

UbuntuNet-Connect 2024 - 17th UbuntuNet Alliance Research and Education Conference, (October 31-November 1, Dar es Salaam, Tanzania)



Role of Research and Education in Artificial Intelligence Projects' Success

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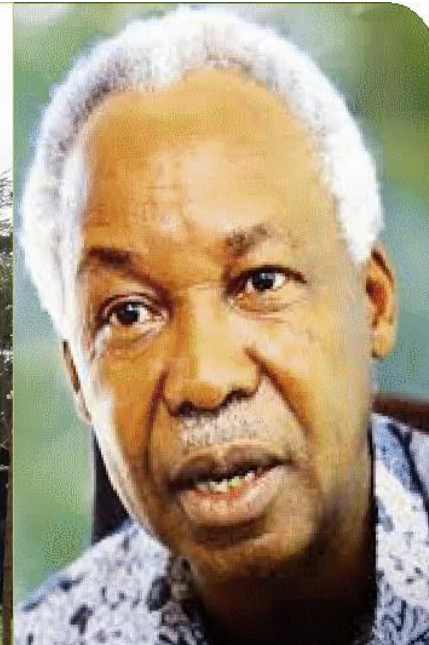
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Conclusion

1. About The Nelson Mandela African Institution of Science and Technology

(Our Motto: Academia for Society and Industry)

- ❑ Network of **Pan African Institutions of Science and Technology (Tanzania, Nigeria, Burkinafaso)**
- ❑ These institutions are the proud brainchild of **the late Nelson Mandela**, envision training and developing the next generation of African scientists and engineers with a view to impacting profoundly on the continent's development through the **application of Science, Engineering, Technology and Innovation (SETI)**.
- ❑ The NM-AIST becomes operational from **2012**
- ❑ Offering Research Intensive Postgraduate Programs: **MSc, PhD and PostDoc**
- ❑ Sub-Saharan Africa Coverage: **Students from Tanzania, Kenya, Uganda, Rwanda, Burundi, S. Sudan, DR Congo, Ethiopia, Mozambique, Malawi, Ghana, Zambia, Cameroon, Comoro, Nigeria.**
- ❑ Four **(4) Schools** ***HUB OF AI Training & Skills Development, Research and Innovation, HPC infrastructure**



AI QUOTE

“Artificial intelligence is not a substitute for human intelligence; it is a tool to amplify human creativity and ingenuity.”

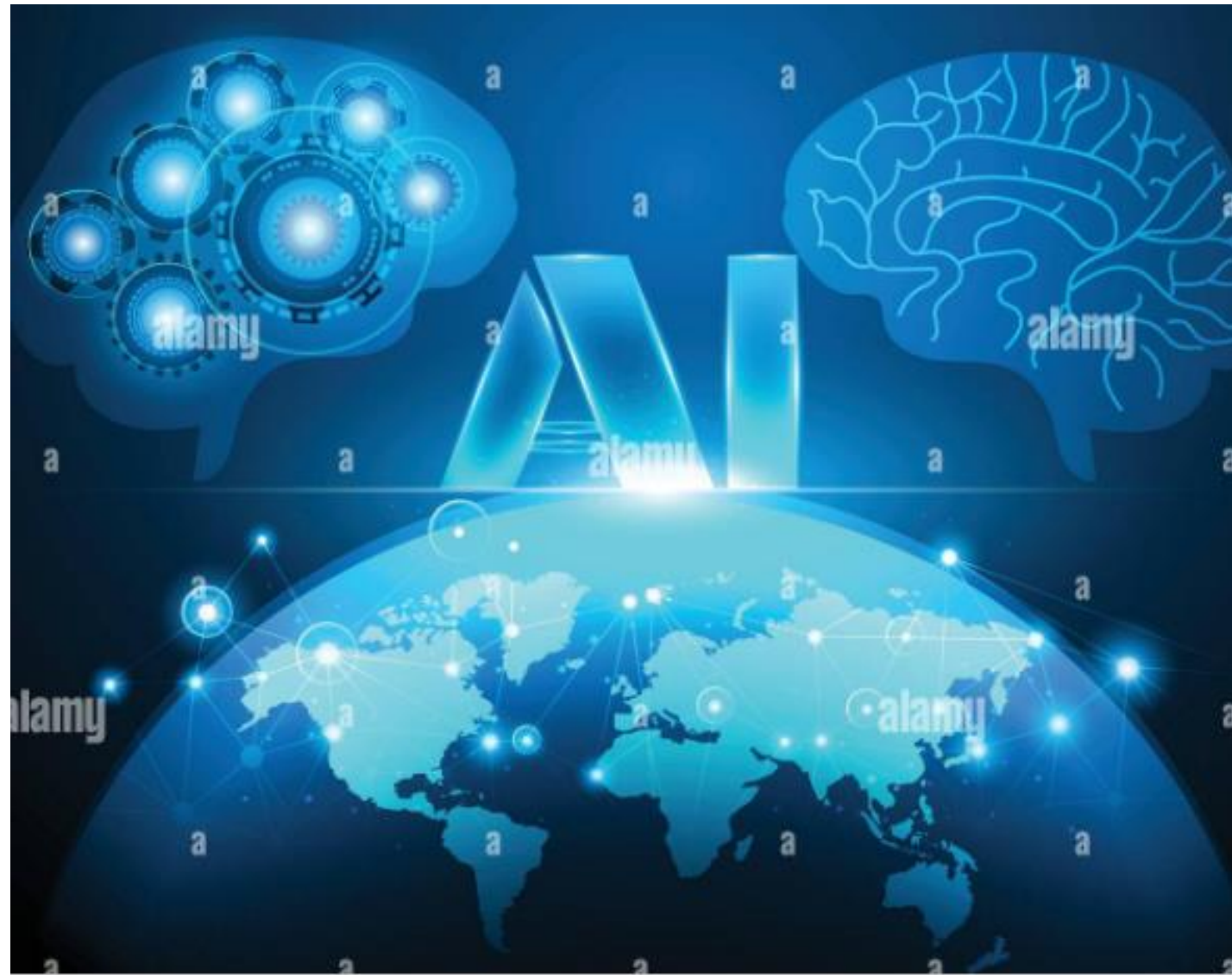
By Fei-Fei Li

*(AI Researcher & Professor, Stanford University; Co-Director,
Stanford Human-Centered AI Institute)*

2. Introduction

- ❑ In 2024 the global information technology (IT) spend is forecast to **total US\$5.26 trillion**, an increase of 7.5% from 2023 (**US\$3.89 trillion, growth of 3.8%**). Artificial Intelligence investment supports IT spending growth (Gartner Inc. report, July 2024). Most of the organisations align artificial intelligence (AI) in their business strategy to achieve strategic objectives and goals as well as deliver expected business value.
- ❑ Despite this growth in IT investment, **85% of AI projects are failing (i.e. 15% are successful)**. These failed AI projects have resulted in organisations not achieving their strategic objectives, goals, create business value in addition to costing them huge amounts of money (Gartner Inc. report, 2024).
- ❑ The focus of this keynote is the **Role of Research and Education in AI Projects' Success.**

