

# **EMERGENCE OF ARTIFICIAL INTELLIGENCE IN FUTURE WARFARE: PREPAREDNESS OF BANGLADESH ARMED FORCES**

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## **Introduction**

History of Humanity and Evolution of Technology is analogous to each other. Use of stone as a tool back in 10 million years ago initiated the human's instinct to use technology. With the passage of time, relationship of human with technology is getting new natural and intuitive interface. There is a trend of making digital relationship where Artificial Intelligence (AI) has unlocked new unbound opportunities. Machine Learning, Deep Learning, Natural Language Processing, Computer Vision, Intelligent Automation and Neural Network have created a different virtual world of knowledge based on intelligence which can be compared to human intelligence. The advent of Siri by Apple, Tesla's autopilot, Waymo by Google, Netflix, Pandora, Amazon Search, Flying Drones all have unleashed an inevitable AI Technology era. Google's self-driving car project has announced the arrival of autonomous machine age in this world. This is an extraordinary moment of time when machines can take the decision to act by itself while taking input data from its environment. Therefore, it is evident that human and machines will take part in future warfare where machines will be employed more autonomously. The advent of new technology always has changed the characteristics of warfare. With no exception, emergence of AI will also dramatically change the nature and laws of warfare so far human has experienced. With all the AI development projects taken by the developed and developing militaries, it is time for Bangladesh (BD) also to take adequate measures to make herself capable of dealing with such techno hype future warfare.

## Evolution of AI Technology, Future Trend and Various AI Applications

### Evolution and History of AI

The concept of AI can be traced back to 100 years ago when Czech writer Karel Capek published “Rossum Universal Robot” in 1920 where the concept of robot and its way of working were perceived<sup>1</sup>. Without developing the proper programming framework, AI was used in World War II in the field of cryptography and ballistic firing table of artillery<sup>2</sup>. The development came through the theory of computation by Alan Turing- an English computer scientist who invented the turning machine to calculate the logic of algorithm to build an electronic brain. This has acted as the foundation of AI thinking.

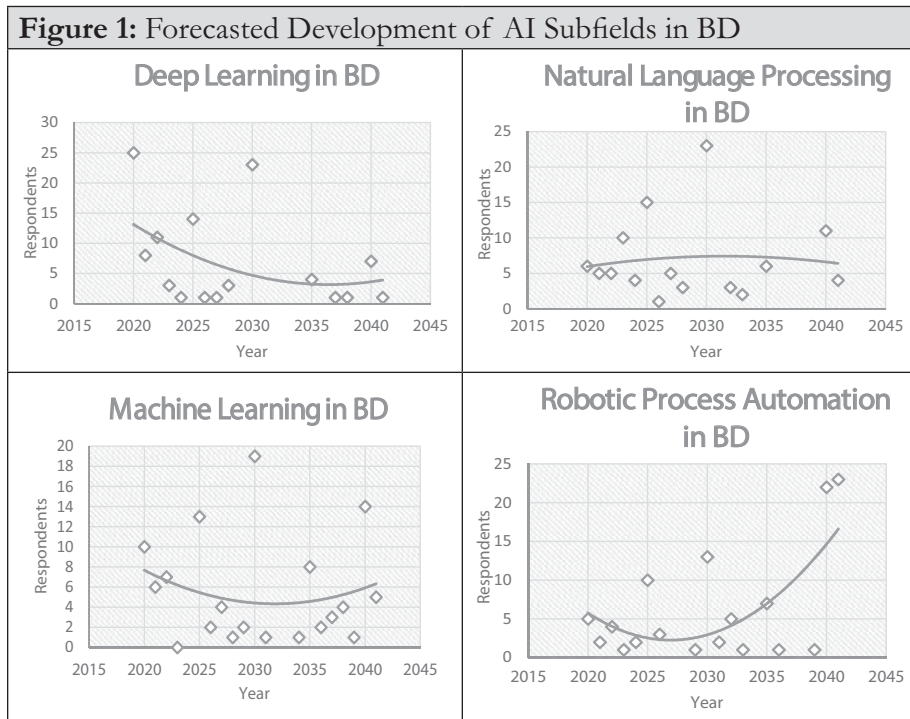
- **The First AI Spring** (1956-1974) marked the development the development of computational tools to act like human to solve geometrical problems, algebraic equations and checkers games.
- **The First AI Winter** (1975-1980) prevailed a short span of time when application of AI algorithms were supported by the limited processor speed and memory capacity of hardware.
- **The Second AI Spring** (1980-1987) emerged as the revival of AI by introducing rule-based programs which could emulate human intelligence for a decision making cycle.
- **The Second AI Winter** (1987-1993) witnessed a collapse as the inception of the economical desktop computers from IBM and Apple challenged the AI-functioned one.
- **The Third AI Spring** (1993-2011) was the boom of the AI application as followed by tremendous advancement in nanotechnology and micro-processor in hardware industries.

1. Capek, K., 1920. Rossum Universal Robot. s.l.:s.n.

2. Tim Sweijts, S. D. S. M. M., 2017. Artificial Intelligence and The Future of Defense. Hague: The Hague Centre for Strategic Studies.

## Trend of AI Development and Future Time Line

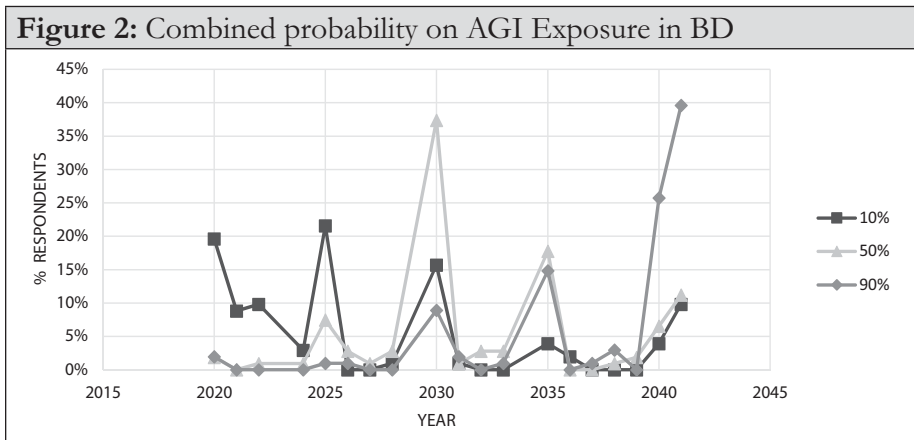
The 3rd AI Spring was finished on 2011 where 3rd AI winter started. After expected finishing of the winter in 2017 with six year duration, it is the 4th AI Spring which is likely to be started from 2018 and tends to prevail 18 years up to 2036. The 4th AI Spring (2018-2036) will be the new phase where predictive algorithm may have seen its pinnacle of development. The respondents of survey group (UGS) who were undergraduate students of computer science and engineering, have made a prediction about the Forester AI subfields exploration<sup>3</sup>. According to them, the time line of exploration of these AI subfields will likely to be extended for BD which they have predicted from 2020 to 2041. The forecasted diagram of various AI subfield exploration in BD are shown in figure 1.



