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PROBLEMS OF THE RA TECHNOLOGICAL ECOSYSTEM: IMPROVEMENT OPPORTUNITIES

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Introduction. Over the past decade, Armenia's technological sector has demonstrated remarkable progress, particularly in software development, artificial intelligence (AI), and digital services. The success of Armenian-founded companies such as Picsart, Krisp, and ServiceTitan showcases the country's ability to generate globally competitive tech enterprises. Additionally, educational and innovation centers like TUMO, the Armenian Code Academy, and the National Polytechnic University play a crucial role in developing a skilled workforce. Despite these advancements, Armenia faces several structural barriers, including limited access to venture capital, insufficient R&D funding, regulatory challenges, and a persistent brain drain.

A well-structured technological ecosystem is vital for Armenia's long-term economic sustainability. In the context of increasing global digitalization and competition, Armenia must strengthen its technological infrastructure, improve industry-academic field (research institutions, universities) collaboration, and attract both local and international investments. Developing a comprehensive strategy to support technological innovation will enhance Armenia's economic resilience, reduce dependence on traditional industries, and position the country as a leading innovation hub in the region. So, the relevance of this study is due to the circumstances listed above. **This study aims** to explore the key factors influencing Armenia's technological ecosystem and propose strategies for its sustainable development.

The primary **purpose** of this research is to analyze the current state of Armenia's technological ecosystem, identify its key challenges, and propose strategic solutions for its sustainable development. A well-functioning technological ecosystem is crucial for fostering innovation, increasing economic competitiveness, and ensuring long-term economic growth. Given Armenia's ambitions to position itself as a regional technology hub, it is essential to assess the effectiveness of existing policies and explore new mechanisms for strengthening the ecosystem.

To achieve this purpose, the research sets the following key objectives:

- **Assess the Current State of Armenia's Technological Ecosystem** – Examine the structure, key players, and performance indicators of Armenia's technological sector, including IT companies, research institutions, and startups.
- **Identify Major Challenges and Barriers** – Analyze obstacles such as regulatory constraints, insufficient venture capital, limited R&D investment, and talent migration that hinder ecosystem development.
- **Evaluate Global Best Practices** – Conduct a comparative analysis of successful technological ecosystems in other countries, drawing lessons applicable to Armenia's context.
- **Develop Strategic Policy Recommendations** – Propose concrete strategies for government agencies, private sector stakeholders, and academic institutions to enhance Armenia's technological infrastructure, investment climate, and human capital.

By addressing these objectives, this study aims to contribute to both academic literature and policy-making processes by offering practical recommendations for the sustainable growth of Armenia's technological ecosystem. The development of technological ecosystems has been widely studied in both academic literature and policy reports, with a particular focus on innovation-driven economies and emerging markets. Scholars and institutions such as the World Bank, OECD, IMF, and Global Innovation Index have analyzed the role of technological ecosystems in economic growth, emphasizing factors like investment in research and development (R&D), digital infrastructure, regulatory frameworks, and human capital development.

In the global context, studies on countries like Israel, Singapore, and Estonia have highlighted the importance of government-led innovation policies, strong venture capital networks, and industry-academic field collaboration in fostering a dynamic technological environment[1][2]. Comparative research suggests that small economies can achieve significant technological growth through targeted policies, international partnerships, and digital transformation strategies. Regarding Armenia, existing studies and reports (such as those published by the RA Ministry of Economy, Ministry of High-Tech Industry, and RA Statistical Committee) provide insights into the current state of Armenia's technological ecosystem, sectoral growth trends, and key challenges[3]. However, while there are various fragmented studies on Armenia's technological progress, comprehensive research that systematically assesses its ecosystem and proposes structured strategies for its development remains limited. This study aims to fill that gap by conducting an in-depth analysis of Armenia's technological ecosystem, identifying barriers to its growth, and proposing actionable policy recommendations. By incorporating both international best practices and Armenia-specific insights, the research will provide a holistic framework for strengthening the country's technological ecosystem.

Literature Review: The study of technological ecosystems is rooted in multiple theoretical frameworks that explain how innovation, entrepreneurship, and institutional support contribute to economic development. This section outlines key theoretical approaches that are relevant to understanding and strengthening Armenia's technological ecosystem.