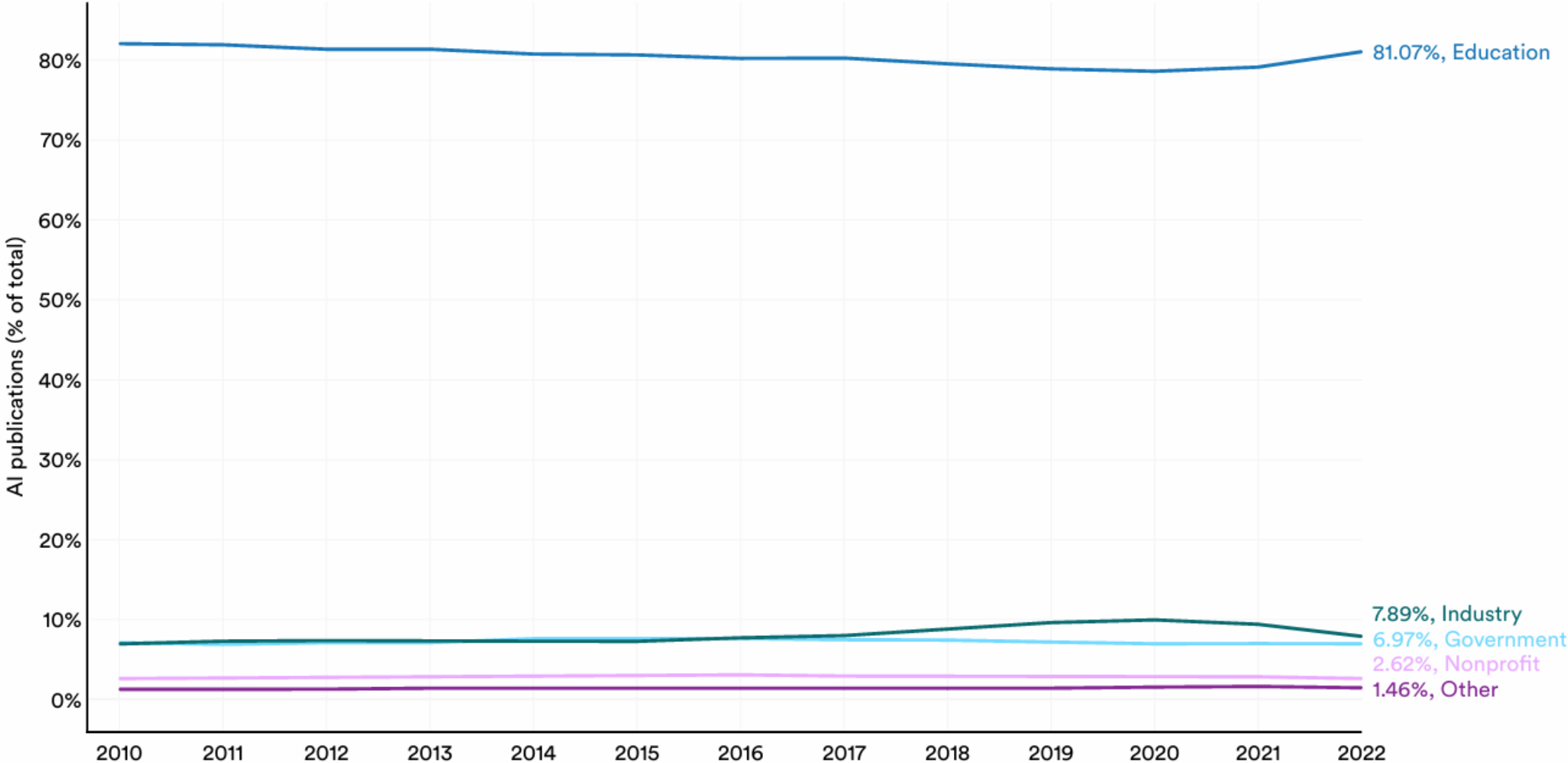
3. Global AI Overview



Research and Development (Global AI Index Report, 2024)

AI publications (% of total) by sector, 2010–22

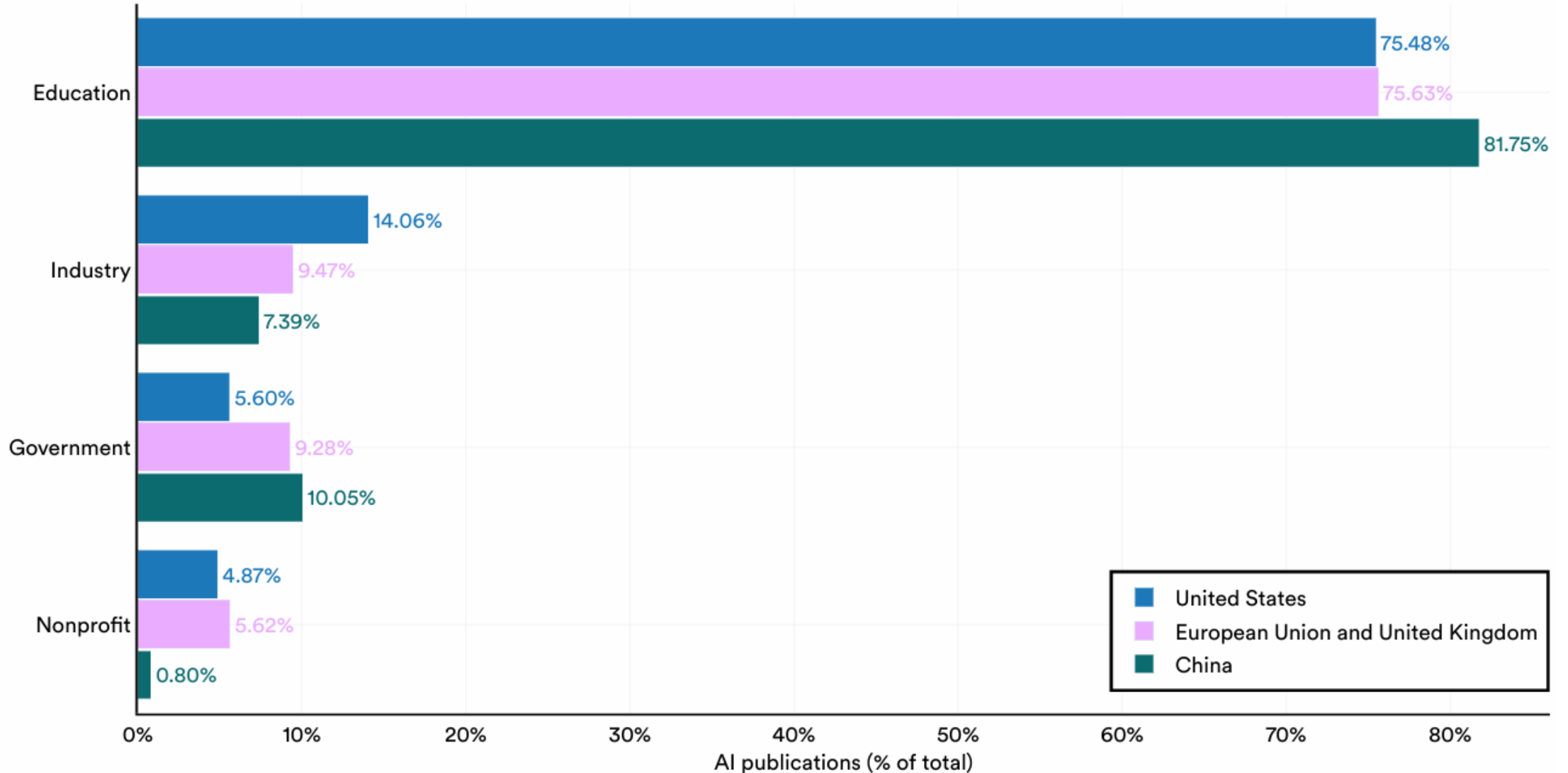
Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report



Research and Development (AI Publications 3 top countries)

AI publications (% of total) by sector and geographic area, 2022

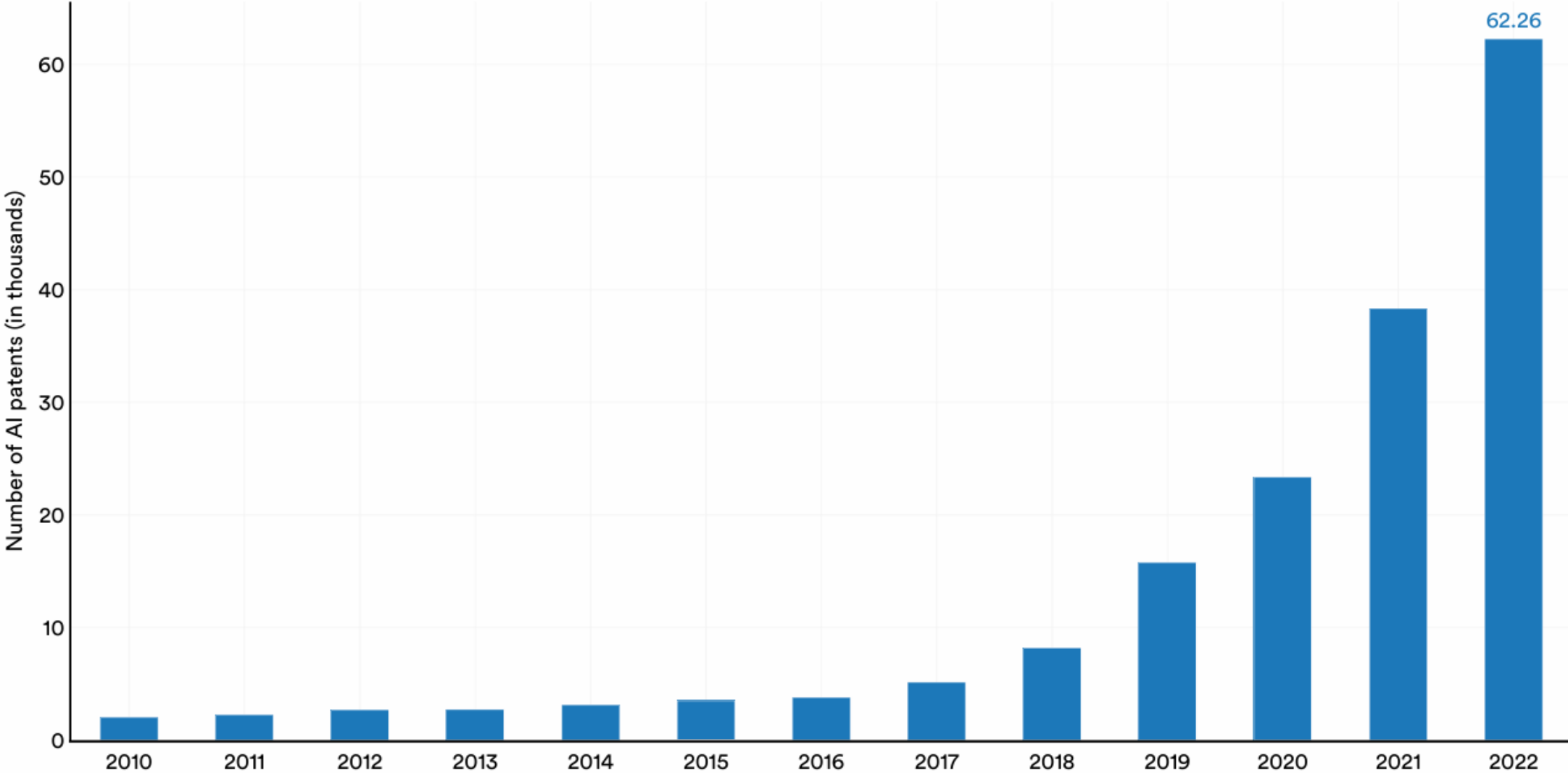
Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report



