete AI system
Course Duration	40 to 60 hours	60 hours	60 – 80 hours

PROGRAMS TO BE SUBSEQUENTLY ADDED – SECTOR SPECIFIC COURSES; ADVANCED COURSES

Sample course coverage areas for different end user segments/ application use cases for AI

Autonomous Vehicles
- Design of AV, ADAS
- Multi platform design

Precision Agriculture
- Design of systems for weather based intelligent agriculture
- Design of AI processed food processing systems

Med Tech
- Design of AI based remote testing and diagnosis development using imaging
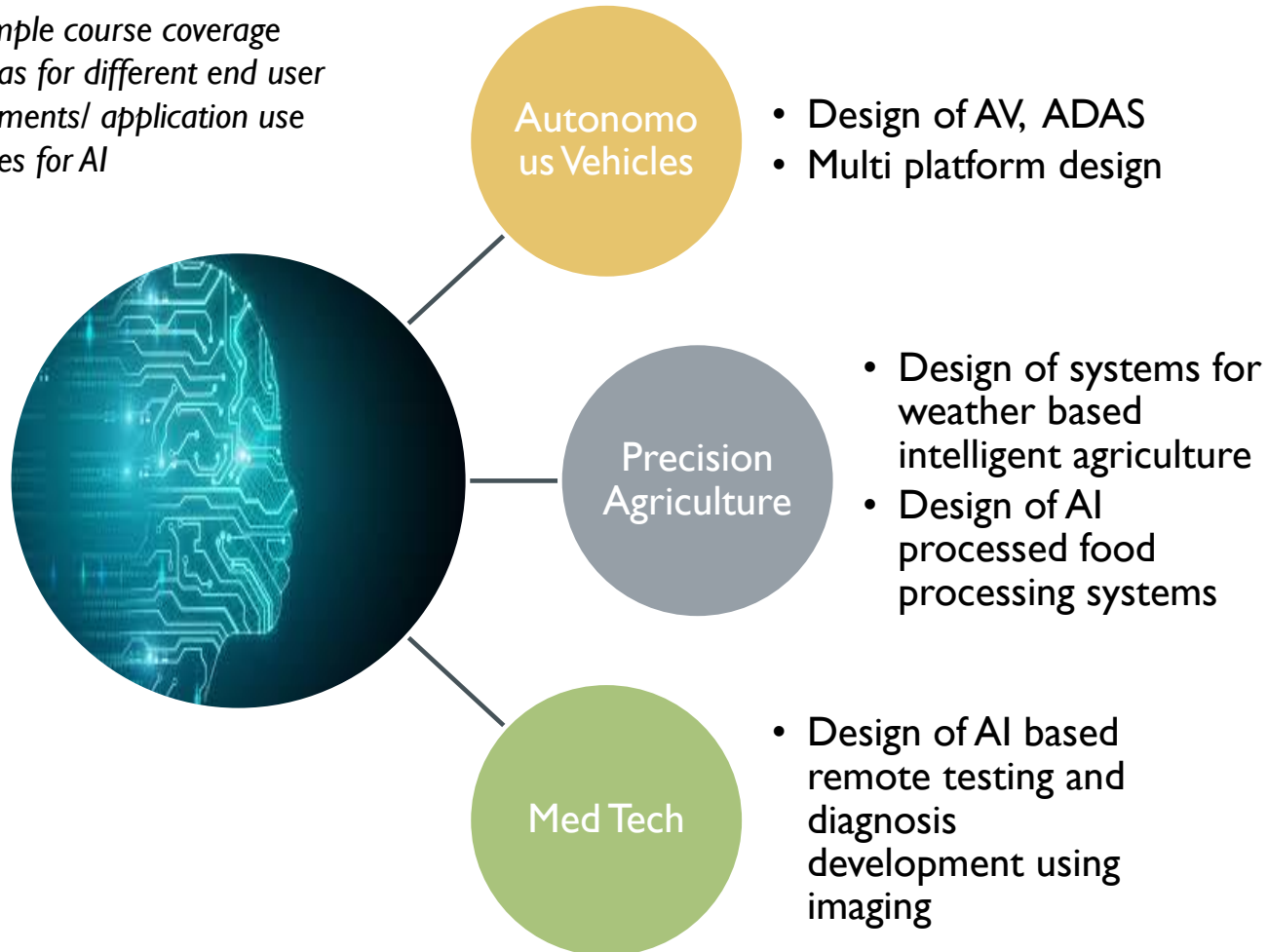
- Advanced program courses can be added after a couple of years
- These are courses to train graduates with 1-2 years of experience in the electronics / IT or related industries who wish to make a transition into a AI job
- The topics/courses covered under advanced level can include:
  - Working on next generation of AI hardware (newer emerging AI silicon)
  - AI chip design – design of AI chip on FPGA/ASIC for specific application/use
  - Improving performance of AI system – understanding the performance enhancement measures of different components of AI hardware/software; integration challenges; efficiency enhancement design measures etc.

Avanteum
DISCOVER FUTURE

TIMELINE FOR CURRICULUM STRATEGY PLAN

MONTH

1-2

3-9

10-11

12

Finalizing Course Plan

- Discussion with academia, industry, to finalize the topics to cover.
- Design of curriculum plan – courses, duration, course coverage topics, depth of coverage etc.

Development of curriculum content

- Formulate a content development advisor committee comprising representatives from academia, industry to foresee content development.
- Develop course content

Validation and Certification for content

- Iterations and finalization of course content
- Development of digital tools to aid content
- Certificaiton of content by authorized content advisory committee

Printing of material; Launch of curriculum

- Printing of requisite course supporting material
- Launch of curriculum - promotion campaigns
- Apply for approval – AICTE or NABET etc

Avanteum
DISCOVER FUTURE

DELIVERY STRATEGY AND RECOMMENDATIONS

COMBINATION OF ONLINE AND CLASSROOM DELIVERY RECOMMENDED

ONLINE

- Theoretical topics are recommended to be delivered online.
- Recommended delivery model for online is to partner with elearning service providers such as Unacademy, Upgrad. ESSCI is recommended to partner with a elearning service provider for hosting of their sessions online. Content and trainer would still be of ESSCI ownership.
- Alternatively, partnering with education service provider such as http://thestrategyacademy.org/ is recommended. They provide the platform for conducting live and interactive online sessions and also provide analysis on student participation, performance, eboard room for discussions etc.
- Sessions are to be scheduled for after college hours at the frequency of 1-2 times a weeks. Per session duration of 2 hours recommended.

CLASSROOM/LAB

Practical sessions are to be conducted at the ESSCI AI Lab. Labs are recommended to be set up at key locations such as Bengaluru, Hyderabad, Chennai, Mumbai, Delhi etc.

A few guest lectures by industry experts are also recommended to be conducted along with the practical sessions in the lab.

The practical sessions are recommended to be planned to coincide with the academic holiday cycles or weekends to facilitate student participation.

Avanteum
DISCOVER FUTURE

RECOMMENDED PLAN FOR TRAINERS

INDUSTRY

- ESSCI is recommended to enrol as training partners industry experts from premier AI platform developers, AI chipset companies, and AI systems companies.
- Apart from guest lectures, the industry experts can be positioned as guides for groups of trainees to assist in their practical sessions.

TTT

- ESSCI would need to allocate the initial 2-3 months of its planning stage for conducting train and trainer sessions.
- Familiarizing the trainers with the online delivery platform, tools available for imparting AV based training, familiarization with the course curriculum etc are activites that shall be covered.

ACADEMIA

- ESSCI is recommended to enrol reputed professors from institutes such as IIT M, IIT B, IIITH etc which have AI dedicated labs and professors well versed in various AI topics.
- Since the online delivery formats permit trainers to deliver from wherever they are, professors would be encouraged to be part of this initiative

GLOBAL TIE UPS

- ESSCI is also recommended to identify institutes globally that impart AI hardware training and explore possibility of engaging their faculty for guest lecture sessions or delivery of specific theoretical topics.
- Online delivery format makes delivery even from foreign locations possible

Avanteum
DISCOVER FUTURE

TIMELINE FOR DELIVERY PLAN

MONTH

1-3

1-3

6-8

8-10

Identifying Online Partner

- Discussion with shortlisted elearning service providers, requesting demos, discussion on partnership models etc.
- Finalizing the elearning partner and having the online medium designed for ESSCI course.

Identifying Trainers

- Discussion with targeted institutes' faculty for forging traniner agreements
- Discussion with industry experts to enrol as guest lectures and practical guides
- Discussion with global institutes for faculty enrolment.
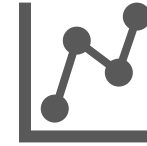
Hosting of Online Medium and Test Runs

- Collaboration with the elearning partner to design and host the online platform
- Mock/demo sessions by trainers to test the platform and remedy any glitches

Launch of elearning platform and trainers

- Official launch of the elearning platform
- Hosting of profiles of trainers on the platform
- Beginning the scehduling of sessions for delivery commencement.

LOCATION STRATEGY AND RECOMMENDATIONS

TRAINING LABS LOCATION STRATEGY PLAN

Key Centers for AI Investment	• Tier 1: Bangalore, Hyderabad, NCR • Tier 2: Chennai, Pune/ Mumbai, Kochi
3 Key Source of Employment Generators	• GCCs • Large Corporates • Start-ups
Establishment of Training Labs for Practical	• In Collaboration with Leading Industry Players • Partnership with Colleges

Average investment per lab is estimated to be INR 20-25 Lakhs*

- Majority of the operational AI companies are located in Bangalore and Hyderabad. Existing AI expertise and technology talent pool are the attractions for investors

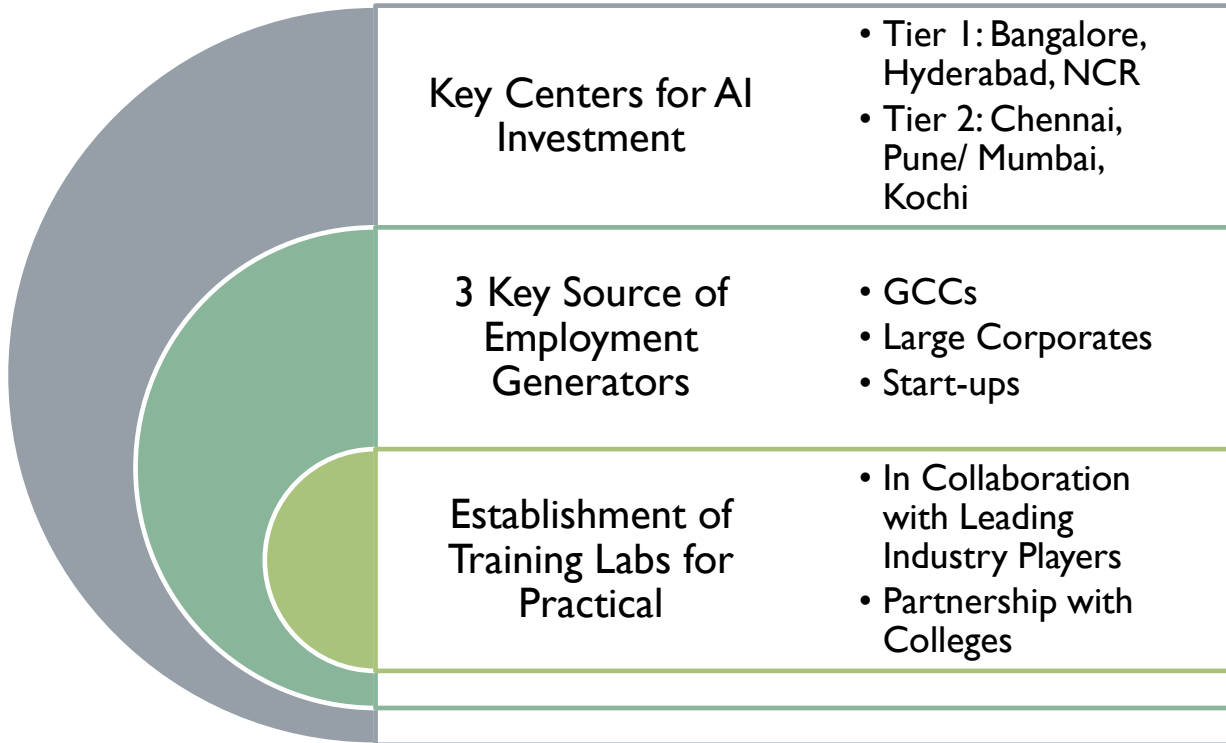- ESSCI should map the catchment geographies of the industry with the possible geographic expansion plans of academic institutions focused on AI. This will open up possibilities of a potential collaboration

- ESSCI should also collaborate with leading AI companies for establishment of open source labs for practical training. These labs can be located within the premises of the company for better resources support.
- Students accessing the short duration scheduled training at these centers need to be supported by ESSCI through MeitY or DST funding.

- ESSCI should explore partner with select colleges to set up in-house practical training labs that can provide 25-30 trainee students with key infrastructure that will include electronics equipment, reference designs and simulation stations.
- Selection of the colleges should be made considering the history of research activities. Papers presented and academic record of students.

* : Just an indicative reference for planning purposes. More detailed infrastructure plan needs to be drawn to know the actual investment quantum.

TIMELINE FOR LOCATION STRATEGY PLAN

MONTHS

1-3

1-4

6-12

12+

Industry Stakeholders Discussions

- Identify the key industry stakeholders who hail from GCC, Large Corporates and Start-ups
- Initiate discussion to understand skills needs, possible training lab infrastructure and resources deployment

Academia Reachout

- Identification of colleges for partnership
- Initiate discussion about partnership benefits, infrastructure needs, co-location and operational needs

Operational Plan

- Finalization of resources commitment – experts, designs, physical infrastructure.
- Organization structure to be finalized
- To launch a marketing campaign for promotion

Launch of Training Labs

- To get the labs off the ground with the first set of industry and academia labs.
- Evaluate the effectiveness and put the feedback into loop for improvement

MARKETING STRATEGY AND RECOMMENDATIONS

SUPPLY AND DEMAND SIDE MARKETING AND BRANDING

SUPPLY

DEMAND

DIGITAL AND ONSITE, EXISTING COMMUNITIES

Awareness Creation

Training Infra

PROMOTION OF INDUSTRY TRAINING LABS

PROMOTING PARTNER INSTITUTES

Institute Partnerships

Reach-out Programs

ESTABLISHING LINKAGES BETWEEN STAKEHOLDERS
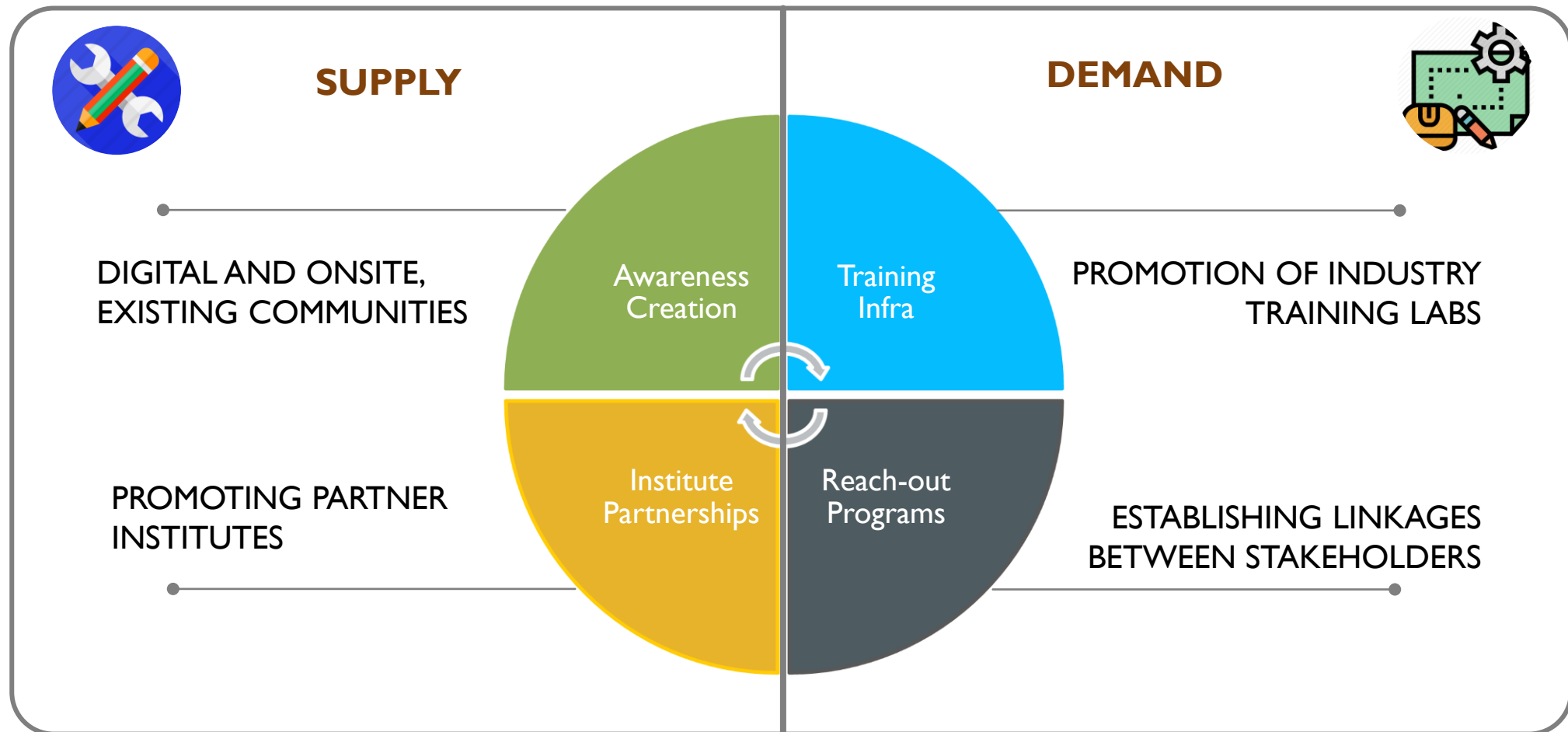
CHANNELS TO CREATE AWARENESS AND MARKETING MEDIUMS

SUPPLY

1. ESSCI should undertake digital marketing campaigns to create awareness among student communities on the exciting AI opportunities. Social media is most potent tool
2. Events like hackathons and technical symposiums to be targeted, in partnership with industry players
3. To organize talks by industry captains on importance of training programs and readiness for industry employment
4. ESSCI should promote the training programs through IEEE student chapters

1. To organize workshops with chosen institutes on the benefits and impact of creating AI training centers. Institute heads and identified champions from faculty to be part of this initiative.
2. Empanelled institutes to be promoted by ESSCI with industry players thus providing them much needed visibility among potential recruiters

DEMAND

1. ESSCI should create a specific portal that should disseminate all relevant information about partner industry training labs. Such portal should include content "leader speak " to enhance credibility of the labs
2. ESSCI should work with institutes to organize tour of industry labs to familiarize students and generate interest
3. Scholarship programs to be instituted for meritorious students that can be sponsored by the partner companies

1. ESSCI should organize workshops across the tier 1 and tier 2 cities to sensitize the industry players on the initiatives undertaken for skills development. This campaign to primarily target non-partner industry players, among GCC
2. Events associated or targeted for start-ups to be used as a platform for promotion among this segment of the industry

TIMELINE FOR MARKETING PLAN

MONTHS 3-5   6-12   6-12   12+

Digital Marketing Campaign

- Creation of collateral for promotion among students. Since social media is to be extensively leveraged, quirky messaging will be effective
- Campaign collateral to be separately created for IEEE chapters

Event Basd Marketing

- Hackathons to be organized for students after developing the program with industry partners
- Workshops to be organized in chosen cities for potential institutes in the geographical area
- Symposium with industry leader speakership series

Industry Awareness

- Industry workshops with GCC and Large Corporates to be organized in tier 1 and tier 2 cities for awareness creation on ESSCI skills development plans
- Separate campaign for startups to align with ongoing industry events

Marketing Training Labs

- Post the creation of training labs by the industry partners, portal content to be developed
- Promotion of institute's AI centers and training labs to be promoted through dedicted portal

