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Leveraging Artificial Intelligence and Robotics in India's Military Strategy

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ABSTRACT

The advent of Artificial Intelligence (AI) and robotics has revolutionised modern warfare, introducing unprecedented dimensions to military strategy and operations. This paper explores the integration of AI and robotics in contemporary warfare, focusing on India's potential to leverage these technologies to enhance its military capabilities. By examining the global AI landscape, analysing the challenges in developing military AI in India, and providing strategic recommendations, this study aims to chart a course for India's AI-driven military advancements by 2030. Through comprehensive analysis, the paper underscores the imperative for India to capitalise on AI and robotics to ensure national security and maintain geopolitical relevance.

Key Words: Artificial Intelligence (AI), Military, India, Warfare, Technology, Strategy, Challenges, Investment, Patents, Research, Development, Trends.

Introduction

> *The development of full Artificial Intelligence could spell the end of the human race. It would take off on its own and redesign itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, couldn't compete and would be superseded.*[1]
>
> *– Stephen Hawking*

In recent years, what once seemed like the realm of science fiction has become a tangible reality. The emergence of AI and robotics has profoundly transformed the nature of warfare. Leading global powers have made significant strides in harnessing AI to bolster their defensive and offensive military capabilities. As a result, India must intensify its efforts to develop and integrate AI and robotics within its military framework to counter potential threats and remain competitive globally. The application of AI in military operations offers numerous advantages, including enhanced efficiency, effectiveness, and safety of soldiers. While AI technology initially emerged within the commercial sector, its potential for military applications has prompted extensive experimentation and adoption by armed forces worldwide. The unique opportunities presented by AI and robotics could significantly augment India's military prowess, providing a strategic edge over its adversaries.[2]

This paper aims to briefly discuss the utilisation of AI and robotics in modern warfare, analyse the current global AI landscape, and address the challenges associated with

developing military AI in India. It will also offer recommendations for advancing military AI capabilities in India, thereby ensuring that the country is well-prepared to navigate the evolving dynamics of warfare in the coming years.

Background

The evolutionary shift of warfare from conventional to unconventional methods has been significantly influenced by technological advancements. Conventional warfare, characterised by traditional military tactics and equipment, is gradually being overshadowed by unconventional tactics enabled by new technologies. The decline in conventional warfare, marked by a decrease in battlefield casualties, can be attributed to factors such as international law, economic interdependence, peacekeeping organisations, and technological progress. India's geopolitical landscape necessitates a robust AI-driven military strategy. With increasing incorporation of AI technologies by global militaries, India must address its relatively slow pace of AI development to avoid falling behind. This paper explores the current state of AI in global military contexts, India's position within this landscape, and the steps required to advance India's military AI capabilities.

Objectives

The primary objectives of this paper are to:

(a) Examine the evolution and emerging dynamics of warfare influenced by AI and robotics.

(b) Analyse the integration of AI and robotics in modern-day warfare.

(c) Assess the current global AI landscape and its implications for military development.

(d) Identify challenges in the development of military AI in India.

(e) Provide strategic recommendations for advancing military AI capabilities in India by 2030.

(f) By addressing these objectives, this paper seeks to provide a comprehensive overview of the role of AI and robotics in contemporary warfare and offer a strategic pathway for India to enhance its military capabilities through technological innovation.

Evolution of Warfare

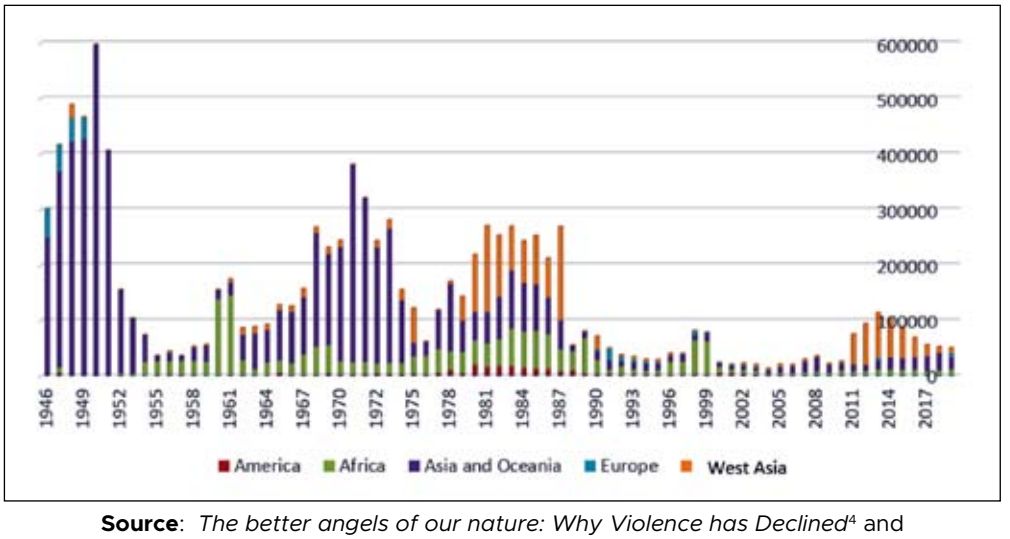
The method of warfare has evolved from conventional to unconventional over a brief period. Conventional war uses traditional military tactics and equipment, while unconventional warfare often involves unorthodox and unconventional tactics. The emergence of new

technologies in the 20th century has led to the development of unconventional warfare tactics. These tactics were often used by groups who lacked the resources to engage in traditional battles.

The emergence of unconventional warfare has significant implications for global security. Unlike conventional wars, which were fought between nation-states, unconventional warfare involves non-state actors who may not be subjected to the same rules of engagement as state armed forces do[3].

Conventional vs Unconventional Warfare Analytics. A glimpse of the number of deaths of soldiers in state-based conflicts from 1946 to 2020, shown in Figure 1, portrays a diminishing trend in the loss of soldiers' lives on battlefields. The simplistic inference drawn from the figure is that conventional warfare is on a decline.

Figure 1 - Deaths in State-Based Conflicts by World Region.



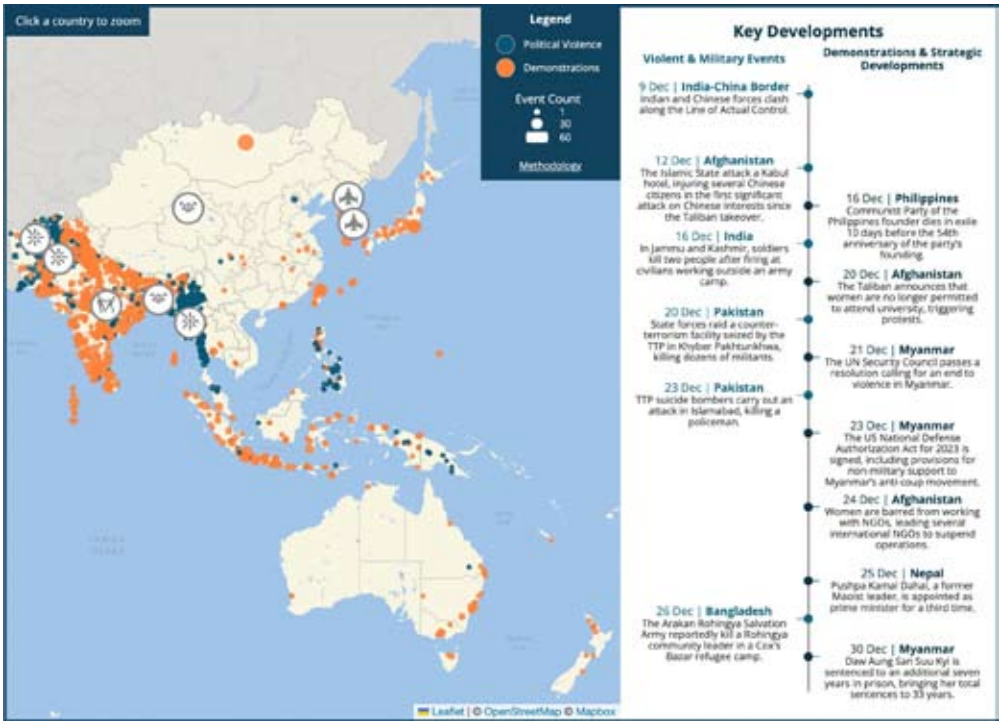
Source: *The better angels of our nature: Why Violence has Declined*[4] and *Historical Trends in Great Power Wars*[5]

The decline in conventional wars can be attributed to the following:

(a) The emergence of international law and diplomacy[6].
(b) Increasing economic interdependence[7].
(c) Institution of international peacekeeping organisations[8].
(d) Technological progress and collaboration[9].
(e) Cultural Shifts due to education[10].