3. Curran, R., Purcell, B. & Kisker, H., 2017. TechRadar: Artificial Intelligence Technologies, Q1 2017, s.l.: s.n.

## Extent of Autonomy in AI

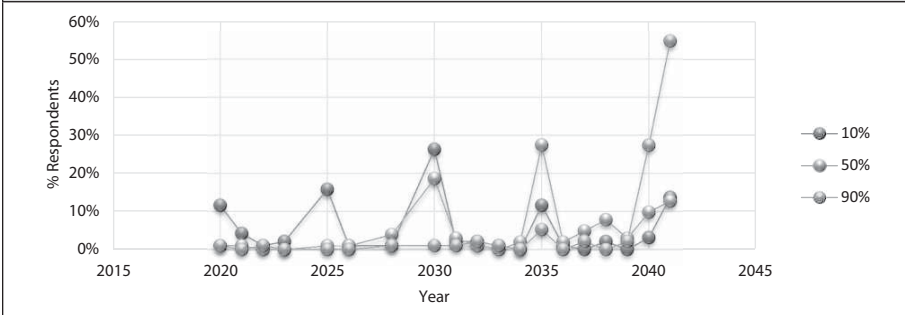
Development of autonomy in AI depends on progress of three categories of AI as ANI, AGI and ASI. The AI technology in present 4th AI spring experiencing the full potential of ANI. Most of the military hardware and weapon platforms across the world have been fully utilizing ANI technology. But the progress of increasing computational power of hardware is paving its ways for AGI. According to Moore's law, the computing power is doubled in each two year in the world. Christopher Moore (2011) showed that the rate of computation capacity of hardware would reach as like as human by 2030 and cross sum of all human capacity by 2050<sup>4</sup>. Bostrom et al (2014) have predicted a possible development of timeline of human-level machine intelligence (HLMI) where he predicted that there was 50% probability that we would witness AGI by 2040<sup>5</sup>. With the prediction by Moore and Bostrom, respondents of survey group (UGS) also predicted the timeline of AGI and ASI which is shown in figure 2 and 3.



4. Moore, C. & Mertens, S., 2011. The Nature of Computation. s.l.:Oxford.

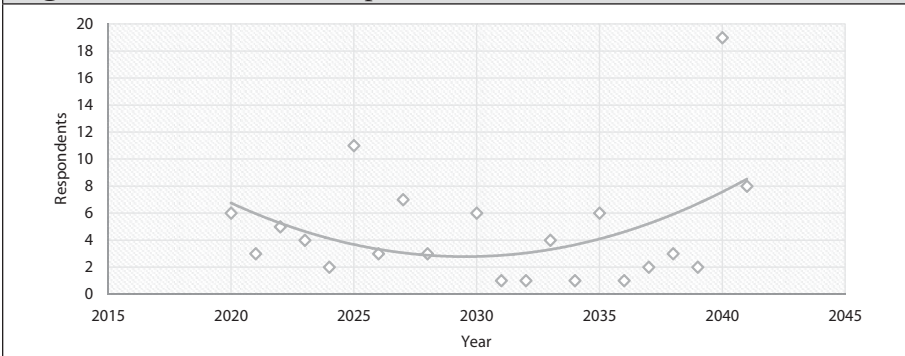
5. Bostrom, N. & Muller, V. C., 2014. Future Progrec in Artificial Intelligence:A Survey of Expert Opinions. Springer.

**Figure 3:** Combined probability on ASI exposure in BD



Therefore, by combining Moore, Bostrom & Muller and respondent's prediction, there will be 50% probability that AGI exposure will be the key factor in the world technology as well as in BD from 2030 to 2040. Military advancement in technology is most likely to follow the general trend line of AGI. But, exploration of AGI will need AI optimized hardware development. The respondents of survey group (UGS) predicted that BD will lack self-developed AI optimized hardware by 2030. Hardware development will experience an upward turn from 2030 to 2041. Therefore, AI exploration by military and commercial by 2030 will have to depend on the acquisition of AI optimized hardware from foreign countries which is evident from figure 4.

**Figure 4:** Timeline of AI Optimized Hardware in BD



## Various AI Driven Branches and Subsets

To cope up with the imminent AGI technology by 2030, military advancement in technology will have to go hand in hand with commercial AI exploration. After considering the present progress of AI in the field of science and engineering, the standing committee of the one hundred year study of AI in 2014 suggested the future AI exploration area. These AI application area will have their individual parameters and characteristics which will expedite many military technology, weapon platforms and applications<sup>6</sup>. From these, the AI applications which can be utilized in various military applications are summarized as following:

- Machine Learning (ML) through which statistical data of battlefields and intelligence will be fed into computers to take informed decisions as like human. This learning will be improved through form of observations and real times inter action with world by autonomously.
- Deep Learning (DL) is a part of ML which is used for object image recognition, automatic speech recognition, activity recognition, natural language processing and audio perception. These are used by taking sensor signal and convert it to recognizable patterns.
- Reinforcement Learning (RL) is a subfield of ML which runs the decision making cycle to arrive at the best possible actions under any environment taking data from the sensors. It is a problem solving autonomous interface system which takes the feedback of its action and adjust its logical computation program for future action.
- Computer Vision (CV) is an AI application which uses the ML algorithm, to classify, identity and divide any object so that it can convert images to edges, gradients and three- dimensional shapes. Conversion of images to date is done by image processing and cognitive science.
- Natural Language Processing (NLP) is the science of understanding of human language by analyzing, understanding and deducing meaning

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6. Horvitz, E. et al., 2014. Artificial Intelligence and Life in 2030. s.l.:Stanford University.

for action in an autonomous way. This voice interactive technology uses various language processing algorithm to convert human command to machine language which is used in RL.

- Crowd Sourcing and Human Computation (CSHC) are the branch of AI where problems are solved by computer and human together. The input data of battlefield are fed into the system where the processing of data to the best possible options are computed keeping human control by human-in-the-loop system.
- Collaborative System (CLS) is the model where human and machines can engage in a shared activity. This model closely functions with crowd sourcing to deal and monitor any situation taking input from all the sensors and surveillance devices for arriving at a common understanding through bringing out the most acceptable actions.
- Internet of Things (IoT) is a network system connecting all kinds of electronic devices which through the internet can efficiently exchange and share data in a broad database. It will allow centralized control of all the physical devices running from aircraft, ships, tanks, guns and other surveillance devices for direct integration in a common platform by which these can be monitored and controlled. It also integrates all the sensors to collect data for intelligence purposes.
- Robotics is the branch of AI where combination of various AI application are carried out in an interactive environments with people. It will use CV, NLP, ML and other form of machine perception to carry out parallel work done by soldiers in battlefield.
- Swarm Intelligence (SI) is the collective system of applications by self-organized agents who can perform a limited capacity but collectively completes a specific assignment. SI will be extensively used in swarm drones, submersible drones, intelligence gathering, and missile defense and enhanced communication.

## **Present Military AI Technology, Future Military AI Development and Trend of Military AI**

The large amount of data related to environment, terrain, people, demography and military capabilities can be managed in a more sophisticated and efficient way than today. The wide range of use of AI can be applied to surveillance, monitoring, cyber protection, cyber offensive capacity, information collection & processing, target selection & engagement, logistics & inventory management, healthcare technology, simulation & training, nuclear weapon control & protection, unmanned combat vehicles, intelligence collection, security and many more. For preparing the military by utilizing such techno hype, developed countries as USA, Russia, UK, Canada, France and emerging countries as China and India are heavily investing in military AI system. Military market of AI in 2016 was USD 5.54 Billion which is predicted to reach USD 18.82 Billion by 2025 having compound annual growth of 14.75% each year<sup>7</sup>.

## **Present Military AI Applications Used by Armed Forces of USA, China, India and Future AI Program**

USA is one of the pathfinder in the field of military AI who is not only rich in manufacturing AI technologies but also expert at the application of it with various military platforms. Their initial breakthrough in academic AI research have given them a clear leading role to both military and commercial AI industry. After the cold war era, shifting efforts from developing nuclear arsenal, USA has focused more on developing AI platforms to augment its military operation capacity and effectiveness in terms of unmanned aerial combat vehicles, surveillance system, stand-off weapon and force projection system. Some of the current military AI applications with future development program of USA have been discussed:

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7. marketsandmarkets.com, 2018. [www.marketsandmarkets.com](http://www.marketsandmarkets.com). [Online]



- Autonomous Deep Learning System (ADLS) will be used extensively in intelligence collection and large data interpretation. The ADLS is built on providing early warning from the conflict zones where fog of war clutters the decision making cycle.
- Human–Machine Collaboration (HMC) will prepare a team with the acumen of a human and tactical acuity of a computer to meet any threat with dual human-machine capacity. It will introduce a new form of warfare where dual intelligence of human and machine will be used at machine speed against the potential threats.
- Assisted Human Operations will enable soldiers to operate in the battlefield using wearable electronics, armored exoskeleton and electronic head-up displays. The soldiers can track the situation which are obstructed visually and also be tracked in high-risk operation to reduce his life risk.
- Advanced Human-Machine Combat Teaming emphasizes on human-machine collaboration where human are able to do cooperative operations with unmanned system. Electronic warfare network and swarming system will be used instead of individual Unmanned Aerial Vehicle (UAV) and Unmanned Underwater Vehicle (UUV) which require multiple operators.
- Network-Enabled Semi-Autonomous Weapons will allow protection of the entire system against cyber-attack by linking the devices under a broad network system and making it hardened for cyber security and enable to work under a centralized command to enhance synergy of various capabilities.
- Machine Learning Approach to Targeting allows to identify, track and engage targets under five broad groups as physical, functional, cognitive, environmental and temporal<sup>8</sup>. Through AI algorithm under cognitive learning system, future joint targeting system are being developed.