STUDY OBJECTIVES & METHODOLOGY
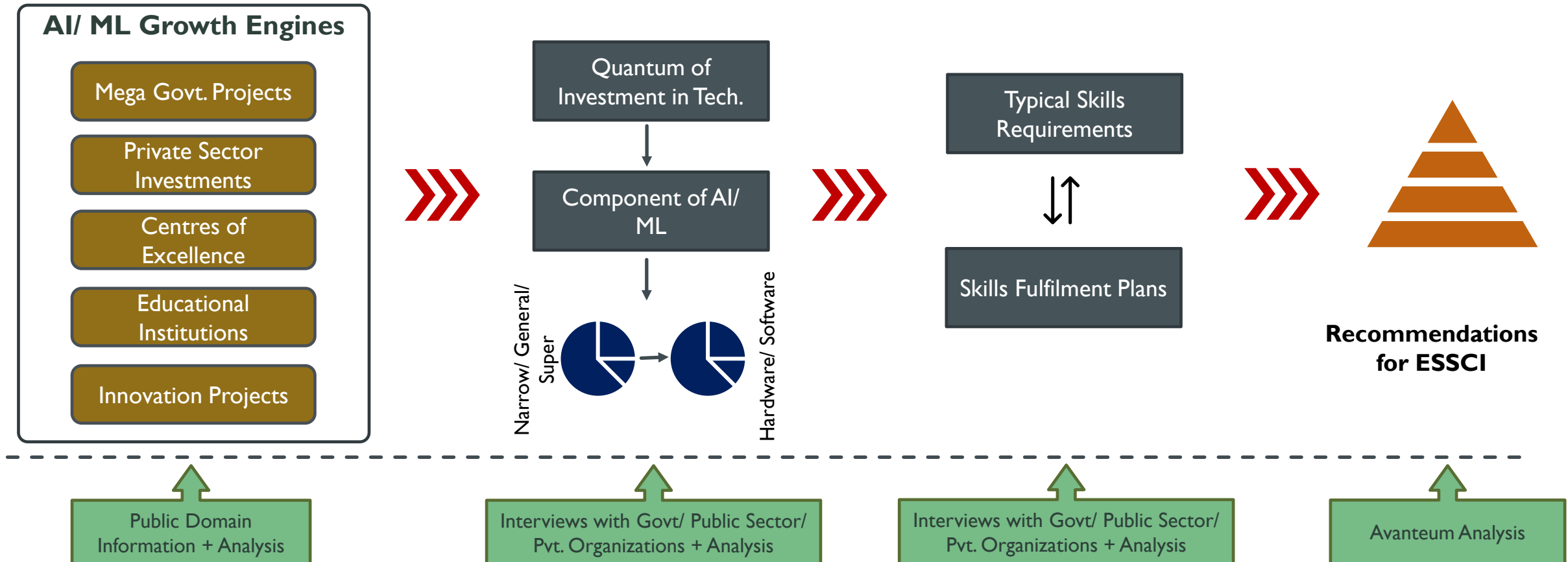
GLOBAL AI INDUSTRY

TIMELINE OF ARTIFICIAL INTELLIGENCE DEVELOPMENT

1950

Genesis
Of AI & The first
Hype Cycle

Current
AI during
2011-2017 &
The Hype Cycle

2035

Future
Of Brains,
Minds & Machines
2018-2035

2018

1983

2010

Resurgence
Of AI during
1983-2010

Avanteum
DISCOVER FUTURE
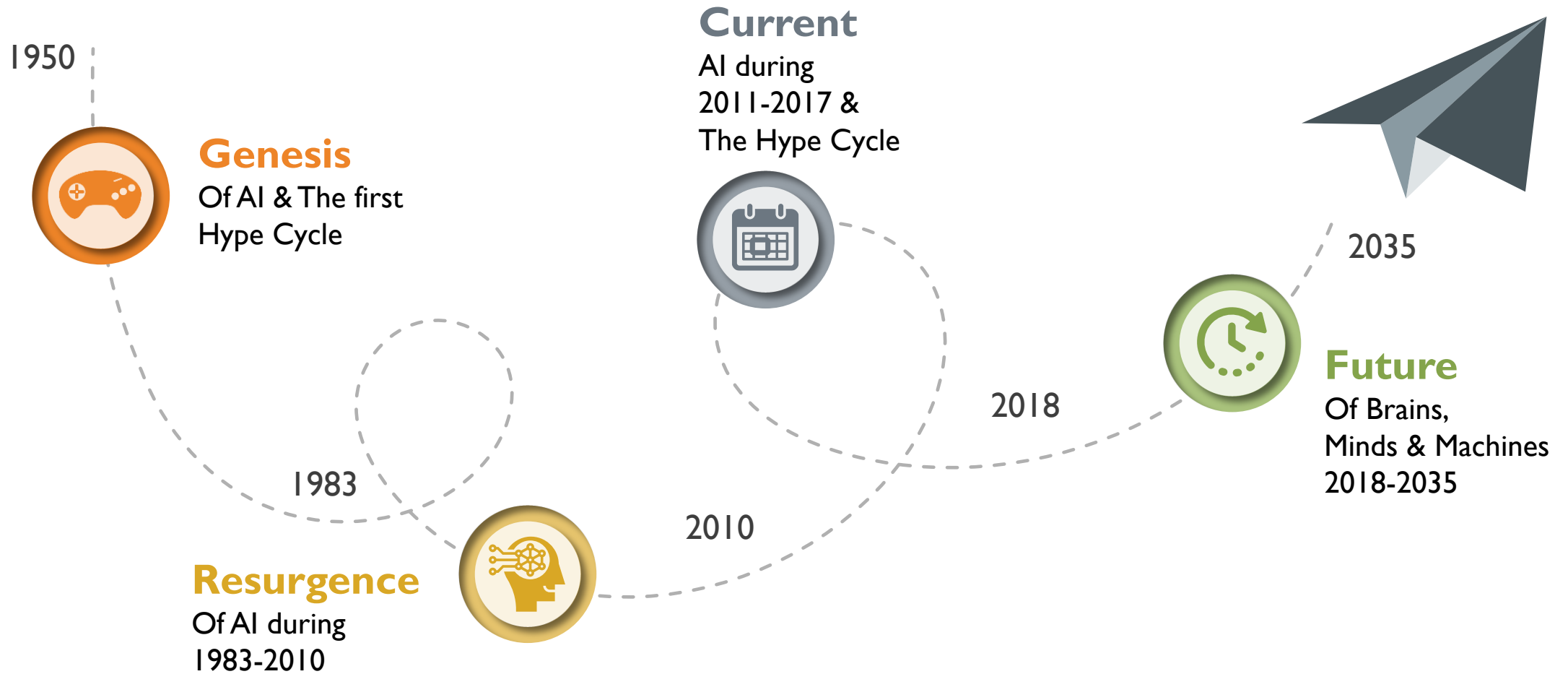
GLOBAL AI MARKET TO ATTAIN 5X SIZE BY 2025

USD Trillion

CAGR: 24%

Year	Value
2018	1.12
2019	1.85
2020	2.57
2021	3.32
2022	3.91
2023	4.33
2024	4.69
2025	5.06
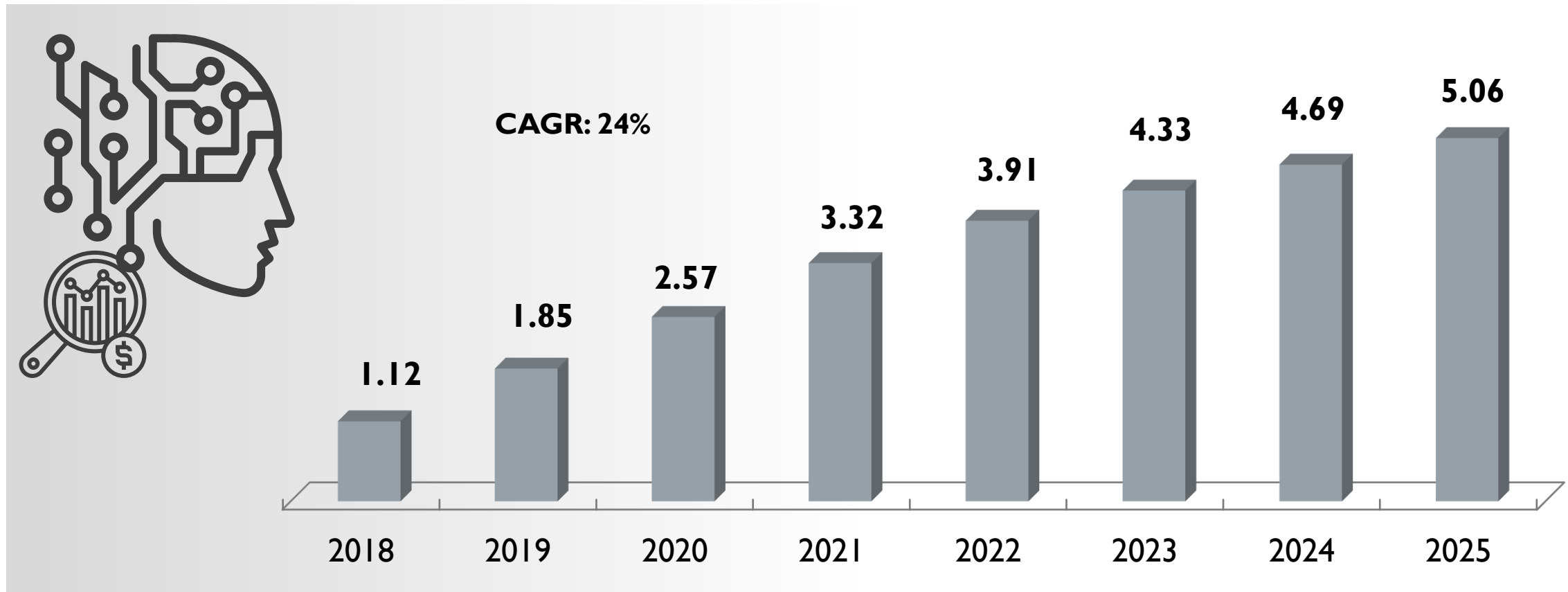
Source: Gartner

HORIZONTAL SEGMENTS LIKE MFG. & TELECOM TO DRIVE GROWTH
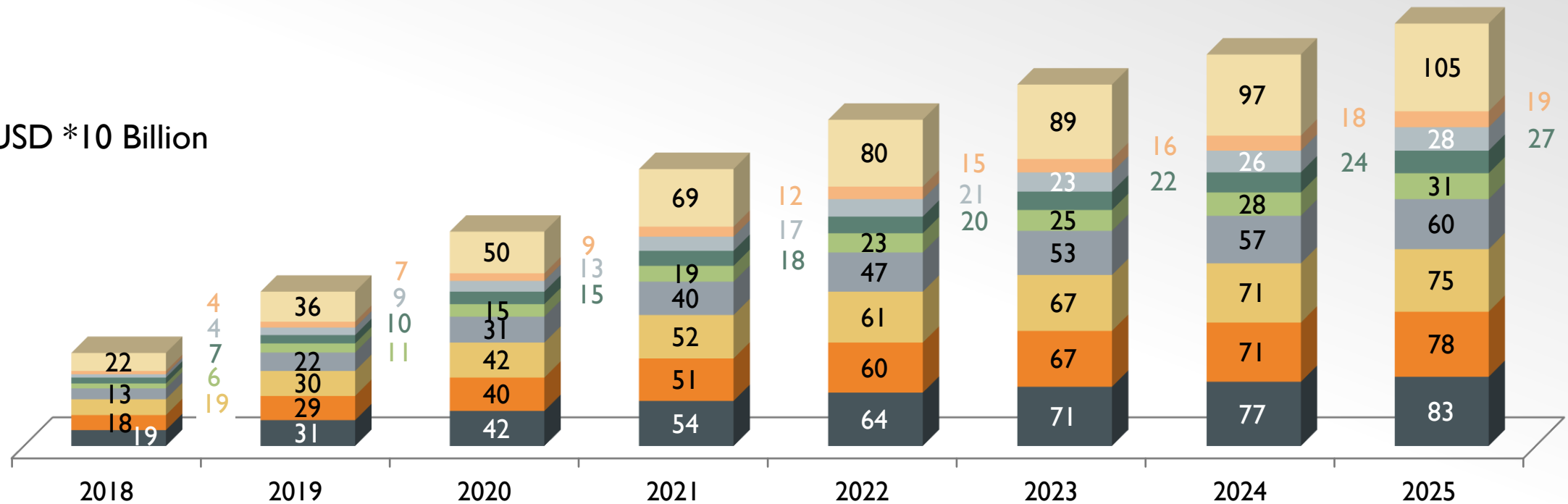
Source: Gartner

FUTURE TRENDS IN AI TO SUPPORT ADOPTION

- Monitoring and Refining Business Processes
- Personalization in Real-Time
- AI Preferred as Data Becomes Accurate and Available
- More Devices on AI-Powered Tech
- Human - AI Cooperation
- AI Increasingly at the "Edge"
- AI for Entertainment
- AI Present in Cybersecurity
- More Interaction with AI, Unknowingly
- Recognition by AI

DEVELOPER CODING REPOSITORIES POINT TO GPU/TPU ECOSYSTEM

Analysis of discussions on developer repositories indicate the most worked upon hardware elements for AI

- GPU & TPU show most repositories

- CUDA main driver to interface with hardware. OpenCL another low level programming framework

- Nvidia hardware sought in developer community

- Lots of repositories around High performance computing, TPU acceleration, virtualization, parallel processing (PPU) etc

- Running higher level apps on AI hardware like Python, Numpy etc

- Languages suited for memory optimization like Rust

- Increased level of hardware abstraction using Pytorch, Tensorflow etc

Treemap of Technologies

gpu (131)

machine-learning (57) · python (51) · deep-learning (42)

tpu (39) · tensorflow (34) · opencl (30) · gpgpu (25)

nvidia (24)

opengl (11) · scientific-computing (11) · neural-network (11) · keras (10) · artificial-intelligence (10)

docker (10) · cpp (9) · metal (8) · edgetpu (8) · tpu-acceleration (7) · kubernetes (7)

pytorch (22)

cupy (10) · hpc (9) · java (7) · nlp (7) · numpy (7) · compiler (7)

cuda (127)

data-science (8) · convolutional-neural-networks (7) · ai (7) · computer-vision (6) · coral (6)

gpu-computing (19) · gpu-acceleration (10) · cudnn (8) · multidimensional-arrays (7) · opencv (6) · rust (6) · linux (6)

neural-networks (6) · optimization (6) · tensor (6)

c-plus-plus (14) · performance (9) · high-performance-computing (8) · vulkan (7) · c (6) · google (6) · parallel-computing (6)

Developer repositories a lead indicator for AI hardware stack

Avanteum
DISCOVER FUTURE

AI Hardware Heatmap
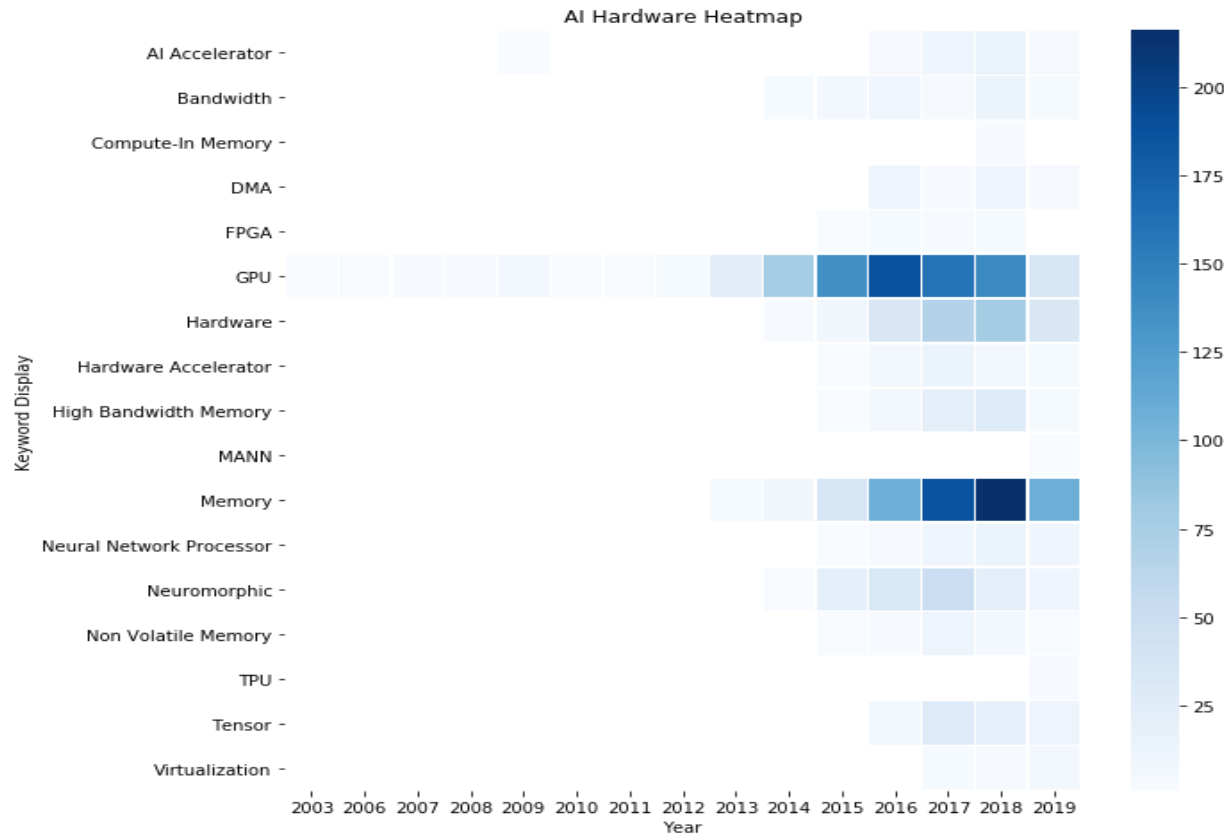
Inferences from published patents in AI Hardware from 2016 onwards:

- GPU and memory key areas of patenting
- GPU has good traction as they were designed for manipulation of images which is similar to NN calculations
- Increasing activity in more AI focused hardware like TPUs, FPGAs and AI accelerators. They optimize matrix multiplication (tensors) and memory management
- AI/ Hardware accelerators (ASICs) a key focus area to ensure NN optimized architectures including in-memory computing & novel data flow architectures
- NN architectures evolving rapidly
- Memory overload high in AI – leads to various mentions for high bandwidth access/ direct access
- RAM for loading big deep learning models is another key patented topic
- Direct access to RAM investigated - DMAs
- Neuromorphic computing - the use of very-large-scale integration (VLSI) systems containing electronic analog circuits to mimic neuro-biological architectures present in the nervous system gaining traction

GPU/TPU, FPGA, AI Accelerators (ASIC), DMA, Neural Network Architecture, Neuromorphic computing are the areas witnessing increased patent activity. This evinces that much of the hardware development in the near future shall focus around these and hence skill set needs of future need to align with these work areas.