India's Need for Military AI. The fact presented in Figure 2 strongly indicates India's unstable geopolitical neighbourhood. It reiterates the need for India to strengthen its AI

Figure 2 - Regional Overview of Asia Pacific as of January 2023[11]



Source: www.acleddata.com[12]

arsenal amidst this precarious geopolitical scenario. Countries worldwide are increasingly incorporating advanced AI technologies into their arsenal. Think tanks believe that AI and robotics provide a strategic advantage in military operations without using an expensive arsenal and limiting collateral damage.

Artificial Intelligence and Robotics in Modern-Day Warfare

The role of AI and robotics in warfare has evolved rapidly in recent years, with governments and private companies making significant investments. AI and robotics are transforming the landscape of modern warfare, including maritime warfare. Here are some recent examples of how AI and robotics are revolutionising maritime warfare:

Autonomous Underwater Vehicles (AUVs). AUVs are used to detect and neutralise underwater mines, survey the ocean floor, and gather intelligence on enemy naval forces. In 2020, the US Navy tested an AUV called the Snakehead, designed to operate in shallow waters and perform a range of missions.[13]

AI for Decision-Making. AI is being used to analyse vast amounts of data from sensors and other sources to provide commanders with real-time situational awareness and

support decision-making. In 2021, the US Navy's Information Warfare Research Project (IWRP) announced that it had developed a Cognitive Artificial Intelligence Reasoning and Collaborative Autonomy System (CARACAS) that can analyse data from multiple sources and make recommendations to Commanders[14].

Swarm Robotics. Swarm robotics involves coordinating large numbers of robots to perform a specific task. Swarm robotics can be used in maritime warfare for mine countermeasures, surveillance, and even offensive operations. In 2020, the UK Royal Navy conducted a demonstration of a swarm of autonomous boats that could be used to protect naval ships[15].

Autonomous Warships. Autonomous warships are a new frontier in maritime warfare, where crewless vessels could operate independently or as part of a more extensive fleet. Here are some recent developments in this field:

(a) ***Sea Hunter***. In 2016, the US Navy tested the *Sea Hunter*, an autonomous warship designed to conduct long-range surveillance and anti-submarine warfare missions. The *Sea Hunter* is equipped with advanced sensors and communication systems that allow it to operate autonomously for extended periods[16].

(b) **Type 82 Destroyer**. In 2021, it was reported that the UK Royal Navy was considering the development of an autonomous warship as part of its future fleet. The proposed Type 82 Destroyer would be equipped with advanced sensors and communication systems, allowing it to operate autonomously in high-threat environments[17].

(c) **Unmanned Combat Vessels (UCV)**. China has also been developing UCVs that could be used for various missions, including mine countermeasures and anti-submarine warfare. In 2021, it was reported that China had tested a new UCV called the JARI, which is equipped with advanced sensors and can operate autonomously[18].

(d) **Unmanned Surface Combatants (USCs)**. The US Navy has also been exploring using USCs for various missions, including mine countermeasures, anti-submarine warfare, and surface warfare. In 2021, it was reported that the US Navy had tested a new USC called the *Ghost Fleet Overlord*, which is designed to operate autonomously and conduct long-range mission[19].

Indian Navy's Tryst with AI and Robotics in Maritime Warfare

The adoption of AI and robotics in the maritime domain is revolutionising naval operations, and enhancing efficiency, safety, and strategic capabilities. In the maritime domain, AI and robotics are being integrated into various aspects of naval warfare.

The Indian Navy (*IN*) has been actively developing unmanned systems for a few maritime applications and has laid out a roadmap for the development and deployment of unmanned systems in its Maritime Capability Perspective Plan (MCPP)[20].

The MCPP released in 2017 outlines the *IN*'s vision for its future force structure and capabilities. One of the key focus areas is the development and deployment of unmanned systems for a range of missions, including mine countermeasures, anti-submarine warfare, and intelligence, surveillance, and reconnaissance (ISR) operations[21].

IN is currently developing the following unmanned vessels as part of its unmanned roadmap initiative[22]:

(a) Unmanned Aerial Vehicles (UAV).

(b) Unmanned Surface Vessels (USV).

(c) Unmanned Underwater Vehicles (UUV).

(d) Remotely Operated Vehicles (ROV).

As per an article by Dr Nivash Jeevanandam, "*Exploring the significance of AI in the Indian Navy, MEITY IndiaAI*", India is making significant strides in modernising its armed forces through the integration of AI, with the *IN* transforming a digitally enabled force to one enhanced by AI. Some use cases being developed for the Indian Navy are as follows:[23]

(a) **Artificial Intelligence in Defence (AIDef) Symposium**. Defence Minister Rajnath Singh unveiled seventy-five new AI products at the Artificial AIDef Symposium at New Delhi, highlighting the push towards modernisation.

(b) **Strategic AI Integration Plan (2018)**. In 2018, the MoD and NITI Aayog developed a strategic plan to integrate AI into the armed forces, including the *IN*.

(c) **Autonomous Fast Intercept Boat**. Developed in collaboration with Bharat Electronics and Goa Shipyards Limited, this boat is designed for surveillance, countermeasures, and exploration.

(d) **Natural Language Processing (NLP)**. The *IN* is enhancing NLP capabilities with voice-to-English technology solutions for languages like Mandarin, Hebrew, and Russian.

(e) **Computer Vision**. Leveraged for biometrics, face recognition, surveillance, and image retrieval to improve combat prowess.

(f) **AI Projects – Proton**. Machine-readable text generation from 2D photographs of handwritten text, transforming data into practical knowledge for improved operational efficacy.

(g) **AI Projects – Anwesh**. An Elastic Search Engine driven by Optical Character Recognition (OCR) for enhanced performance efficiency and decision-making.

(h) **AI Projects – Hawksecure**. An advanced AI engine designed for behavioral and trend analysis to boost cybersecurity and detect anomalies.

(j) **Centre of Excellence in AI**. Established at INS *Valsura* to promote AI and ML integration across all domains, with a focus on partnerships with private entities, academia, and industry.

(k) **Collaboration and Training**. The *IN* collaborates with entities like Goa and BEL Shipyards and provides AI/ML training to officers and personnel. An AI core group meets biannually to discuss AI/ML matters and ensure project compliance with schedules.

The *IN* is contemplating using UUVs and ROVs for mine countermeasures and other missions[24]. Such initiatives of continuing an Unmanned Roadmap could lead to the development of Maritime Autonomous Surface Ships (MASS) and Unmanned Warships. MASS is a perfect example of integration of major AI domains such as: -

(a) Electronic Navigation Charts as the base layer for AI decision-making to ensure safe navigation, collision avoidance, innocent passage through maritime zones of other countries, intelligence gathering, etc.

(b) Communication integrating the following segments:

  (i) **Satellite Communications**. MASS can communicate with land stations via satellite links. This capability enables them to stay connected even when they are out of the range of traditional radio or cellular networks. Satellite communication systems can provide high bandwidth connectivity for data, voice, and video transmission.

  (ii) **Radio Communications**. MASS can also communicate with land stations using radio frequency (RF) communications. VHF and HF radios are commonly used for short-range communications, while MF/HF radios are used for long-range communications. MASS can also use satellite-enabled radios for additional communication capabilities.

  (iii) **Underwater Acoustic Communication**. MASS can use underwater acoustic communication to communicate with other MASS or underwater systems, such as Autonomous Underwater Vehicles. Underwater acoustic communication is commonly used for long-range, low-data rate communication.

(c) **Defect Rectification**. A fully autonomous warship or MASS will require active integration of AI with robotics. AI will identify the defects and guide the robotics assembly onboard to undertake the defect rectification.

(d) **Remote Sensing**. Remote sensing technologies, such as Radar and Light Detection and Ranging (LIDAR), can be integrated into maritime autonomous surface ships to help them detect and avoid obstacles and track other vessels.

The indigenous institution of an autonomous surface ship by India would require the integration of primary AI domains such as Electronic Navigation Chart base layer, Satellite Communications, Radio Communications, Under Water Acoustics, Remote

Sensing, Robotics, etc. These AI applications, being interdisciplinary in nature, require customisation of existing applications/technologies. Therefore, military AI would always be a subset of the overall AI architecture of the country. Hence, it is strongly opined that to develop India's military AI architecture, it is essential to resurrect India's overall AI architecture.