Research and Development (Number of AI Patents Granted)

Number of AI patents granted, 2010–22

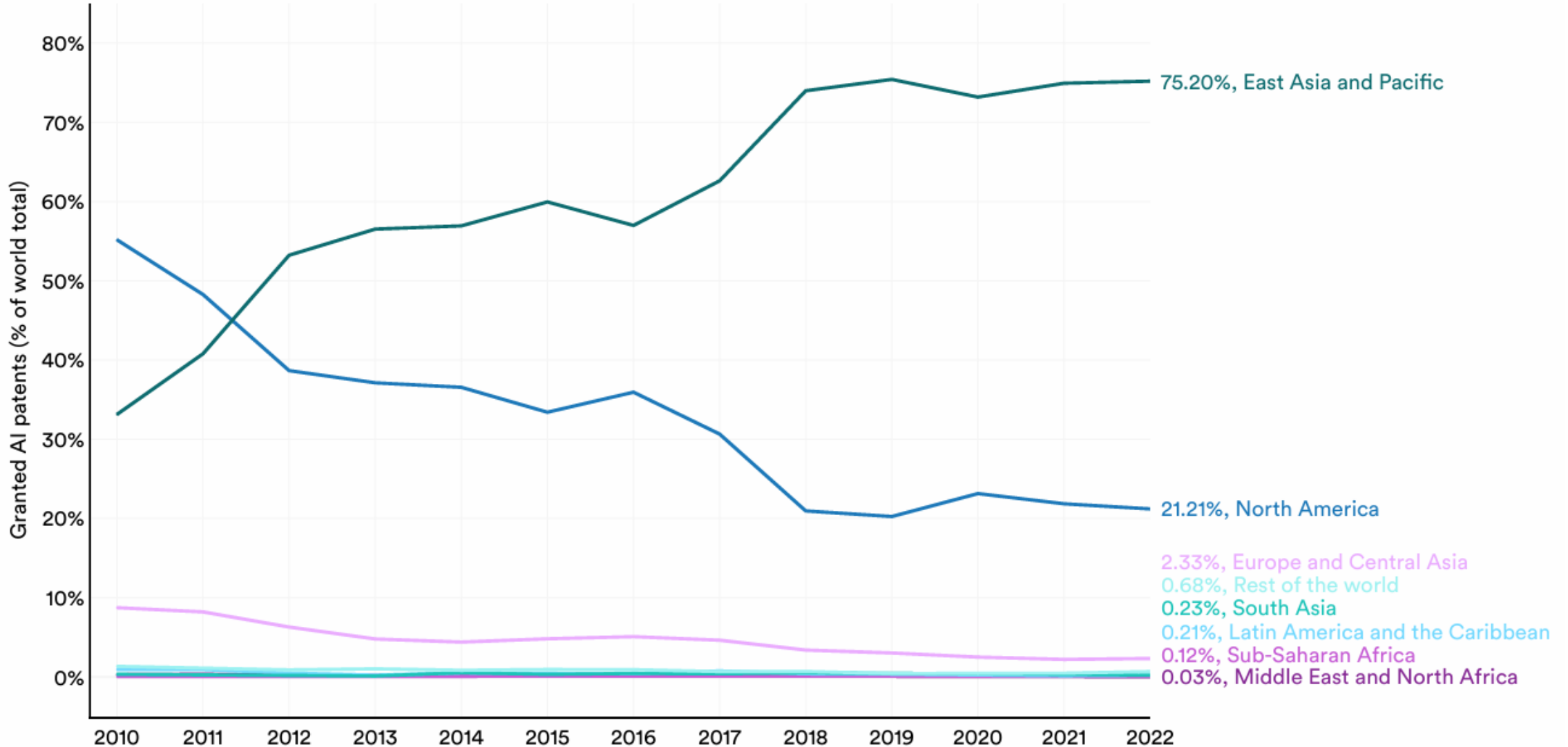
Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report



Research and Development (Granted AI Patent by Region)

Granted AI patents (% of world total) by region, 2010–22

Source: Center for Security and Emerging Technology, 2023 | Chart: 2024 AI Index report

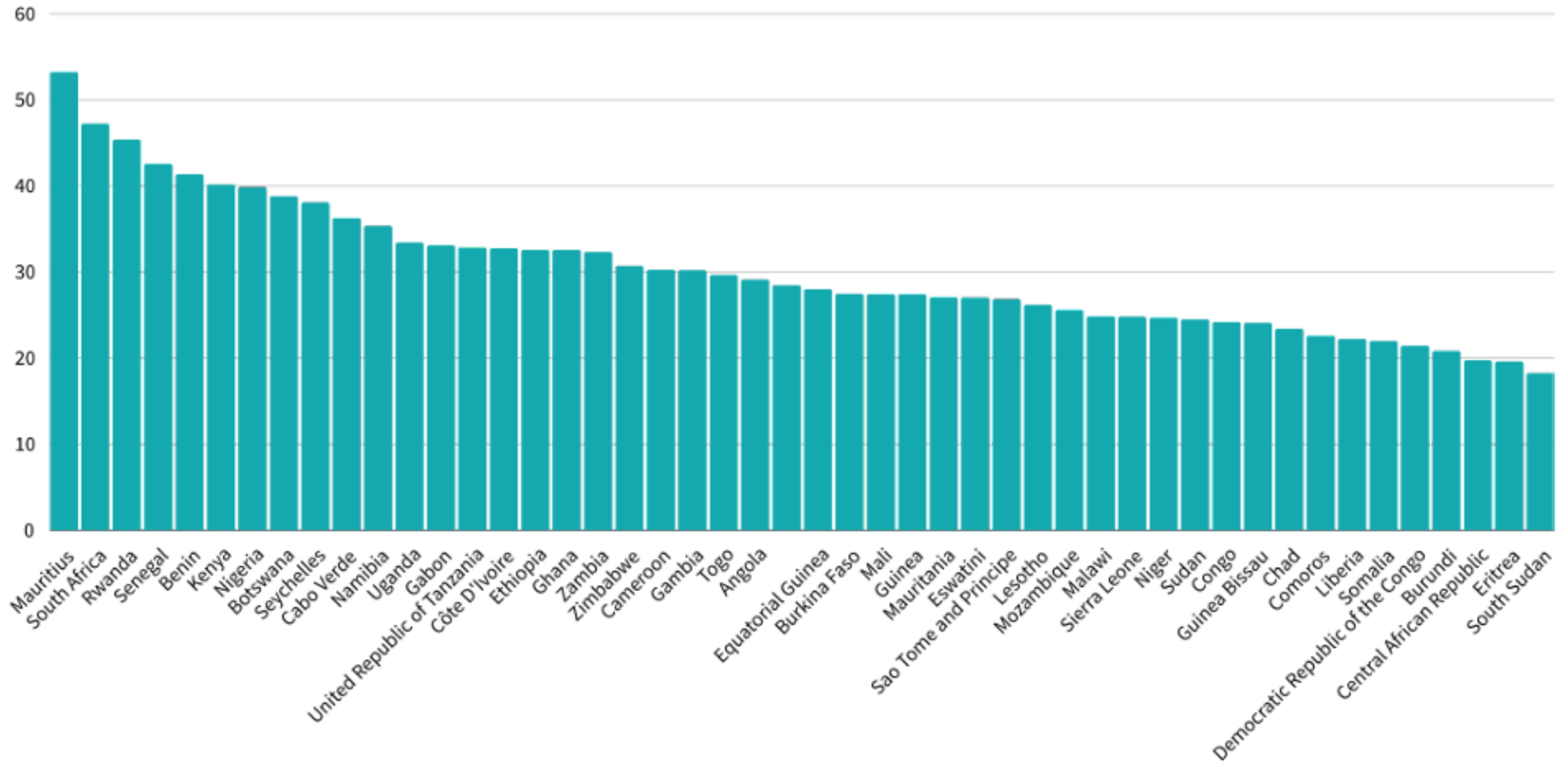


Government AI Readiness Index- Findings

Global leading countries (top10) in government AI adoption as of 2023 (Oxford Insights, 2023):

