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Assessing Armenia's potential for an AI-driven defense industry: An index-based analysis

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Abstract

The development of the AI-based defense industry is particularly important for small countries engaged in regional conflicts. In this sense, it is crucial for Armenia to consider the possibility of having an AI-based defense. Since the information on defense is data-sensitive and the available data are not sufficient to assess the country's potential, we have considered several key international economic indices that are closely related to the development of the field. The analysis focuses on indices such as the Global Innovation Index (GII), Global Competitiveness Index (GCI), ICT Development Index (IDI), Human Development Index (HDI), Global Cybersecurity Index (GCI), and AI Readiness Index, among others. The research findings have shown that Armenia has the potential to develop an innovative defense industry. Several strategic recommendations have been suggested, targeting the areas where improvements are required.

Keywords: Selected text in Word: AI, defense, Armenia, economic indices, human capital.

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1. Introduction

The research seeks to shed light on the reasons of the establishment of a technological defense industry in Armenia. For the achievement of this objective, the research applies a methodology based on the international economic index, which is noteworthy because of the scarce information available on defense topics that are publicly accessible. This limitation constrains the applicability of classic research techniques and thus alternative approaches are needed. Using international economic indices enables the study to explore and understand the economic factors and trends affecting the n quite within its scope. This approach does not only allow appreciating the scope and the need for the sector as such for operationalization but also eliminates reliance on sensitive or classified information.

To underline the significance of AI-based industry development in RA, there is a need to introduce the overall picture of Armenia's economy. Due to its underdeveloped status, the country's industrial sector is heavily reliant on mining, which

is its primary focus. Exports of copper, molybdenum and gold have also been successful, making up around 28 percent of the industrial output of the country between the years 2018 and 2022 [1]. Such an over dependence on the export of natural resources puts the country in a position whereby it is poised to be affected by price variations across the globe, thereby making it unable to maintain stability within its economy.

In 2021, the nation's public debt was recorded to be $9 billion making the national debt to GDP ratio 60.8 percent. In order to balance their accounts, the state borrows frequently, and approximately ten percent of the yearly budget executes the debt payments including interest payments for loans both within the country and outside [2]. Another dimension adding further stress on economy include social protection expenditures such as pensions, healthcare and education that feature so prominently on the country's budget. The walks costs for the budget 2024 proposes some moderate expansion in the taxation on expenditure in the areas mentioned that is a significant financial burden [3]. Provision of these social services, the expenditure on defense and the servicing of the national debt curtails further investment in other areas of the economy thus increasing the reliance on home grown defense industrial capacity which would help cut down spending and dependence on foreign countries since defense spending.

Many components can shape the capabilities of the military, some of them for instance, are in the areas of modernization and sustainability. However, the degree of modernization achieved is largely dependent on how advanced the techniques of employing the weapon systems and equipment are. The architecture that AI and other automated technologies like military defense systems are building, sooner or later, will become an integral architecture in armed hostilities [4]. The most modern AI algorithms show excellent results owing to making use of a large volume of data [5]. A typical example can be seen in the applications of military AI algorithms in natural language and speech processing, pattern and object recognition, and others [6-8]. Lack of such credits would mean failure on the Armenian part since its aims are to expand areas of investment in national defense as well.

Nonetheless, this brings up the question of whether Armenia can initiate its defensive system industry's technological reorientation. The country's industrial base is still underdeveloped and lacks the necessary diversification beyond mining and basic manufacturing, despite advancements in growing sectors like technology and IT. This demonstrates the necessity for Armenia to develop a cutting-edge defense sector in order to foster economic growth and resilience.[1]

2. Literature Review

Many researchers have looked into the role and impact of AI in defense, noting the advantages it provides to military operations. It is important to assess if Armenia has the right setup for creating an AI-focused defense industry to understand the country's potential. Horowitz, et al. [9] discuss what nations need to introduce AI in their defense systems, like technology infrastructure, skilled workforce, and investment in research and development. Sundström [10] emphasizes that having the right infrastructure is essential for improving AI management. Murphey highlights the skills gap in AI, which includes a wide range of skills from basic STEM knowledge to specialized expertise in areas such as machine learning.

They stress that military government bodies have historically been important for technological change, mainly in industrial economies. While military action has always affected innovation, the ways and systems through which this occurs have changed. Mowery observes that after World War II, there were large military R&D spending, particularly in the U.S., but he highlights a shortage of comparative research on military R&D's effects on innovation in other NATO nations, indicating that this lack restricts the overall understanding of the wider importance of defense R&D [11].