Despite India's ambitious Unmanned Roadmap, India is yet to capitalise on worldwide AI advancements. The wait for India continues as the slow pace of AI development is creating a widening gap in cutting-edge technology and rapidly changing the warfare landscape. Hence, there is a need to identify and address the compelling reasons for the lag of military AI development in India by assessing the current AI landscape.

Current AI Landscape

The global AI landscape is characterised by an increasing focus on using AI to improve military capabilities and operational efficiency. At this juncture, there is a need to explore various facets of India's position in AI. Accordingly, the following tenets have been studied:

(a) Sector-wise investment in the field of AI.

(b) Investment in AI-based Research and Development projects.

(c) Quality of research in AI.

(d) AI Talent Pool.

(e) Private Sector and Start-Ups.

Table 1 - Ranking of Countries in AI against Key Pillars.

Country	Global Rank				
	AI	Capital	Research	Development	Talent
US	1	1	1	1	1
China	2	2	2	2	24
UK	3	4	5	11	3
Canada	4	6	10	10	7
Israel	5	3	7	9	5
Singapore	6	5	4	14	4
S. Korea	7	15	12	3	28
India	17	11	25	6	2

Source: AI Index Report 2023, Stanford University[25] and Global AI Vibrancy Tool[26]

Global rank in terms of the basic tenets of development of AI, such as Investment, Research and Development and availability of 'Talent Pool' of top countries, including India, has been illustrated in Table 1.

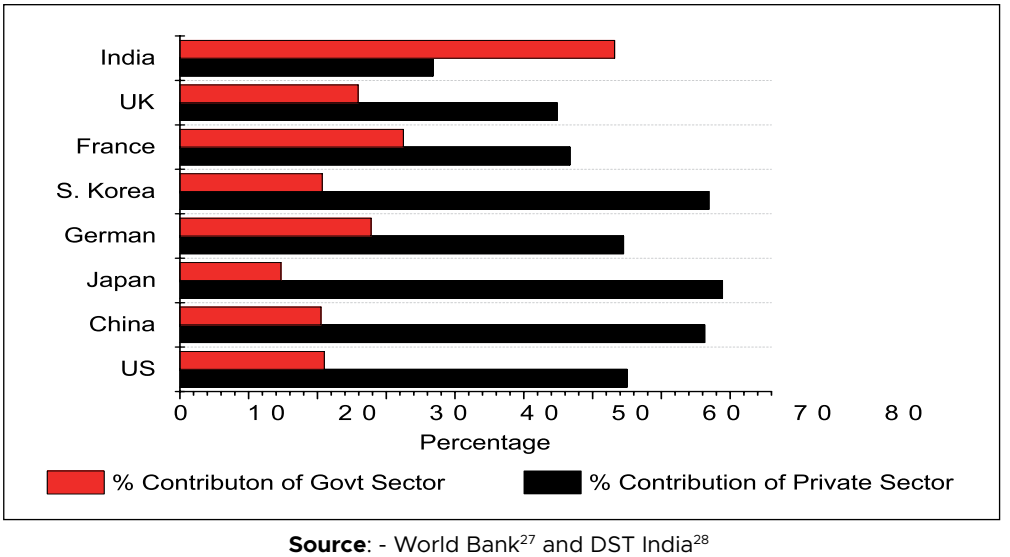
Sector-Wise Investment in AI. The percentage of capital investment by the two main sectors, namely the government and the private sectors in AI, is also a good indicator of a nation's growth.

Figure 3 indicates that the countries maintaining higher positions in the AI leaderboard are the ones where the private sector has contributed more than twice compared to the government sectors. The following are the deductions from the trend shown in the graph:

(a) The contribution of the Indian private sector should at least be twice the investment by the government players in India.

(b) The private sector investment needs to grow at least four times to ensure that the investment is twice the government investment.

Figure 3- Sector-Wise Investment in AI R&D

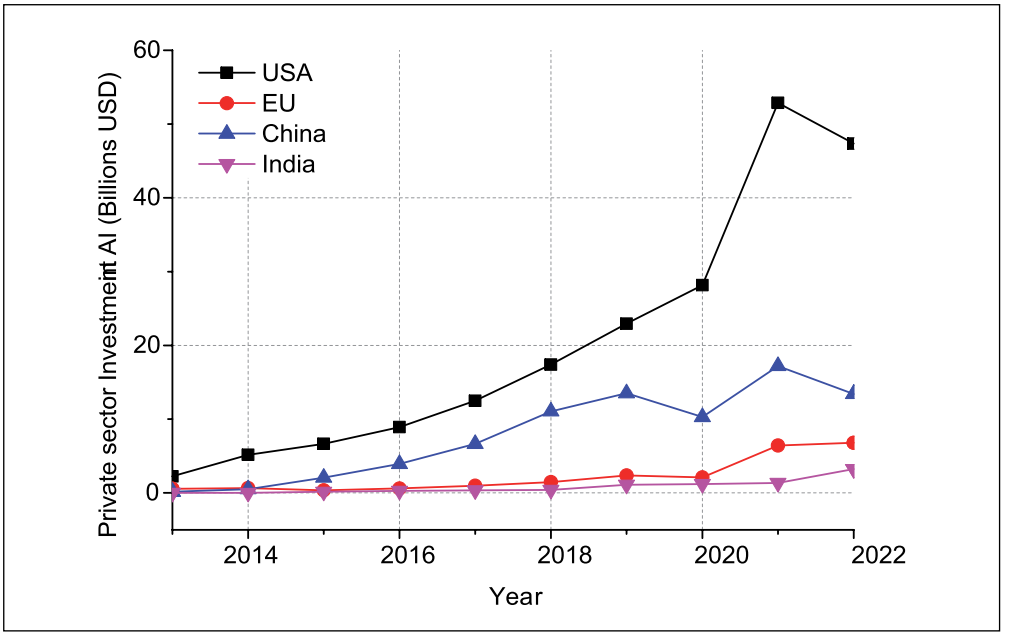


Source: - World Bank[27] and DST India[28]

Figure 4 hints that the private sector investments towards AI R&D in India after 2020 have shown a slow rise compared to global leaders in AI. This pace needs to improve further to compete with AI leaders. The private sector investment in India was 3.24 billion USD in 2022.[30] Referring to the deduction in the paragraph above, i.e., India's private sector investment should be at least four times the current investment, the recommended private sector investment in India in 2023-24 should be 13 billion USD.

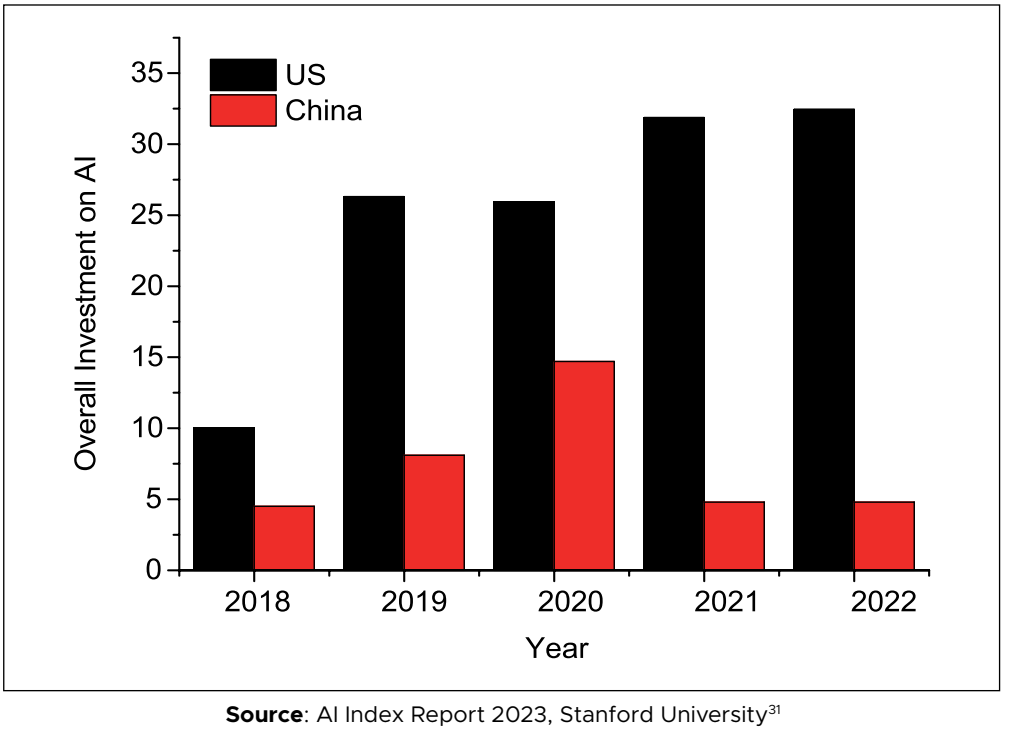
Investment in AI Research and Development. Investment in AI-based research and development worldwide has increased recently. The pattern of AI investment by the USA and China, the top two economies, has been studied and presented in Figure 5.