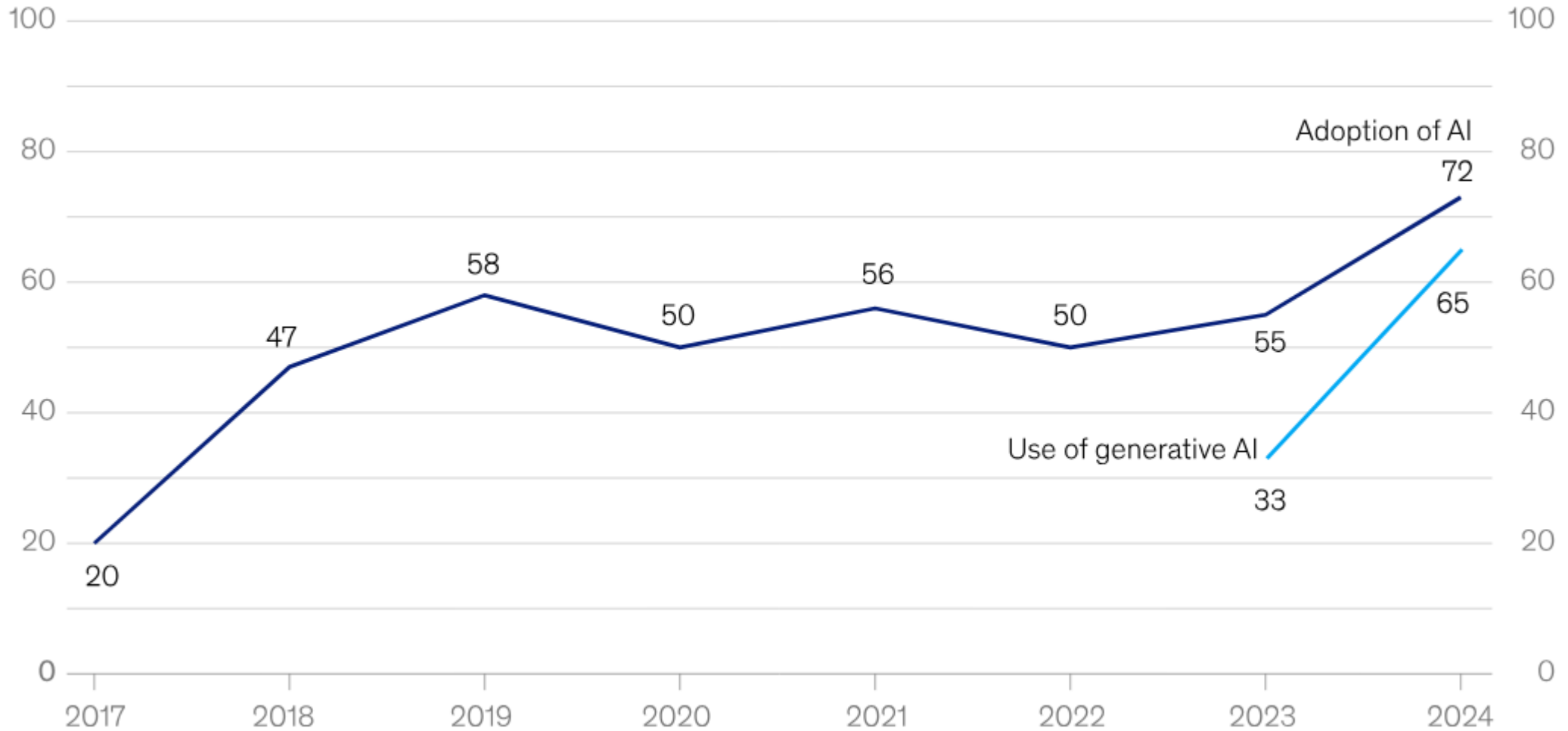
Global Ranking	Country	Total score	Government Pillar	Technology Sector Pillar	Data & Infrastructure Pillar
1	United States of America	84.80	86.04	81.02	87.32
2	Singapore	81.97	90.40	66.19	89.32
3	United Kingdom	78.57	82.50	68.80	84.42
4	Finland	77.37	88.34	60.36	83.39
5	Canada	77.07	85.30	64.73	81.17
6	France	76.07	84.03	60.40	83.80
7	Republic of Korea	75.65	87.55	54.36	85.02
8	Germany	75.26	80.78	63.28	81.72
9	Japan	75.08	82.76	56.85	85.61
10	Netherlands	74.47	78.90	61.96	82.55

Government AI Readiness Index- Findings (Africa)...



Global Adoption of AI (Source: McKinsey Report, May 2024)

AI adoption in industries has increased dramatically in year 2024



Global AI Initiatives



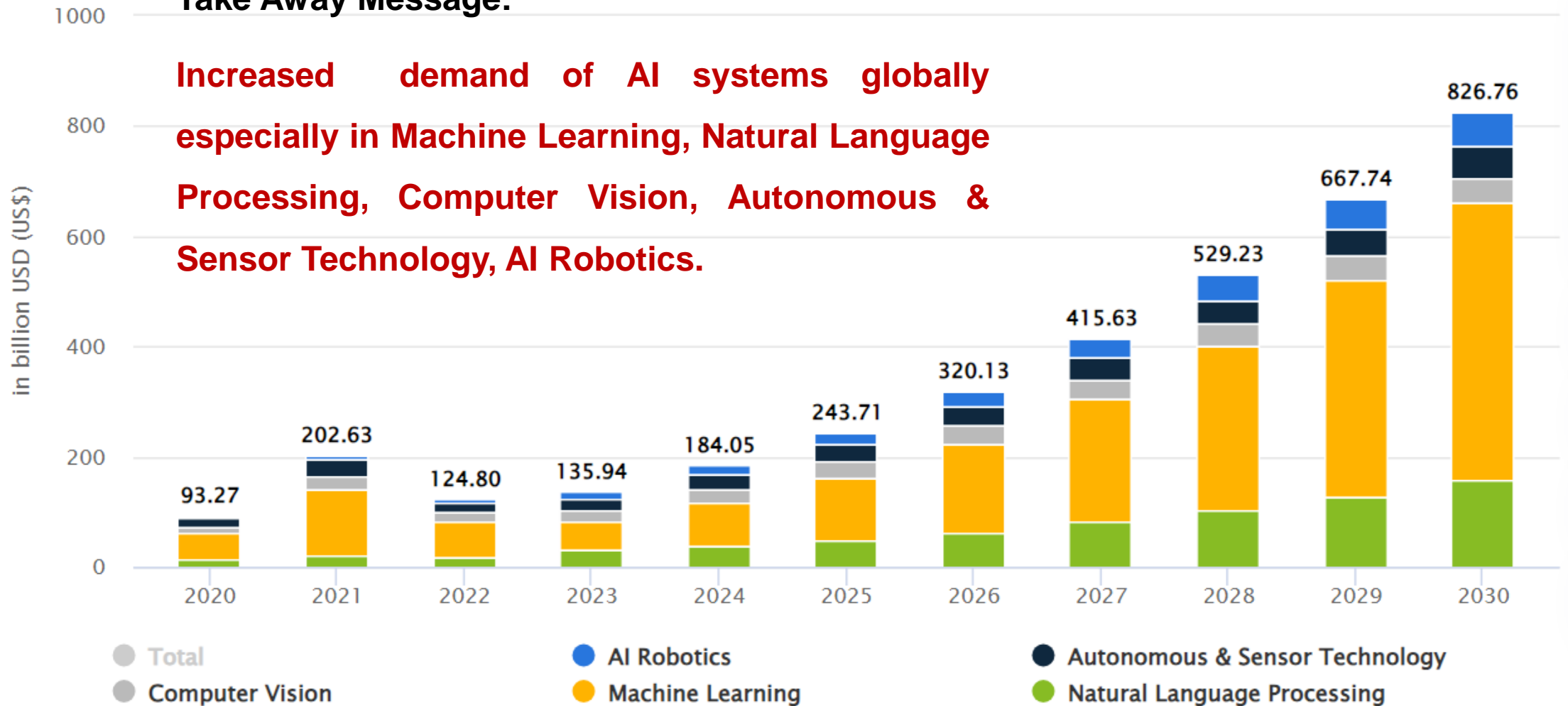
Global AI Market Trend (Source: Global AI Market Report 2024) ...

- ❑ Current, the global AI market is worth **around \$196.63 billion**
- ❑ Global AI market is expected to reach **\$1.81 trillion by 2030**
- ❑ AI industry value is projected **to increase by over 13 times over the next 7 years.**
- ❑ For example, the US AI market is forecast to reach **\$299.64 billion by 2026.**
- ❑ By 2025, as many as **97 million** people will work in the **AI space.**
- ❑ AI market size is expected to grow by at least **120% year-over-year.**
- ❑ **83%** of companies claim that AI is a top priority in their business plans.

Global AI Market Size Forecast (2020-2030) ...

Take Away Message:

Increased demand of AI systems globally especially in Machine Learning, Natural Language Processing, Computer Vision, Autonomous & Sensor Technology, AI Robotics.