AI HARDWARE INCREASING IN IMPORTANCE

Analysis of patent trends show that the proportion of AI hardware patents are progressively increasing
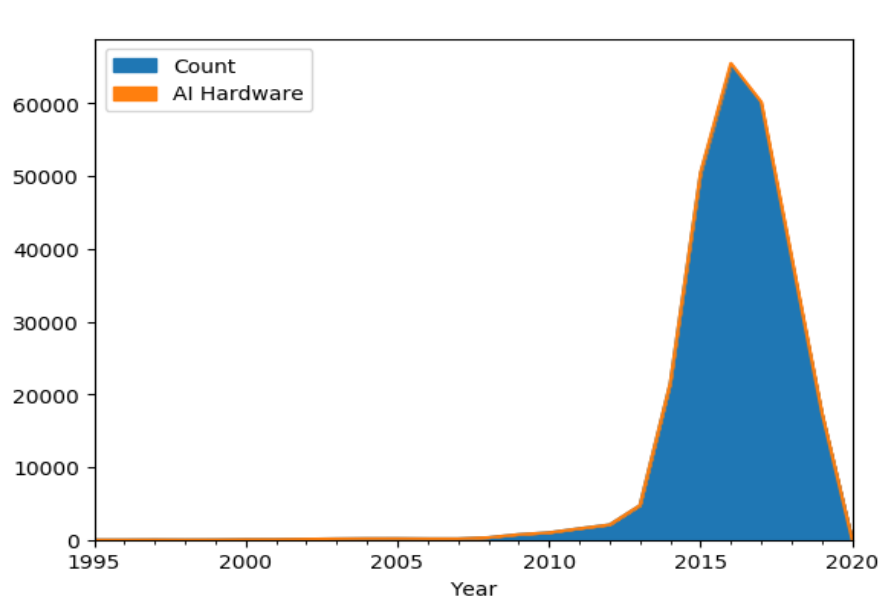
Figure A
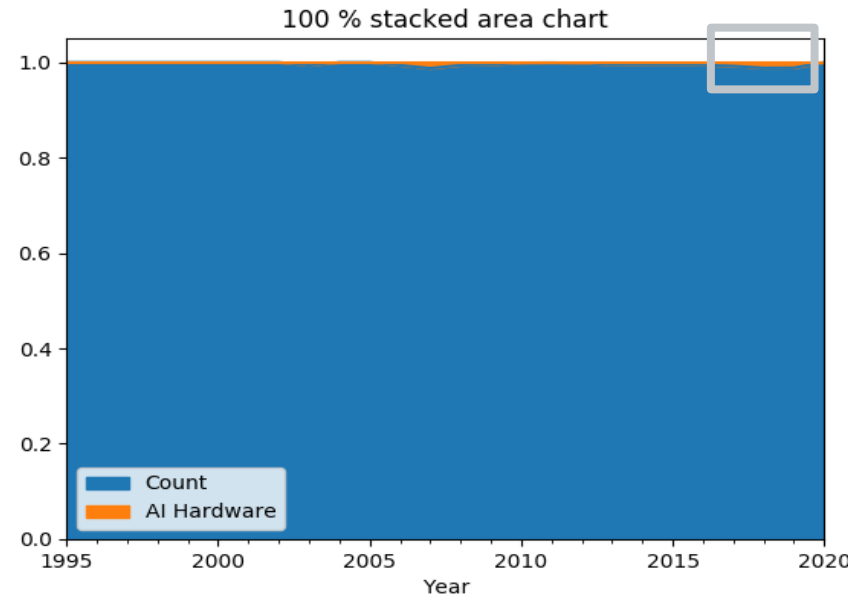
Figure B

Commentary:
- Companies exponentially increasing patent filing (Figure A)
- Share of "AI Hardware" (shown in Orange) increasing over a period of time indicating it's increased importance (Figure B)

- Note – number of patents filed drops in the last couple of years
- This is due to late publishing of patents filed and **DOESN'T** indicate a drop in numbers per se
- Below chart shows the histogram of time in days it takes from a patent application to it being published
- Mean is 499 days and a median of 432 days
- Approximately 40% of patents get published after 1.5 years
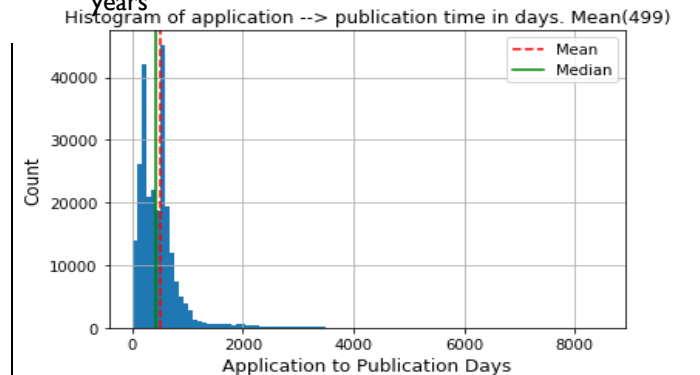
Share of AI hardware patents increasing

Analysis of patent trends show direction of future hardware development and hence the skill needs globally

AI Hardware

Optimized NN operations	Processors… CPU, GPU
	Tensors… TPUs

Store data during training & testing	Short term memory storage & in compute
	Long term storage (Ex: non volatile)

Communication between components	Drivers for GPU… CUDA etc
	High bandwidth access memory
	Edge device to cloud connections

New architectures	Neuromorphic
	Custom built accelerators… FPGA, ASICs

Scalable frameworks	Virtualization
	Parallel processing (GPU-CPU clusters)
	Multi threading

Energy/ Power management	

Technology Affinity Network Map
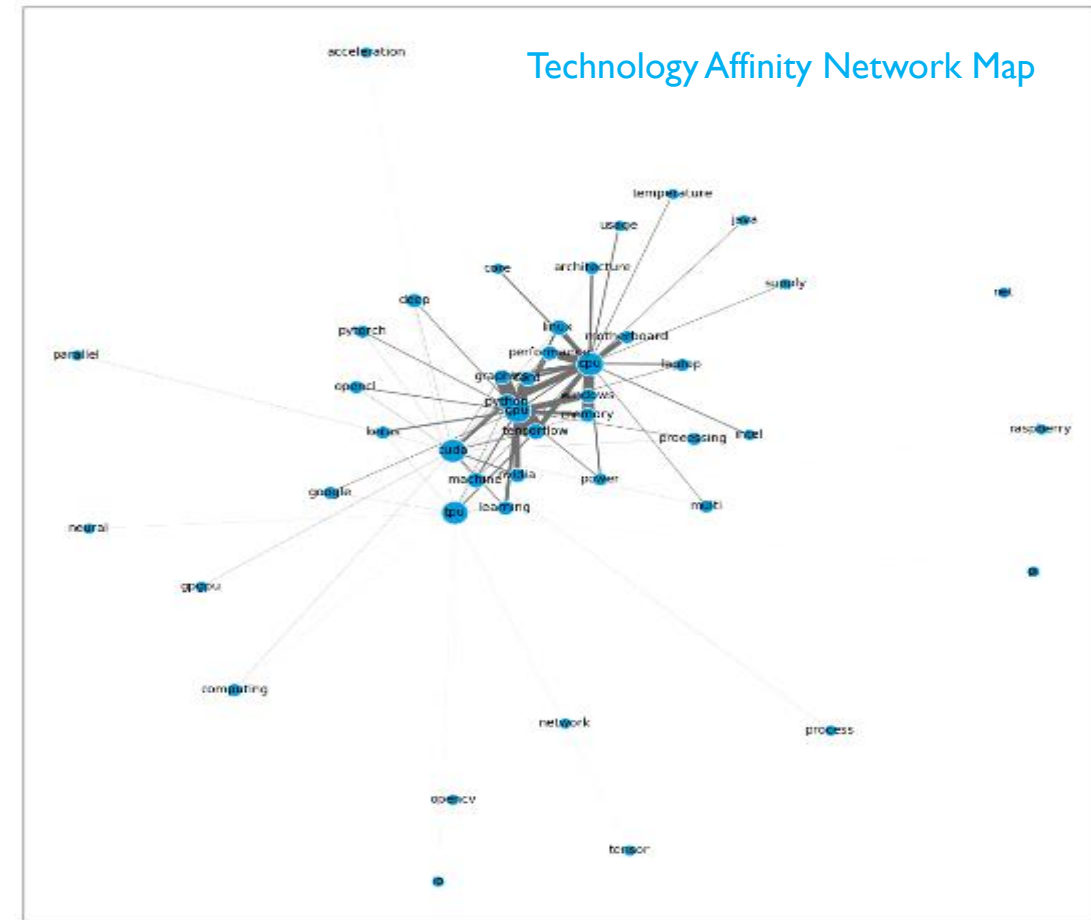
Epicenter of AI hardware is GPU/ CPU, Memory, Tensors and programming abstraction

AI IN INDIA - OVERVIEW

AI IN ITS NASCENT BUT AIDED BY TREMENDOUS MINDSHARE

Potential to add ~ US$ 1 Trillion to India's economy by 2035

Productivity Enhancement

Smarter Supply Chain Management

Enablers for AI Adoption in India

Better Decision Making

Better Delivery of Social Welfare Services

Multifarious Use Cases
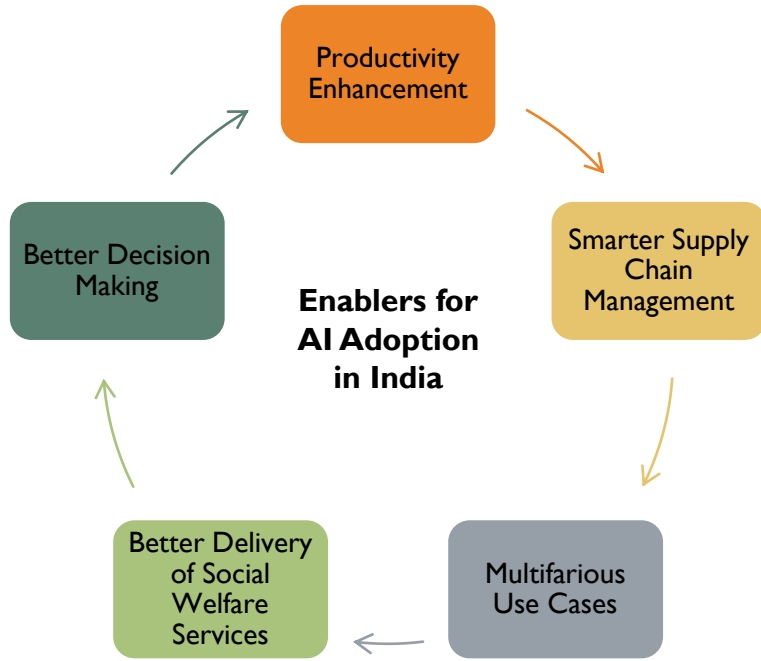
- Advent of AI has triggered the emergence of numerous start ups catering to addressing unique challenges faced in different industries that AI can help address. Certain estimates indicate that as of 2019, there were as many as ~1700 AI start ups in India.

- With 12,135 publications, India ranks 3rd globally in core AI research publications and in terms of number of AI specialists, India ranks 9th with 555 as of Q4 2019.

- Grassroot level AI adoption in agriculture, income tax assessment, healthcare, mobility etc. are evident across applications and industries. The pace of local innovation and development of indigenous AI solutions is not yet commensurate with the opportunities and potential.

- Multiple pilot projects underway – e.g.: Govt of India in collaboration with IBM to deploy IBM's Watson for predictive intelligence to impart to farmers; Govt of Karnataka partnering with Microsoft to offer AI based solutions to its farmers etc.

- Vibrant population of engineering graduates augurs well with current requirements for AI recruiters; prominent activity currently being in the automation of IT services, the demand currently is witnessed for more AI software personnel.

- There is tremendous impetus from the Government to harness the potential of AI in delivering social welfare projects in the spheres of education, healthcare and other public services.

- Agriculture, healthcare, mobility, infrastructure, BFS and education are some of the sectors seeing larger penetration of AI. The huge drive towards digitization is enabling availability of huge data sets which is proving favourable for AI's growth in India.

Avanteum
DISCOVER FUTURE

AI INDIA – INDUSTRY DYNAMICS

Multiple use cases fuel growth; Ecosystem and skilled workforce portend challenges to growth

- **Multiple use cases from various end user sectors**. E.g.: 1. Agro tech – real time advisory on weather ; yield improvement; quality enhancement of produce etc. 2. Med tech – E.g.: better access to diagnostics and healthcare delivery in remote regions through AI diagnostic devices; intelligence to compliment doctors

- **Government push for digitization and** AI, availability of huge data sets of information and strong **well developed IT industry ecosystem**

- **Ongoing research** in the field of AI by both academia and industry

Challenges

Drivers
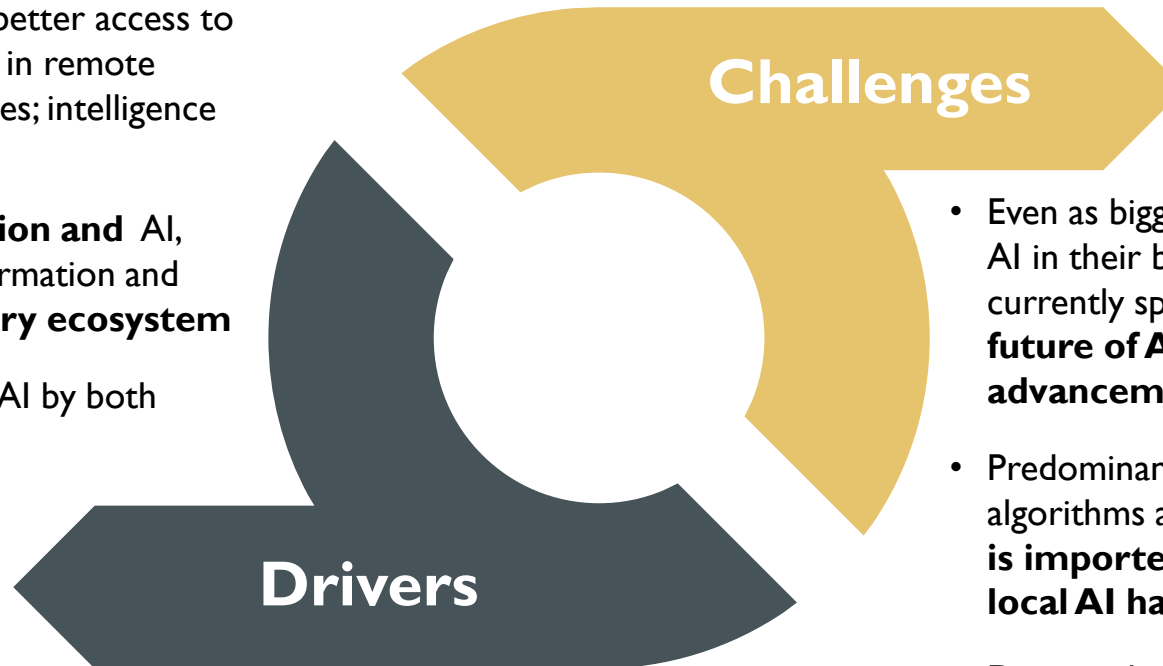
- Even as bigger corporates are investing and adopting AI in their business, much of the AI development is currently spearheaded by start ups in India and the **future of AI depends on the successful advancement of the start ups**

- Predominant focus and development is in AI algorithms and software in India. All **AI hardware is imported implying potential prospects for local AI hardware** development.

- Despite the huge potential and breadth of use cases, there is a **dearth of AI skilled workforce** in the country currently. Government, academia and industry are working together to address this.

Interplay of multiple entities makes the AI value chain very vibrant and dynamic

Collaborate with /offer product/services to the start ups or design centers or the AI divisions of corporate majors

Data Scientists / Data Analytics Providers

Semiconductor Companies – ODMs/Fabless/Fabs

AI start ups – software/systems companies

AI Offshore Design/Engineering Centers

MNCs with AI Divisions

System Integrator / End User Sector Product Company / Parent company / EMS

B2B/B2C Consumer – Final Product/Service End User

Academia / Research Institutes

Government / Policy Makers/ Regulatory Bodies

Value chain for AI in India is still in the nascent stages and varies based on the use case/application or end user industry. The value chain depicted here represents some of the common value adding entities across the ecosystem for AI in the country.

EDGE COMPUTING GROWING EXPONENTIALLY

Hyper automation, hyper storage technologies, suitability of cloud are some of the key emerging trends

Preference for open source in Hardware and more local activity in Hardware Design/Development

There is negligible work on GPUs, accelerators etc happening in India and is all imported. Evolving customized solutions across various use cases shall drive the need for indigenous development of hardware. IIT Madras that developed Shakti processors are working on developing India's first locally developed accelerator on open source. This could be trigger for more indigenous development .

Transformation in Data Storage Technologies

Data explosion and adoption of more data analytics by firms of all sizes and stature are leading to the need for more efficient data storage technologies that help in reducing total cost of ownership. Smart data centers that allow operators to infuse proactive sustainability. Data scientists are expected to increasingly work with engineers to ensure right computational power, storage for their designs.

Even as Cloud has grown due to AI services; Edge Computing seen to be preferred in specific applications

Concerns over data privacy is likely to alter the preference for more device level storage (edge) over cloud. Also most AI use cases which involve working sites in remote locations with no access to network infrastructure makes it essential for more of device level storage and computing across many AI applications in India, specifically in healthcare, banking etc.

RPA and Hyper Automation to be on the rise

Adoption of RPA, rising infusion of machine learning are all leading to a phase of hyper automation leading to the replacement of human roles with automation that use AI for intelligent decision making. AI is thus expected to aid in hyper automation through improved productivity and enhanced efficiencies.

More Analytics leading to More Customized Services

Growing complexity in data sciences, leads to need for building more explainability into the machine language is gaining traction so as to provide decision makers more insight into the AI models method of assisting decision making. Varying complexities across use cases creates the need for advanced customizations in AI solutions at the hardware, middleware and software levels.

ESTIMATION OF AI HARDWARE SPENDING AND DEMAND FOR PROFESSIONALS – DIRECT OPPORTUNITY

ESTIMATION OF COUNT OF AI HARDWARE PROFESSIONALS - METHODOLOGY

Industry Size/GVA Added by Industry
- Agriculture
- Healthcare
- Manufacturing
- Mobility
- Retail
- Fintech

SPENDING ON TECHNOLOGY

SPENDING ON AI

SPENDING ON AI HARDWARE

Non Manpower costs

Manpower costs

SPENDING ON AI HARWARE WORKFORCE

Broadly estimated based on inputs such as: average spending on technology as proportion of revenues by leading companies in the sector; national level public-private investment in technology in sector among others

Assuming an average annual spend per AI hardware resource

NUMBER OF AI HARDWARE PROFRESSIONALS

This process is replicated for each industry vertical and for the entire period of this study.

ESTIMATION FUNNEL FOR AI HARDWARE SPENDING IN INDUSTRY, INDIA

TOTAL SPENDING ON AI HARDWARE TO DOUBLE EVERY YEAR IN INDIA

Total AI Hardware Spending (US $ Million), India

CAGR (2020-2025): 97%

2019	2020	2021	2022	2023	2024	2025
860.8	1,816.5	3,839.1	8,126.7	17,232.5	36,170.5	54,577.3

SPENDING ON AI HARDWARE PROFESSIONALS TO ALSO DOUBLE EVERY YEAR IN INDIA

Spending on AI Human Capital (US $ Million), India

129.1 — 2019
317.9 — 2020
767.8 — 2021
1,828.5 — 2022
4,049.6 — 2023
8,680.9 — 2024
14,190.1 — 2025

MOBILITY & AGRI/FOODTECH TO DRIVE DEMAND FOR AI HARDWARE PROFESSIONALS

Annual Demand for AI Hardware Workforce, India

CAGR (2020-2025): 92%

- 2019: 7,200
- 2020: 16,888
- 2021: 39,351
- 2022: 90,750
- 2023: 1,85,650
- 2024: 3,78,…
- 2025: 4,34,967
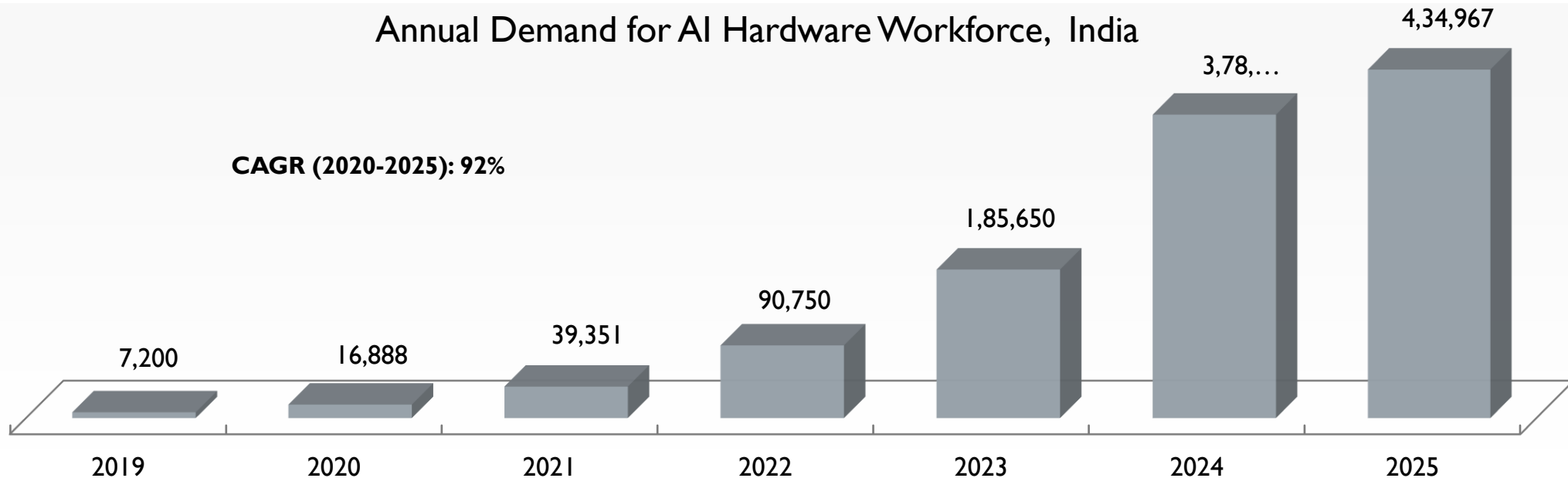
Note: Assumption - average per annum spend on 1 AI resource = INR 8 L = US$10,750 for 2019 progressively increasing to US$12,000 per annum for 2025

- Research indicates that the overall count of AI professionals in India was estimated at 72,000. Our research shows that hardware professionals would account for 10-12% of this workforce currently.

- The annual demand for AI hardware professionals is expected to grow at a CAGR of 92% over the next five years driven by the increasing use cases for AI that shall influence increased adoption across key sectors. While mobility is expected to account for 32% of this demand by 2025, followed by agriculture and healthcare at 23% and 22% respectively.