Familoni [12] breaks down AI in cybersecurity as a double-edged sword, both from its advantages and its difficulties. Artificial intelligence can help cybersecurity workers to detect threats faster, thus increase their response speed without causing long backlogs for fellow analysts. However, the AI also has its set of problems, like that cyber attacks go through AI-security enabled systems and network services by using machine learning as a data theft practice [12].

However, without necessary rules and regulations AI in defense may turn as Blauth admits into a double-edged sword. The author stresses the urgent need for comprehensive global regulation, especially within the framework of the United Nations, to address these challenges [13]. Trabucco emphasizes the necessity to have interoperability in the context of an AI partnership. Interoperability refers to the ability of different groups to work together and share information effectively. Another significant challenge is to ensure legal interoperatibility and common international legal obligations on the usage of AI.

Still there are prerequisites that countries should fulfill in order to be able to establish AI-based defense industry. Most of those prerequisites can be considered within the countries performance accorind to international economic indices. For Armenia, we have considered the following indices: Global Innovation Index, Global Competitivness index, ICT Development Index, Human development Index, AI readiness index, etc.

3. Methodological Approach

Our literature review have shown the niches which are necessary for the field development.Hence the choice of indices is based on the research results. Many defence systems of a country, especially those linked with AI projects, remain classified and therefore pose a hindrance on researchers. Normally, governments do not share detailed defence strategies, particularly with regard to the use of AI in autonomous weapons and other defence systems like cyber defence or military surveillance technologies. It would seem then, due to lack of localized direct data, that proxy data from global indices would serve our purpose.

[1] Radar Armenia, The possibilities of diversification of Armenia's economy were discussed, retrieved September 10, 2024 from https://radar.am/en/news/social-2631731970/.

These indices measure a country's economic capability, innovation potential, and digital infrastructure to offer greater insight into a country's AI-based defense readiness. Creating an AI-driven defense industry involves a multi-parameter approach that enables combinations of variables like R&D investment, digital infrastructure, skilled manpower, and a strong innovation ecosystem. This feedback, as also captured in global indices (e.g., AI Readiness Index, Global Competitiveness Index, ICT Development Index) is an important input. The combination of these metrics can provide a good picture of the ecosystem for AI innovation in the absence of direct defense-related data. Besides, this evaluation method (Index-Based Comparative Analysis) can be utilized for an in-depth study of various economic and technological indices which will further present a systematic comparison of Armenia's performance inside the key indices. It allows the drawing of practical conclusions concerning the country's ability to use AI technologies in its defense sector. In addition, the country's prospects in this field can be predicted by this technology.

4. Research

4.1. Global Innovation Index (GII)

Armenia's consistent progress in the Global Innovation Index (GII)[2] over recent years has significantly enhanced its capacity to develop an AI-based defense industry. Between 2022 and 2023, Armenia advanced eight positions in the GII, reaching 72nd place in 2023. This improvement reflects the country's growing innovation ecosystem, driven by advancements in ICT infrastructure, research and development (R&D), human capital, and institutional support—key factors for nurturing an AI-driven defense sector. Thus, Armenia has seen growth in its ICT sector, laying a solid foundation for the development of AI technologies, including defense applications such as cybersecurity, autonomous surveillance, and drone technology.

The Tumo Center for Creative Technologies, based in Yerevan, offers educational programs in AI, programming, and robotics to Armenian youth, fostering early exposure to digital and AI skills.[3] Armenia has made strides in AI research and technological development through collaborations between academic institutions and the private sector. For instance, Innovative Solutions and Technologies Center (ISTC)[4], in collaboration with IBM, focuses on research in AI, machine learning, and other high-tech fields, which can have direct applications in defense. The ArmSec Foundation[5], a cybersecurity initiative, conducts research and develops AI-driven cybersecurity systems.