One of the fundamental theories in this field is the **National Innovation System (NIS) theory**, which emphasizes the role of institutions, policies, and networks in fostering

[1] World Intellectual Property Organization, 2023, Global Innovation Index (last access 15.01.2025, 15:30)
https://www.wipo.int/en/web/global-innovation-index/2023/index#:~:text=For%20the%2013th%20year%20in,Global%20Innovation%20Index%202023%20rankings

[2] 2023-2024 World Economic Forum Annual Meeting, Annual Report (last access 18.01.2025, 12:05)
https://www.weforum.org/meetings/world-economic-forum-annual-meeting-2023/

[3] The Ministry Of High-Tech Industry Of The Republic Of Armenia, Activity report 2023 of the Ministry of High-tech Industry presented to the Prime Minister (last access 24.01.2025, 17:10)
https://hightech.gov.am/en/tegekatvakan-kentron/ayl/norutyunner/varcapetin-e-nerkayacvel-barjr-texnologiakan-ardyunaberutyan-naxararutyan-2023-t-gorcuneutyan-hasvetvutyun

technological progress[4][5]. According to this approach, the interaction between government agencies, research institutions, and private enterprises determines a country's capacity for innovation. Studies suggest that countries with strong NIS frameworks (such as Finland and South Korea) have successfully transitioned into knowledge-based economies through targeted investments in R&D and policy coordination. In Armenia, efforts to develop an innovation-friendly environment have been fragmented, with limited policy coordination between key stakeholders.

Another important perspective is the **Triple Helix Model of Innovation**, which describes the dynamic interaction between academic field, industry, and government in fostering technological advancements[6]. This model highlights the need for universities to go beyond traditional education and actively engage in technology transfer and commercialization. In countries like the United States and Germany, strong university-industry collaborations have played a key role in technological breakthroughs. Armenia has made some progress in this area, with institutions like the National Polytechnic University and the Armenian National Engineering Laboratories (ANEL) contributing to technical education. However, university-led innovation remains underdeveloped due to weak commercialization mechanisms and insufficient funding for applications.

The **Entrepreneurial Ecosystem Theory** provides another relevant framework, focusing on the conditions that support high-growth startups and technological innovation[7]. This approach identifies key factors such as access to capital, mentorship networks, and regulatory ease as crucial for ecosystem success. Silicon Valley, for instance, has thrived due to a combination of venture capital availability, strong entrepreneurial culture, and policies that support innovation. In Armenia, despite the emergence of successful startups like Picsart and Krisp, limited access to venture capital and risk-averse investment culture remain significant barriers to scaling innovative businesses.

The study of technological ecosystems has been widely explored in global economic literature, with a particular focus on the policies and strategies that drive innovation and competitiveness. Existing research highlights successful case studies from various countries, providing valuable insights that can inform Armenia's approach to strengthening its technological ecosystem.

One of the most well-documented success stories is Israel's high-tech ecosystem, often referred to as the "Startup Nation"[8]. The country's rapid technological advancement has been attributed to a combination of strong government support, military-driven innovation (such as the role of Unit 8200), a robust venture capital market, and close university-industry collaboration. The Israeli Innovation Authority has played a crucial role in funding early-stage startups and promoting R&D initiatives, demonstrating how targeted

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[4] Bengt-Åke Lundvall, NATIONAL SYSTEMS OF INNOVATION: 2016, TOWARDS A THEORY OF INNOVATION AND INTERACTIVE LEARNING, The Learning Economy and the Economics of Hope, pp. 85-106

[5] John Groenewegen , 2006, Marianne Van Der Steen, The Evolution of National Innovation Systems, Journal of Economic Issues, Vol. 40, No. 2, Jun., pp. 277-285

[6] Loet Leydesdorff, The triple helix: an evolutionary model of innovations, Research Policy Volume 29, Issue 2, February 2000, Pages 243-255

[7] Daniel J. Isenberg, June 2010How to Start an Entrepreneurial Revolution, THE BIG IDEA, Harvard Business Review,

[8] Daniel Senor, Saul Singer, October 2009Start-Up Nation The Story of Israel's Economic Miracle, Twelve Books,

government interventions can accelerate technological growth. Armenia has similarities with Israel, particularly in terms of a strong diaspora network and a growing IT sector, making Israel's model a relevant case for comparison.

A different but equally successful case is Estonia's digital economy transformation, where the government has implemented e-Government services, digital identity systems, and blockchain-based solutions[9]. Estonia's strategy has significantly reduced bureaucratic inefficiencies and positioned the country as a leader in e-Governance and digital innovation. Given Armenia's ongoing digitalization efforts, Estonia's experience offers a practical model for enhancing e-Government services, improving cybersecurity measures, and promoting digital literacy.