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8. Lewis, C., 2016. [www.warontherocks.com](http://www.warontherocks.com). [Online]

- Augmented Reality (AR) technology superimposes the virtual geo-tagging of object information over the real time object to alert soldiers about the current environment of the operational area. It will transform the battlefield with geo-tag, flows the information seamlessly and aids in taking instant decision under a catastrophic high risk situation<sup>9</sup>.

China is emerging as the next dominant leader in the AI domain when Chinese government has officially revealed its plan in 2017 to become world's pre-eminent practitioner of AI in both research and application by 2030 through creating an AI industry worth USD 150 Billion<sup>10</sup>. The plan includes three phases as keeping pace with AI technologies by 2020, achieving major breakthrough by 2025 and leading the world of AI by 2030<sup>11</sup>. Making AI focused education as the cornerstone of Chinese national strategy, Peoples Liberation Army (PLA) is preparing a military-civil fusion to take full potential of private sector progress in AI technology to exploit its military capabilities. Few important AI applications of Chinese Armed Forces are discussed:

- Quantum Technology (QT) will enable to make better sensors for greater situational awareness to reduce the ambiguity in the grey zone of battle space. It will enable to track aircraft, to crack encrypted signal codes by developing sophisticated equipment and weapon based QT<sup>12</sup>.
- Battlefield Singularity is being developed to cope up with the operational tempo of machine-age warfare. Keeping human out of the loop, it aims at developing fully autonomous decision making system using deep learning at machine speed to support the human cognition and decision making cycle in the battlefield.
- Intelligentized is the AI system which uses neural network through supervised learning from human experts and reinforcement learning from operating battlefield environment. The 'value networks' evaluate

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9. Bevond, 2015. <http://bevond.com>. [Online]

10. Williams, G., 2018. [www.wired.co.uk](http://www.wired.co.uk). [Online]

11. Lee, A., 2017. [www.scmp.com](http://www.scmp.com). [Online]

12. Blair, A., 2018. [www.dailystar.co.uk](http://www.dailystar.co.uk). [Online]

the brand courses of action and ‘policy network’ will finalize specific course of action<sup>13</sup>.

- Intelligent Unmanned Systems will develop unmanned platform for operating in both air and water. Introducing UAV swarming, it will explore the role intelligentized command and control (C2) in a joint environment of warfare<sup>14</sup>.
- Semi-Autonomous Missile System will develop missiles capable of connecting the way points autonomously, avoiding engagement by interceptions, optimizing strike location and achieving maximum lethality. The automated flight guidance and target recognition mechanism will enhance the operation versatility of the tactical and strategic missiles.

India has been considering AI as one of the critical ingredients of its national security strategy as well as for its commercial market. To envisage the future trend of military technology, Center for Artificial Intelligence and Robotics (CAIR) was set up in 1986 with Indian Institute of Information Technology (IIIT). The Defense Research and Development Organization (DRDO) has established CAIR as one of its apex laboratory where the emphasis is being provided on intelligent system, unmanned system, information security and net centric system for tactical common control & communication system<sup>15</sup>. Some of the recent military AI projects are discussed:

- AI Techniques for Network Centre Operations (ANCO) has been developed to carry out various dimension of network centric operations.
- Development of Surveillance and Reconnaissance application has been undertaken which is developing autonomous navigation system with visual outlook.

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13. Kania, E., 2017. [www.lawfareblog.com](http://www.lawfareblog.com). [Online]

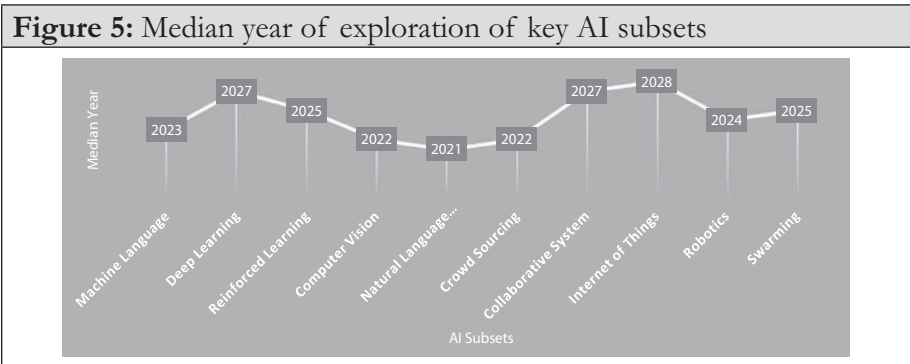
14. Spiegeleire, S. D., Maas, M. & Sweijs, T., 2017. Artificial Intelligence and The Future of Defense. 1st ed. Hague: The Hague Centre for Strategic Studies (HCSS).

15. DRDO, 2018. [www.drdo.gov.in](http://www.drdo.gov.in). [Online]

- Unmanned Ground Vehicle (UGV) is getting attention for carrying out low-intensity conflicts along with UAV and UWV.
- Voice Recognition System has been applied on the Network Traffic Analysis (NETRA) to monitor internet data transfer and uses.
- Multi Agent Robotics Framework (MARF) has been developing to bring out various miniature robots for employment in navies high-risk security situation along with dealing with handling of Improvised Explosive Devices (IED) and evacuation system for personnel.
- Image Interpretation has been getting more emphasis for identification of the various objects, living beings and preparations of image maps<sup>16</sup>.

## Concentration of Efforts of Military Hardware on AI Fields

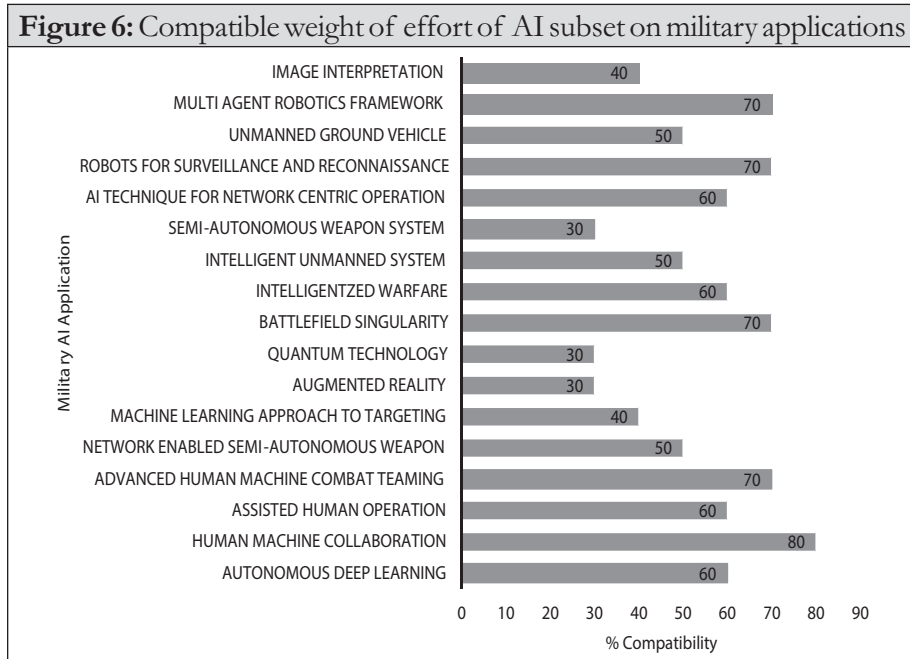
The development of AI has been carried out both by commercial and military institutions for varied purposes. Apparently they look incompatible to each other based on purposes but their exploration fields are complementary to each other. The time line of key AI subsets is shown in figure 5.