Armenia's educational system is also directly engaged in producing STEM field skilled workforce. The Armenian National Polytechnic University is one of the country's leading institutions that has established programs in AI, robotics, and cybersecurity, all of which are critical for modern defense applications. Graduates from the Armenian National Engineering Laboratories (ANEL) have developed AI solutions that could be applied to unmanned aerial vehicles (UAVs) used in military operations. In addition to the Global Innovation Index (GII), reports from the World Bank and UNESCO emphasize the strength of Armenia's human capital in tech-related fields, showcasing its potential for innovation. However, these reports also highlight that while there are programs focusing on AI development in the technological sector, not all efforts are directed toward defense applications of AI. There is a clear need for targeted initiatives that concentrate specifically on the military uses of AI, as well as for more skilled labor in AI-related fields tailored to defense needs.[6]

These is also due to Armenia's government clear commitment to fostering innovation by supporting tech startups and AI research initiatives underlined in the Digital Transformation Agenda 2020-2025[7].It is a government initiative aimed at boosting the digital economy, with specific attention to fostering innovations in AI, including its defense applications. Another embodiemtn of government's commitment is the establishment of the Engineering City. The initiative, supported by the government, provides space for tech companies to innovate in high-tech fields. This innovation hub is expected to produce AI technologies that may serve Armenia's defense needs, such as autonomous drones and intelligent surveillance systems.[8]

4.2. Global Competitiveness Index (GCI)

While Armenia has shown improvements in specific areas, its ranking in the 2022 GCI report placed it at 74th among 141 economies, a similar range to its ranking in the Global Innovation Index (GII). The GCI assesses factors like infrastructure, macroeconomic stability, innovation capability, and technological readiness, all of which are critical to developing advanced industries, including an AI-based defense sector. As for the analysis of Armenia's position in GCI, the country needs to improve both physical and digital infrastructure to support AI initiatives in defense. High-speed internet and modern data centersare vital for real-time data processing and communication required by AI-driven military technologies. In developing autonomous drones or AI-powered surveillance systems, Armenia would benefit from infrastructure improvements, allowing faster data transmission for battlefield analytics. The World Economic Forum's GCI report[9] also highlights the role of infrastructure in boosting innovation capacity. Although Armenia has made strides in establishing an innovation ecosystem, the Global Competitiveness Index (GCI) underscores the necessity for increased investment in R&D and enhanced collaboration among institutions, government, and the private sector. The country's relatively underdeveloped

[2] GII 2023 https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2023-section1-en-gii-2023-at-a-glance-global-innovation-index-2023.pdf
[3] AI and education, scaling the learning curve, https://tumo.ai/
[4] Innovative Solutions and Technologies Center (ISTC) https://www.eif.am/eng/projects/ibm/
[5] ArmSec foundation, https://newsroom.aua.am/organizer/armsec-foundation/?eventDisplay=past
[6] Skills Development in the Era of AI https://documents1.worldbank.org/curated/en/099858406262414962/pdf/IDU143bca00811b081469e199101e65e709473f8.pdf
[7] Digital Transformation Agenda for the Republic of Armenia
https://unu.edu/egov/project/digital-transformation-agenda-republic-armenia
[8] The Engineering City
https://engineeringcity.am/
[9] GCI 4.0: Global Competitiveness Index 4.0
https://prosperitydata360.worldbank.org/en/indicator/WEF+GCI+GCI4

financial markets make it difficult for tech startups and innovative companies to secure the funding needed for large-scale defense projects. By improving access to venture capital and government grants, AI startups could grow their operations. The GCI report emphasizes the need to develop financial markets to encourage technological innovation. As a result, the gaps identified by the GCI—such as insufficient infrastructure, underdeveloped financial systems, and the necessity for specialized training—directly affect Armenia's capacity to build an AI-based defense industry, thus hindering the progress of AI applications in defense.

4.3. ICT Development Index (IDI)

In recent years, Armenia has made consistent progress in its IDI ranking-having been ranked 68th among 176 countries in 2021 data and 71st in 2023. This ranking indicates moderate ICT development against the backdrop of global standards and shows that the country is somewhat equipped to support technology-driven sectors. This progress can be attributed, most notably, to major success in terms of broadband access, mobile penetration, and affordable internet, which promote AI development, particularly in autonomous drones, AI-enhanced surveillance, and real-time battlefield analytics.

Faster communication and data processing rates, both essential for modern-day AI-based defense operations, have been made possible by the growing spread of 4G networks and the more widespread availability of fiber-optic Internet. While advancements in ICT have been evident, financial constraints resoundingly constrain large-scale investments in development, innovation, and infrastructure in Armenia. Substantial funding is needed for developing AI-based defense systems, which is not easy to secure given Armenia's relatively small economy. Apart from that, since Armenia has not developed its cybersecurity capabilities as those of most advanced nations, it encounters other challenges in this regard. Strong and dependable cybersecurity is imperative to secure AI-based defense systems against digital threats.