Figure 4 - Private Sector Investments in AI



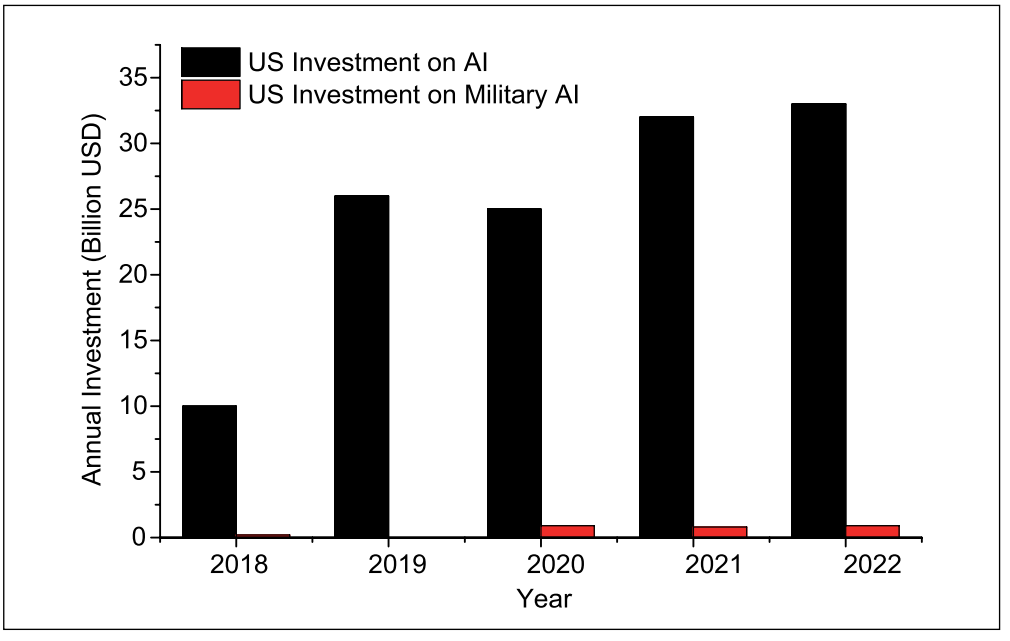
Source: AI Index Report-2022, Stanford University[29]

Figure 5- Annual Investment in AI by the US and China



Source: AI Index Report 2023, Stanford University[31]

Figure 6 - Comparison of Investment in AI and Military AI by the US



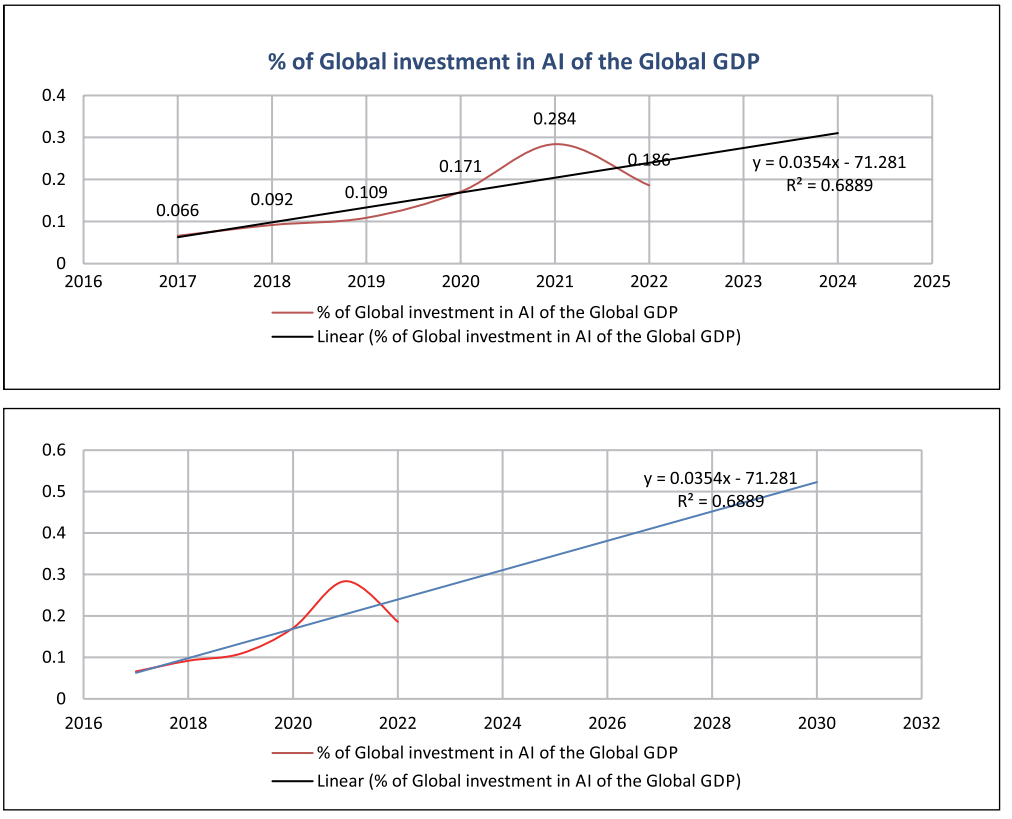
Source: AI Index Report 2023, Stanford University[32]

Examination of data *iro* USA presented in Figure 6 indicates that the proportion of AI investment in the defence sector compared to the total AI investment averages at a ratio of 1:25. India's overall AI investment in 2022 was 3.24 billion USD. Applying the above proportion of 1:25, the Defence AI investment should have been 0.13 billion USD or Rs 965 crores. India's allotted defence AI budget is Rs 1000 crores annually for the next five years.[33] It is observed that the template ratio of 1:25 works precisely for India.

Similarly, India's recommended AI investment in 2023, as mentioned in the paragraph above, is 13 billion USD; hence the proposed Defence AI investment for India for 2023 using the ratio 1:25 is estimated to be Rs 3900 crores or 0.5 billion USD.

(a) **AI Share in GDP**. The data *iro* percentage of global GDP spent on AI in the past few years is presented in Figure 7. The graph indicates a steady rise in the percentage share of GDP towards research and development of AI. Further, it has been ascertained that investment in AI has the potential to significantly boost a country's economy and positively impact the GDP growth (Figure 8 refers). Comparing figures 7 and 8, it is evident that the positive impact on the percentage of returns from AI, in terms of GDP envisaged by 2030, against the portion of investments in AI will see growth at an average of 60 times. A regression analysis on the percentage of global investment in AI (refer to Figure 7) indicates that India's AI investment should rise to 0.5% of its GDP by 2030. India's GDP for

Figure 7 - Percentage of Global GDP Invested in AI.



Source: www.statista.com[34]

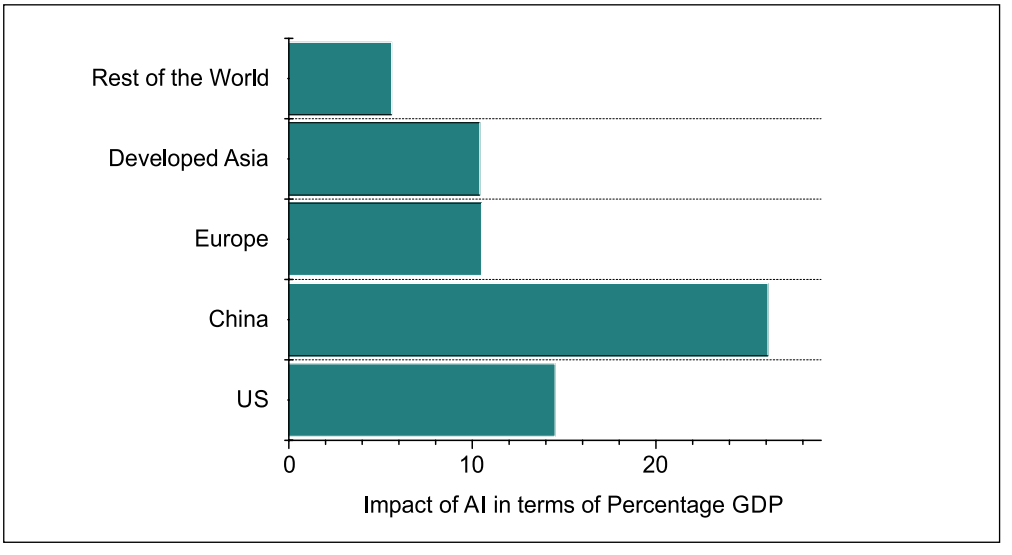
2022 was Rs 234.71 Lakh Crore[35] or 3.14 trillion USD. India's GDP is estimated to be 7 trillion USD by 2030[36]. **Accordingly, India's investment in AI for the year 2030 is proposed to be 35 billion USD**.