Avanteum
DISCOVER FUTURE

40 TIMES INCREASE IN DEMAND FOR AI HARDWARE WORKFORCE FROM 2020 TO 2025

Total AI Hardware Workforce, India

CAGR (2020-2025): 109%

Year	Value
2019	12,011
2020	28,899
2021	68,250
2022	1,59,000
2023	3,44,650
2024	7,23,…
2025	11,58,376
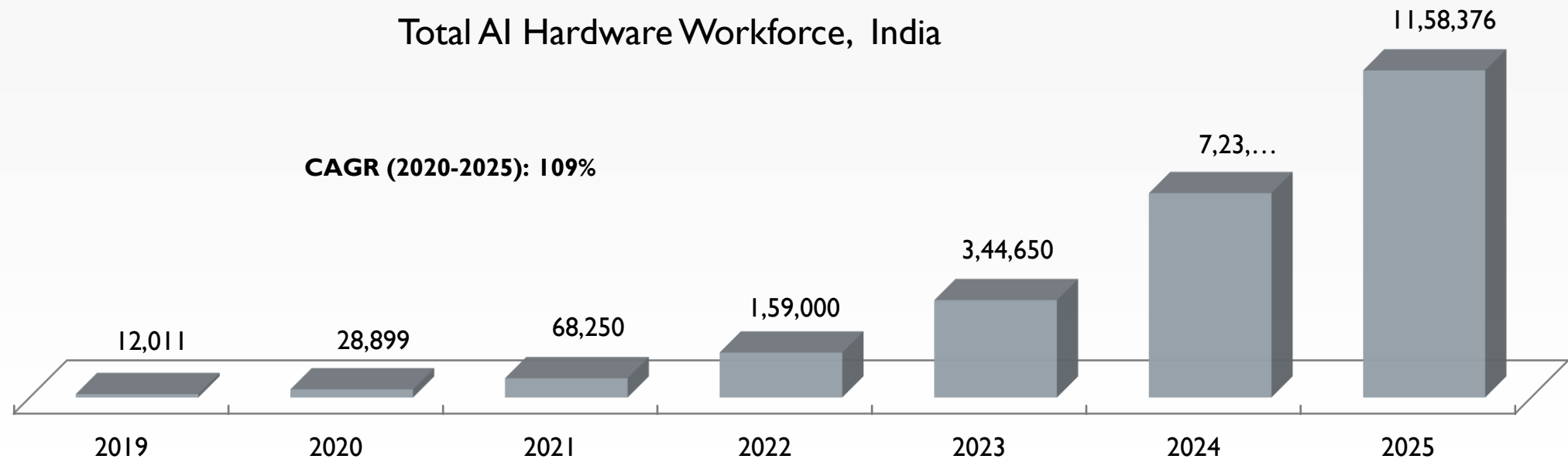
- **Board design engineers, circuit design engineers, engineers with digital electronics expertise, hardware integration engineers, engineers adept in computer architecture** are expected to be dominant among AI hardware professionals over the next 5-6 years.
- For some specialized applications in med tech and mobility, preference for domain expertise and specialized qualification like biotech engineering is expected to be demanded. Otherwise, engineers across the streams of electronics, instrumentation, electrical and computer science are expected to most preferred.

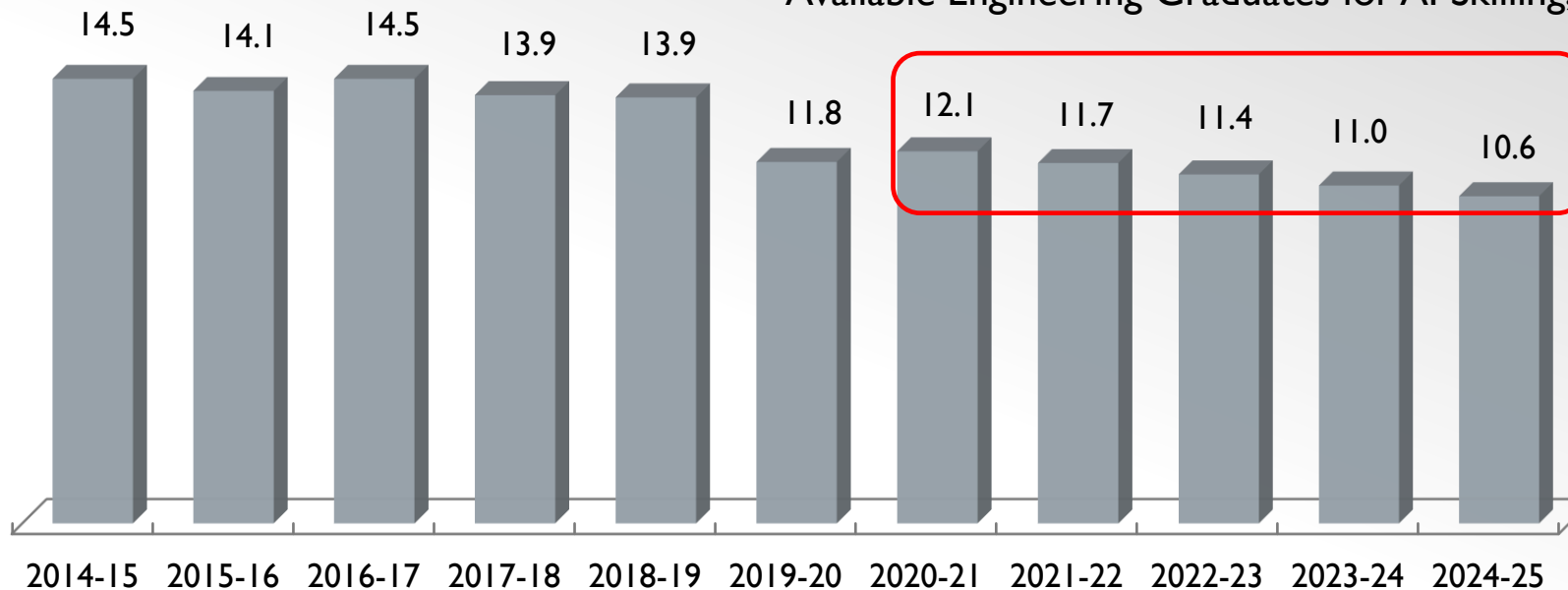# ON THE SUPPLY SIDE, 32% OF THE ENGINEERING GRADUATES TO BE AVAILABLE FOR AI HARDWARE SKILLING BY 2025

All figures in lakhs	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Overall Engineering Graduates	**42.5**	**42.0**	**40.8**	**39.4**	**37.7**	**36.6**	**35.5**	**34.5**	**33.5**	**32.5**	**31.6**
Computer Science Engineers	9.9	9.8	9.5	9.2	8.8	8.5	8.3	8.1	7.8	7.6	7.4
Electronics Engineers	7.1	7.0	6.8	6.6	6.3	6.1	5.9	5.8	5.6	5.4	5.3
Electrical Engineers	4.4	4.4	4.3	4.1	3.9	3.8	3.7	3.6	3.5	3.4	3.3
Total Engineering Graduates for AI jobs	**21.5**	**21.2**	**20.6**	**19.9**	**19.1**	**18.5**	**18.0**	**17.4**	**16.9**	**16.4**	**16.0**
Less the graduates who go abroad for higher studies (based on MEA historic stats)	1	1	1	1	1	1	1	1	1	1	1
Less the graduates employed (as per India Skill report)	6.0	6.2	5.2	5.0	4.2	5.7	4.8	4.7	4.6	4.4	4.3
Available Engineering Graduates for AI skilling	**14.5**	**14.1**	**14.5**	**13.9**	**13.9**	**11.8**	**12.1**	**11.7**	**11.4**	**11.0**	**10.6**

Note: Historic statistics (2014-15 to 2018-19) taken from the All India Survey on Higher Education (AISHE) reports from the Ministry of Human Resource Development. Forecasts for 2019-20 till 2024-25 estimated using historical trends and anticipated educational trends.

Source: MHRD, Avanteum Analysis

INDUSTRY DEMAND FULFILMENT POSSIBLE THROUGH FINISHING SCHOOL INTERVENTION

Available Engineering Graduates for AI Skilling, India

Year	Value
2014-15	14.5
2015-16	14.1
2016-17	14.5
2017-18	13.9
2018-19	13.9
2019-20	11.8
2020-21	12.1
2021-22	11.7
2022-23	11.4
2023-24	11.0
2024-25	10.6

- Immediate finishing school intervention will ensure timely availability of skills for industry
- Decline in available engineering graduates reflects rationalization of oversupply

- Estimates indicate the availability of ~10 to 12 lakh of engineering graduates from the streams of Electronics, Instrumentation, Electrical and Computer Science on an annual basis ready to be skilled in a finishing school for being employment ready for AI job profiles.

- Areas of skilling include hardware board design, PCB design, circuit design, computer architecture, hardware integration and testing etc.

Avanteum
DISCOVER FUTURE

AI HARDWARE JOB PROFILES AND SKILL SET REQUIREMENTS

SECTOR	AGRICULTURE & F OOD TECH	HEALTHCARE	MOBILITY	MANUFACTURING	RETAIL	FINTECH
USE CASES	Precision Farming Drone based Smart Farming Crop Insurance Agriculture Robotics Precision Food Processing Effective Packaging & Storage	Smart Diagnostics Remote Patient Monitoring Early Detection / Predictive Diagnostics Robotic Surgery Smart Drug Discovery	Autonomous Vehicles Fleet/Cruise Tracking Smart Mobility – Traffic Mgmt Intelligent Urban Mobility Efficient Rail Transportation	Smart Manufacturing Asset Management Plant Optimization Predictive Assessment of Shut Down	Automated Customer Management Smart Inventory Management Smart Retail Assistants Personalized Offers	Automated Virtual Financial Assistants Predictive Wealth Mgmt Automated Claims Process Algorithmic Trading

HARDWARE JOB PROFILES

HARDWARE ENGINEER   TESTING ENGINEER   INTEGRATION ENGINEER   ML ENGINEER

TYPCIAL HARDWARE ACTIVITIES

- ▪ **Product / System Electronic Board Design**
- ▪ **Box Assembly of Components**

- ▪ **Integration of Hardware and Software**
- ▪ **Programming of Hardware**

- ▪ **Customized Product – Board Design**
  - ▪ **Hardware Software Integration**
  - ▪ **Interface Hardware Engineering**

- ▪ **Testing of Final Product**

Avanteum
DISCOVER FUTURE

AI HARDWARE JOB PROFILES AND SKILL SET REQUIREMENTS

SECTOR	AGRI & FOOD TECH	HEALTHCARE	MOBILITY	MANUFACTURING	RETAIL	FINTECH

HARDWARE JOB PROFILES	**HARDWARE ENGINEER** **TESTING ENGINEER** **INTEGRATION ENGINEER** **ML ENGINEER**					
PREFERRED ENGG STREAMS	**ELECTRONICS ENGINEERS** **INSTRUMENTATION ENGINEERS** **ELECTRICAL ENGINEERS** **COMPUTER SCIENCE ENGINEERS**					
BASIC H/W SKILLS DEMANDED	**Embedded design Robotics** **Computer Architecture** **Edge Computing** **Circuit Design** **Signal Processing Techniques** **Verilog/System** **Verilog** **VHDL** **PyMTL** **AHDL** **MATLAB** **PCB Design** **Hardware Architectures** **Analog and Digital Design**					

SPECIFIC AI SKILLS DESIRED

Understanding of – Network Architecture, Accelerator Architectures, Parallel Computing, Edge Computing, Convolutional and Recurrent Neural Networks (CNN, RNN), GPU Acceleration, NVIDIA Drive Platform, Design and Implementation of hardware architectures for deep learning/ML, Deep learning accelerators, Building FPGA accelerator systems using deep learning tools, SoC AI solutions, Neural network processing units (NNPU), Optimization of AI architectures, Mathematics – linear algebra/calculus/probability theory.

Working knowledge on AI Platforms – Intel Xeon Phi, Intel Arria FPGA, Intel Movidius MyraidX VPU, NVIDIA Jetson/Jetson Nano/Jetson X2/Jetson Xavier, Google TPU / Coral, TI BeagleBone, GAPUINO GAP8 etc.

Technologies – TensorFlow, PaddlePaddle, MXNet, Caffe, Digits, Pytorch, NVIDIA Tensor RT, Horovod, Keras, Torch, CNN, CFCM (coarse-to-fine context memory), Generative Adversarial Networks (GAN), CUDA, Numba, NumPY, OpenACC, ML Algorithms such as XGBoost, cuGRAPH, cuML, RAPIDS.

ADDITIONAL OPTIONAL SKILLS	**Algorithm coding** **Python** **C++ Java Perl** **ABAP** **VB** **Selenium** **Junit** **Jmeter** **Power Shell** **COBOL**

Avanteum
DISCOVER FUTURE

A MULTITUDE OF AI FOCUSED COMPANIES WILL BECOME HUNTING GROUND FOR HARDWARE PROFESSIONALS

1700 AI start ups in the country. Most offer ML algorithms for various applications, there are a healthy number product/system start ups that make their own AI embedded hardware. E.g. Netradyne, Nebulaa, Aindra, Intello Labs, Multicoreware. As the IP is held in both hardware and software, they recruit and train h/w engineers in-house.

Indigenous chip companies that design ASICs for AI such as AI processors, computer architectures for AI and AI accelerators. E.g. Manjeera Digital Systems, Alpha IC and Rise Group of IIT Madras.
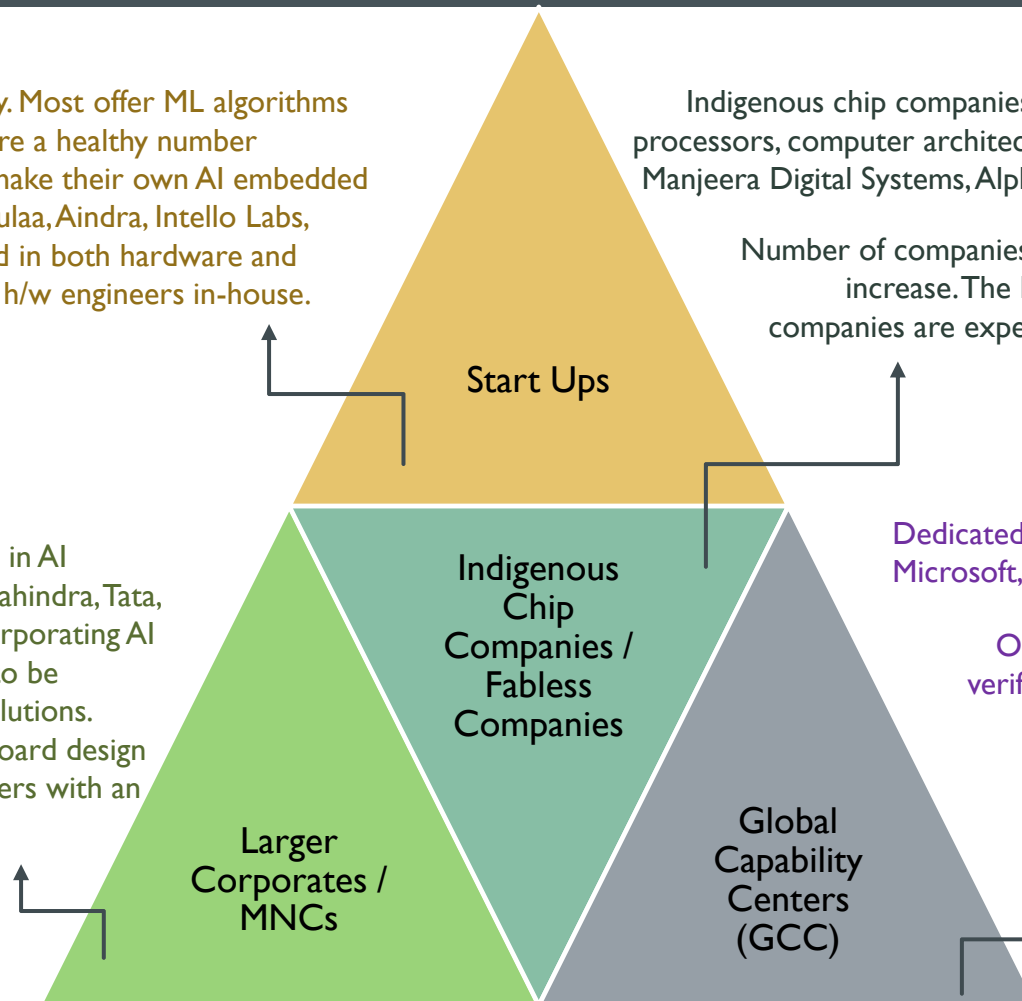
Number of companies limited but expected to witness a sharp increase. The hardware professionals recruited by such companies are expected to be limited with experience being key

Major corporates have invested in AI divisions inhouse. E.g. include Mahindra, Tata, Siemens, etc. Investment in incorporating AI solutions as platform offerings to be integrated into products and solutions. Skills demand is for hardware board design engineers, and hardware engineers with an understanding of software integration.

Dedicated AI development centers in India. E.g. Microsoft, Google, NVIDIA, Intel.

Outsourced implementation jobs involving verification and physical design will dominate their activities

Hardware skills demand to include computer architecture knowledge, hardware programming skills apart from algorithm coding skills

Triangle diagram labels: Start Ups; Indigenous Chip Companies / Fabless Companies; Larger Corporates / MNCs; Global Capability Centers (GCC)

Proportion of Hardware Professionals, 2019	
Start ups	~30%
Large Corporates	~54%
GCC	~ 15%
Indigenous AI Chip Companies	<1%

Proportion of Hardware Professionals, 2025	
Start ups	~20%
Large Corporates	~ 25%
GCC	~ 54%
Indigenous AI Chip Companies	1%

NCR

Pune/
Mumbai

Hyderabad

Bengaluru

Chennai

Kochi

■ Tier 1 Center

□ Tier 2 Center
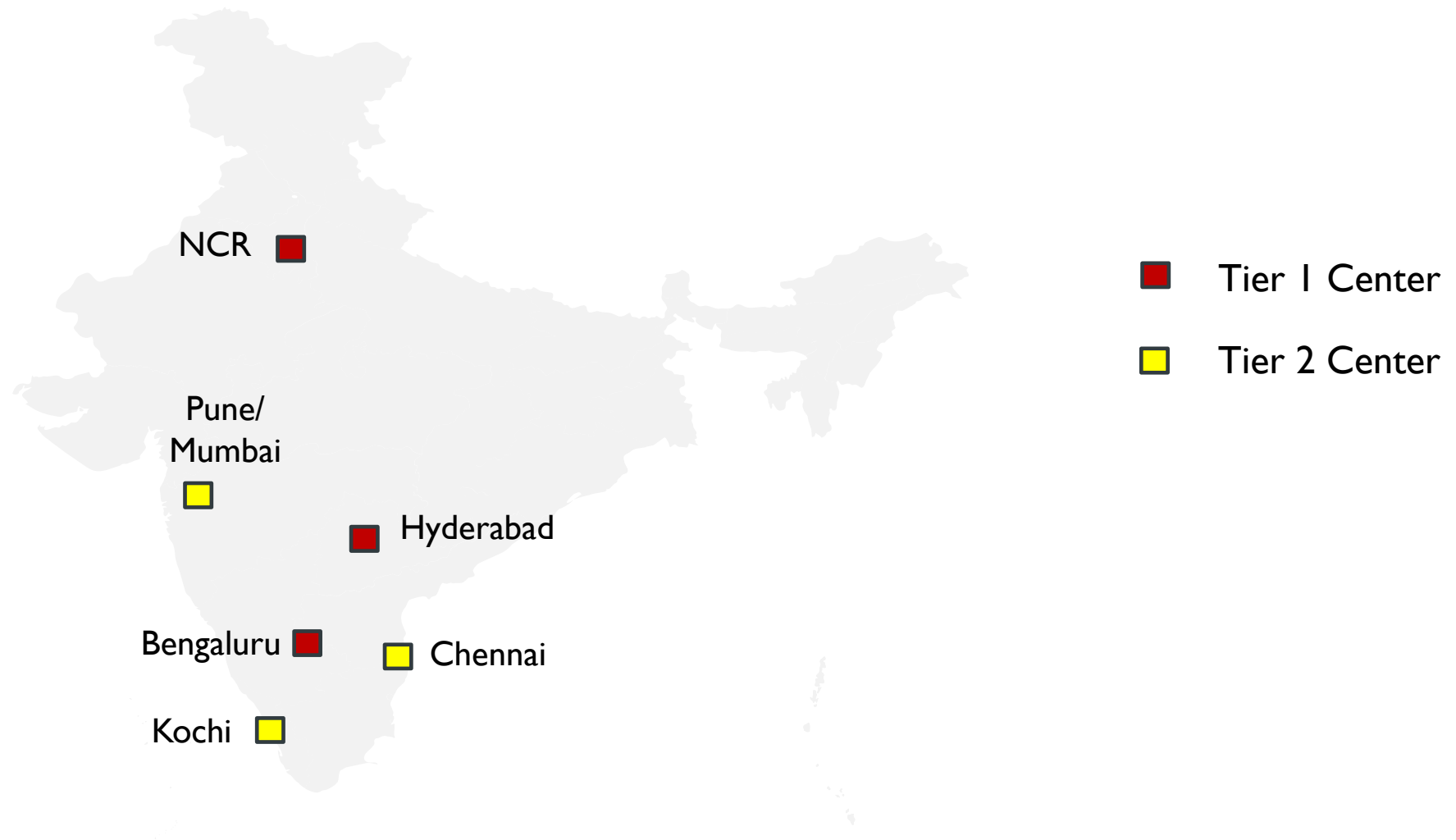
AI IN AGRICULTURE

AGRICULTURE SECTOR: SPENDING ON AI HARDWARE

Industry Size, US$ B	**Spending on Technology,** US$ B	**Spending on AI,** US$ B	**Proportion of AI Spending on Hardware ,** US$ M