Source: <https://www.statista.com/outlook/tmo/artificial-intelligence/worldwide#market-size>

4. AI Project Success

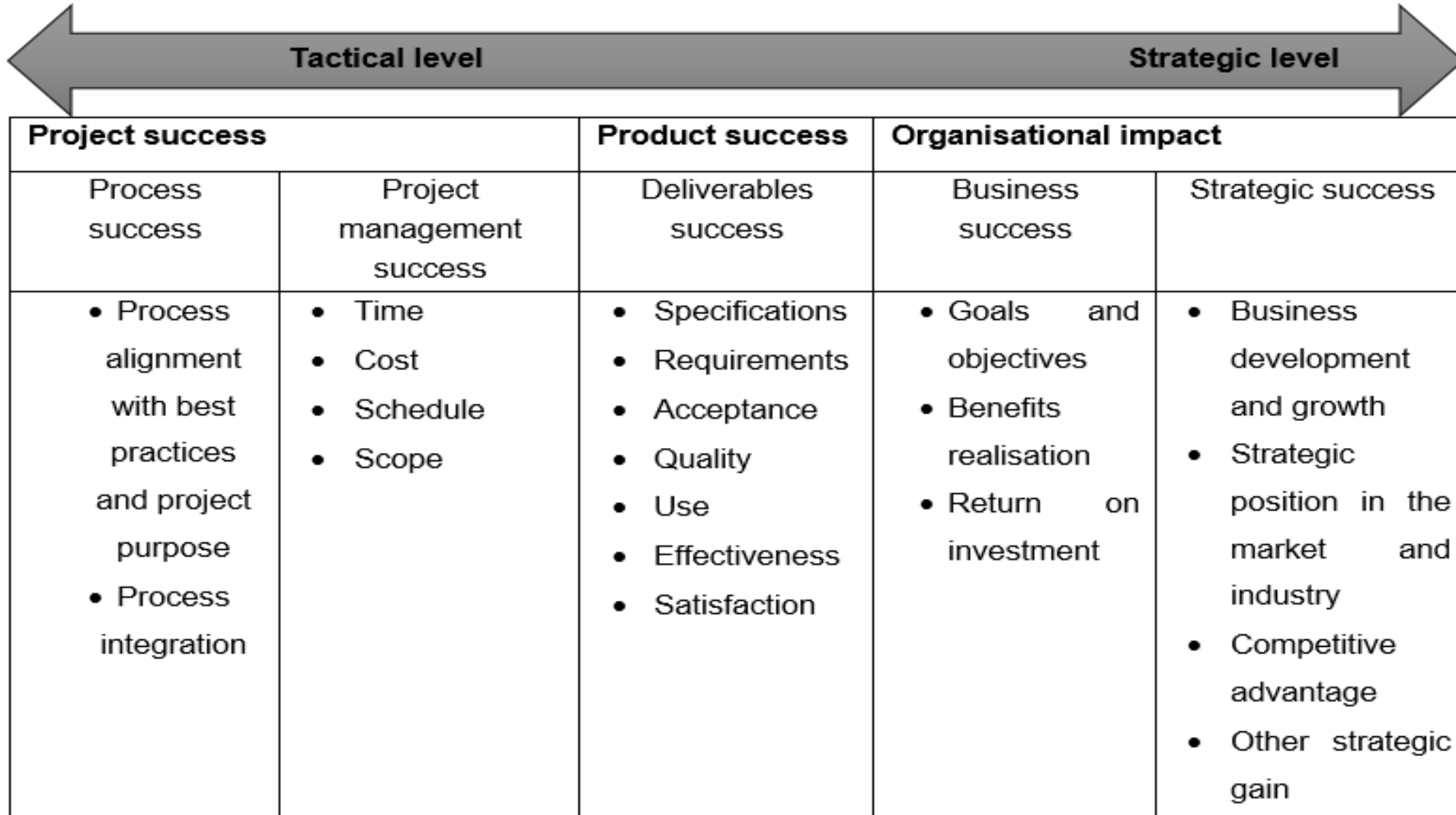


Iron Triangle

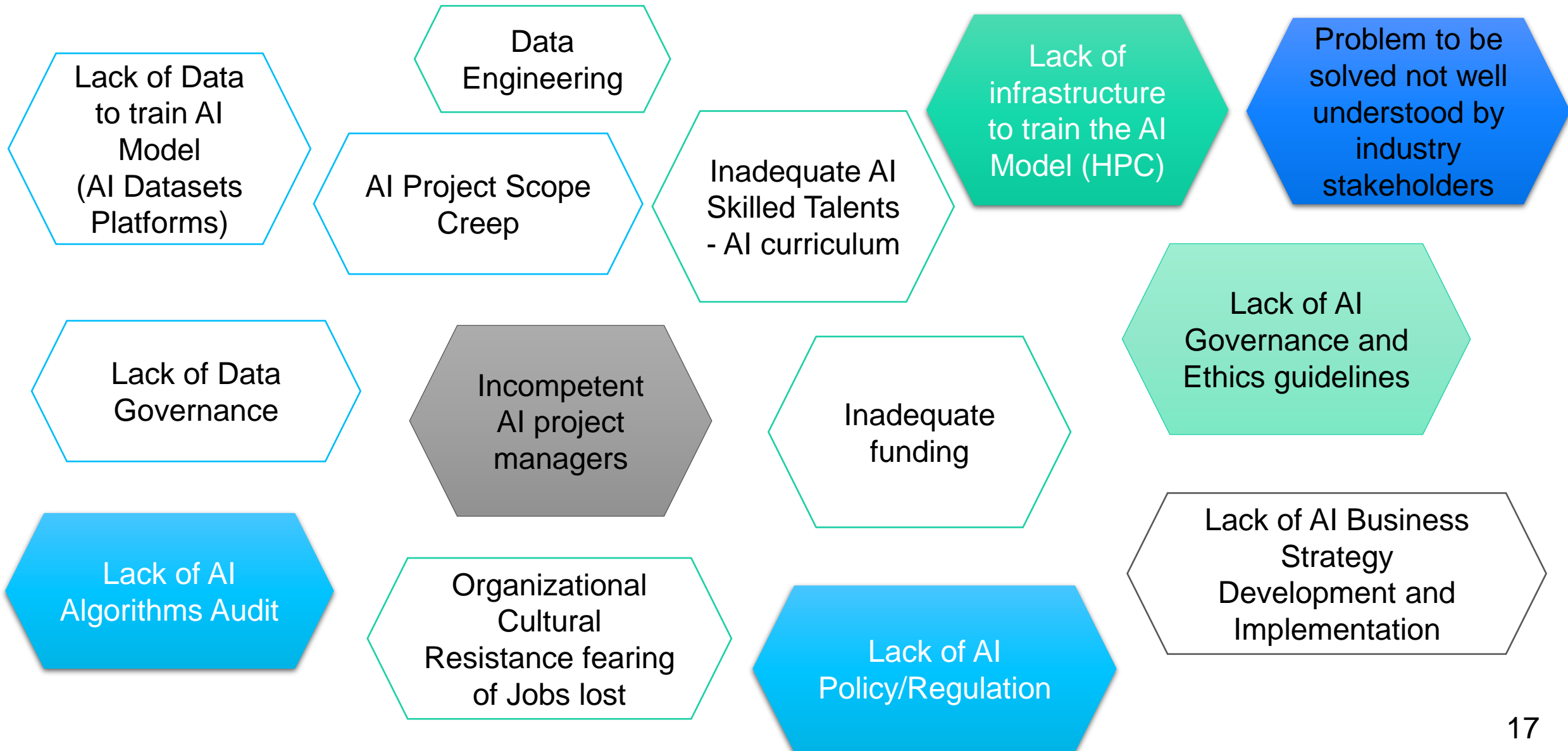


Five dimensional view of project success (2000-Present)

Source: Bannerman, P. L. (2008). *Defining project success: a multilevel framework*. Paper presented at PMI® Research Conference: Defining the Future of Project Management, Warsaw, Poland. Newtown Square, PA: Project Management Institute.



5. Why AI Projects Fail?



6. Role of Research and Education in AI Projects' Success

Research and Education are **fundamental pillars** in the success of AI projects, as they provide the:

- ❑ **knowledge,**
 - ❑ **research and innovation, and**
 - ❑ **talent necessary for AI development.**

Role1: AI Training and Skills Development

- ❑ Education is critical for producing AI experts who can design, develop, and manage AI projects.
- ❑ AI and Data Science Curriculum that covers Mathematics for AI and Data Science, Data Science, Statistics, Computer Science.
- ❑ Universities, colleges, research institutes, bootcamps, schools' digital clubs and online platforms train individuals in essential AI skills **such as machine learning, deep learning, data science, and software engineering.**



Availability of AI Expertise and Skills

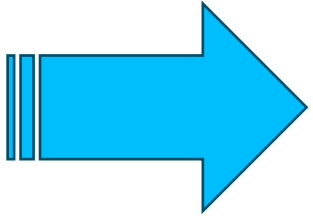
✓ **AI Experts:** A talent with expertise in AI, data science, statistics, mathematics, computer science and the relevant domain is crucial for developing, implementing, and optimizing AI solutions.

✓ **Building Interdisciplinary Skills:**

Combining Technical AI Skills and Domain Knowledge

Many AI projects require a combination of **technical AI skills and domain-specific knowledge** (e.g. healthcare, finance, agriculture)

✓ **Reskilling the Workforce:** As **AI transforms industries**, research & education plays a critical role in reskilling **professionals from other fields to work on AI-related projects**. Programs focusing on **AI for non-technical audiences**, such as business leaders or healthcare professionals, help integrate AI successfully into various sectors.