(b) **Investment in AI vs Number of Patents**. Investment in Research and Development of AI has snowballed in recent years, leading to a significant increase in the number of published patents.

The trend of global investment in AI over the past ten years and the corresponding outcome in terms of the number of patents are represented in Figure 9. It is observed that both the key parameters follow a progressive trend and are highly correlated. Such a trend is a good benchmark for a nation-state to determine its investment goals.

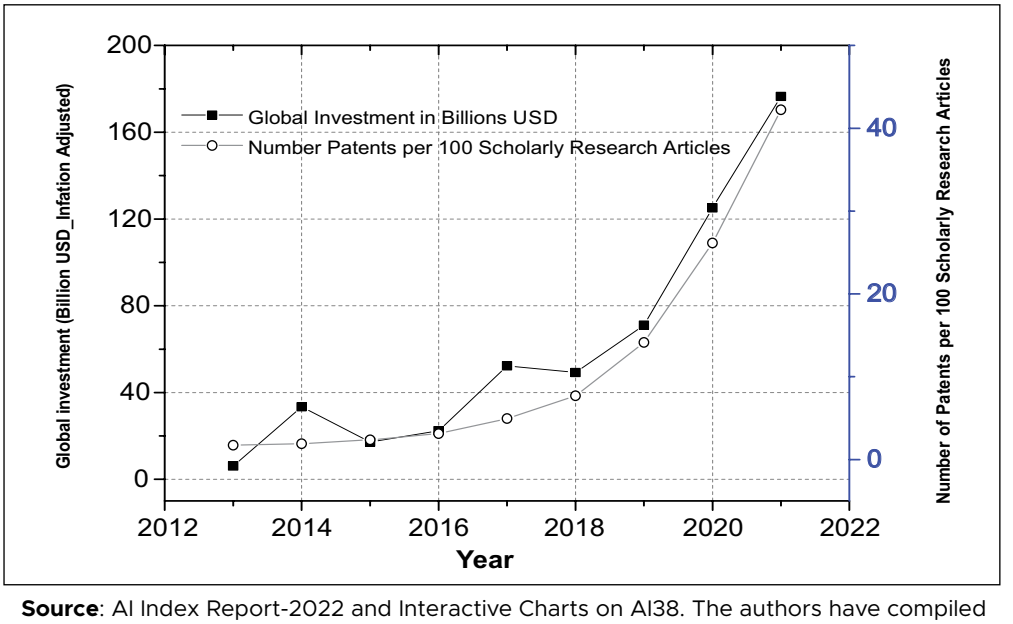
A regression analysis in Figure 10 concludes that a linear correlation exists between 'Investment in AI' (Inv) and 'Number of Patents filed in AI' (P). Accordingly, India's forecasted investment in AI till 2030 has been worked out and presented in Table 2.

Figure 8 - Estimated Impact of AI on GDP of Countries by 2030



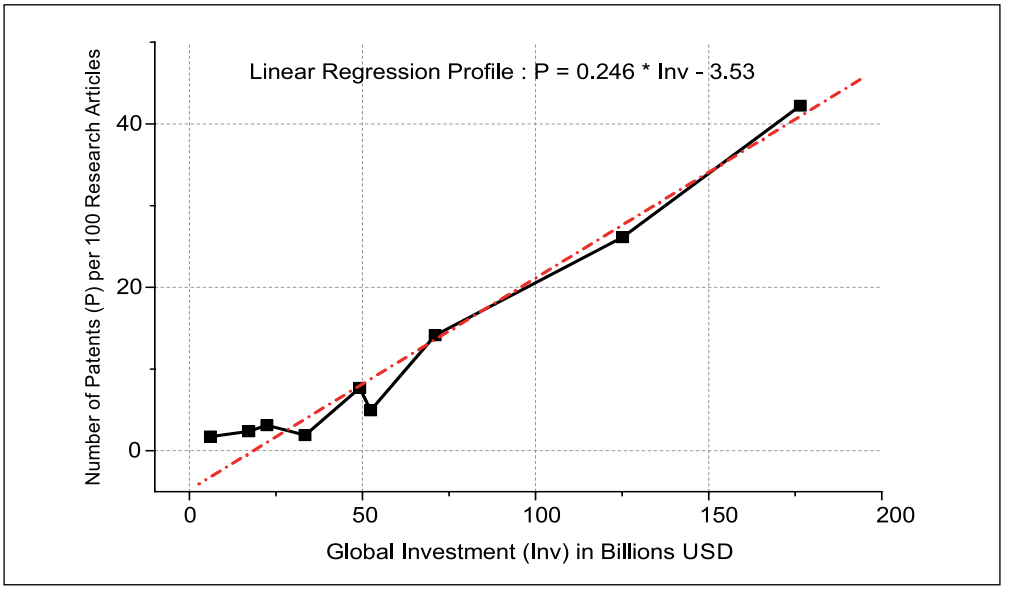
Source: Report on '*Impact of AI on GDP Worldwide by Region*' and Report on '*How AI can enable a Sustainable Future*'[37]

Figure 9 - Investment vs Number of Patents



Source: AI Index Report-2022 and Interactive Charts on AI38. The authors have compiled and depicted the data for the number of patents per 100 Scholarly Research Articles.

Figure 10 - Prediction: Graph for Investment vs AI Patents



Source: Data and graph deduced by the authors

Table 2 - Requisite Investment for Progressive Research and Development in India

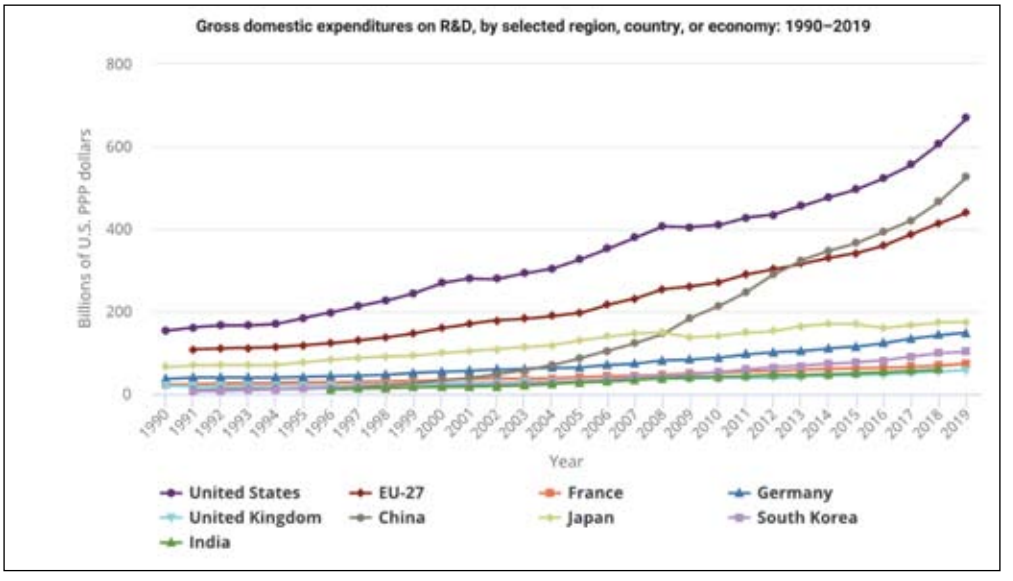
Year	Number of Patents per 1000 Scholarly Research Articles	Investment in Billion USD
2024	6-8	12-16
2025	10	20
2026	20	24
2027	30	28
2028	40	32
2029	50	36
2030	60	40

Source: Data in the table deduced by authors.

Table 2 indicates the proposed investment by India to achieve an excellent Investment-to-Number of Patent ratio, matching with the global trend. For India to develop new AI technologies and be an inventor, **it is proposed that India follow the recommended investment pattern steadily**.

(c) **India's Position in the Research and Development of AI (AI R&D)**. China and the US currently lead the overall investment in AI R&D. Overall, investment in AI R&D is critical to maintaining global competitiveness and driving innovation. Figure 11 is indicative of the minuscule Indian investment in AI as compared to the US and China, which invest approximately ten times more in R&D of AI.