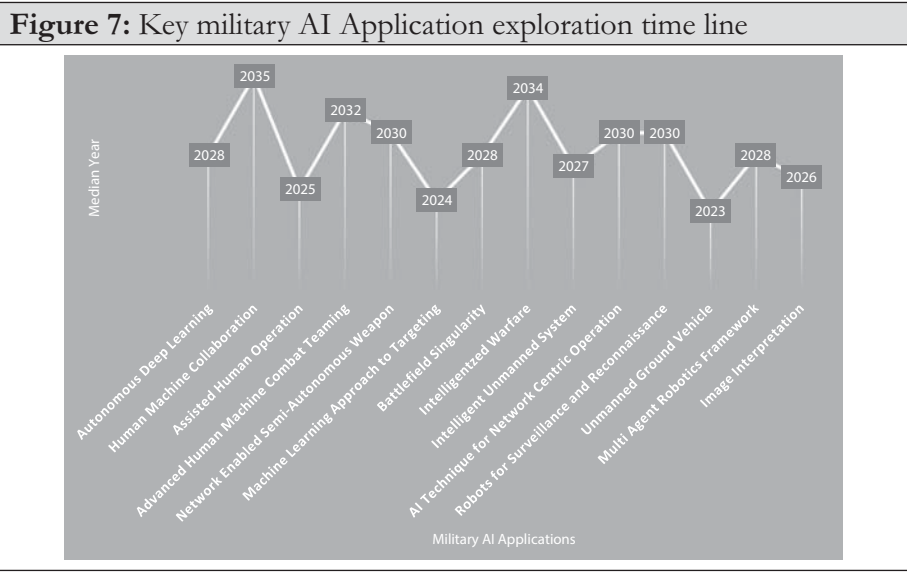
As these AI subsets will be the foundation programming of the various military AI applications, therefore the complementary role of these AI

16. Chakravorty, P., 2017. <http://www.indiandefencereview.com>. [Online] Available at: <http://www.indiandefencereview.com/news/artificial-intelligence-and-its-impact-on-the-indian-armed-forces/> [Accessed 19 7 2018].

subsets in current and future military AI applications have been predicted. The complimentary role of these AI subsets have been converted into compatible weight of effort of AI subsets and shown in figure 6.

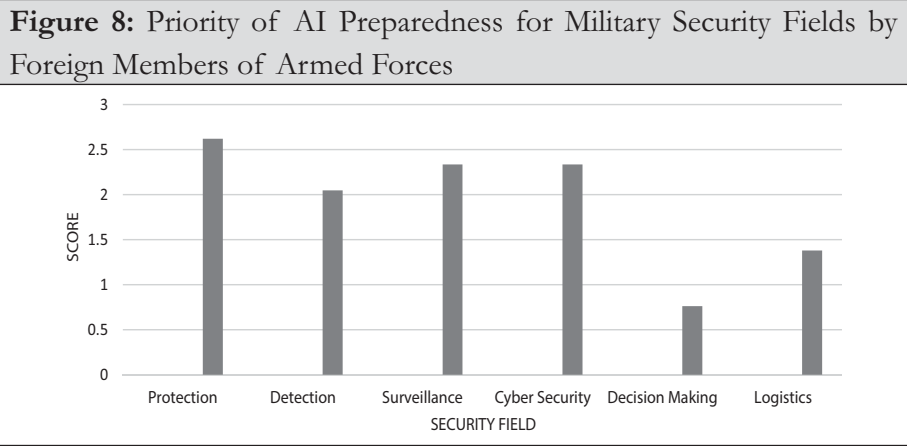


After analyzing the above figure, more than 40% weight of effort of AI subsets can be considered as having immediate attention of the scientist. These also tend to have maximum application chances and likely to be explored earlier. However, the time line of exploration is not known as there are no clear military steps taken to explore these fields independently. By studying the different time line of AI subsets and compatible military AI applications, a combined compatible time line of military AI applications in regards to AI subsets has been shown in figure 7.



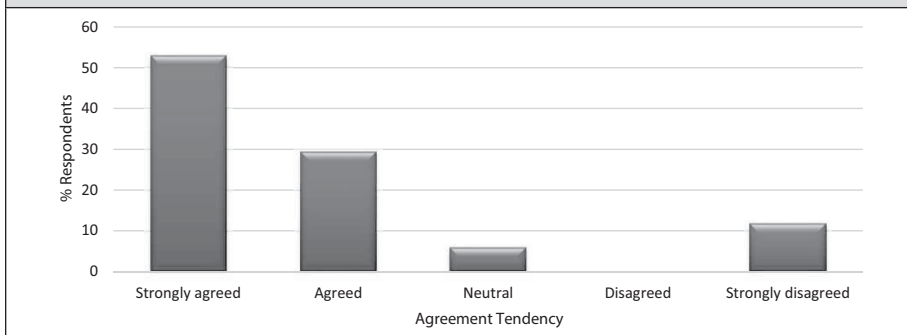
### AI Development Priority in Broad Security Fields

The respondents of survey group (Foreign) comprising foreign armed forces members have preferred protection, cyber security, surveillance and detection as their priority of future AI development for their armed forces. The relative priorities of AI development for military security fields are shown in figure 8.



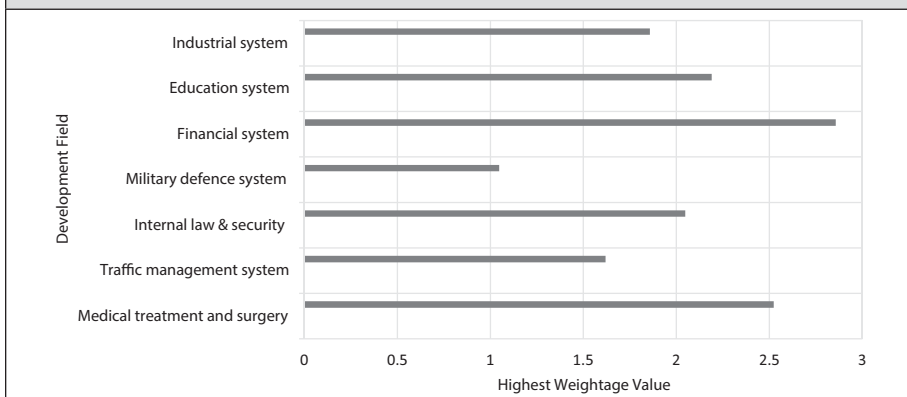
The likelihood of international terrorism using AI technology is much higher. More than 80% respondents of foreign armed forces members also showed higher concern about this non-traditional threat as shown in figure 9 and opined that their armed forces should also get ready to combat the AI threat posed by the terrorist groups.

**Figure 9: AI Preparedness for Non-Traditional Threat by foreign Members of Armed Forces**



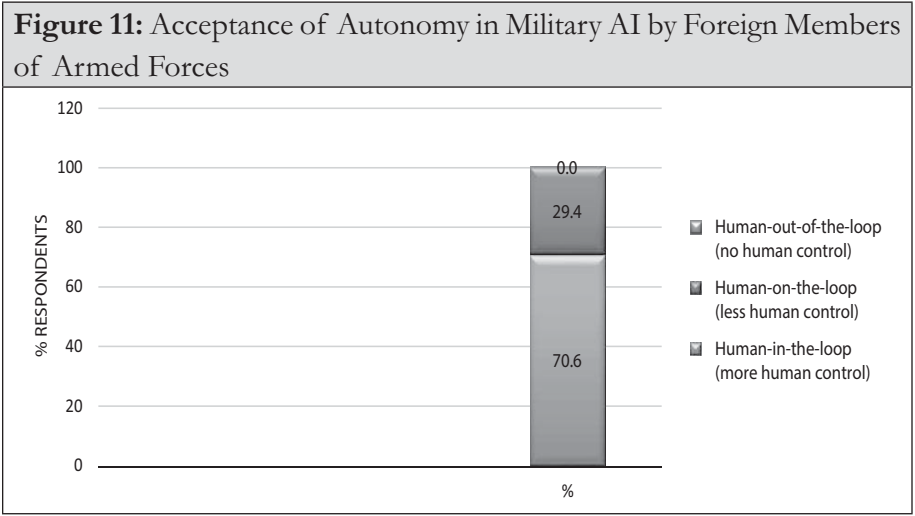
For prioritizing national field for AI, the respondents of foreign armed forces members preferred financial, medical, education and internal law & security sectors over military defence system. The preferences is shown in figure 10.