Industry Size, US$ B
- 775.5 (2019)
- 1,556.9 (2024)

Spending on Technology, US$ B
- 62.0 (2019)
- 374.1 (2024)

Spending on AI, US$ B
- 3.1 (2019)
- 160.6 (2024)

Proportion of AI Spending on Hardware , US$ M
- 155.1 (2019)
- 12,477.6 (2024)
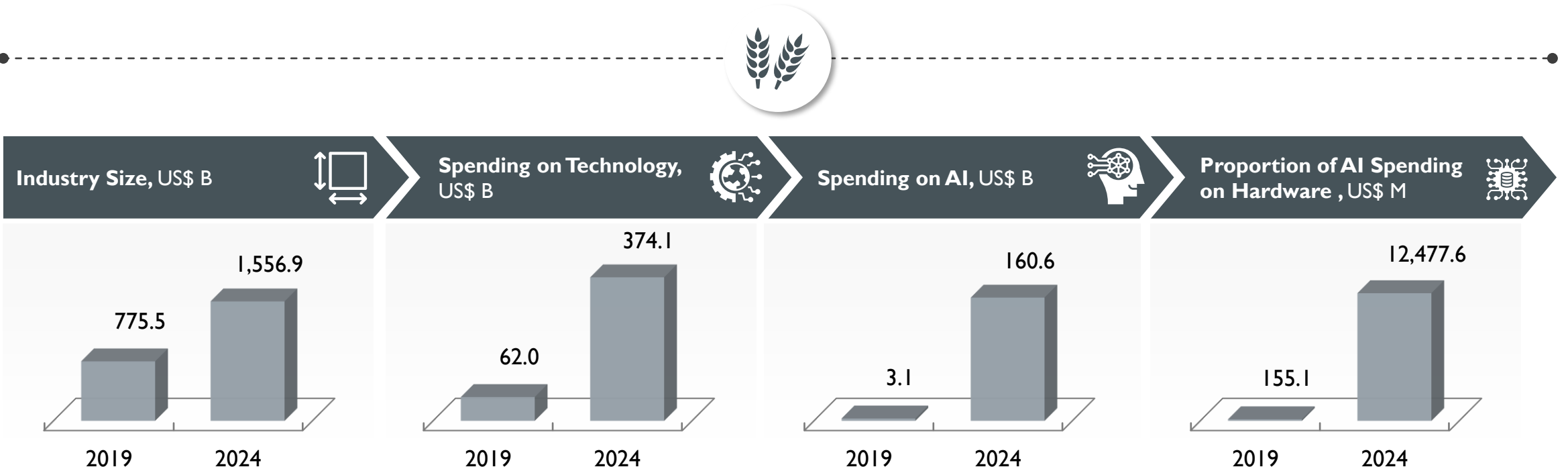
- Growing need for precision agriculture is driving AI spending in agro tech sector.

- Multiple innovations in AI based products to cater to yield enhancement, measure of quality of produce across the value chain to maintain quality and thus demand higher pricing, aid farmers in informed farming practices are some of the evolving AI use cases in agriculture.

- *Note – Assumptions considered include investment in technology as proportion of industry size to grow from 8% in 2019 to 20% by 2024; AI spending as proportion of technology spending to grow from 5% in 2019 to 30% by 2024.*

AGRICULTURE SECTOR: SPENDING ON AI HARDWARE & ASSOCIATED HUMAN CAPITAL

Spending on AI Hardware, US$ M

Spending on AI Human Capital for Hardware, US$ M

Spending on AI Hardware, US$ M:
- 2019: 155.1
- 2020: 344.3
- 2021: 764.4
- 2022: 1,697.0
- 2023: 3,767.2
- 2024: 8,318.4
- 2025: 12,477.6

Spending on AI Human Capital for Hardware, US$ M:
- 2019: 23.3
- 2020: 60.3
- 2021: 152.9
- 2022: 381.8
- 2023: 885.3
- 2024: 1,996.4
- 2025: 3,244.2
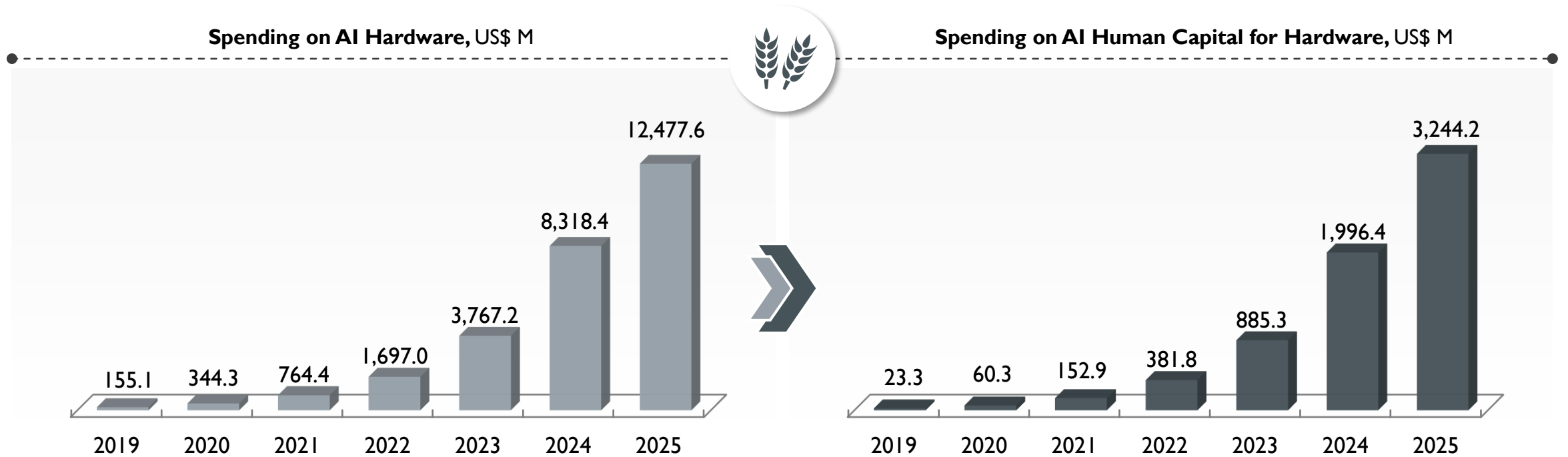
- Increasing trend towards farm mechanization, smart irrigation, smart farming to improve yields and farm productivity are driving the need for Precision Agriculture. This is the greatest influencer for higher spending on technology and specifically AI in Agriculture.

- The spending on AI hardware is mainly towards the development of specialized products and systems that address specific productivity/efficiency/yield challenge.

Avanteum
DISCOVER FUTURE

AGRICULTURE SECTOR: POTENTIAL DEMAND FOR AI HARDWARE PROFESSIONALS

Base of AI Hardware Professionals

- 2019: 2,164
- 2020: 5,478
- 2021: 13,589
- 2022: 33,201
- 2023: 75,345
- 2024: 1,66,368
- 2025: 2,64,831

Annual Demand for AI Hardware Professionals

- 2019: —
- 2020: 3,314
- 2021: 8,111
- 2022: 19,612
- 2023: 42,144
- 2024: 91,023
- 2025: 98,463
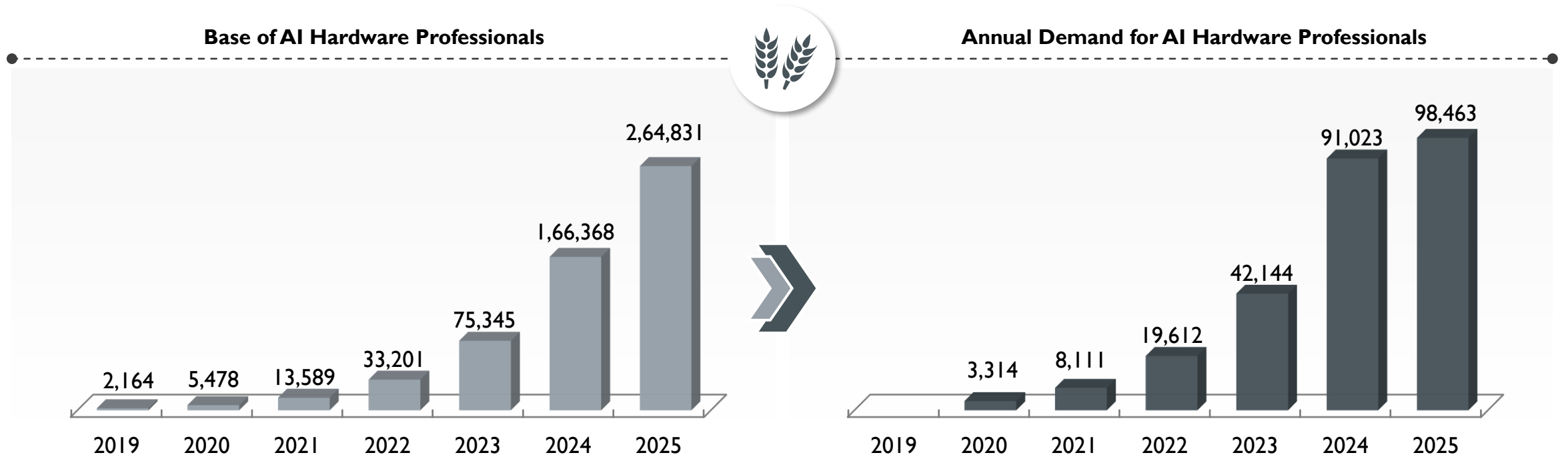
- Existing base of AI professionals is arrived at by taking a thumb rule that the average spend on one AI professional per year is ~ INR 8 Lakh (US$ 10,750) for 2019 going up to INR 9.25 Lakh (US$ 12,250) by 2025.

- This is based on a weighted average computation of proportion of hardware professionals at various levels and their corresponding annual salaries.

Avanteum
DISCOVER FUTURE

www.avanteum.com

AI IN HEALTHCARE

HEALTHCARE SECTOR: SPENDING ON AI HARDWARE

Industry Size, US$ B	Spending on Technology, US$ B	Spending on AI, US$ B	Proportion of AI Spending on Hardware, US$ M
2019: 204.7 / 2025: 649.3	2019: 30.7 / 2025: 160.7	2019: 2.5 / 2025: 70.0	2019: 196.5 / 2025: 12,053.3
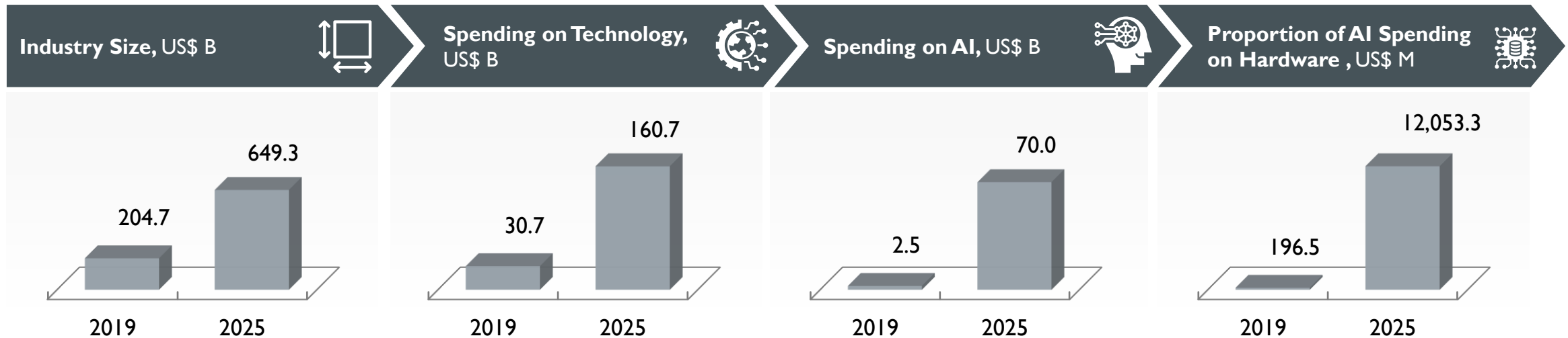
- Remote patient monitoring and tele diagnosis drives innovation in med tech and development of AI power devices that enable remote diagnosis and quick turn around; Medical imaging and medical signal processing are 2 areas witnessing emergence of many AI start ups in India.

- Most AI innovations in healthcare currently happening at the platform/software and systems level.

Avanteum
DISCOVER FUTURE

HEALTHCARE SECTOR: SPENDING ON AI HARDWARE & ASSOCIATED HUMAN CAPITAL

Spending on AI Hardware, US$ M

Spending on AI Human Capital for Hardware, US$ M

Year	Spending on AI Hardware (US$ M)	Spending on AI Human Capital for Hardware (US$ M)
2019	196.5	29.5
2020	414.6	72.6
2021	874.9	175.0
2022	1,846.0	415.4
2023	3,895.1	915.3
2024	8,035.5	1,928.5
2025	12,053.3	3,133.8
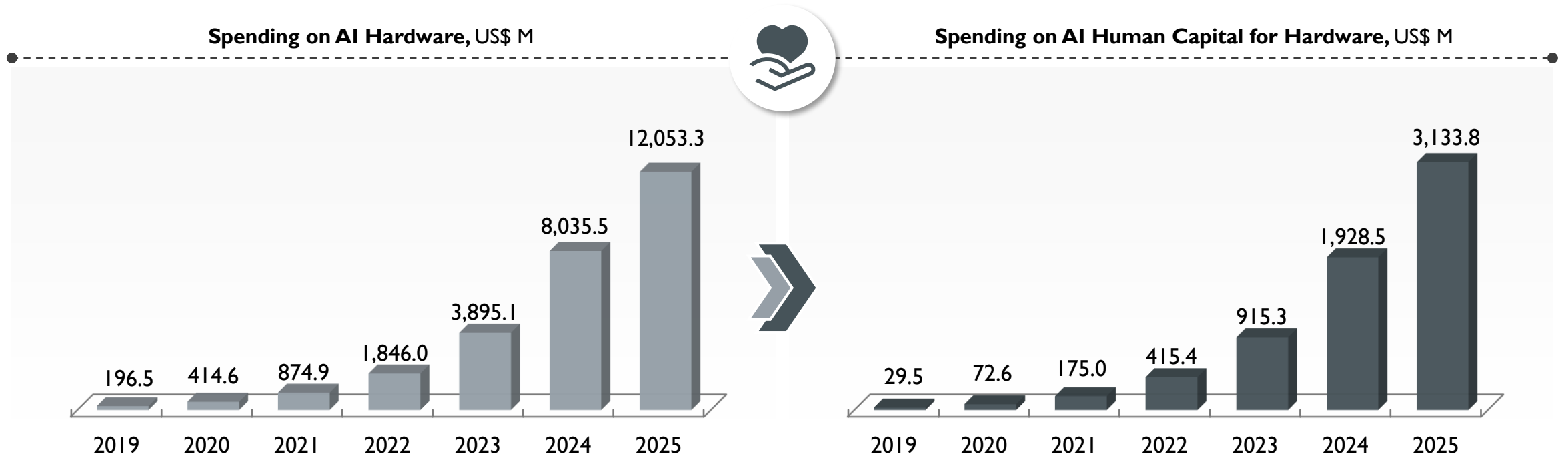
- Challenges of unequal access, poor quality and rising costs are driving innovation in the healthcare industry for design and development of innovative auto diagnostic devices that aid in early detection and diagnosis of diseases, innovative products that aid in remote telemedicine and remote diagnosis and treatment of diseases, newer devices that aid in robotic surgery etc. Such innovations are driving the tech spending in Healthcare and a significant proportion of it is for AI.

HEALTHCARE SECTOR: POTENTIAL DEMAND FOR AI HARDWARE PROFESSIONALS

Base of AI Hardware Professionals

Year	Value
2019	2,742
2020	6,597
2021	15,554
2022	36,118
2023	77,902
2024	1,60,710
2025	2,55,824

Annual Demand for AI Hardware Professionals

Year	Value
2019	—
2020	3,855
2021	8,957
2022	20,564
2023	41,784
2024	82,808
2025	95,114
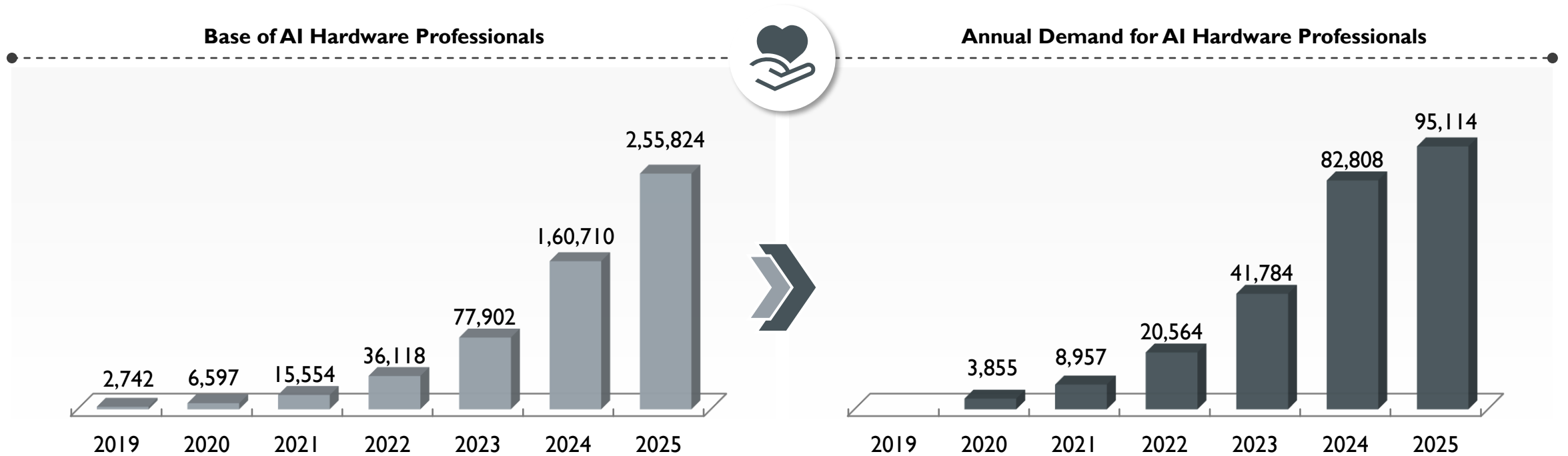
- 3rd largest segment demanding AI hardware professionals next only to Mobility and Agriculture
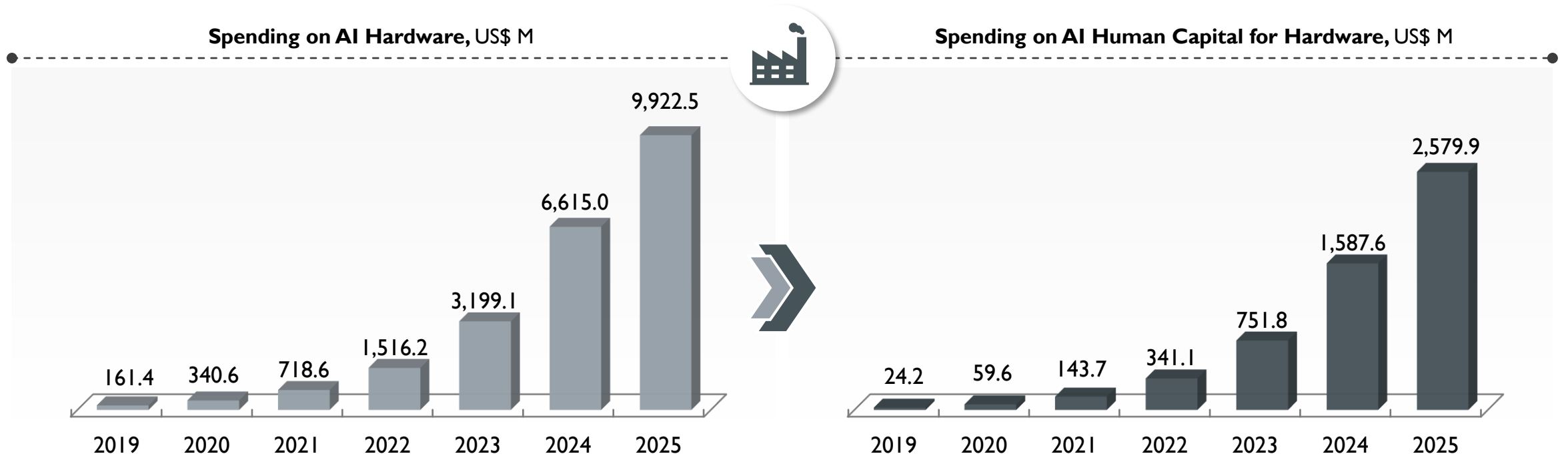- Product/system start ups and medical device manufacturers are the key recruiters