Figure 11 - Research and Development Investment in AI by Countries



Source: Graph reproduced from 'The Global State of Science and Engineering Research'.[39]

AI Research Quality. There is often a trade-off between quantity and quality of research and innovation in AI. Therefore, balancing both and prioritising quality is crucial to ensure that AI is used responsibly and effectively[40]. The author has quantified both the Quality and Quantity of global research in AI and has presented the same in Table 3.

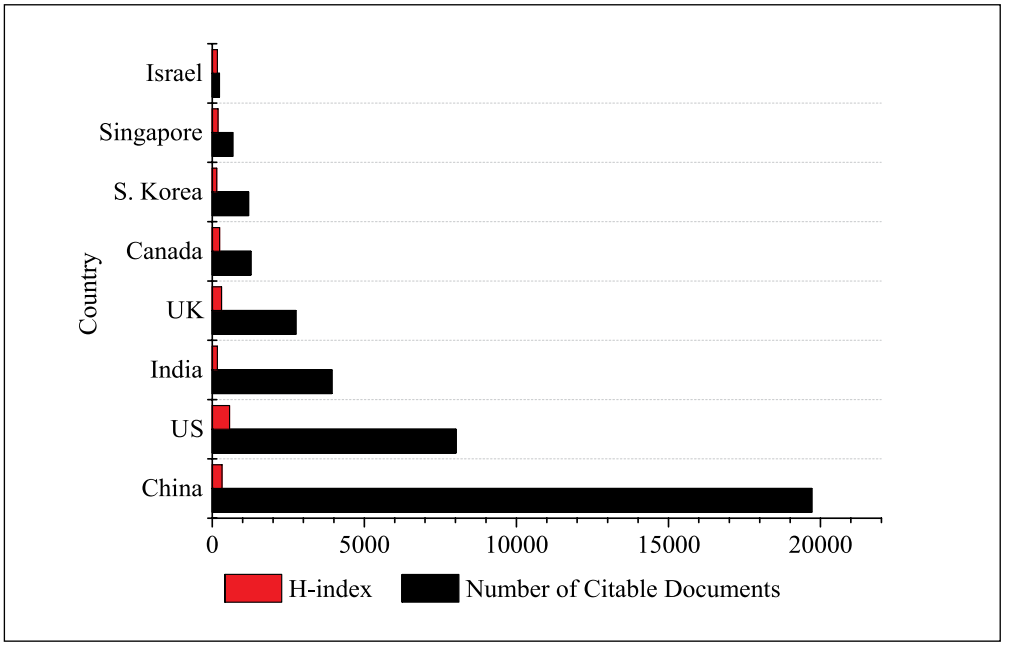
Table 3 - Quantity vs. Quality of Research.

Country	Number of Citable Documents	Rank based on Citable Documents	H-index	Rank based on H-index
China	19714	1	324	2
US	8011	2	572	1
India	3933	3	167	17
UK	2750	4	309	3
Canada	1269	11	245	5
S Korea	1196	12	153	19
Singapore	677	16	190	10
Israel	241	41	168	16

Source: Report on Scimago Journal & Country Rank[41]

As per Table 3, India ranks third, following the US and China, regarding the quantum of AI-related publications. However, India ranks 17th on the quality of these publications, measured by their productivity and citation rate (represented by the Hirsch or 'h'-index). A low H-index indicates that the Indian research papers do not transcend their impact

Figure 12 - Number of Citable Research Articles with H-Index



Source: Report on Scimago Journal & Country Rank[42]

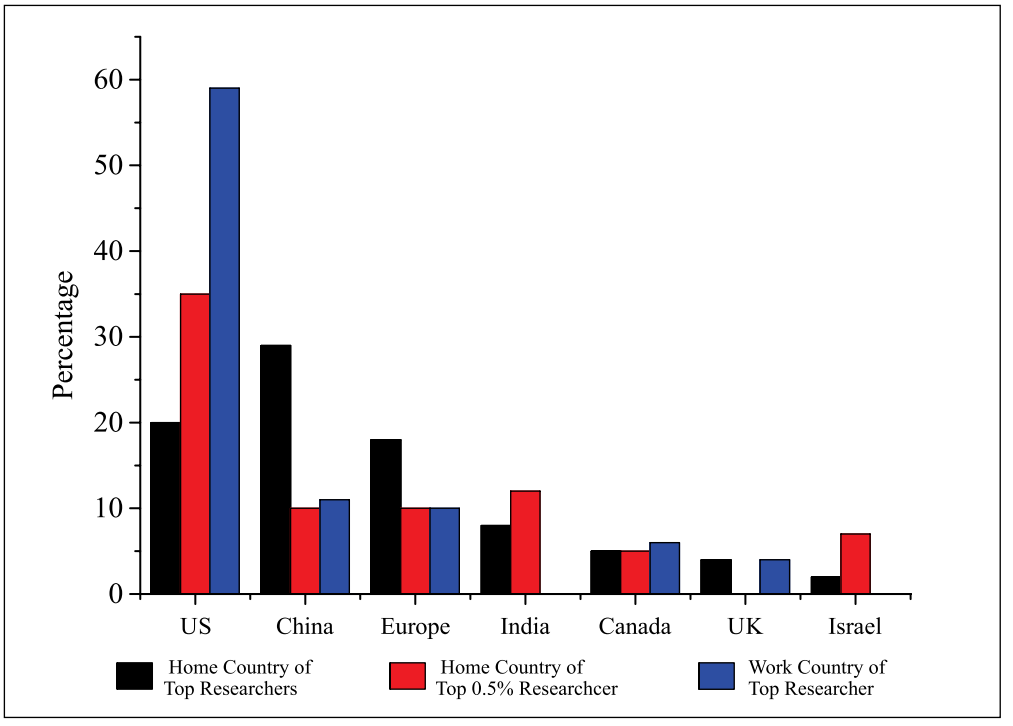
in the international AI research arena. However, the interpretation changes if the same tabulated data is visualised in a graphical format, as illustrated in Figure 12.

Figure 12 indicates that China ranks first in the number of citable documents and second in H-Index. But the ratio of China's citable documents to H-Index is 61:1, which is not a favourable quality ratio. Israel ranks 41st in total citable documents and 16th in the H-Index, indicating a quality research ratio of 1.4:1. India ranks 3rd in citable documents and 17th in the H-Index. India's citable documents to H-Index ratio is 24:1. India should aim to achieve a quality index like Israel by 2030 to at least 10:1. Even with the present number of citable documents of 3933 if India achieves this ratio, India's H-index will be 393, placing India ahead of China. India should improve its quality of research to achieve an H-index with a ratio of 10:1 by 2030.

AI Talent Pool. The talent pool in AI requires an increasing number of experts and professionals to meet the growing demands. There is an intense competition for AI talent among leading technology companies as they seek to hire the best and brightest to drive innovation and growth.

Figure 13 paints an inspiring talent pool resource from India, but the top Indian AI researchers have outsourced their competence towards developing AI to other countries. It also indicates a very sordid scenario with no leading Indian researcher working for India. Hence, India faces a vital challenge of building world-leading AI capabilities

Figure 13 - Percentage of Top AI Researchers



Source: Report on the Global AI Talent Tracker, Marco Polo[43]