In addition to national case studies, broader research on technological ecosystems highlights several key factors that contribute to success:

- Government-led R&D investment and innovation policies
- Strong venture capital markets and financing mechanisms for startups
- Academic institutions actively engaged in technology transfer and commercialization
- Business-friendly regulatory frameworks that reduce barriers for tech entrepreneurs A globally competitive digital infrastructure and cybersecurity framework

While Armenia has made notable progress in IT sector development, gaps remain in funding availability, regulatory flexibility, and institutional coordination[10]. By integrating lessons from successful global practices, Armenia can create a more sustainable and competitive technological ecosystem.

Methodology. This study employs a mixed-methods research design, integrating both qualitative and quantitative approaches to provide a comprehensive analysis of strategies for strengthening Armenia's technological ecosystem. The research framework is structured to assess current challenges, identify best practices, and propose policy recommendations based on empirical data and case studies. The qualitative component of the study includes literature analysis, and case studies of successful technological ecosystems in other countries. The literature review examines existing research on innovation policies, startup ecosystems, and government-led technology initiatives. Case studies from Israel, Singapore, and Estonia serve as comparative benchmarks for identifying strategies that could be adapted to the Armenian context.

The quantitative component involves statistical analysis to assess the performance of Armenia's technological sector. Data is collected from sources such as the National Statistical Committee of Armenia, the World Bank, and the Global Innovation Index. Key indicators analyzed include R&D expenditures, startup survival rates, venture capital investments, and technology sector employment trends**.** By combining qualitative insights with quantitative data, this research ensures a holistic evaluation of Armenia's technological ecosystem and provides evidence-based recommendations for policy improvements. This study relies on a combination of primary and secondary data sources to analyze Armenia's technological ecosystem and compare it with global best practices. The data sources are selected to ensure reliability, accuracy, and relevance to the research objectives.

Analysis. Armenia's technological ecosystem has experienced notable developments in recent years, characterized by both advancements and challenges. This

[9] Tarvi Martens, Electronic identity management in Estonia between market and state governance, Identity in the Information Society, July 2010

[10] The Ministry Of High-Tech Industry Of The Republic Of Armenia, Activity Report 2023

section provides an analysis of the current state, focusing on key metrics such as the number of IT firms, employment trends, revenue generation, and innovation rankings. As of the end of 2023, Armenia's Information and Communication Technology (ICT) sector encompassed over 3,000 active firms, collectively employing more than 20,000 individuals. This sector has been a significant contributor to the national economy, generating annual revenues exceeding one billion dollars. Notably, the ICT industry has been growing at an annual rate of 20%, a trend that may accelerate due to the influx of high-skilled IT professionals following geopolitical events in the region[11]. However, recent data indicates a contraction in the sector. In the first half of 2024, the number of taxpayers in the IT sector declined by 12.4%, dropping from 10,674 to 9,354. Correspondingly, employment in the sector decreased by 5.4%, with the workforce shrinking from 36,773 in 2023 to 34,814 in 2024[12]. The IT services market in Armenia is projected to reach a revenue of approximately US$143.37 million by 2025. This projection underscores the sector's potential for growth, despite recent contractions in the number of firms and employment figures[13].

Armenia's position in the Global Innovation Index (GII) has seen fluctuations over the past decade. In 2024, Armenia improved its ranking by nine positions, securing the 63rd spot among 133 economies. This improvement reflects positive developments in certain innovation metrics. However, when compared to its historical performance, where Armenia ranked as high as 59th in 2013, the current position indicates room for further enhancement in the nation's innovation capabilities[14]. A significant challenge within Armenia's technological ecosystem is the low adoption rate of modern digital technologies among firms. Over 60% of Armenian companies have not integrated advanced digital solutions into their operations, and only 7% have adopted such technologies in critical business functions like production and service delivery. This lag in digital maturity hampers the competitiveness of Armenian firms on both regional and global scales[15].

Armenia's technological ecosystem exhibits a blend of growth potential and existing challenges. While the IT sector has historically been a robust contributor to the economy, recent declines in the number of active firms and employment raise concerns. The projected revenue growth in IT services and improvements in the Global Innovation Index are positive indicators. However, the low rate of digital technology adoption among firms highlights a critical area needing attention to ensure sustained growth and competitiveness in the global technology landscape.