AI IN MANUFACTURING

MANUFACTURING SECTOR: SPENDING ON AI HARDWARE

Industry Size, US$ B	Spending on Technology, US$ B	Spending on AI, US$ B	Proportion of AI Spending on Hardware, US$ M
403.5 (2019)	40.4 (2019)	3.2 (2019)	161.4 (2019)
1,031.1 (2025)	309.6 (2025)	74.5 (2025)	9,922.5 (2025)
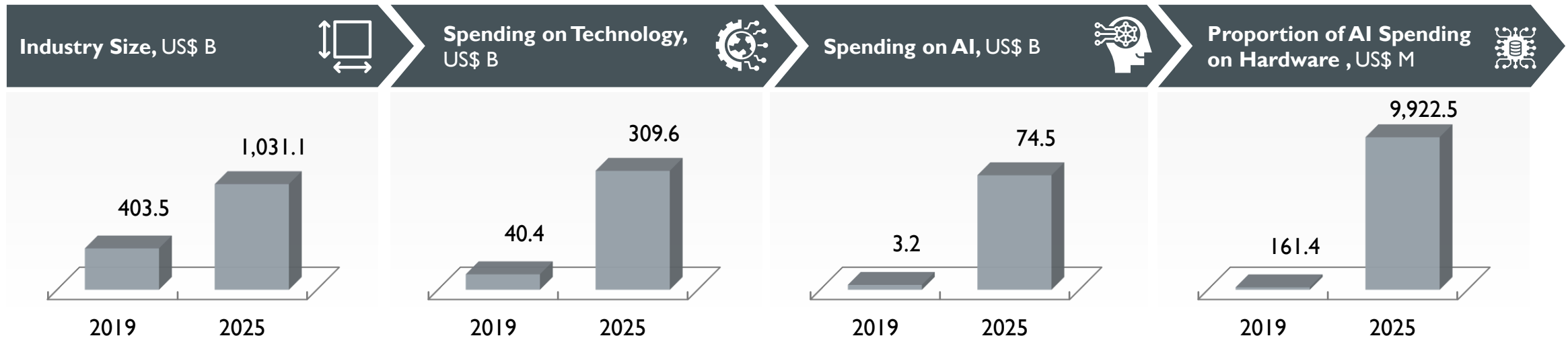
- Manufacturing has to contribute much more than the desired level of 25% of the GDP to achieve USD 5 trillion economy. Inorganic growth can happen through technology adoption.

- Advent of Industry 4.0, greater usage of analytics and improvement in quality standards have resulted in greater usage of AI technology. Given the large volumes of data produced by manufacturing, AI is a natural beneficiary of the industry by-product.

Avanteum
DISCOVER FUTURE

MANUFACTURING SECTOR: SPENDING ON AI HARDWARE & ASSOCIATED HUMAN CAPITAL

Spending on AI Hardware, US$ M

Year	2019	2020	2021	2022	2023	2024	2025
Value	161.4	340.6	718.6	1,516.2	3,199.1	6,615.0	9,922.5

Spending on AI Human Capital for Hardware, US$ M

Year	2019	2020	2021	2022	2023	2024	2025
Value	24.2	59.6	143.7	341.1	751.8	1,587.6	2,579.9

- Move towards precision manufacturing and increasing automation and digitization of production processes are driving the need for higher technology in manufacturing across industries. AI in manufacturing is contributed towards preventive maintenance aimed at extending plant and machinery life and enhancing productivity.

- As smart manufacturing penetrates the conventional manufacturing processes, there is expected higher spending on AI integrated hardware as well as equal investment in AI control software that aid in master control of factories.
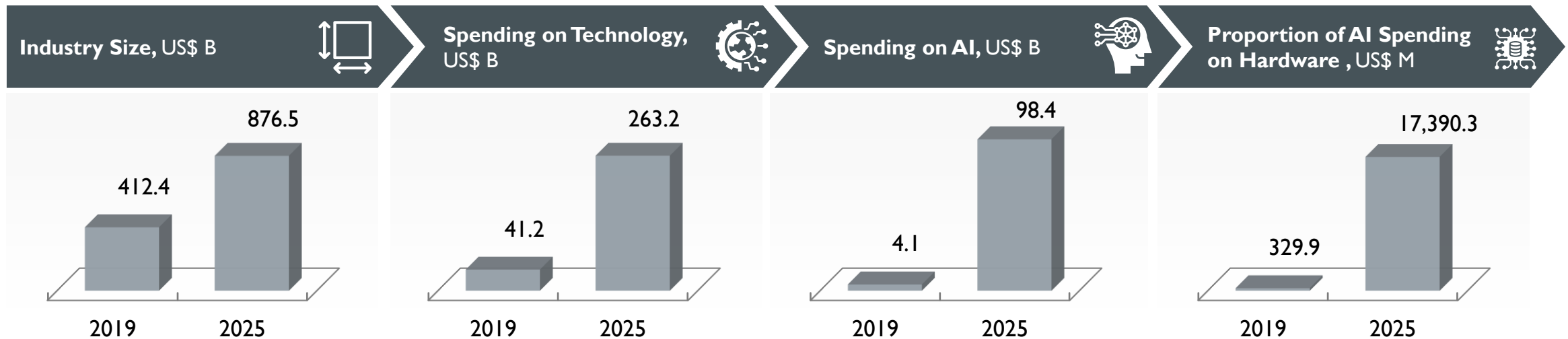
Avanteum
DISCOVER FUTURE

Existing Base of AI Hardware Professionals

Annual Demand for AI Hardware Professionals

	Existing Base of AI Hardware Professionals							Annual Demand for AI Hardware Professionals					
Year	2019	2020	2021	2022	2023	2024	2025	2019	2020	2021	2022	2023	2024	2025
Value	2,252	5,418	12,775	29,664	63,983	1,32,300	2,10,600		3,166	7,357	16,890	34,318	68,317	78,300
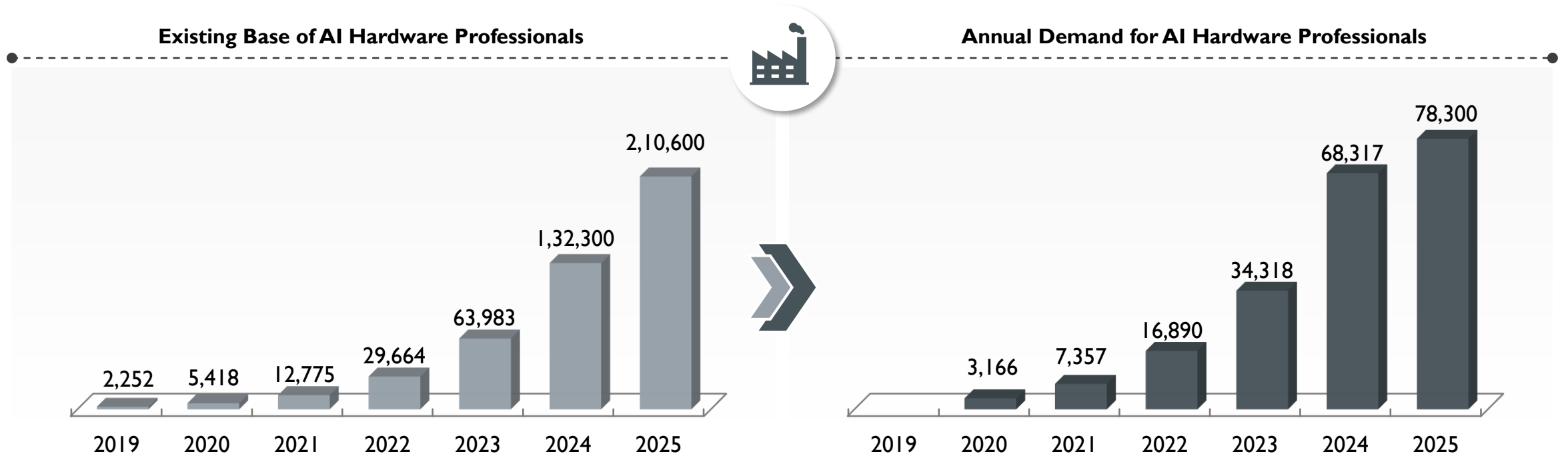
- Sectors witnessing a higher level of automation in manufacturing are expected to be the primary demand generators for AI hardware professionals
- Skill set requirements would also include knowledge and expertise in robotics, automation, HMI etc
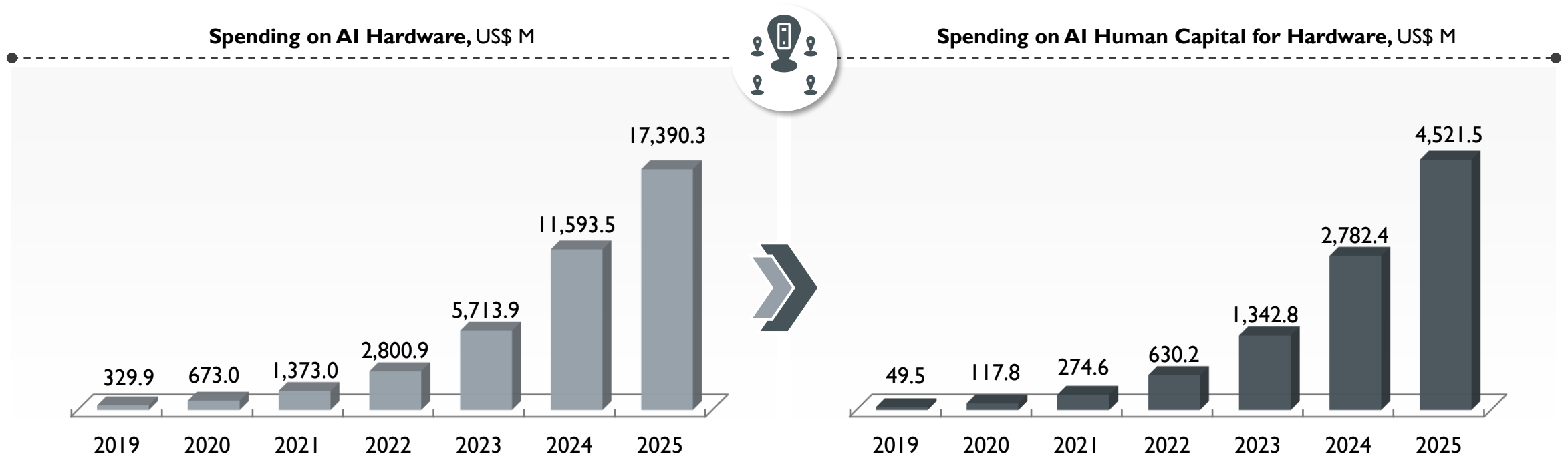
AI IN MOBILITY

MOBILITY SECTOR: SPENDING ON AI HARDWARE

Industry Size, US$ B	**Spending on Technology,** US$ B	**Spending on AI,** US$ B	**Proportion of AI Spending on Hardware,** US$ M
2019: 412.4	2019: 41.2	2019: 4.1	2019: 329.9
2025: 876.5	2025: 263.2	2025: 98.4	2025: 17,390.3

- Automotive industry has been the earliest to embrace networked philosophy and also integration with telecom. Usage data and multiple parameters make mobility a prime candidate for technology adoption.

- AI will be used extensively to improve safety, enhance user experience and integrate with hitherto unused areas like healthcare.
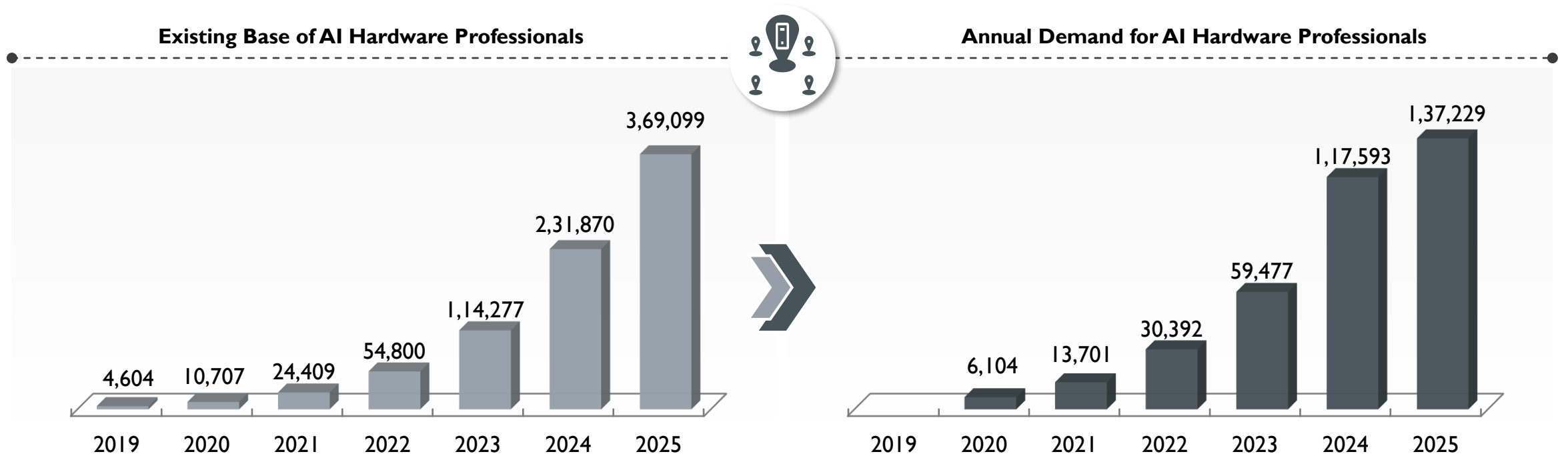
Avanteum
DISCOVER FUTURE

MOBILITY SECTOR: SPENDING ON AI HARDWARE & ASSOCIATED HUMAN CAPITAL

Spending on AI Hardware, US$ M

Year	Value
2019	329.9
2020	673.0
2021	1,373.0
2022	2,800.9
2023	5,713.9
2024	11,593.5
2025	17,390.3

Spending on AI Human Capital for Hardware, US$ M

Year	Value
2019	49.5
2020	117.8
2021	274.6
2022	630.2
2023	1,342.8
2024	2,782.4
2025	4,521.5

- The automotive and logistics sectors are pioneers when it comes to AI adoption. Applications that drive AI usage in the mobility space include growth in autonomous vehicles, remote management of fleet/cruises, inclusion of more intelligent safety and comfort features as well as intelligence for preventive maintenance.

- Even the transition towards electric vehicles is expected to influence the trend of increased spending on electronic/control hardware and in turn the spending on AI that is likely to be a component of most hardware sub systems of vehicles going forward.
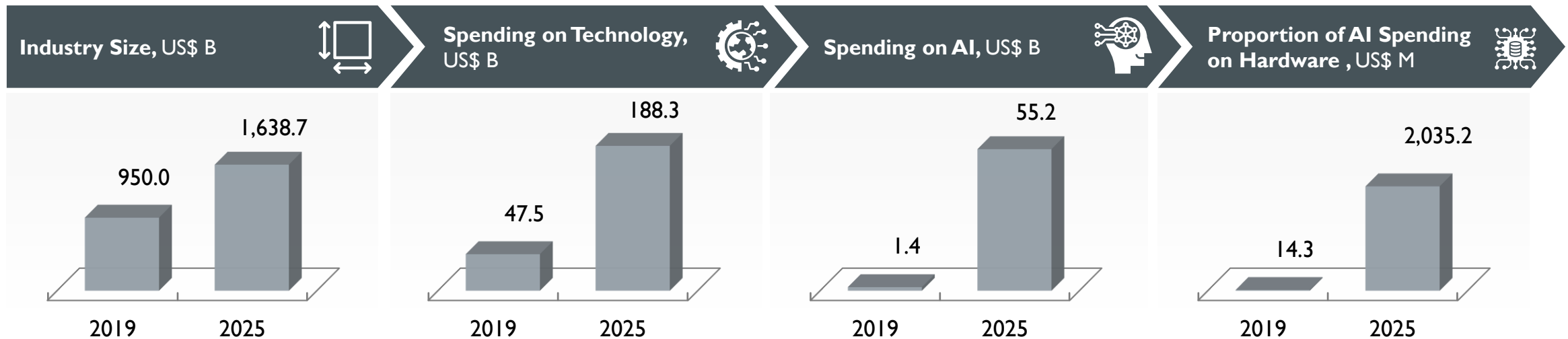
MOBILITY SECTOR: POTENTIAL DEMAND FOR AI HARDWARE PROFESSIONALS

Existing Base of AI Hardware Professionals

- 2019: 4,604
- 2020: 10,707
- 2021: 24,409
- 2022: 54,800
- 2023: 1,14,277
- 2024: 2,31,870
- 2025: 3,69,099

Annual Demand for AI Hardware Professionals

- 2019: —
- 2020: 6,104
- 2021: 13,701
- 2022: 30,392
- 2023: 59,477
- 2024: 1,17,593
- 2025: 1,37,229

- The largest demand generator for AI professionals. Rapidly advancing technologies such as autonomous vehicles to drive this demand.
- Skill set needs to include understanding of automobile sub systems apart from knowledge in hardware design and engineering.
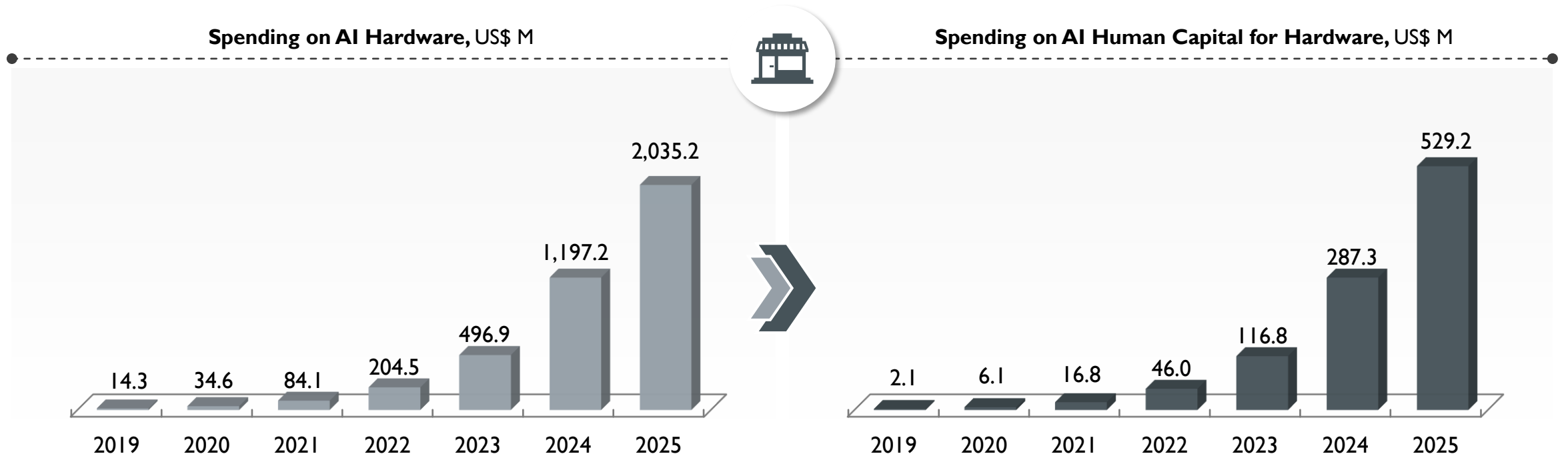
Avanteum
DISCOVER FUTURE

AI IN RETAIL

RETAIL SECTOR: SPENDING ON AI HARDWARE

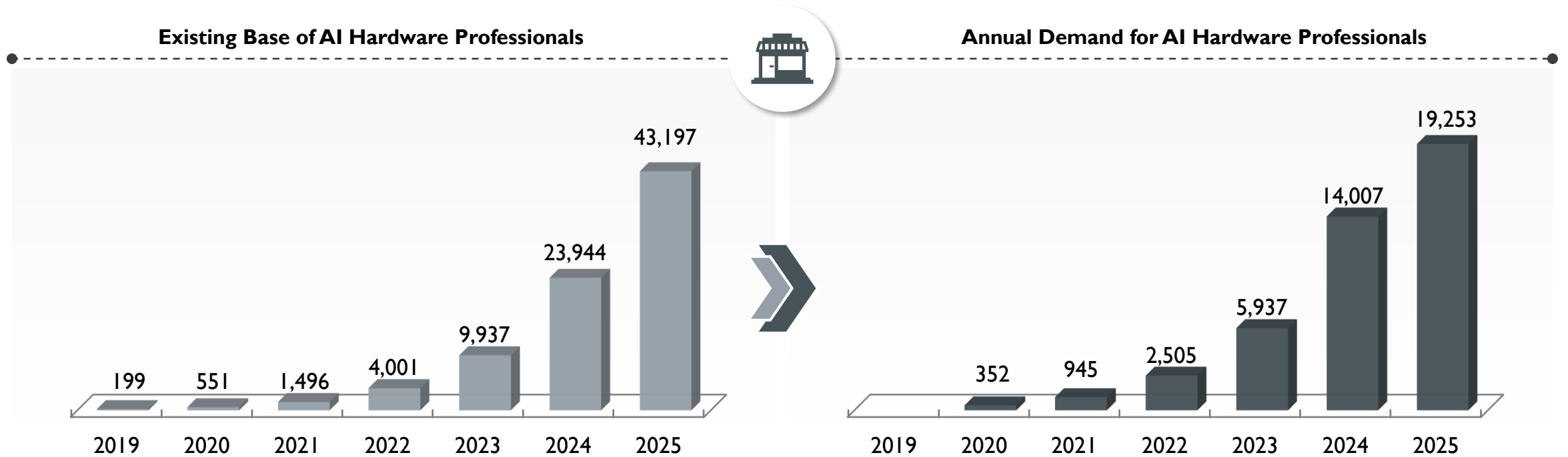| **Industry Size**, US$ B	**Spending on Technology**, US$ B	**Spending on AI**, US$ B	**Proportion of AI Spending on Hardware**, US$ M
950.0 (2019), 1,638.7 (2025)	47.5 (2019), 188.3 (2025)	1.4 (2019), 55.2 (2025)	14.3 (2019), 2,035.2 (2025)

- Retail industry has undergone transformation on account of competition from online platforms and also through consolidation. Consolidation has led to scale which can be managed by leveraging technology.