**Figure 10: Priority of National Development Field for AI in Other Countries**



### Ethical Concern for Autonomy in Military AI

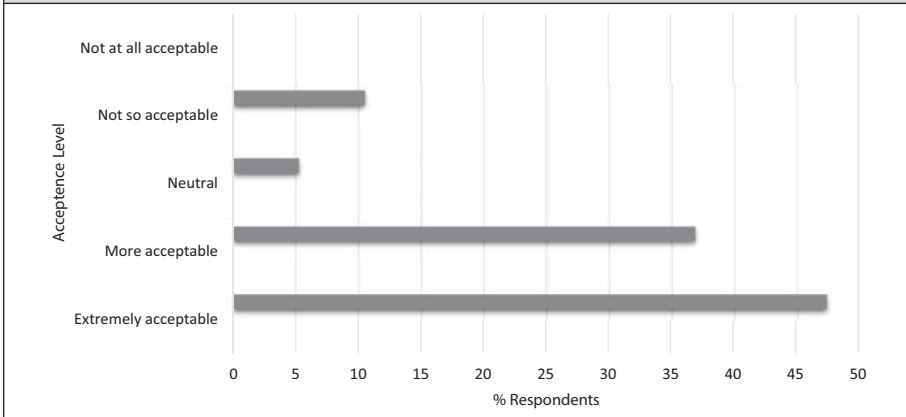
To understand the psyche towards autonomous lethal weapon, an ethical acceptance is needed across the members of the armed forces. Today’s AI application in military mainly revolves through human-in-the-loop mechanism. Now, AI is driving military weapon technology towards AGI and ASI where the human control will be either in supervising role or having no control on machine. Therefore, human-on-the-loop and human-out-of-the-loop weapon technology are going to be the ultimate military application technology in future. But the general acceptance by respondents of foreign armed forces members towards human-in-the-loop still remains 70.6% which clearly indicates that the autonomy of military AI is not yet accepted by other members of armed forces. The preference is still with ANI. The responses is shown in figure 11.



With this psyche towards ANI, more than 84% respondents of survey group (Foreign) preferred ANI military technology in conflict situation with human-in-the-loop mechanism. The responses is shown in figure 12.



**Figure 12: Ethnical Acceptance of Military AI Technology by Foreign Members of Armed Forces**

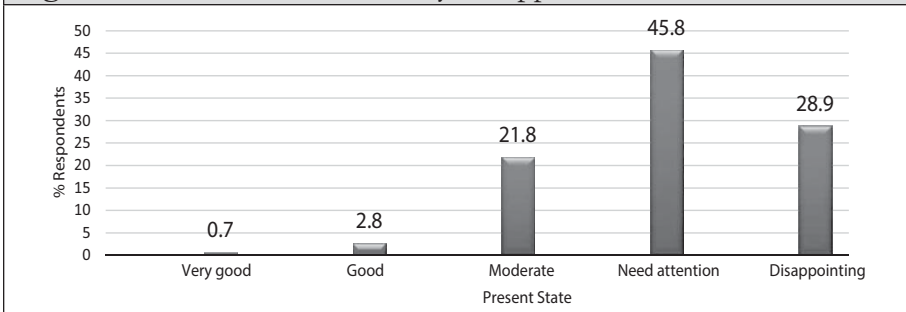


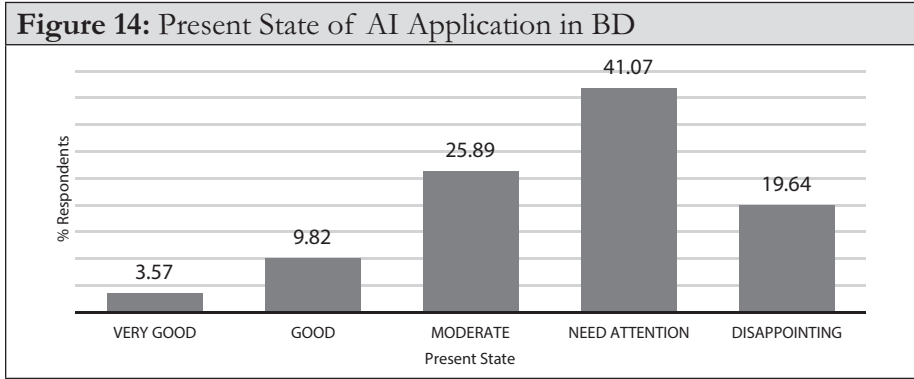
## Preparedness of Bangladesh Armed Forces For AI Technology

### Present State of AI Application in BD and BD Armed Forces

The general picture of present state of AI in BD Armed Forces has been reflected as disappointing and need attention as 74% respondent of survey group (Military) opined who were mid-level members of Bangladesh Armed Forces; whereas 60% respondents of survey group (UGS) reflected same status for BD as a whole. The reflection of their opinion is shown in figure 13 & 14.

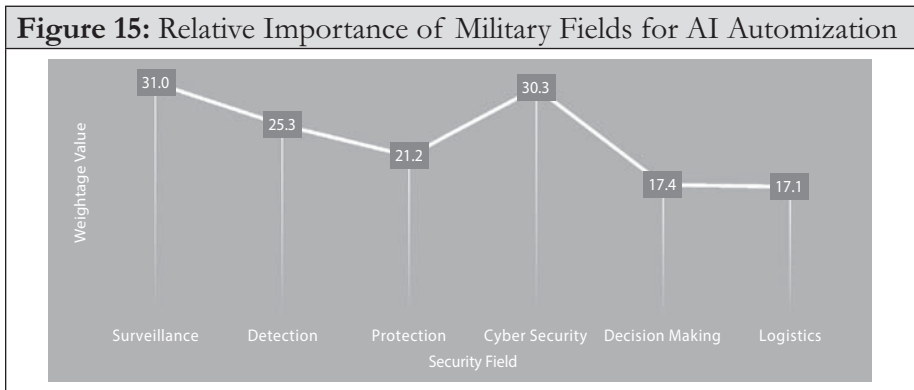
**Figure 13: Present State of Military AI Application in BD Armed Forces**





## AI Applications and Related AI Subsets for BD Armed Forces

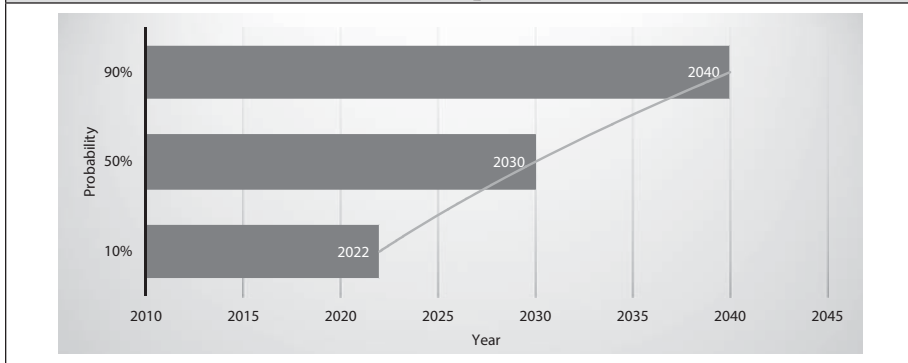
As AI is a transformative military technology, to get maximum utilization by harnessing this game changer, there are six fields which has scope for automization with AI applications. To deal with the trend of future warfare, the military professionals of survey group (Military) have identified various military security fields which need to be safeguarded as shown in figure 15.