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[11] International Trade Administration, Armenia Country Commercial Guide, (last access 03.02.2025, 11:25)
https://www.trade.gov/country-commercial-guides/armenia-information-and-telecommunication-technology?utm

[12] FitchRatings, RATING ACTION COMMENTARY, (last access 04.02.2025, 10:45)
https://www.fitchratings.com/research/sovereigns/fitch-affirms-armenia-at-bb-outlook-stable-24-01-2025#:~:text=Fitch%20Ratings%20%2D%20London%20%2D%2024%20Jan,of%20this%20Rating%20Action%20Commentary.

[13] Online statistics portal "Statista" (last access 10.02.2025, 13:00)
https://www.statista.com/outlook/tmo/it-services/armenia?utm

[14] World Intellectual Property Organization webpage, (last access 10.02.2025, 15:20)
https://www.wipo.int/edocs/gii-ranking/2024/am.pdf?utm

[15] World Bank Group, Armenia's Digital Technology Adoption by Firms, (last access 12.02.2025, 16:10)
https://www.worldbank.org/en/country/armenia/publication/armenia-s-digital-technology-adoption-by-firms?utm

The chart 1 illustrates the number of IT firms and employment trends in Armenia's technological ecosystem from 2019 to 2024. The steady increase in both indicators from 2019 to 2023 highlights the sector's expansion, driven by a combination of government incentives, foreign investments, and the growing role of Armenia as a regional IT hub. However, in 2024, a decline is observed in both the number of IT firms (-12.4%) and employment (-5.4%), indicating emerging challenges within the sector.

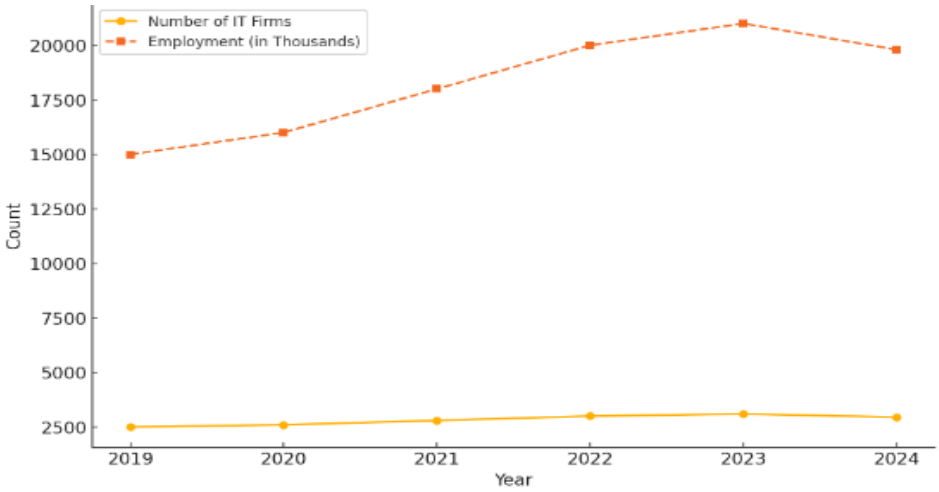

Chart 1. Trends in IT firms And Employment in Armenia (2019-2024)[16]

The decrease in active firms and employment can be attributed to multiple factors, including recent tax policy changes, talent migration, and increasing regional competition. Armenia's competitive advantage in the IT sector has historically relied on a highly skilled workforce and favorable business conditions. However, the current contraction signals the need for strategic interventions to sustain growth.

From a policy perspective, these trends emphasize the importance of strengthening the technological ecosystem by introducing targeted initiatives such as improved digital infrastructure, enhanced research and development (R&D) funding, and incentives for startups. Additionally, efforts to retain skilled professionals through talent development programs and competitive wages will be crucial in reversing the downturn. The observed decline in 2024 underlines the need for adaptive strategies to ensure long-term stability and resilience in Armenia's IT sector. If left unaddressed, the loss of firms and skilled workers could hinder the country's aspirations of becoming a regional innovation leader. Therefore, a comprehensive policy framework that aligns with global best practices is necessary to strengthen Armenia's technological ecosystem and sustain its growth trajectory.