Technical Skills Required

- **Programming Languages and Tools:** Proficiency in languages like Python, R, Java, C, C++, and familiarity with libraries and frameworks such as scikit-learn, pandas, NumPy, and Jupyter for data manipulation, analysis, and model development, TensorFlow, Keras, or PyTorch.
- **Machine Learning:** This involves creating algorithms that can learn and make predictions or decisions based on data. Skills in machine learning include understanding various algorithms (such as regression, classification, clustering, deep learning), feature engineering, model evaluation, and tuning.
- **Deep Learning:** A subset of machine learning that focuses on neural networks, deep learning requires skills in building and training deep neural networks, using frameworks like TensorFlow or PyTorch, and understanding architectures such as CNNs (Convolutional Neural Networks) and RNNs (Recurrent Neural Networks).

Technical Skills Required ...

- **Natural Language Processing (NLP):** NLP deals with the interaction between computers and human languages. Skills here involve text preprocessing, sentiment analysis, named entity recognition, language modeling, and applications like chatbots or language translation.
- **Computer Vision:** This area deals with enabling computers to gain a high-level understanding from digital images or videos. Skills include image classification, object detection, image segmentation, and using frameworks like OpenCV or TensorFlow for computer vision tasks.
- **Generative AI:** Generative AI refers broadly to AI techniques and models that can generate new content, such as images, text, audio, or video, based on patterns learned from data. It has been used in various fields for creating new content, simulations, creative tasks (art, music generation), and more.

Technical Skills Required ...

- **Large Language Models (LLMs):** LLMs specifically refer to AI models that are trained on large datasets of text to understand and generate human-like language. These models are designed to understand and generate human-like text based on the patterns and structures they have learned from the data. Some prominent examples of large language models include GPT (Generative Pre-trained Transformer) series developed by OpenAI, such as GPT-3, GPT-4 and models like BERT (Bidirectional Encoder Representations from Transformers) developed by Google.
- **Application of CHATGPT:** CHATGPT refers to the conversational agent you're currently interacting with. CHATGPT is designed to understand and respond to natural language input in a human-like manner, providing information, answering questions, engaging in discussions, and assisting with various queries across different topics.

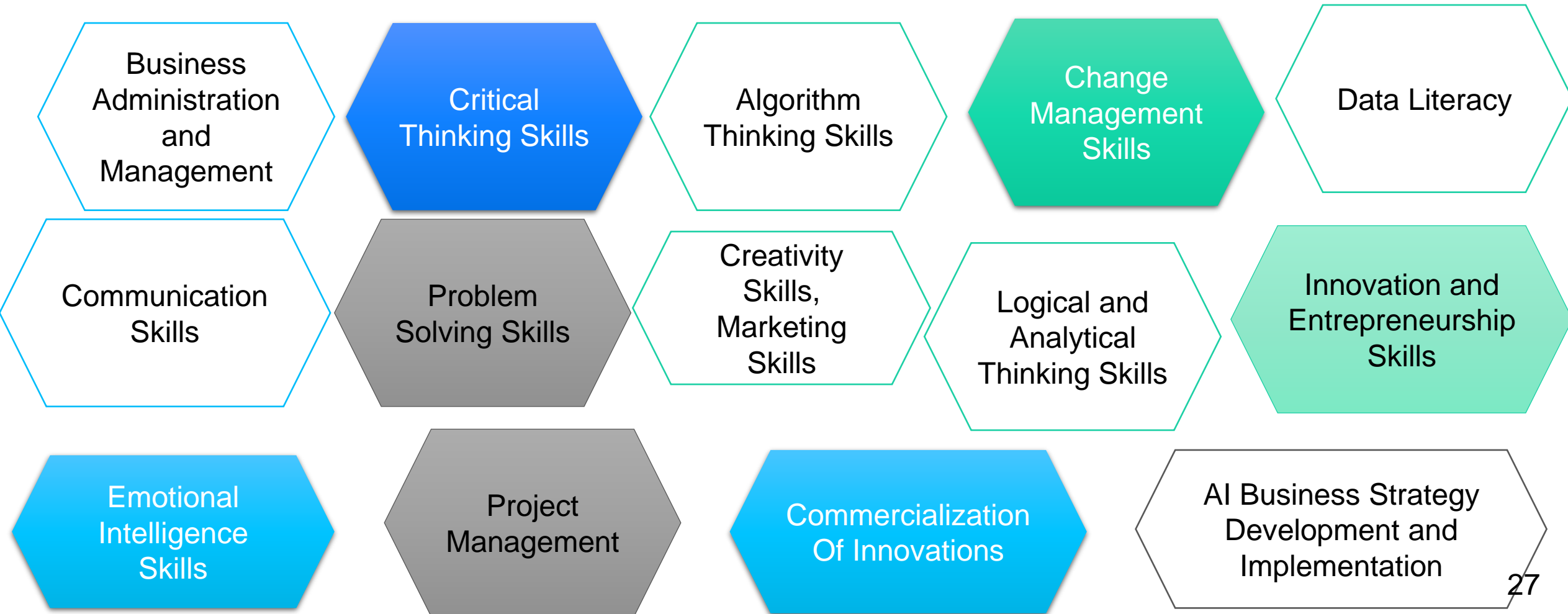
Technical Skills Required ...

- **Reinforcement Learning:** This branch focuses on teaching agents to make sequences of decisions. Skills include understanding Markov Decision Processes (MDPs), policy gradients, Q-learning, and applying these to real-world problems like game playing or robotics.
- **AI Ethics/Responsible AI:** Understanding the ethical implications of AI systems, including fairness, accountability, transparency, and mitigating biases in data and algorithms.
- **Data Engineering:** Skills in managing large-scale data pipelines, data preprocessing, data integration, and ensuring data quality and consistency for AI applications.
- **Data Analytics:** Data analytics tools like Tableau, Power BI, SAS
- **Data Governance:** Framework for data governance that ensures data integrity, security, adherence to regulations, and proficient data handling in a company/organisation.
- **Deployment and Scalability:** Knowledge of deploying AI models into production environments, optimizing them for performance and scalability, and integrating them with existing systems.

Soft Skills

(Soft skills are also important to implement successful AI project)

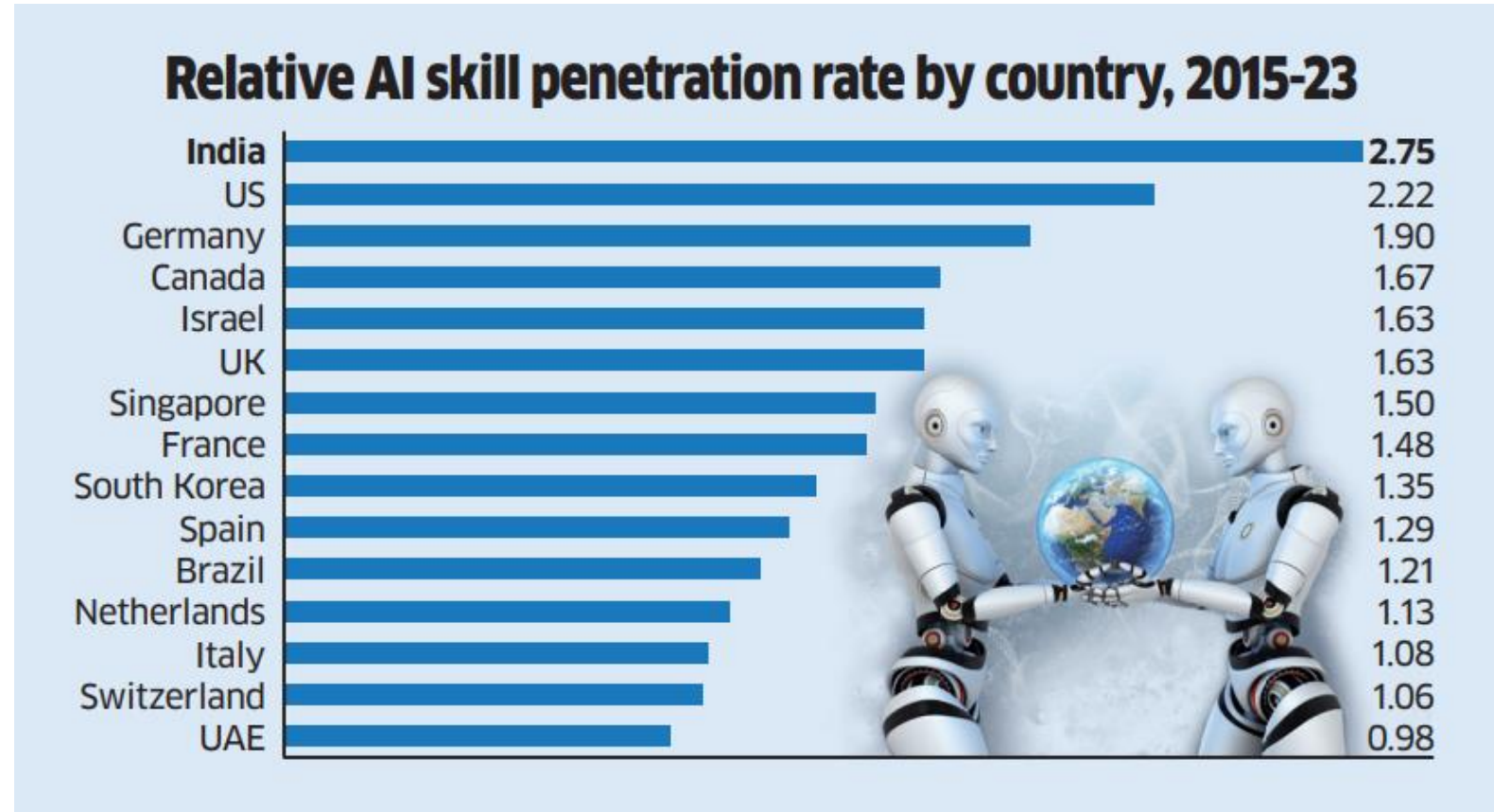
(Job and wealth creation, STARTUPS / Innovation Hubs, Business Companies)