The country faces further threats of cyber attacks from the immediate vicinity, accentuating the need for foreign advanced AI-driven cyber defense solutions. Sadly, due to the current level of

poor cybersecurity measures, this further stalls the implementation of AI technologies in the defense sector. For a more detailed analysis on the cybersecurity issues, we have considered this issue with reference to the Global Cybersecurity Index.

While Armenia's startup ecosystem is on the verge of expansion, many of its AI start-ups are concentrated in commercial or consumer applications, with little focus on defense. The ICT index also points out the lack of a solid and focused military technology innovation sector, which restricts Armenia in the production and deployment of Artificial Intelligence for defense purposes. They demonstrate the nuanced complexities and challenges Armenia faces in developing an AI-based defense capability.

4.4. Global Cybersecurity Index (GCI)

As per the latest Global Cybersecurity Index (GCI) report, Armenia held 71st position out of 182 countries in 2020 and has since then dropped down to 90th in 2023. This ranking demonstrates moderate progress in the country's cybersecurity front, which carries utmost importance as a measure to assess the viability of the future establishment of an AI-based defense industry. Although notable improvements have been made in the field of cybersecurity, much remains potent in the approaches currently proffered by Armenia. For any defense mechanism to work well, the data must be securely transferred and hardened against the pernicious effects of cyber-attacks or data breaches-Armenia remains heavily burdened by those challenges.

In that regard, the continuous unsteady geopolitical situation in Armenia has inevitably forced into the cyberspace the need for structured cyber defense. Likewise, Armenia would now be vulnerable to cyber-attacks by armies operated from Azerbaijan, which further ruins its chances of a buildup on AI-related military weapon systems. As constant cyber threats are existing, more often than not, the resources are shifted from research and development in AI defense applications to handling immediate tactical concerns.

The establishment of CERT-AM is a very encouraging step toward ramping up the capacity of Armenia's response to cybersecurity incidents. Such a project is crucial in managing possible vulnerabilities in AI-driven defense technologies and fortifying the overall national security.[10] Armenia's presence in international cybersecurity frameworks, such as NATO's Partnership for Peace [14] is another step towards improving its cybersecurity protocols and learning from more advanced nations.[11]

Developing an AI-based defense industry necessitates significant funding, particularly in the realms of cyber defense and AI research. However, Armenia's relatively small defense budget constrains its capacity to invest in advanced technologies and the requisite infrastructure to protect against cyber threats. Moreover, ongoing geopolitical tensions, especially with Azerbaijan, render Armenia a frequent target for cyberattacks. These attacks reveal vulnerabilities in the country's digital and cybersecurity infrastructure, which in turn diverts resources away from long-term technological advancements, including AI development for defense purposes.

The 2020 Nagorno-Karabakh conflict highlighted this issue, as numerous cyberattacks were directed at Armenian infrastructure. Such threats emphasize the urgent need for enhanced cyber defense capabilities to protect AI-driven military technologies and ensure national security.[12]

As per the 2021 Human Development Index (HDI) report, Armenia is ranked 85th among 191 countries, with an improvement to 79th for 2024, thus it is listed in the "high human development" category. HDI measures the three most

[10] Government computer incident response centre, retrived August 3, 2024 from https://cert.gov.am/en/
[11] NATO CCDCOE: https://ccdcoe.org
[12] The Cyber Battlefield is Just as Important: Armenia's Cybersecurity, retrieved June 10, 2024 from https://evnreport.com/magazine-issues/the-cyber-battlefield-is-just-as-important-armenia-s-cybersecurity/

important aspects of a country's progress: life expectancy, education, and standard of living. Though it is not exactly linked to defense, this index still provides the crucial information about the socio-economic conditions that are favorable for technological advancements. HDI is a higher measure of a country's potential for innovation, as education and living standards are often improved along with the increase in output of innovations. Armenia's increasing HDI is coupled with its better innovation ranking in the world, thus the likely scenarios are rising AI and defense tech-wise. A first-class education system, especially in STEM disciplines, is indispensable for the development of students who can become the AI developers of the future in defense. The HDI of Armenia shows its strong educational roots, especially in technology and engineering, which makes it possible to train highly qualified professionals to participate in AI defense projects.[13]

Broadly speaking, the HDI-related socio-economic basis is just one aspect that makes up a rich landscape for AI development in defense. A growing tendency from the broad estimation of the human development towards the much localized assessment of AI readiness is taken up by the Government AI Readiness Index, hence giving a crystal clear position to the present standing issues regarding AI integration in Armenia. The Government AI Readiness Index 2021, which was published by Oxford Insights, placed Armenia 76th out of 160 countries concerning its AI readiness, improving to 66th place in 2023. This index evaluates several variables, including infrastructure, education, innovation ecosystems, and government policies. Despite Armenia's progress in developing its technological infrastructure, it is still insufficiently advanced to accommodate a huge wave of AI modes, which means things that still need improvement. The country lacks an integrated AI innovation ecosystem that involves research institutions, private

sector collaboration, and continued government support. The absence of large-scale AI research laboratories and the lack of public-private sector cooperation are other factors hindering innovation and the commercialization of AI technologies.