The chart 2 presents the annual revenue trends in Armenia's IT services market from 2019 to 2024. The sector demonstrated consistent revenue growth, increasing from approximately $800 million in 2019 to $1.2 billion in 2023. This upward trajectory reflects the expansion of IT firms, increasing foreign direct investment (FDI), and a rising demand

[16] International Trade Administration, Armenia Country Commercial Guide (last access 13.02.2025, 11:50)
https://www.trade.gov/country-commercial-guides/armenia-information-and-telecommunication-technology?utm

for digital solutions, both domestically and internationally. However, in 2024, the sector experienced a decline in revenue to $1.14 billion, marking the first contraction in recent years. This decline is likely linked to the reduction in the number of IT firms and employment observed in the previous chart. Several factors may have contributed to this downturn, including geopolitical risks affecting investor confidence, tax policy adjustments, and a slowdown in global demand for outsourced IT services. Additionally, the competition from emerging IT hubs in Eastern Europe and Central Asia poses challenges for Armenian firms seeking to expand their market share.

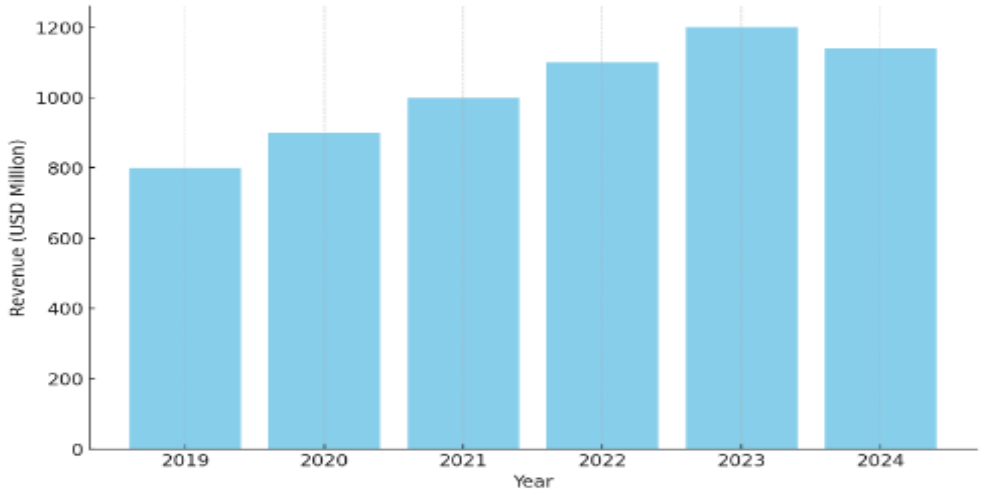

Chart 2. IT Services Market Revenue in Armenia (2019-2024)[17]

The fluctuations in IT sector revenue highlight the need for a more resilient and diversified technological ecosystem. While Armenia has successfully positioned itself as a competitive player in software development, fintech, and AI, the sector remains vulnerable to external shocks. Strengthening domestic demand for IT services, fostering deeper integration with global innovation networks, and ensuring long-term policy stability are critical to sustaining revenue growth. To reverse the recent decline and reinforce Armenia's position as a regional technology hub, targeted strategies should include increased R&D funding, enhanced support for tech startups, and the expansion of public-private partnerships. Strengthening the technological ecosystem through infrastructure investments and workforce development will be crucial in ensuring sustainable growth and resilience in the coming years.

The chart 3 illustrates Armenia's ranking in the Global Innovation Index (GII) from 2019 to 2024. The GII measures a country's innovation performance based on various factors, including R&D investment, digital infrastructure, business sophistication, and human capital. Armenia's ranking fluctuated between 65th and 67th place from 2019 to 2021, showing moderate but inconsistent performance in innovation-related indicators. However, a gradual improvement is observed from 2022 onwards, with Armenia reaching 63rd place in both 2023 and 2024.

[17] Online statistics portal "Statista" (last access 13.02.2025, 12:35) https://www.statista.com/outlook/tmo/it-services/armenia?utm

This upward trend reflects progress in key areas such as IT sector development, government-backed innovation programs, and increased engagement with international tech firms. The improvement in ranking suggests that Armenia's technological ecosystem has become more competitive, benefiting from policy initiatives aimed at supporting digital transformation, attracting foreign investments, and fostering a startup-friendly environment. However, despite these advancements, Armenia still lags behind global leaders and regional competitors in innovation capacity, patent generation, and technological exports. The stagnation at 63rd place in 2024 indicates that Armenia has reached a critical threshold where further progress requires deeper structural reforms. To continue improving its innovation standing, Armenia must address challenges such as limited funding for research and development, a shortage of highly specialized tech talent, and insufficient collaboration between the academic field and industry. Additionally, strengthening intellectual property protection and enhancing digital infrastructure will be crucial for maintaining long-term innovation growth.