India AI Success Stories: AI Skills Penetration

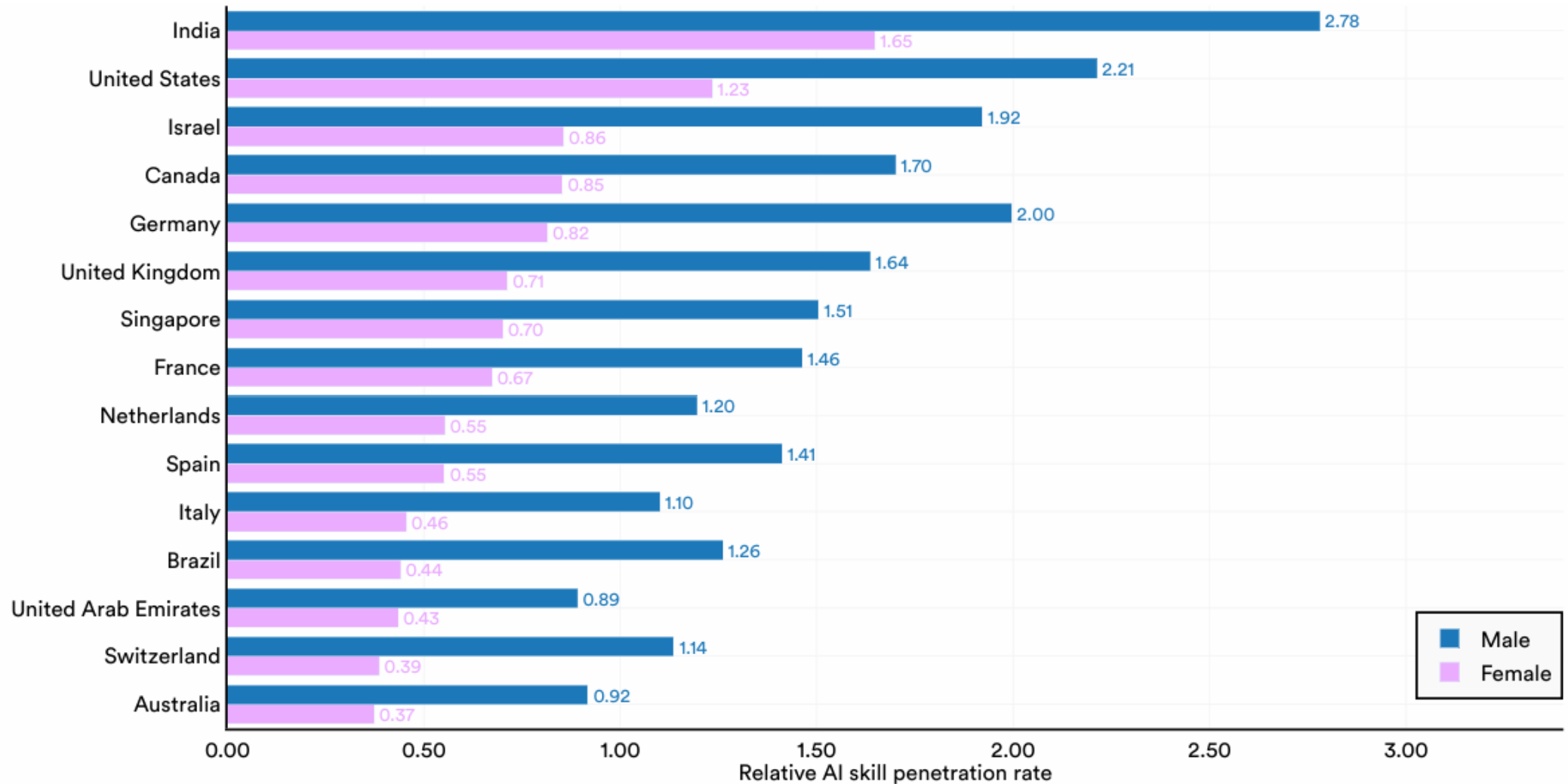
- ❑ India is **number one in the world in terms of relative AI skill penetration**
- ❑ India is in the **top four globally when it comes to relative AI hiring rate (India exports AI experts globally).**

(Source: The Artificial Intelligence Index Report 2024 published by Stanford University)

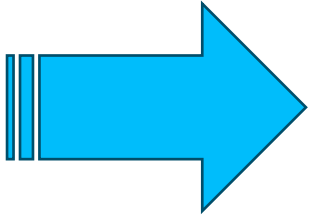


Global AI Skill Penetration Rate per Gender

AI skill penetration rate across gender is greater for men than women. India (1.65), the United States (1.23), and Israel (0.86) have the highest reported relative AI skill penetration rates for women (AI Index Report, 2024)



Role 2: Availability of AI Infrastructure



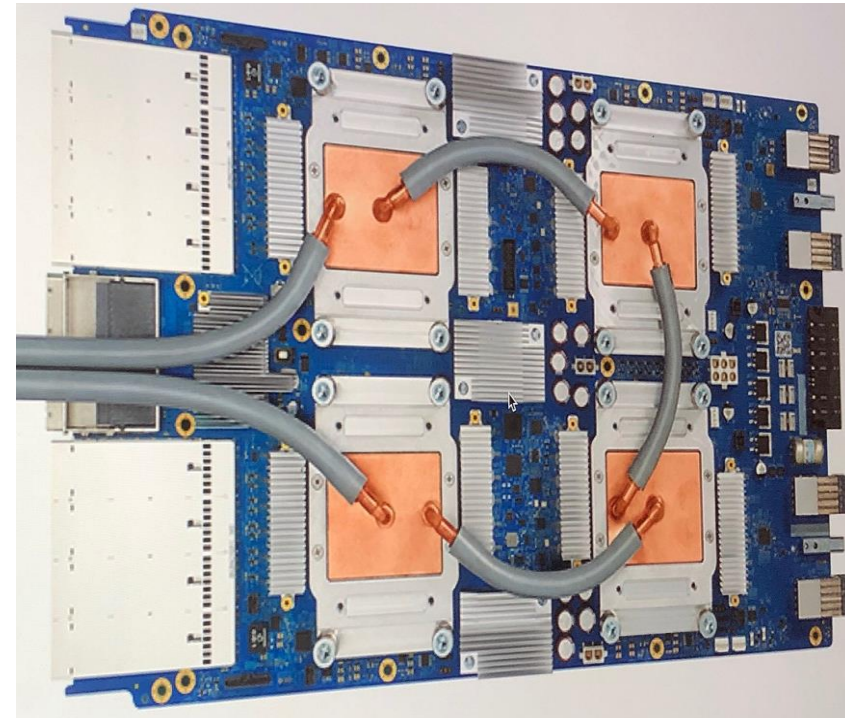
- ✓ Adequate computational resources, storage, and technology infrastructure are necessary for handling data processing, model training, and deployment.
- ✓ High-performance Computing (HPC): Many AI projects require **massive computational power**, which universities can provide through their research infrastructure. This access to computing resources is essential for training complex AI models.

Availability of AI Infrastructure ...

❑ High-performance computing (HPC) with:

1. **Tensor processing units (TPUs):** Specialized processors designed by Google for AI applications built with TensorFlow.

- TPUs can handle large-scale computations with high throughput and low latency, offering significant performance improvement. TPUs are very important for artificial intelligence and machine learning because of their ability to accelerate the training and deployment of deep learning models at scale.
- TPUs processing efficiency for tensor operations enables **faster model training times, reduced infrastructure costs, and improved performance, all of which help drive advancements in AI research and applications.**



Availability of AI Infrastructure ...

2. **Graphics processing unit (GPUs):** Are processors capable of handling a wide range of computational tasks beyond graphics rendering.