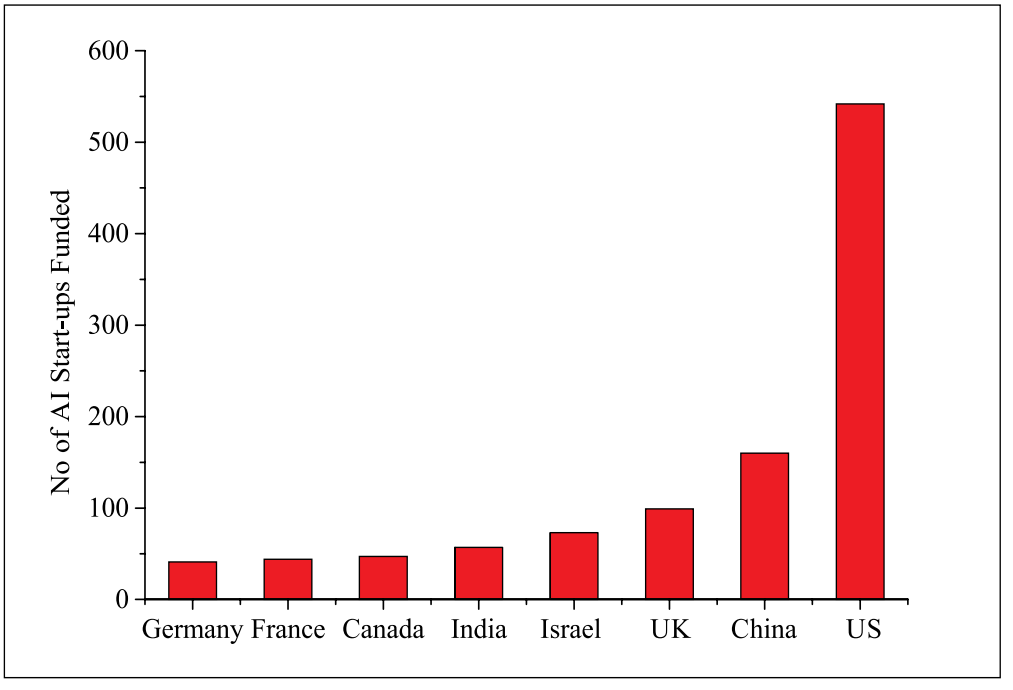
without these top researchers. The figure also indicates that the USA and the UK absorb AI talents from other countries. To be on the AI leader board, it is proposed that India should target to be the "work country" for at least 30% of top AI researchers by 2030.

State of Startups

Investment by Countries in AI Startups and Companies. Assessing a country's investment in AI startups and companies is equally important because AI is critical to modern economies and militaries. Countries that invest in AI will have a competitive advantage globally. By investing in AI startups and companies, governments can ensure that they have access to the latest technological advances. Many AI Startups in leading countries are represented in Figure 14.

Figure 14 indicates that India is the fifth largest fund investor in AI startups and companies. These startups and companies are at the forefront of research and development and have contributed significantly to the growth of AI in various industries such as healthcare, finance, transportation, and military[46]. The Defence Advanced Research Projects Agency (DARPA) of the US invests heavily in AI research and development to address national

Figure 14 - AI Startups and Companies Funded by Countries.[44]



Source: NetBase Quid, 2022[45]

security challenges and improve military capabilities. Many of the breakthroughs in AI have been achieved by DARPA-funded startups and companies[47].

Indian startups have forayed into all domains, including healthcare, defense, and entertainment[48]. As per MeitY IndiaAI report 75@75start-ups, 75 startups performing exceedingly well in varied sectors were identified. Only two out of the 75 startups mentioned by the IndiaAI report are defence startups. A staggering number of startups have been observed to be from the IT services domain, which can directly or indirectly assist in developing algorithms for operations by defence forces.

Analysis of Figure 14 brings the following observations to the fore:

(a) India's AI expenditure in 2022 stood at 3.24 billion USD49. India funded 57 AI startups in 202250. The average AI investment by India is 0.05 billion USD per startup.

(b) In 2022, the USA invested 33 billion USD in AI to fund 542 startups/companies, with an average investment of 0.06 billion USD per company.

(c) India's recommended AI investment in 2023 is 13 billion USD51, hence India, as on date, should have funded 260 startups/companies.

(d) In 2030, India should invest 35 billion USD52 and it is anticipated to fund approximately 700 startups/companies.

Challenges for Military AI and Robotics

The following challenges are envisaged in the basic tenets of military AI implementation in India:

(a) Lack of funding for research and development activities.

(b) Limited availability of a skilled workforce with expertise in machine learning, computer vision, and natural language processing.

(c) Limited access to standardised and centralised data repositories.

(d) Unclear regulations related to military AI development and use.

(e) Ethical concerns related to privacy, human rights, and accountability.

(f) Limited interoperability among different AI systems and platforms.

(g) Security vulnerabilities and risks associated with AI-enabled systems.

(h) Limited scalability of AI technologies in the military.

(j) Difficulty in integrating AI technologies with existing military systems and processes.

(k) Limited testing and evaluation of AI-enabled systems in real-world scenarios.

(l) Dependence on foreign technology and equipment for AI development.

(m) Limited collaboration and knowledge sharing among military agencies and branches.

(n) Resistance to change and adoption of new technologies in traditional military culture.

(p) Limited public awareness and support for military AI development and use.

Recommendations

Implementing Vision India 2030. India is among the top ten countries in the development of AI when compared to each tenet of AI development. However, the ranking in each vertical could be more appreciably consistent with the required growth on the ground. The reasons have been studied statistically, and opportunities/challenges in each tenet of AI have been established. To be on the AI leaderboard by 2030, India must construct a concrete plan-of-action. Hence, the statistically evaluated AI landscape vis-a-vis the existing challenges for the implementation of military AI recommends the following factual and conceptual framework:

(a) **Investment**. The following investment pattern is recommended for India:

Factual Framework

(i) The private sector's investment in overall AI should be 13 billion USD[53] instead of 3.24 billion USD in the year 2022 and should be incremental.

(ii) The proposed military AI investment in R & D for India 2023 should be 0.5 billion USD[54].

(iii) India must invest at least 35 billion USD in AI by 2030[55] to maintain pace with the global AI leaders.

(b) **Research**. To roll its research wheel to reach an innovative paradigm, India will have to:

Factual Framework

(i) Invest profusely in AI R&D to register at least 60 patents from every 1000 research articles[56] published.

(ii) Produce quality research citable documents to achieve an h-index with a ratio of 10:1 by 2030[57].

Conceptual Framework

(iii) All agencies and organisations of the government and public sector holding critical data need to integrate into National Data Repositories. This data will be used to train, validate and create new AI models for the Indian Armed Forces.

(iv) The Indian Armed Forces must be adaptive towards AI integration. The R&D of Military AI should start with quasi-Military AI R&D to integrate existing arsenal and systems with AI. This integration should be aimed at developing accurate weapon firing solutions, enabling battlefield awareness through integration of space, land, sea, and subsea domains, intelligence gathering through cyber warfare, logistics management, predictive machinery maintenance, medical support at farfetched locations, etc.

(c) **Talent Pool**. India's performance in the field of AI, particularly Military AI, will depend mainly on the AI talent pool. To resurrect India's talent pool, the following is recommended:

Factual Framework

(i) India needs to hold on to its talented AI pool by offering better positions and perks, research support, quality of life, and an AI-thriving environment.

(ii) India should aim to harness 30% of the world's top AI professionals by 2030[58] to ensure innovation, complex AI development, and AI ethics management for various requirements.

Conceptual Framework

(iii) India must amalgamate skill development as per the National Education Programme - 2020 (NEP-2020) for machine learning, computer vision, and natural language processing expertise.

(iv) The government can provide financial incentives to encourage individuals to pursue careers in AI. This can include scholarships, research grants, and tax incentives for companies that invest in AI research and development.

(v) The government can establish AI research centres that bring together researchers, academicians, and industry professionals to work on cutting-edge AI projects. These centres can provide training and research opportunities to develop the AI talent pool in India.

(d) **Startups**. India must rigorously support and invest in AI startups to ensure that:

Factual Framework

(i) India should be fiscally equipped to fund approximately 700 startups/ companies in the year 2030[59] and incrementally increase year after year.

Conceptual Framework

(ii) These startups developing different AI domains should collaborate to create cross-sector collaboration within the country.

(iii) These funded startups should be tasked to address AI issues that have limited economic scalability in the market but are essential in developing Military AI.

(iv) India should promote global collaboration to help startups access international markets, investors, and technology. This can include creating partnerships with other countries, providing support for startups to participate in international events and competitions, and encouraging foreign investment in Indian startups.

Conclusion

The transformation of warfare through the integration of AI and robotics is not just an opportunity but a necessity for maintaining national security and geopolitical relevance. The profound impact of AI on modern military operations has been evidenced by the advancements made by leading global powers, making it imperative for India to accelerate its efforts in this domain. This research paper has highlighted the significant potential of AI and robotics in enhancing military capabilities, from autonomous vehicles and decision-making systems to swarm robotics and unmanned warships.

India's current standing in the global AI landscape not only shows promise but also underscores the need for substantial improvements. The challenges identified—such as the disparity in private sector investment, limited R&D funding, inadequate infrastructure, and the lack of a comprehensive policy framework—must be addressed to unlock the full potential of AI and robotics in India's defence sector. The recommendations provided in this paper, including boosting private investment, enhancing R&D efforts, developing robust AI infrastructure, establishing clear policies, fostering collaboration, and focusing on talent development, offer a strategic roadmap for India's journey towards AI-driven military advancements.