- Large offline retail chains are investing in AI to exploit the immense opportunities that exist in enhancing footfalls and targeted user experience and loyalty.

RETAIL SECTOR: SPENDING ON AI HARDWARE & ASSOCIATED HUMAN CAPITAL

Spending on AI Hardware, US$ M

Spending on AI Human Capital for Hardware, US$ M

Spending on AI Hardware (US$ M):
- 2019: 14.3
- 2020: 34.6
- 2021: 84.1
- 2022: 204.5
- 2023: 496.9
- 2024: 1,197.2
- 2025: 2,035.2

Spending on AI Human Capital for Hardware (US$ M):
- 2019: 2.1
- 2020: 6.1
- 2021: 16.8
- 2022: 46.0
- 2023: 116.8
- 2024: 287.3
- 2025: 529.2

- Much of the AI applications in retail fall under the software segment , chief amongst them being biometric capture of customer details to map with past retail experiences and offer customized offers, enhancing the customer retail experience through intelligent shopping assistance etc.

- Primary hardware spending and specifically AI hardware spending is expected to be in introduction of intelligent PoS systems, and intelligent surveillance systems.
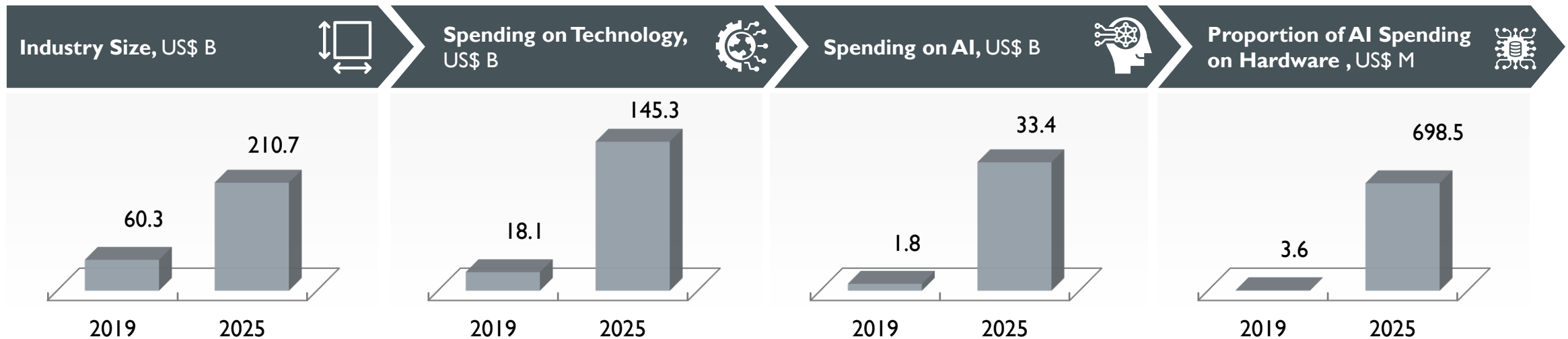
RETAIL SECTOR: POTENTIAL DEMAND FOR AI HARDWARE PROFESSIONALS

Existing Base of AI Hardware Professionals

Annual Demand for AI Hardware Professionals

Existing Base of AI Hardware Professionals:
- 2019: 199
- 2020: 551
- 2021: 1,496
- 2022: 4,001
- 2023: 9,937
- 2024: 23,944
- 2025: 43,197

Annual Demand for AI Hardware Professionals:
- 2019: (none)
- 2020: 352
- 2021: 945
- 2022: 2,505
- 2023: 5,937
- 2024: 14,007
- 2025: 19,253

- Retail to witness higher demand for AI software professionals. Hardware engineers would primarily be required to help interface hardware systems and aid in development of appropriate algorithms that work seamlessly on the hardware employed.

Avanteum
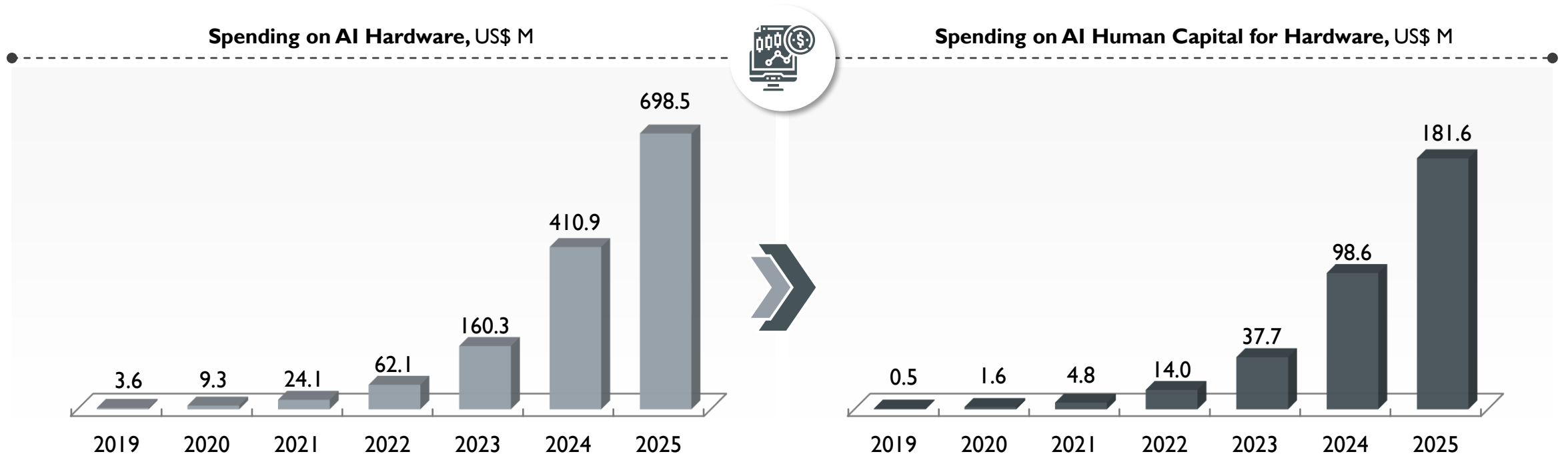DISCOVER FUTURE

AI IN FINTECH

FINTECH SECTOR: SPENDING ON AI HARDWARE

Industry Size, US$ B	**Spending on Technology,** US$ B	**Spending on AI,** US$ B	**Proportion of AI Spending on Hardware,** US$ M
60.3 (2019), 210.7 (2025)	18.1 (2019), 145.3 (2025)	1.8 (2019), 33.4 (2025)	3.6 (2019), 698.5 (2025)

- Digitization of different sectors have indirectly catapulted the prospects of the financial sector as technology was the cornerstone of this transformation. Demonetization was the biggest trigger.

- Apart from digital wallets, AI is being used extensively in ensuring credit risk management, better financial discipline, avoiding errors among others.
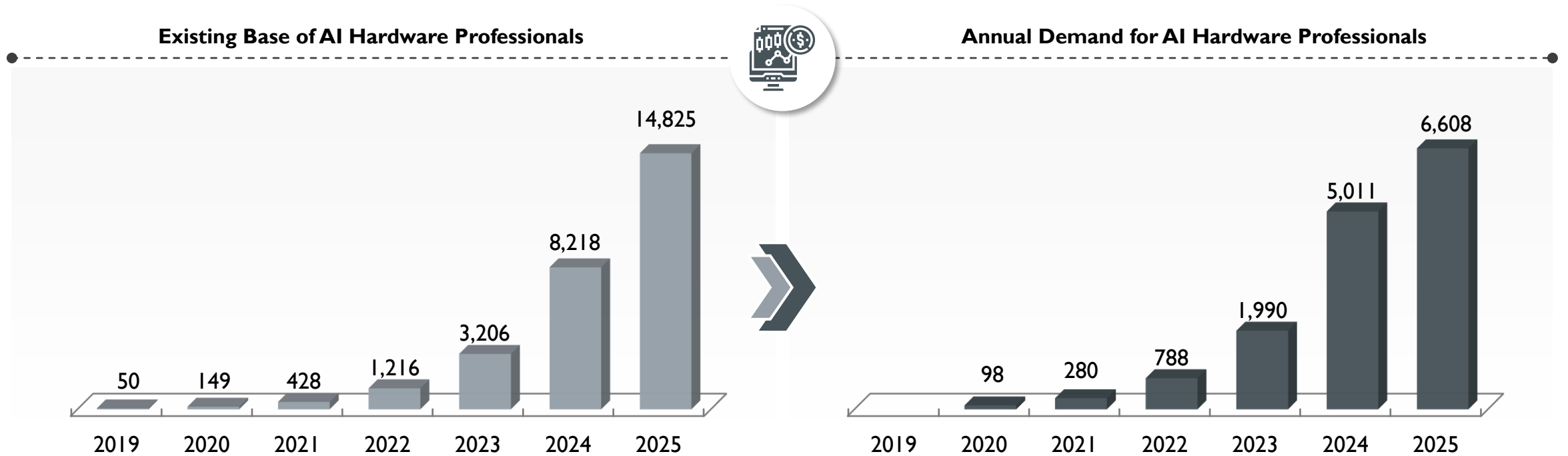
Avanteum
DISCOVER FUTURE

Spending on AI Hardware, US$ M

Spending on AI Human Capital for Hardware, US$ M

Spending on AI Hardware, US$ M:
- 2019: 3.6
- 2020: 9.3
- 2021: 24.1
- 2022: 62.1
- 2023: 160.3
- 2024: 410.9
- 2025: 698.5

Spending on AI Human Capital for Hardware, US$ M:
- 2019: 0.5
- 2020: 1.6
- 2021: 4.8
- 2022: 14.0
- 2023: 37.7
- 2024: 98.6
- 2025: 181.6

- Much of the AI applications in fintech also fall under the software segment , chief amongst them being automated banking and financial services offerings, automated wealth management services, intelligent claims handling etc.

- Primary hardware spending and specifically AI hardware spending is expected to be in introduction of new interface devices and intelligent security systems.

FINTECH SECTOR: POTENTIAL DEMAND FOR AI HARDWARE PROFESSIONALS

Existing Base of AI Hardware Professionals

14,825

8,218

3,206

1,216

50   149   428

2019   2020   2021   2022   2023   2024   2025

Annual Demand for AI Hardware Professionals

6,608

5,011

1,990

788

98   280

2019   2020   2021   2022   2023   2024   2025

- Fintech to witness higher demand for AI software professionals. Hardware engineers would primarily be required to help interface hardware systems and aid in development of appropriate algorithms that work seamlessly on the hardware employed.

Avanteum
DISCOVER FUTURE

INDIRECT OPPORTUNITY FOR SKILLING – ARISING FROM AI INFLUENCE IN SECTORS

INDIRECT OPPORTUNITY – RECAP OF ESTIMATION METHODOLOGY

Indirect Opportunity

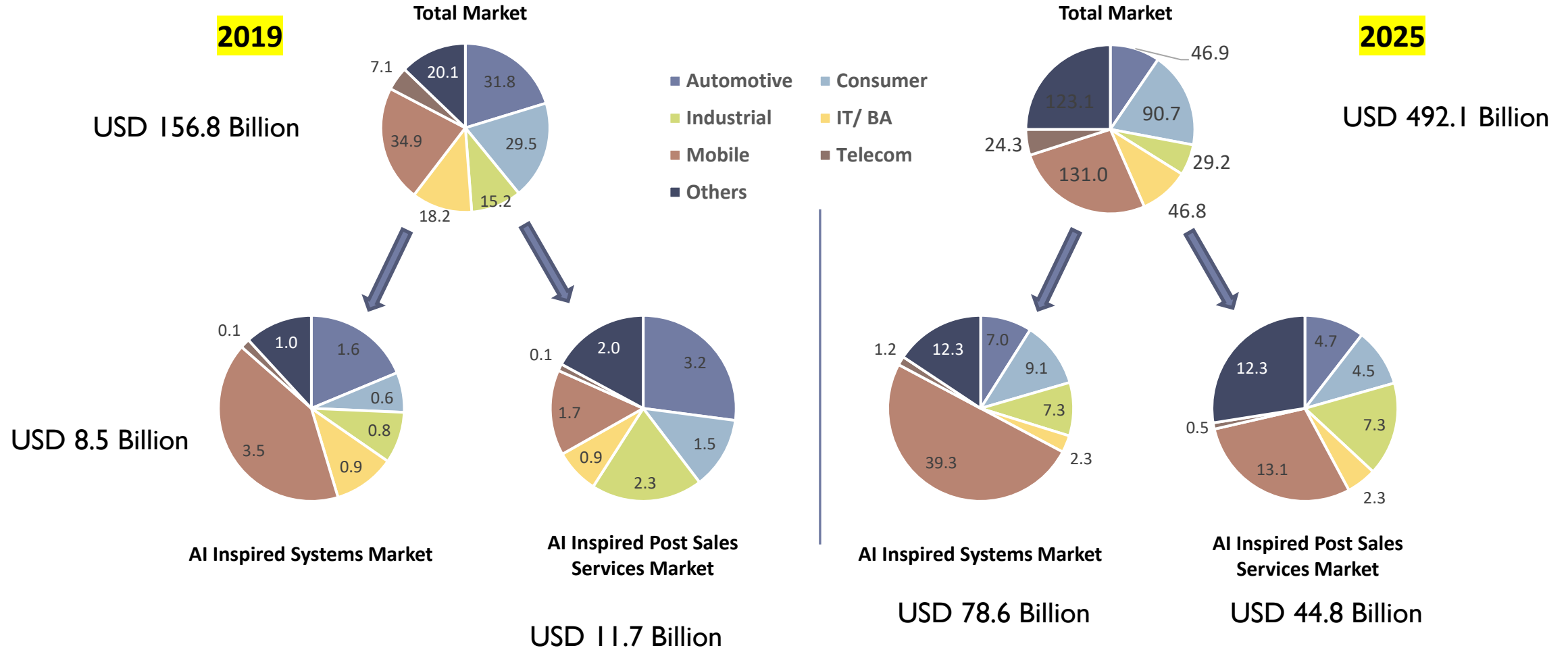Areas of development/ investment in Systems Hardware (due to AI) in India

↓

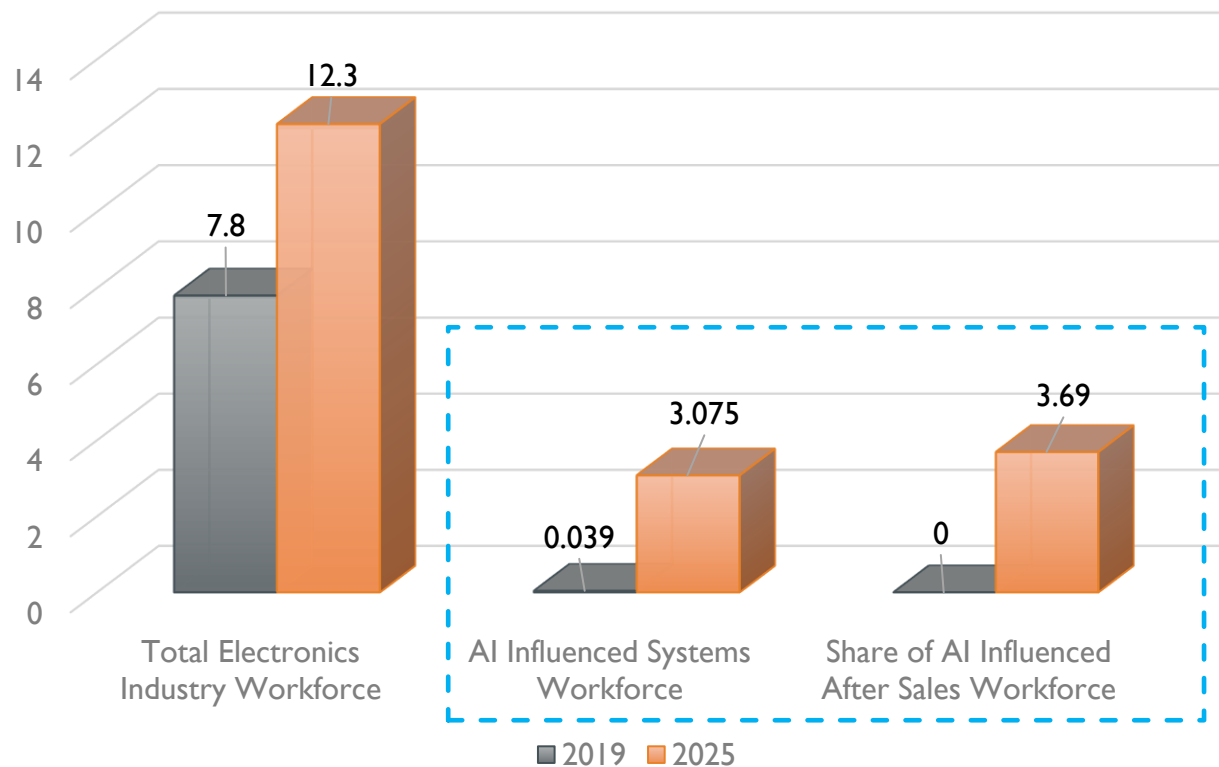Evaluation of skill sets required to service the systems hardware activities

↓

Analysis on the electronics Hard-ware skill development needs to address the adjacent opportunities

AI INDUSTRY GROWTH OFFERS INDIRECT OPPORTUNITIES FOR ELECTRONICS SYSTEMS SKILLS DEMAND

2019

USD 156.8 Billion

Total Market

- Automotive
- Consumer
- Industrial
- IT/ BA
- Mobile
- Telecom
- Others

31.8 / 29.5 / 15.2 / 18.2 / 34.9 / 7.1 / 20.1

USD 8.5 Billion

AI Inspired Systems Market

1.6 / 0.6 / 0.8 / 0.9 / 3.5 / 0.1 / 1.0

AI Inspired Post Sales Services Market

3.2 / 1.5 / 2.3 / 0.9 / 1.7 / 0.1 / 2.0

USD 11.7 Billion

2025

USD 492.1 Billion

Total Market

46.9 / 90.7 / 29.2 / 46.8 / 131.0 / 24.3 / 123.1

AI Inspired Systems Market

7.0 / 9.1 / 7.3 / 2.3 / 39.3 / 1.2 / 12.3

USD 78.6 Billion

AI Inspired Post Sales Services Market

4.7 / 4.5 / 7.3 / 2.3 / 13.1 / 0.5 / 12.3

USD 44.8 Billion

AI INFLUENCED INDIRECT OPPORTUNITIES TO CONTRIBUTE HALF OF INDUSTRY WORKFORCE BY 2025

AI Influenced Workforce Growth

Chart values (2019 / 2025):
- Total Electronics Industry Workforce: 7.8 / 12.3
- AI Influenced Systems Workforce: 0.039 / 3.075
- Share of AI Influenced After Sales Workforce: 0 / 3.69

Legend: ■ 2019 ■ 2025

Unit in Millions

- Every investment of USD 20,000 leads to employment of one working hand. This value is expected to increase as greater EMS activities and increased automation are expected to penetrate

- 3X increase in market demand will lead to a 57% jump in workforce demand

- Current AI influenced systems workforce is just 0.5% of the pool and set to jump to 25% by 2025

- Aftersales service is handled by solutions companies themselves but will pave way for organized service support to touch 30% of workforce by 2025

AI USE CASES

AI IN AGRICULTURE

Use case 1

Digitizing Quality across Fresh Produce Supply Chains – Intello Labs products' detect variance from specifications and match output to needs

Mobile app based AI platform (Intello Track) that enables objective grading of fresh produce based on color, size and visual effects. Images captured via mobile app, connect to AI powered edge computing device to deliver insights for growers/packers/exporters/retailers etc on which supplier has better quality, which location has better quality etc.