Consideration:

- Cost effectiveness**
- Speed and performance**
- Power Consumptions**

Example: NM-AIST High Performance Computing (HPC)

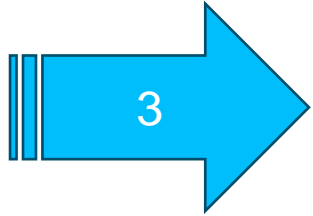


NM-AIST PARAM KILIMANJARO

Specifications:

- ❑ Total Computational Speed
RPeak: 14.4Teraflops (Pure CPU 10 TF+GPU 4 TF)
- ❑ Total Nodes: 7 CPU nodes + 1 GPU node
- ❑ Total Cores: 5320 (CPU 160 cores + GPU CUDA cores 5160)
- ❑ Total Memory: 480 GB
- ❑ Storage: 100 TB + 30 TB Backup

Role 3: Availability of Dataset Platforms



- ✓ Dataset Platforms: are the cornerstone of AI systems development. Data with high quality and quantity, relevant, and sufficient data are essential for training effective AI models. Poor data can lead to inaccurate or biased outcomes.
- ✓ Data Access: Universities/Research institutes often have access to large datasets, either through collaborations or publicly available data. Datasets are crucial for training AI models, and universities and research institutes play a key role in curating and sharing it.
- ✓ **Data governance framework** is important.

Availability of Datasets ...

Usage of Datasets:

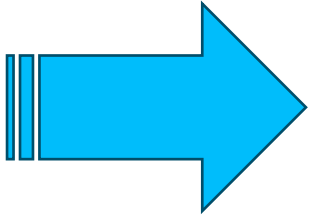
1. Training and Evaluating Models: AI models, especially those based on machine learning and deep learning, require large amounts of data to learn patterns, make predictions, and generalize effectively. High-quality datasets provide the raw material for training these models.

2. Improving Accuracy: The quality and diversity of the dataset directly impact the accuracy and performance of an AI model. Datasets with diverse examples help models generalize better to unseen data and reduce biases.

3. Benchmarking: Standardized datasets are used to evaluate and compare the performance of different AI models. Benchmarks enable researchers and practitioners to assess progress in the field and identify the most effective approaches.

4. Enabling Research and Innovation: Access to varied and high-quality datasets accelerates research and innovation in AI. Researchers can experiment with new algorithms and approaches, pushing the boundaries of what AI can achieve.

Role 4: Research and Innovation



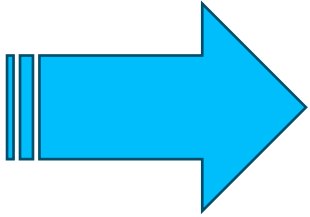
- ✓ **Cutting-edge Research:** Universities are hubs for pioneering research in AI. Many groundbreaking AI algorithms, such as deep learning and reinforcement learning, were developed in academic settings. They push the boundaries of AI through novel research and collaborations across disciplines.
- ✓ **Innovation Incubation:** Universities often partner with industries to pilot new AI technologies and incubate innovations. Many **AI startups** have emerged from university research labs, where faculty and students work on real-world problems.
- ✓ **NM-AIST Example:** Next Slide

Example: NM-AIST 5D Business Model

- 1. Research and Innovation.**
- 2. Postgraduate Training and Skills Development.**
- 3. Outreach & Community Engagement.**
- 4. Incubation Management.**
- 5. Commercialization.**

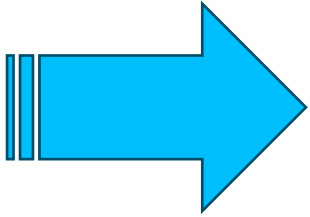


Role 5: Business Alignment and Objectives



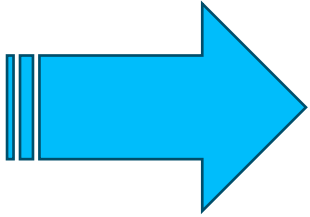
AI projects should be aligned with the business's strategic objectives of industries/government/society. Clearly defined goals ensure that AI implementations address specific problems or opportunities, such as improving operational efficiency, enhancing customer experience, or driving innovation.

Role 6: Model Development and Validation



Algorithm selection: Choosing the right algorithms and models for the specific business problem is crucial. This includes deciding between supervised, unsupervised, or reinforcement learning, among others. Validation and Testing of AI models ensure their accuracy and reliability in real-world scenarios.

Role 7: Ethical Consideration



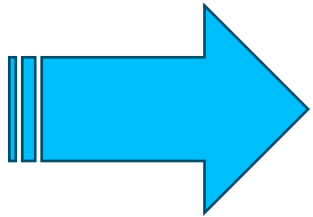
Addressing ethical issues, such as data privacy, bias, and fairness, helps build trust and ensures that the AI system operates responsibly.

Ethical Consideration...

1. UN Secretary-General's AI Advisory Body established in 2023: Launched its Interim Report: Governing AI for Humanity. The report calls for a closer alignment between international norms and **how AI is developed and rolled out.**
2. UNESCO Recommendations on the Ethics of Artificial Intelligence: **The protection of human rights and dignity is the cornerstone of the Recommendation**, based on the advancement of fundamental principles such as transparency and fairness, always remembering the importance of human oversight of AI systems.
3. Data Protection and Privacy Act. Eg. EAC Data Governance Policy Framework, EU AI Act: It establishes a common regulatory and legal framework for AI within the European Union.
4. Country's AI Policy/ AI Strategy
5. AU Continental AI Strategy etc.

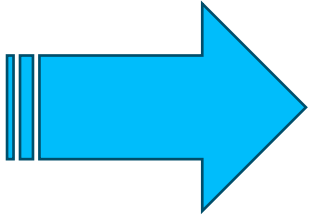
Role 8: Establish and strengthen Researchers/Educators/

Leaners AI knowledge sharing platforms



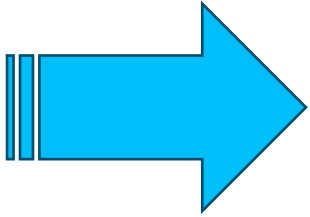
- ✓ Encouraging students and researchers to **share knowledge through conferences, publications, and online communities**. Collaborative research platforms democratize access to AI knowledge, enabling more people to contribute to AI projects.
- ✓ Build a **global network of researchers and practitioners** who collaborate on solving global challenges through AI. This sharing of knowledge, tools, and techniques accelerates the success of AI projects across borders.

Role 9: Strengthen Academia-Industry partnership



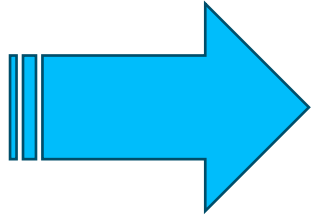
Partnerships with Tech Companies such as Google, Microsoft, Nvidia, SAP, Oracle etc. Universities to collaborate with tech companies on AI projects, providing both a space for innovation and access to cutting-edge research. These partnerships ensure that research aligns with industry needs and that discoveries are transferred into practical applications.

Role 10: Project Management Best Practices and Standards



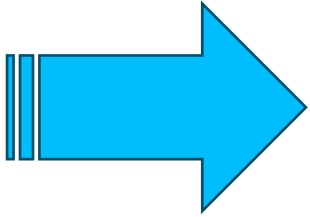
Effective project management best practices, including project planning, risk management, scope management, stakeholder management, procurement management, communication management, resource management, project audit and timeline management, are crucial for keeping the project on track and within scope. (PMBOK, 2PM, Agile project management methodology etc), PMOs

Role 11: Deployment and Integration with Existing Systems



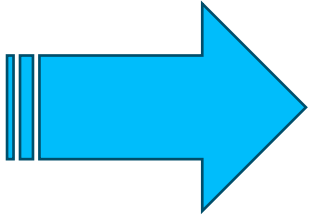
The ability to seamlessly integrate the AI solution with existing systems and workflows impacts its overall effectiveness and adoption. Providing training for end-users helps ensure that they can effectively interact with the AI system and leverage its capabilities.

Role 12: Continuous Monitoring and Evaluation



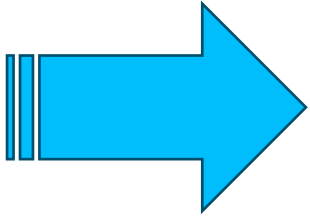
Monitoring and evaluation of the AI system's performance help in identifying issues, making improvements, and ensuring ongoing relevance.

Role 13: Regulatory Compliance



Adhering to relevant regulations and standards is crucial for legal and ethical deployment of AI systems.

Role 14: Scalability



Designing the AI solution to scale effectively ensures that it can handle increased data loads and user demands as the AI project grows.

Conclusion/Take aways

Higher learning Institutions and Research Networks have a role to play in AI skills development and conducting research activities by including among others the key AI Research Areas in 2024:

- Generative AI**
- AI Ethics and Fairness**
- AI and Robotics**
- Healthcare AI**
- AI for Climate Change**
- Quantum AI**
- Multimodal AI**
- Federated Learning**
- AI in Creativity and Art**

A savanna landscape with a snow-capped mountain in the background and an elephant in the foreground. The mountain is covered in snow and has a blue sky above it. The foreground is a grassy field with some trees and a dirt path.

Elizabeth Mkoba (PhD)

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Asante Sana!

Thank you!