By adopting these measures, India can not only bridge the gap with global leaders in military AI but also ensure that its armed forces are equipped with cutting-edge technologies to counter emerging threats. The proactive adoption and integration of AI and robotics in military strategies will not only enhance operational efficiency and effectiveness but also safeguard national security in an era where technological superiority is becoming increasingly decisive. As India moves towards 2030, a concerted effort in leveraging AI and robotics will be critical in shaping a secure and technologically advanced defence ecosystem, ensuring the country's readiness to face the challenges of the future battlefield.

Strategic Roadmap for Development of AI and Robotics in Maritime Defence. Strategic roadmap for advancing India's AI and robotics capabilities in the maritime defence sector is as appended:

(a) **Increased Investment in AI and Robotics**. India should target an annual allocation of at least 35 billion USD towards AI research and development by 2030, with a dedicated investment of 0.5 billion USD in military AI. This financial boost will foster a robust innovation and technological advancement ecosystem.

(b) **Fostering Research and Development**. Establishing specialised research centres and promoting collaborations with global experts will be essential to push the boundaries of AI technology. Encouraging the publication of innovative technical journals and improving the H-index ratio to 10:1 will foster a culture of continuous learning and innovation.

(c) **Attracting and Retaining Talent**. Creating an AI-friendly infrastructure and environment is crucial to retaining local talent and attracting international experts. India should aim to become a hub for top AI researchers, targeting to attract 30% of the world's leading AI minds.

(d) **Encouraging Patents and Innovations**. India should strive to register at least 60 patents for every 1,000 scholarly research works by 2030. This initiative will highlight the country's innovative spirit and contribution to the AI domain, fostering a competitive and creative research environment.

(e) **Boosting the Startup Ecosystem**. India should focus on nurturing its startup ecosystem to support military AI development. By the end of the decade, the goal must be to fund and witness the emergence of 700 AI startups, providing a fertile ground for innovation and entrepreneurial growth.

(f) **Developing AI Architectures for Military Applications**. Investing in AI architectures specifically tailored for military use is crucial. These systems should support rapid deployment in dynamic and unpredictable environments, such as battlefields, ensuring technological superiority in military operations.

(g) **Collaboration and Partnerships**. Encouraging collaborations between defence manufacturers, academic institutions, and MSMEs will be pivotal in driving innovation. These partnerships can lead to the development of sophisticated AI and robotic systems tailored to the Navy's specific needs.

(h) **Building Robust AI Infrastructure**. Investing in state-of-the-art AI infrastructure, including data centres and high-performance computing systems, will provide the necessary foundation for advanced AI research and applications.

Notes

1 "What are the three types of AI", accessed 24 June 2024, www.deccanherald.com
2 Layton Peter, "Fighting Artificial Intelligence Battles: Operational Concepts for Future AI-Enabled Wars by Department of Defence, Australian Govt," *Joint Studies Paper Series* No 4 (2021): 1-100.
3 Thomas Rid and Marc Hecker, "Introduction: Understanding and Countering Unconventional Warfare*," Journal of Strategic Studies* 42, no. 5 (2019): 651.
4 Pinker, Steven. *The better angels of our nature: The decline of violence in history and its causes*. Penguin UK, 2011
5 Levy, Jack S. *War in the modern great power system:* 1495–1975. University Press of Kentucky, 2014
6 Christine Gray, *International Law and the Use of Force* (Oxford University Press, 2018).
7 Edward D Mansfield and Jack Snyder, "Democratic Transitions, Institutional Strength and War," *International Organisation,* no. 2 (2002): 297-337.
8 Danilo Di Mauro, *The UN and the Arab-Israeli conflict: American hegemony and UN intervention since 1947,* (Routledge, 2012), pp 27-30.
9 Richard A Matthew and Bryan McDonald, "The Transnational Politics of Industrial Hazard and the Emergence of New Eco-Social Movements," *Journal of World-Systems Research*, (1995) : 102-109.
10 Johan Galtung, "Violence, peace, and peace research," *Journal of peace research,* no. 3 (1969): 167-191.
11 "Regional-overview-asia-pacific-january-2023," accessed 10 March 2023,
12 https://acleddata.com/2023/02/03/regional-overview-asia-pacific-january-2023/ accessed on 10 Mar 23

13 "US Navy tests new Snakehead autonomous underwater vehicle," Naval Technology, (2020).
14 "US Navy develops cognitive AI system for real-time decision-making," Naval Technology, (2021).
15 "UK Royal Navy successfully tests autonomous swarm boats," Naval Technology, (2020).
16 "US Navy's autonomous warship Sea Hunter completes trials," Naval Technology, (2018).
17 "Royal Navy considering autonomous warship as part of future fleet," The Guardian, (2021).
18 "China Conducts Test of Unmanned Combat Vessel," USNI News, (2021).
19 "US Navy Tests Ghost Fleet Overlord Unmanned Surface Vessel," The Drive, (2021).
20 "Maritime Capability Perspective Plan," Indian Navy, accessed 09 April 2023, https://www.indiannavy.nic.in/
21 "Indian Navy Maritime Capability Perspective Plan (2017-2030)," Ministry of Defence, Government of India, accessed 10 April 2023, https://www.mod.gov.in/dod/mcpp/
22 "Unmanned Systems," Indian Navy, accessed 03 April 2023, https://www.indiannavy.nic.in/
23 "Exploring the significance of AI in the Indian Navy, MEITY IndiaAI" assessed 20 October 2024, https://indiaai.gov.in/article/exploring-the-significance-of-ai-in-the-indian-navy
24 "Indian Navy looks to procure large autonomous surface vessels," Jane's 360, accessed on 03 April 2023, https://www.janes.com
25 AI Index Report 2023, Stanford University and Global AI Vibrancy Tool
26 Who's leading the global AI race?",https://aiindex.stanford.edu/report/ accessed in 03 Mar 23.
27 "Artificial Intelligence- Investment Trends", accessed 10 March 2023, https://documents.worldbank.org/
28 "DST Annual Report 2022-23", accessed 01 April 2023, https://dst.gov.in/
29 "AI Index Report-2022, Stanford University", accessed 01 April 2023, https://aiindex.stanford.edu/report
30 "India ranks fifth among countries with largest investments in artificial intelligence," assessed 13 April 2023, https://www.wionews.com/india-news
31 AI Index Report – Measuring Trends in Artificial Intelligence – 2023", accessed 15 Mar 23, https://aiindex.stanford.edu/report/
32 *Ibid*
33 "Indian Armed Forces get ready for future warfare! Undergoing essential changes due to AI", accessed 14 March 2023, https://www.financialexpress.com/
34 "Global Investments in AI," accessed 17 March 2023, https://www.statista.com/
35 "National Income 2022-23," Govt of India, (2023)
36 "India 2030: Exploring the Future," Niti Aayog, Govt of India, (2019)
37 How AI can Enable a Sustainable Future", https://www.pwc.co.uk/ accessed on 01 Mar 23.
38 https://ourworldindata.org/ accessed on 16 Mar 23.
39 "The Global State of Science and Engineering Research," accessed 15 March 2023, https://data.worldbank.org/
40 "Balancing AI: Do good and avoid harm," accessed 21 March 2023, https://www.ibm.com/think/insights/ai-ethics-balancing
41 https://www.scimagojr.com/, accessed on 17 Mar 23.

42 *Ibid*
43 "Report on AI Talent Tracker", https://macropolo.org/, accessed on 29 Mar 23
44 "AI Start-up Funding Status," accessed 29 March 2023, https://netbasequid.com/
45 https://netbasequid.com/ accessed on 29 Mar 23.
46 Jiang, Fei, Yong Jiang, Hui Zhi, Yi Dong, Hao Li, Sufeng Ma, Yilong Wang, Qiang Dong, Haipeng Shen, and Yongjun Wang, "Artificial intelligence in healthcare: past, present and future," *Stroke and vascular neurology* 2, no. 4 (2017).
47 "Artificial Intelligence" Defense Advanced Research Projects Agency (DARPA), USA
48 "MeitY India AI report 75@75 startups," Govt of India.
49 Data is deduced at Para 25 of this article.
50 *Ibid* 42
51 Data is deduced at Para 23 of this article.
52 Data is deduced at Para 28 of this article.
53 Data is deduced at Para 23 of this article.
54 Data is deduced at Para 26 of this article.
55 Data is deduced at Para 28 of this article.
56 Data is deduced at Para 31, Table 2 of this article.
57 Data is deduced at Para 36 of this article
58 Data is deduced at Para 38 of this article.
59 Data is deduced at Para 42 (d) of this article.

Disclosure Statement

The views expressed in the article are solely those of the authors.

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