AI powered sorting machine (Intello Sort) that segregates produce based on color, size and visual defects. Enables multiple commodities sorting on a single line. Helps eliminates defective/decayed produce and also provides insights on quality of suppliers, quality of commodities at different supply locations etc.

AI powered scanning machine (Intello Pack) that monitors the color, size and visual defects in fresh produce at the packing stage and helps in elimination of defects while assuring quality maintenance at packing. It provides insights to manage the quality of packing professionals, accept or reject packaged produce based on the quality etc.

AI powered Handheld NIR scanner which detects Brix , pH , TSS, dry matter, moisture, pesticide residue in fresh produce. Provides insights that aid in decision making on the quality of produce in any farm, analytics for making purchase decisions etc.

✓ Maintain quality of the fresh produce across the supply chain

✓ Identifying supplier mal - practices / poor quality suppliers and initiate remedial action

✓ Identify supply locations with best quality

✓ Minimize returns/ replacements in delivery

Benefits of AI

AI IN AGRICULTURE

Use case II

Quality Assessment of Agricultural Produce using AI – Nebulaa's Matt Grain Analyzer, built on Deep Learning provides fast and 360 degree testing of all morphological characters of grains

Matt Automatic Grain Analyzer is a one stop solution to the woes of farmers, traders, exporters, retailers and consumers alike.

Backed with deep learning AI prowess, the Matt Analyzer takes a test sample of the commodity and within less than a minute provides entire analysis on the test sample covering all major morphological characteristics of agricultural produce.

Farmers benefit from a quality certificate for their produce that ensuring fair pricing. Traders are able to compare and analyze the various supplier's produce from the comfort of their office without visiting mandis, exporters benefit from the knowledge that all their exports are of top quality and consumers get value for their money in the form of premium quality food produce.

Analysis Results			
Particular	Count	% by Count	% by Weight
Total Grains	729	-	-
Broken Grains	95	13.03	6.98
Admixture	26	3.57	4.15
Organic Impurities	13	1.78	1.70
Other Edible Seeds	26	3.57	2.63
Inorganic Impurity	15	2.06	2.54
Shrivelled Grains	45	6.17	3.54
Damaged Grains	25	3.43	3.42
Vertical Broken	26	3.67	2.30
Weevield Grains(% By Count)	16	2.19	1.97
Slightly damaged grains	9	1.23	1.
Uniformity	-	-	More Uniform
Luster	-	-	Normal

20,000 Matt Analysis Tests Conducted

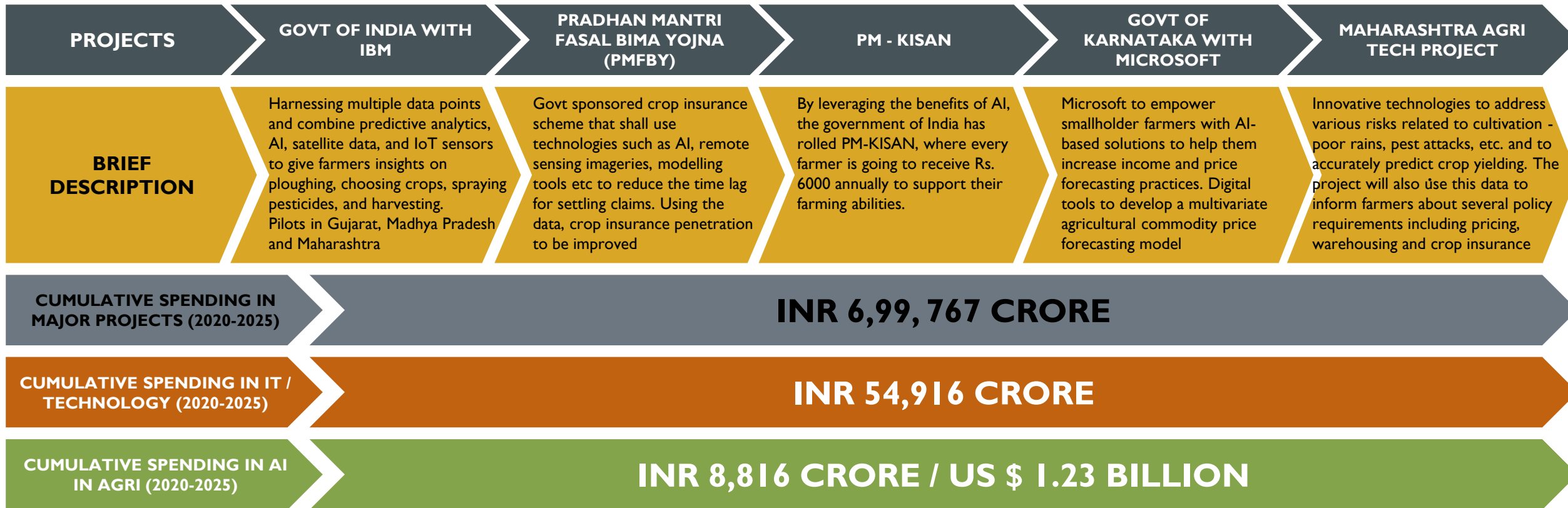**6 States** have undertaken Pilot and Commercial Deployments

Usage across **FMCG, Seed Industry, Miller, Mandis, Public Distribution**

✓Reduces the time of grain assessment from 30 minutes to 1 minute

✓Eliminates need to do visual quality checks at mandis and warehouses

✓Quality certificate enables better pricing for farmers and eliminates rejects/returns for traders/exporters

Benefits of AI

AI IN AGRICULTURE

Major Public Projects and Spending in AI

PROJECTS	GOVT OF INDIA WITH IBM	PRADHAN MANTRI FASAL BIMA YOJNA (PMFBY)	PM - KISAN	GOVT OF KARNATAKA WITH MICROSOFT	MAHARASHTRA AGRI TECH PROJECT
BRIEF DESCRIPTION	Harnessing multiple data points and combine predictive analytics, AI, satellite data, and IoT sensors to give farmers insights on ploughing, choosing crops, spraying pesticides, and harvesting. Pilots in Gujarat, Madhya Pradesh and Maharashtra	Govt sponsored crop insurance scheme that shall use technologies such as AI, remote sensing imageries, modelling tools etc to reduce the time lag for settling claims. Using the data, crop insurance penetration to be improved	By leveraging the benefits of AI, the government of India has rolled PM-KISAN, where every farmer is going to receive Rs. 6000 annually to support their farming abilities.	Microsoft to empower smallholder farmers with AI-based solutions to help them increase income and price forecasting practices. Digital tools to develop a multivariate agricultural commodity price forecasting model	Innovative technologies to address various risks related to cultivation - poor rains, pest attacks, etc. and to accurately predict crop yielding. The project will also use this data to inform farmers about several policy requirements including pricing, warehousing and crop insurance

CUMULATIVE SPENDING IN MAJOR PROJECTS (2020-2025)	**INR 6,99,767 CRORE**
CUMULATIVE SPENDING IN IT / TECHNOLOGY (2020-2025)	**INR 54,916 CRORE**
CUMULATIVE SPENDING IN AI IN AGRI (2020-2025)	**INR 8,816 CRORE / US $ 1.23 BILLION**

Note:

For Cumulative spending on major projects – annual budgetary allocation for PMFBY and PM Kisan alone considered; an yearly increment of 10% in spending assumed.

For Cumulative spending on IT/Technology – for 2020, it is considered as 5% of total spending and steady increments assumed, such that by 2025 it is 10% of the total spending

For Cumulative spending on AI – for 2020, it is considered as 5% of total spending on It and Tech and steady increments assumed, such that by 2025 it is 22% o f total IT and Tech spending.

This does not include overall spending of AI in Agriculture; only represents the spending from major government projects.

# AI IN HEALTHCARE / MEDTECH

Use case 1

Democratizing access to quality healthcare using deep technologies such as AI – Aindra's Astra AI platform and accompanying devices enable point of care detection systems for cancer disease

Aindra IS is an automatic stainer for staining blood samples mounted on glass slides. Equipped with advanced mechatronics and software it enables perfect staining of samples. A one stop shop the products sleek compact and portable design make it a highly favored point of care detection system in place of huge laboratory space occupying stainer systems.

Aindra's Vision X provides crisp images of whole slides thus enabling digitization of slides. The digitized slides enable faster turn around time for the diagnostic reports as the slides can be transferred to the clinician for quite evaluation thus enabling telepathology
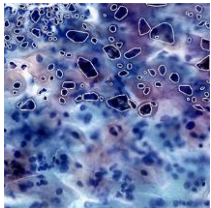
Aindra AS or Astra is a AI platform that facilitates computational pathology for quicker and precision diagnosis. Astra benefits in being built on data from experienced pathologists.

✓ Point of care detection system that alleviates the need for patient to travel to distant labs

✓ Enables faster turn around of test results through digitization of slides that can be immediately sent to clinicians for diagnosis

✓ Portable and very effective for remote locations

Benefits of AI

Technology driven Cardiac Care in low resources hospitals – Tricog offers preliminary diagnosis of ECG to ensure a higher survival rate among patients

Insta ECG addresses the need of remote hospitals, clinics and health centers which do not have enjoy round the clock services of cardiologist.

Insta ECG is a communicator that helps connect the available ECG device, acquire patient data and send the same over an existing 2G to 4G network to the cloud. The Interpretation and analysis of an ECG data is done at Tricog center by experts and report is furnished within 10 minutes. **Vcardia** is an app based comprehensive unit that integrates the ECG device and the communicator. It is compact, portable, and comes with 4G connectivity. This is offered as an integrated device for ECG measurement and analysis.

Both Insta ECG and Vcardia are AI powered devices that has been developed by building into a large pattern of cardiac related symptoms and incidents. The algorithms have been developed in-house and remains the IP.

Tricog team has designed the board to the entire system. It collaborates with Interconnect (Coimbatore) to design the PCB and partners with PCB Power (Ahmedabad) to manufacture. Kaynes (Mysore) undertakes the manufacturing of devices.

Tricog utilizes Comp. Science engineers grads for programming on the GPUs, given the need on signal processing. Hardware engineers work on PCB design and systems. They also employ diploma holders for final assembly and testing of devices. Tricog finds it difficult to find full stack developer and hence train freshers for 12 months. They find the technicians good with their skills.

The focus is on Edge computing related activities in future for multiple reasons and would require hardware engineers.

> AI driven ECG specific system opens new design and manufacturing opportunities

Opthalmology is a highly specialized and under-addressed problem globally – Remidio solves this problem with ingenious solution involving AI and hardware

The challenge in eye care stems from the challenge of widespread problem, expensive diagnostic equipment and lack of commensurate volume of experts. Moreover the prevalence of eye problems are high in low income communities which calls for innovative solutions.

Remidio has developed Retinal imaging device which uses Gullstrand principle to separate the illumination and the imaging paths of light to achieve high quality reflex free images of the retina. The primary data collection camera is a done on Apple iphone. The camera is modified to capture the required image and processed using AI technology. Apple phones are the only brand that are FDA approved under the GDPR compliance.

Remidio has another product "Fundus on Phone" is also based on Apple iphone device and modified and certified camera. The application is for Anterior Imaging purpose and helps achieve the resolution which regular devices are not able to.

The Remidio team uses generic Nvidia GPU on which the required algorithms are written using Python. Electronics engineers are preferred who come with 2 to 3 years of relevant experience. Hiring freshers for GPUs is not a preferred choice.

Remidio also manufactures the device in-house for which an extensive supply chain has been developed. The system is design by the internal team which comprises of ophthalmologists and mechanical engineers. Many components are imported and assembled in the Remidio's unit at Bangalore.

Though technicians suffice for assembly and testing functions, mechanical engineers are available at the same cost today.

Marrying conventional hardware and AI technology is an unique experiment

AI IN MOBILITY

Use case 1

Netradyne's Driveri® Technology combines Artificial Intelligence with video and advanced onboard sensors to detect, reason and determine causality of events. Device with high processing capability to handle thousands of data points and real time insights/alerts
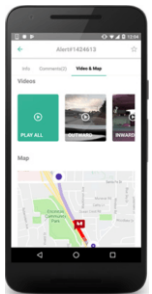
Driveri® incorporates intuitive, deep learning, vision based technology that aids in reducing accidents by creating new safety standards for commercial vehicles. It empowers drivers with awareness on risky driving behavior and also aids in rewarding safe driver decision making.

A best in class solution for autonomous vehicles, Driveri® enables efficient remote fleet management by providing effective real time insights and alerts. By providing real time in cab alerts, it enables drivers to adjust as risky events occur and take remedial measures immediately.

Multiple camera views provide context and clarity for driver and passenger safety. While the external view cameras identify key risk factors as they occur regardless of speeding activity such as speed or u turn etc., the internal view cameras provide a more holistic view of driver and passenger safety helping in identifying distracted driver behaviors and policy violations.

The Driveri® technology platform processes data in real time with up to 100 hours of storage. Unlike legacy platforms that rely on video to be uploaded to the cloud then reviewed by humans, thousands of data points are analyzed on the device, delivering real-time insights and alerts. This is possible through on device memory enabled by edge computing.

✓Real time insights and alerts to avert accidents

✓Remote monitoring and management of fleet/cruises

✓No time lag in decision making enabled through on device memory and computing

✓Real time tracking of driver safety and performance

Benefits of AI

Avanteum
DISCOVER FUTURE

AI IN MOBILITY

Use case II

Unique software solutions for the autonomous vehicle industry by focusing on cost and energy efficient designs that can target GPUs, DSPs, FPGAs, and custom embedded hardware – MulticoreWare's autonomous vehicles and advanced driver assistance systems (ADAS) solutions

Multicoreware's offers suite of products and services spanning compilers, machine learning, video codecs, image processing and augmented/virtual reality. Expertise in accelerating software and algorithms for multi core heterogenous platforms covering GPGPUs, DSPs, FPGAs, and mobile and embedded platforms. Multicoreware's solutions aid in building AV and ADAS as per requirements of customer's power, performance and cost requirements.

MulticoreWare has been involved in the design and development of the OpenCV open-source vision library and the Khronos OpenVX standard for portable and power-efficient vision processing.

MulticoreWare's expertise involves enabling state of the art image processing and vision algorithms on any platform – embedded, mobile or workstation and cloud. By collaborating with mobile device manufacturers, app developers, and semiconductor vendors, MulticoreWare has improved the capability of their devices by utilizing the CPU, GPU, DSP, and other processing elements available in modern SoCs. Incase of GPU or FPGA enabled workstations and cloud servers, MulticoreWare aids in design of algorithms to utilize the power of modern GPUs, FPGAs and server-class hardware.

✓Portability of custom and open source algorithms to dozens of architectures.

✓Power efficient vision processing.

✓Efficient performance on multi core heterogenous platforms

Benefits of AI

IoT Technology for identification of defective parts in high speed manufacturing lines – Valliance Solutions offers a detection systems to result in 100% quality compliance

Physical defects like abrasions, cuts, patches etc., in manufactured products are mostly detected by human intervention. The flip side of this intervention is a slow process involved and also it not being 100% fool proof. The cost of product rejection leads to not just monetary losses but also reputation that further leads to negative business impact.

Intelligent Defect Identification is a AI platform developed by Valliance to overcome this manufacturing process challenge. It primarily uses Image processing techniques through the usage of precision cameras. The inputs involve image of normal and abnormal product finishes from different stages of production that are to the localized 'learning service'. Analytical models were built to differentiate between OK vs Not OK characteristics to meet preset quality specifications.

This system imparts a high level of confidence and can be deployed on any conventional hardware in a manufacturing unit with low decision latency during production process. Valliance's solution comprises of smart precision cameras for detection, GPUs and mobile based application interface.

Valliance leverages Comp. Science engineers grads for programming on the GPUs, Electronics engineers are hired for sensors and Edge computing related activities. Lateral hiring is the preferred mode over in-house training.
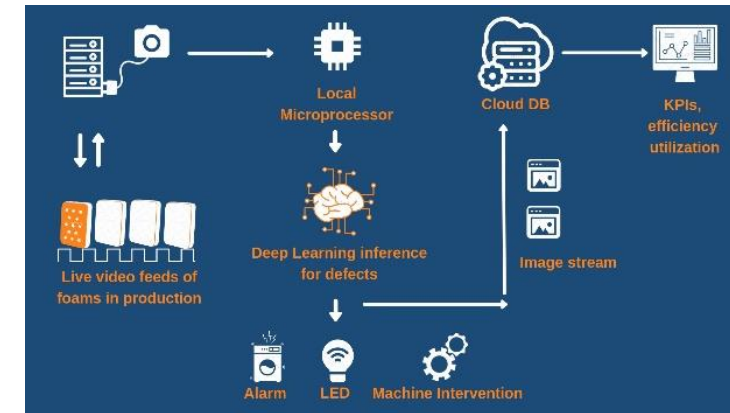
AI based defect detection is expected to catapult the challenge of quality inspection in Indian products

Applying AI to existing set of information from customers can greatly enhance credit risk - by Primid Fintech

To have better and deeper information about customers is crucial to the credit risk management of banks and financial institutions. Possession of information can help avoid or minimize losses.

ML is the key element that allows for different factors to be evaluated to make well-grounded decisions, and every new piece of information processed by the algorithm makes its predictions more accurate.

Application of predictive analysis to large amounts of data in real time is made possible by AI technology. This can help identify investors with less than noble intentions working in unison across multiple accounts. Such actions would typically be impossible for a human investment official, that too during the crucial time period.

This system imparts a high level of confidence and can be deployed on any conventional hardware in a manufacturing unit with low decision latency during production process. Valliance's solution comprises of smart precision cameras for detection, GPUs and mobile based application interface.

Valliance leverages Comp. Science engineers grads for programming on the GPUs, Electronics engineers are hired for sensors and Edge computing related activities. Lateral hiring is the preferred mode over in-house training.

BIBLIOGRAPHY

Sources and links used in this research

- Ai. Business

- Accelerating India's economic growth with AI – Accenture

- AI derived business value forecast - Gartner

- Landscape of AI/ML Learning in India – Itihaasa research

- The state of tech skilling landscape in India – Great Learning

- AI and Big Data Talent Demand and Supply Report – Nasscom and Zinnov

- AI Hardware – New opportunities for Semicon Companies – Mckinsey & Company

- India Skills Report 2020 – Wheebox

- National Strategy for AI – Niti Aayog

- AI Task Force Report

- WIPO Technology Trends report 2019

Avanteum Advisors is an advisory firm providing services on strategy, implementation and insights to organizations in the automotive, transportation, logistics and industrial segments.

Through our consulting, analytics, insights, our clients are exposed to innovative strategies that help them discover future growth, creating the "right" product, competitive price positioning, choice of appropriate channels, building smart brand connect and ensuring organizations are geared to create, develop and retain satisfied customers.

We provide solutions in the areas of Corporate, BU strategy, Sales, Marketing & Distribution, Customer insights, Digital and R&D Innovation.

CHENNAI

Avanteum Advisors LLP
D2 Juniper, AK55, TAS Enclave
10th Main Road, Annanagar
Chennai 600 040 Tamil Nadu, INDIA

Ph. No. +91 98401 52397
E-mail: vramakrishnan@avanteum.com

MUMBAI

Avanteum Advisors LLP
13/22, Vijaynagari Annex
Off. Ghodbunder Road, Waghbil
Thane 400 615 Maharashtra, INDIA

Ph. No. +91 98670 05330
E-mail: vijay.kakade@avanteum.com

BANGALORE

Avanteum Advisors LLP
3105, Prestige Kensington Gardens
17, HMT Main Road
Jalahalli 560013 Karnataka INDIA

Ph. No. +91 99865 90331
E-mail: vniju@avanteum.com

Avanteum
DISCOVER FUTURE