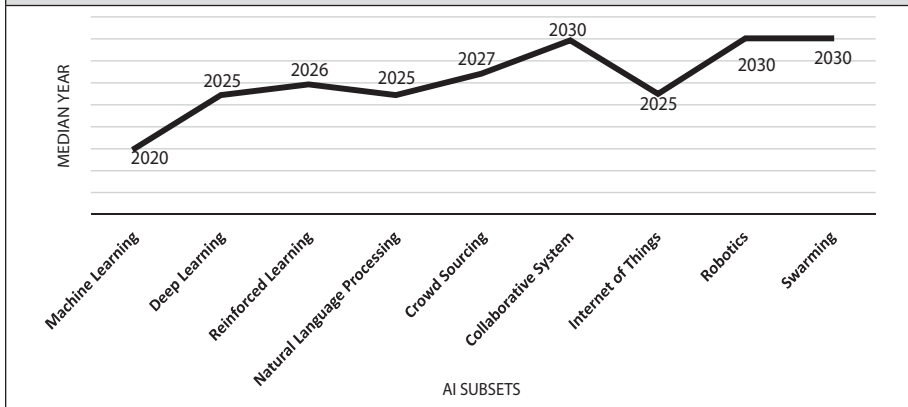
The development of AGI will take the lead role as most of the AI academic respondents of survey group (UGS) opined that there is a 50% probability of development of AGI by 2030 in BD which would have definite impact on the various dimensions of the military fields. Other types of probability of incorporating AGI in BD Armed Forces is shown in figure 16. The

combined development plan of various AI subsets for BD Armed Forces is also shown in figure 17.

**Figure 16: Probability of AGI Incorporation in BD Armed Forces**



**Figure 17: Development Plan of Various AI Subsets for BD Armed Forces**



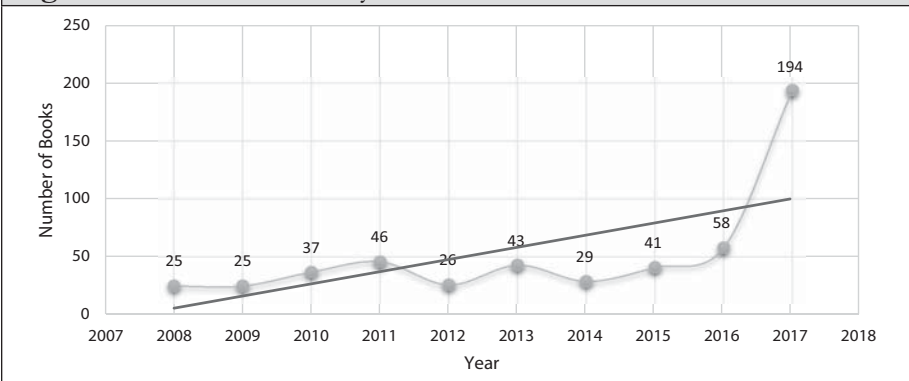
## Feasibility of R&D, Ethical Regulations and Road Map to AI for BD Armed Forces

### Feasibility of Military AI R&D for BD Armed Forces

- **AI R&D Capacity by BD Engineering Universities:** To understand the present capabilities of BD engineering universities and

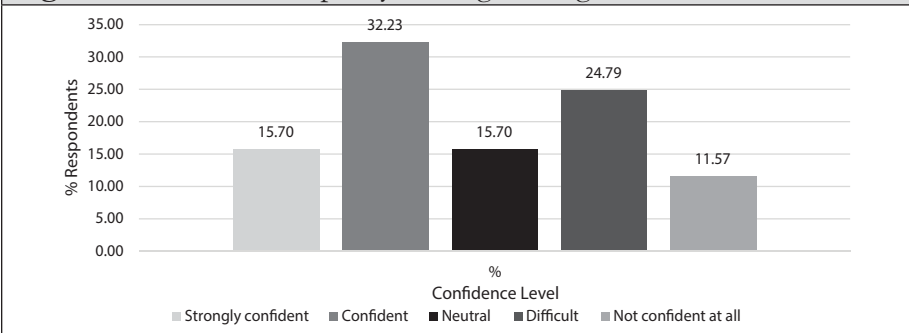
academicians to foster R&D of AI, the AI related publications have been sorted out. It is found that the volume of publications from BD is quite low compared to that of other countries. From 1996 to 2017, there are only 557 academic publications on AI from BD (SJR, 2018) holding 61st position globally. A comparison of 2017 AI publication with other countries are shown in figure 18<sup>17</sup>.

**Figure 18: AI Publication by BD From 2008-2017**



The confidence level of BD engineers in developing AI R&D as opined by the respondents is shown in figure 19.

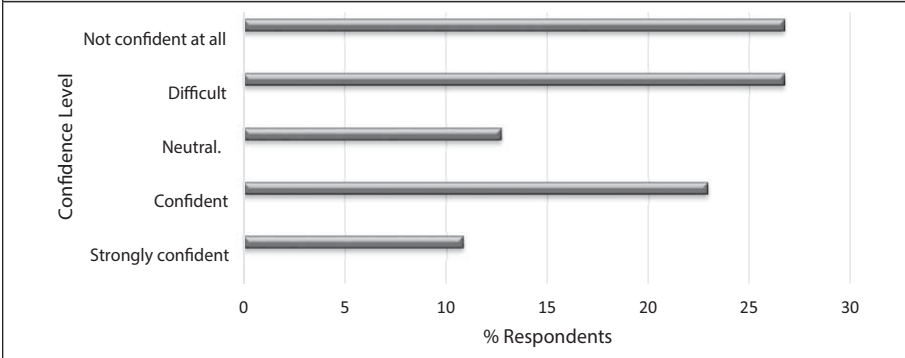
**Figure 19: AI R & D Capacity of Engineering Universities of BD**



- **AI R&D Capacity by BD Armed Forces:** 53% respondents of survey group (Military) have opined that BD Armed Forces do not have right technical skilled people who can contribute in AI R&D. The opinion of the respondents is shown in figure 20.

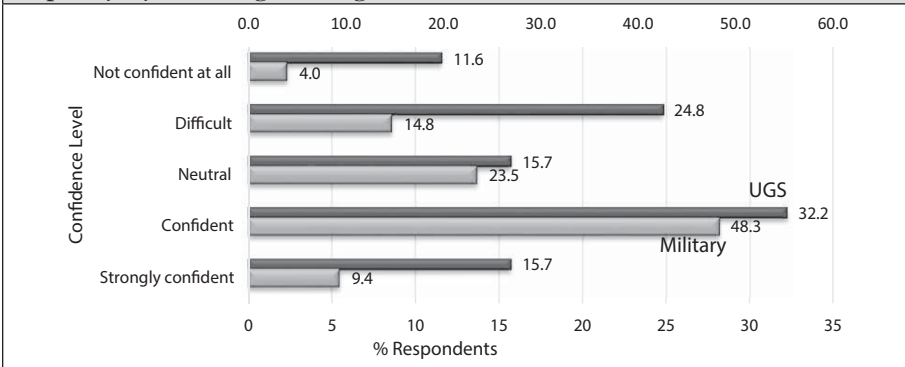
17. SJR, 2018. [www.scimagojr.com](http://www.scimagojr.com). [Online]

**Figure 20: AI R & D Capacity by BD Armed Forces**



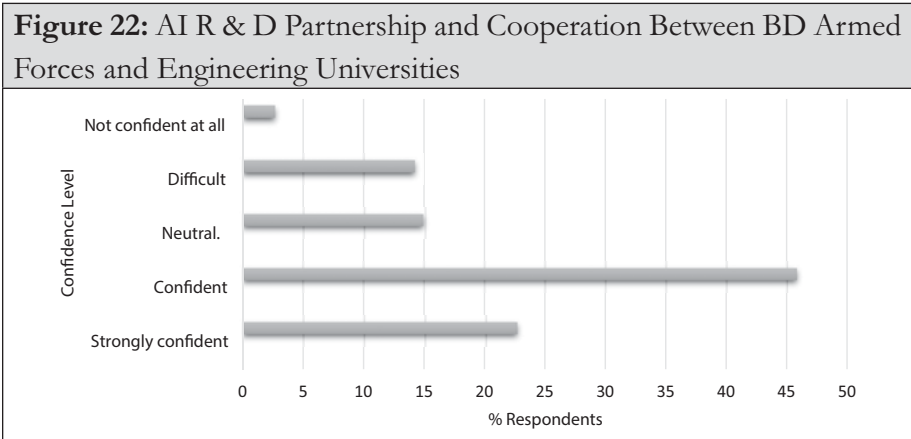
- But 58% respondents were confident that BD engineering universities have right technical skilled engineers who can contribute in the development of AI R&D if government makes scopes and sponsored it. The combined opinion of the respondents is shown in figure 21.