Furthermore, Armenia has not managed to establish any kind of substantial defense-tech industry linkage that, while serving to advance AI in the defense application, will communicate a need for the same. Although the education system is strong in Armenia regarding sciences, technology, engineering, and mathematics (STEM) areas, many of Armenia's already trained professionals leave the country for better career opportunities abroad. In that frame, the United States and Russia, together with Western European countries, stand out. The migration process, coupled with brain drain, diminishes the ecosystem's ability to retain qualified personnel required to speed up AI development, especially in sectors such as defense. Consequently, the migration of AI experts seriously diminishes Armenia's ability to create local innovation in many domains, including AI-based military technologies.[14]

5. Results

Armenia's progress in implementing AI-based technologies, particularly within the defense sector, is tempered by several critical gaps that must be addressed to ensure sustainable development. The country's innovation ecosystem has shown consistent improvement, as demonstrated by its rise in the Global Innovation Index. This progress is underpinned by a strong foundation in STEM education, with a number of institutions and AI labs. Additionally, government-led initiatives, including the Digital Transformation Agenda 2020-2025 and the establishment of Engineering City, highlight Armenia's commitment to promoting AI innovations with potential defense applications.

Nevertheless, Armenia is confronted with numerous obstacles that are stalling the full realization of AI capabilities in defense. While improvements in the country's infrastructure can be observed, they will not suffice for a full-scale implementation of AI techniques, especially in defense-related areas like real-time data processing and autonomous systems. The underdevelopment of its finance sector also limits access to venture capital, further stalling the growth of AI startups in innovation. One major vulnerability is that Armenia regularly suffers cyberattacks from neighboring countries, threatening its defense systems. Additionally, there is a brain drain, with many brilliant AI professionals leaving for greener pastures abroad, compounded by other socioeconomic problems, making it unmanageable to retain this talent within the country. The absence of clear mechanisms for transferring AI-based technologies to the defense sector aggravates the predicament. This calls for Armenia to take a more focused approach to this issue. Infrastructure should ideally be the first area to receive investment to boost AI developments concerning real-time data processing. Reforms to financial systems ought to provide better access to funding for AI startups, thereby fostering innovation in both sectors, namely AI and defense. Cybersecurity should be significantly strengthened to protect such critical AI systems. Finally, government policies can be implemented to retain skilled professionals by offering more competitive opportunities within the country and establishing mechanisms for utilizing AI technologies for defense purposes. With these strategic steps, the country will be better positioned to catch up with nations that lead in the development of AI defense innovations.

6. Conclusion

In summary, Armenia is at the crossroads when it comes to creating AI-based defense solutions.

1. While the country has achieved considerable progress in innovation spurred on by the upgrading of its educational capabilities, government initiatives, and global ranking such as the Global Innovation Index, it continues to be plagued by a great number of very serious problems.

2. Widespread infrastructural substandards, shortage of financial capacities, and inadequacies in cybersecurity present significant barriers to the structured use of AI technologies in defense applications.

[13] UNESCO data on Armenia's education, retrieved 11 September, 2024 from https://unesdoc.unesco.org

[14] Worlds Bank Group, Migration and Brain Drain , retrieved July 15, 2024 from https://documents1.worldbank.org/curated/en/657051570692065211/pdf/Migration-and-Brain-Drain.pdf

3. High continuing brain drain from the developing sector brings about a serious problem for the attraction and retention of talented people ultimately capable of spearheading innovation into this sector.

For it to outgo such hurdles, Armenia must consider a speedy and multi-pronged approach directed toward enhancing investment in technological infrastructure, financial backing to tech startups, and possible support to cybersecurity measures, with continual attention to the overall environment required for AI talent retention. That would enable Armenia to place itself better for increased seriousness at the global AI-regulating weapons stage and guarantee a more secure and technology-smart future.

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