**Figure 21: Combined Opinions of Survey Group 1 & 3 About R & D Capacity by BD Engineering Universities**



- **Options for AI R&D by BD Armed Forces:** Analyzing the combined opinions of both groups of respondents, it can be inferred that the difficulty level of military R&D can be overcome as the confidence level shows significant strength. Therefore, removing the difficulty in the confidence level of CSE undergraduate students, BD Armed Forces has its only option of utilizing them as the in-country professional for AI R&D with proper sponsorship and scholarship program. The most

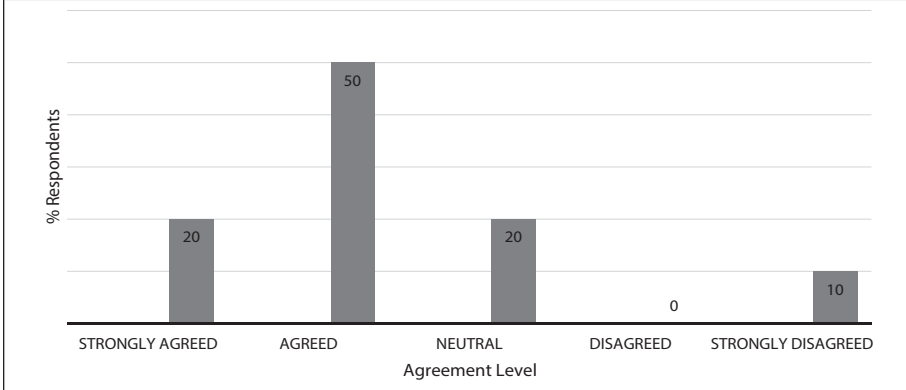
prominent reason is that the intellectual level about AI knowledge is increasing as evident from the increasing AI research works and self-interest of the engineering students. Sufficient fund to conduct R&D, dedicated research work focusing AI algorithm for military applications, allotting more credit hours for AI in undergraduate level, harnessing robotics & AI club activities and nationwide awareness for AI will help removing the non-confident gesture of the AI engineers. A partnership and cooperative approach towards development of AI would make the AI R&D successful. 68 % respondents of survey group (Military) are confident to establish an AI R&D between BD Armed Forces and local engineering universities. The response is shown in figure 22.



### Proposed AI R&D Strategy for BD Armed Forces

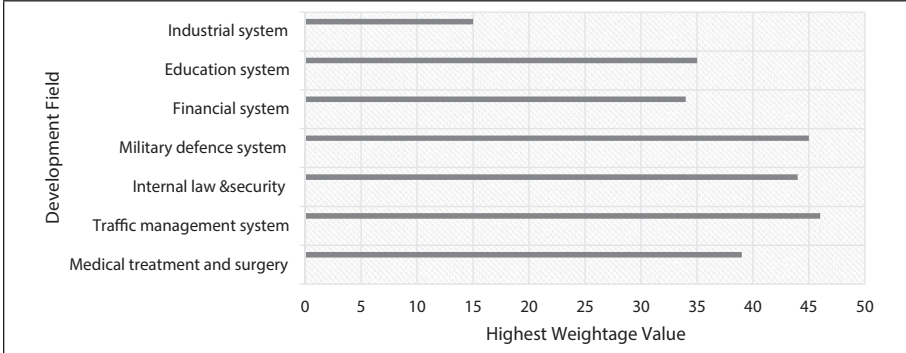
70% respondents of survey group (Military) emphasized that AI R&D should be a shared responsibility of government, military and stakeholders. The opinion is shown in figure 23.

**Figure 23: AI R & D as Shared Responsibility with Government, Military and Stakeholders**



With this shared development of AI R&D, various national requirement in public sectors along with security issues can be brought under AI technology. The preferred priority is shown in figure 24.

**Figure 24: Priority of National Development Field For AI R & D**



The proposed AI R&D fundamentals can be summarized as following:

- Make Two-Fold AI research objectives which can deal with both military security and render social benefit by providing maximum value for the protection and services for the well-being of the people. These long-term sustained reward pay-off AI development need to be planned for mid and long term spanning 7 and 15 years respectively.

- Focus on Cognitive AI algorithm so that development of various AI subset programming languages for perception, sensing, thinking, acting and teaming can be developed.
- Establish AI enabled hardware industry in collaboration with the various AI techno giant commercial firms so that we can build our own foothold and maintain self-dependency in long run.
- Create effective interface between Human-AI Machine in such a way that AI application are made keeping human on the loop. This collaboration will allow sharing the workload, relieving human for more cognitive tasks and above all, holding the control of AI machine with human will allow averting undesirable occurrence and consequences.
- Address legal, ethical and fundamental principles for the use of AI application so that human value is put on highest priority by making the rules of engagement transparent and explicit in its application and accountability by design.
- Developing large datasets from interactive environments so that data of intelligence value can be stored and accessed. These data feed will have to be carried out by various sensors, visual processing equipment, air platforms, naval platforms and satellites. Methods have to be experimented for smooth access of these data by various military platforms after duly analyzed by deep learning methods.
- Decision making process algorithm following Gartner analytics maturity model can be developed. The descriptive diagnostic, predictive and prescriptive sequences should be developed to help facilitating the decision making process.

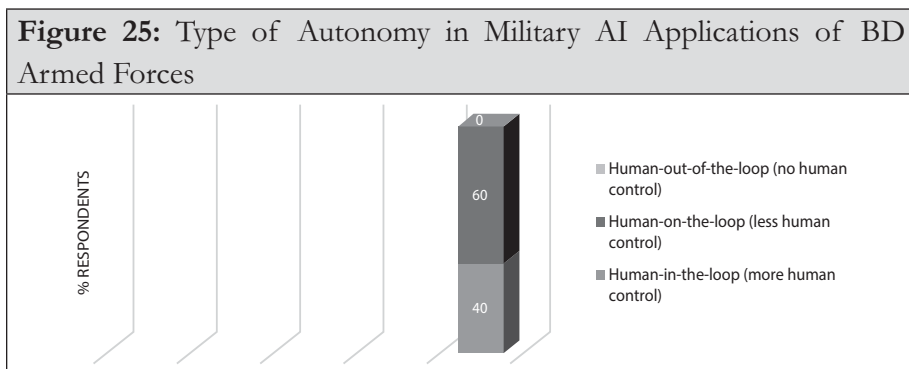
## **Suggested Ethical Regulations Guidelines for AI**

Keeping the ethical issues, acceptance level of working with machine and using machines autonomously, following ethical guidelines can be suggested:



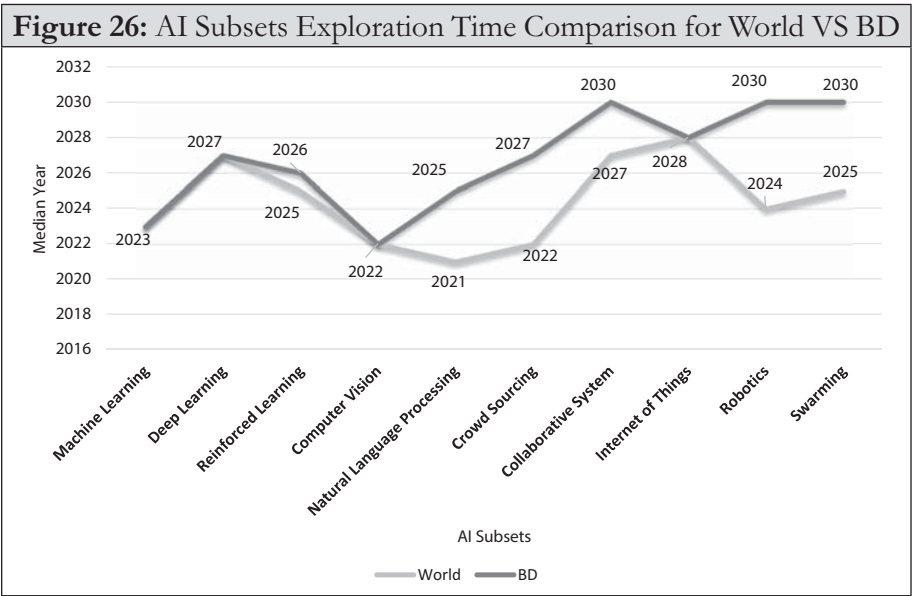
- An appropriate level of human judgment has to be instilled in all the military AI algorithm.
- Distinguish characteristics between a civilian, insurgent, terrorist and opponent military need to be ensured.
- Enforcing accountability and holding responsibility to the appropriate authority in case of fatalities by autonomous use by AI machine due to failure of identification and recognition of target.
- Asimov's ethical rules for robot behavior need to be followed in designing military AI algorithms.
- There has to be a balance between obeying, surviving and protection choices made by military AI application.
- Data access must protect the privacy of people of the society unless it is proved harmful to the state.
- Data protection framework with self-regulation has to be established in all the stakeholders involved in AI R&D.

In case of allowing extent of autonomy in USV and UAV, 60% respondents of survey group who were members at policy and decision level accepted human-on-the-loop AGI having less human control on the machine and allowing it to work more autonomously. The responses is shown in figure 25.

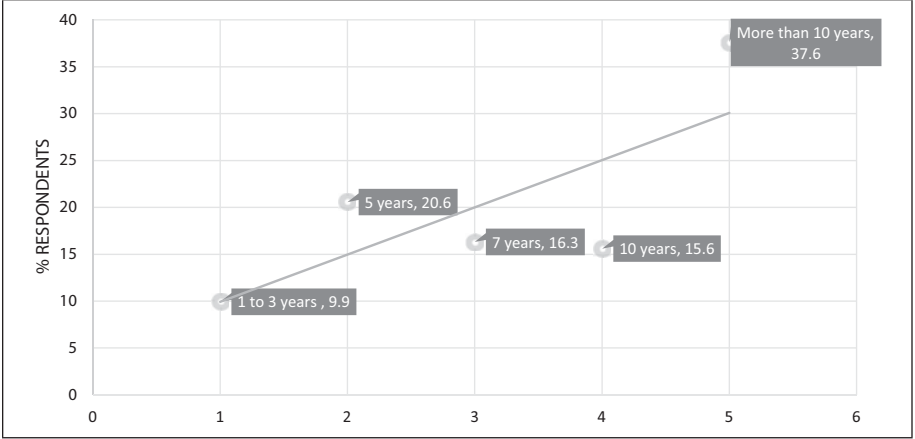


### Suggested Road Map for Military AI Capabilities

The road map for attaining military AI capabilities has been designed based on exploration of AI subsets, policy formulation, partnership arrangement, developing applications for prioritized military security fields, assembling AI compatible hardware, formulating R&D cell, accumulating technical workforce, awareness program, educating service members, data sharing, communicating and connecting stakeholders under a common platform. To do so, a 12-year-road-map has been suggested where target year for AI subsets was decided on the exploration year of AI subsets in world’s technological forum which would be pursued in BD. The timings are shown in figure 26. These time line will be followed under various security field where related military AI applications can be developed. Within these time frame, other support infrastructure and regulatory issues have been arranged in terms of their relative necessity of formulation. The concerned stakeholders are mentioned responsible under specific task head under its own time frame. The timeline for Road map has been agreed upon by the respondents of survey group (Military) as more than 10 years. The opinions are shown in figure 27.

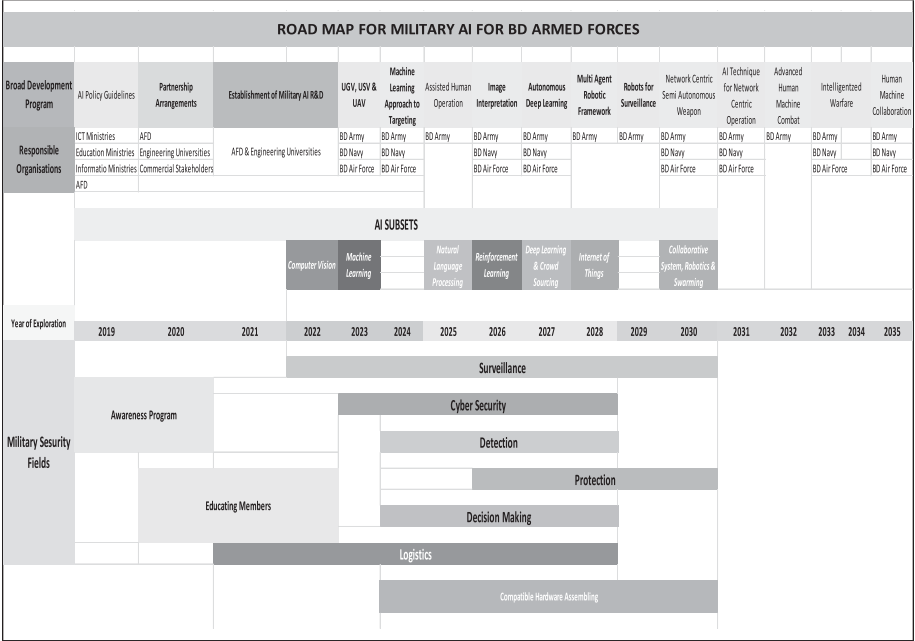


**Figure 27: AI Road Map Formulation Time Line**



## Proposed Road Map Architecture

**Figure 28: Proposed Road Map for BD Armed Forces**



## Recommendations

With the above discussion on various factors of AI development for BD Armed Forces, following recommendations are made:

- A shared national AI R&D center can be established under joint coordination and partnership with BD Armed Forces with civil engineering universities to explore the AI subsets algorithms for both social and security applications. Leading techno giants may be invited for co-production of AI compatible hardware in BD.
- National AI policies covering the ethical issues, development objectives and usage fundamentals of autonomy can be developed and implemented through ICT ministry.
- Knowledge awareness program among members of BD Armed Forces can be taken with a view to informing how AI can be used.
- AFD can integrate the future development program of three services keeping compatibility with AGI technology.
- Efforts need to be taken by three services and law enforcing agencies for allowing access and use of data to build a common intelligence database which can be maintained by AFD.
- A 12-year road map to AGI technology can be implemented by assigning responsibilities to concerned stakeholders for development of key AI subsets and cognitive AI algorithms with human-on-the-loop control system.

## Conclusion

The military AI applications pursued by various countries are the result of their long term planning and research efforts for obtaining capacities to meet the challenges posed by the AI technological inevitability. The future war will be fought with the dominance of information rather than indiscriminate use of lethal weapon. The use of munitions would be the

last resort which would also demanding precise data location. The decision maker would be facilitated through 4-dimensional data interpretation by the AGI technology. Thereby, AGI will soon appear as controlling such interpretation, eases and broadens the scope of its application. The human-machine interface will soon bring the humanity in a complex and compound scenario where dependency and supremacy should be retained by human causing machine to facilitate only. AGI will cause scopes to spare human for more cognitive work for which we are meant to. BD Armed Forces must take every endeavor to explore and emphasize our human intelligence capacities for the development of key AI subsets by infusing civil-military expertise. BD has the intellectuals' leaders who are contributing various leading research projects around the globe. It's time to reconcile and reemerge our intellectual strength to prepare the defense forces by the concerted efforts by all the stakeholders. Such a drive will open the unexplored opportunities not only for military but also for the people of the country.

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