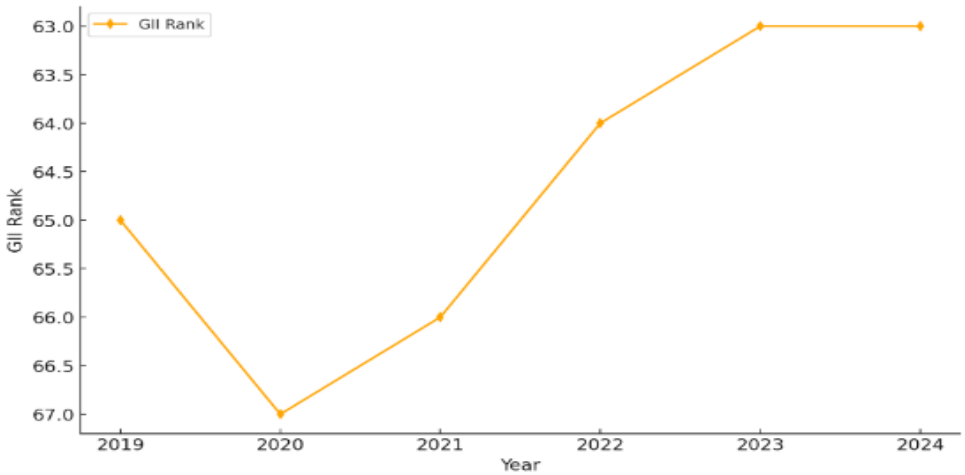

Chart 3. Global Innovation Index Rank for Armenia (2019-2024)[18]

For Armenia to solidify its position as a leading technological hub in the region, a comprehensive strategy is needed. This should include increasing public and private sector investments in R&D, incentivizing high-tech entrepreneurship, and integrating Armenia more effectively into global innovation networks. By addressing these gaps, Armenia can achieve a more robust technological ecosystem and improve its global innovation ranking in the years ahead. Armenia's technological sector has demonstrated significant growth in recent years, but several persistent challenges threaten its long-term sustainability. The previous analysis highlighted a recent decline in IT sector employment, firm numbers, and revenue generation, signaling structural weaknesses in the ecosystem. Additionally, despite moderate improvements in Armenia's Global Innovation Index ranking, the country remains behind leading global and regional innovation hubs. Addressing these barriers is critical to achieving a more resilient and dynamic technological ecosystem.

One of the primary constraints on Armenia's tech sector is the limited availability of venture capital and angel investor networks. While foreign direct investment (FDI) in the

[18] World Intellectual Property Organization webpage (last access 22.01.2025, 16:15) https://www.wipo.int/edocs/gii-ranking/2024/am.pdf?utm

IT sector has grown in the past decade, local investment remains weak. According to the World Bank, Armenia's total gross domestic expenditure on research and development (GERD) was only 0.23% of GDP in 2023, significantly lower than regional competitors such as Estonia (1.75%) and Israel (5.6)[19]. This underinvestment hampers the ability of startups to scale, limiting innovation and global competitiveness. Although the Armenian government has introduced various grant programs through initiatives like the Innovative Solutions and Technologies Center (ISTC) and the Enterprise Incubator Foundation (EIF), these efforts are not sufficient to match the growing demand for high-tech funding. The absence of a well-established venture capital ecosystem means that many promising startups struggle to transition from early-stage development to international expansion, often seeking funding abroad[20]. Armenia's Ease of Doing Business ranking has improved over the years, yet bureaucratic obstacles continue to slow down startup development. Complex licensing procedures, inconsistent enforcement of intellectual property rights, and slow regulatory adaptation to emerging technologies create additional burdens for entrepreneurs. According to the Global Competitiveness Report 2024**,** Armenia ranks 67th in regulatory efficiency, significantly trailing behind innovation-driven economies like Finland (3rd) and Singapore (2nd)[21].

Furthermore, the 2023 Armenian Startup Ecosystem Report highlights that tax policies and compliance costs disproportionately impact early-stage technology firms, reducing their ability to reinvest in innovation[22]. Without streamlined policies and regulatory incentives, startups may continue to face significant barriers to scaling operations domestically and internationally.

A critical challenge facing Armenia's technological ecosystem is the loss of highly skilled professionals to migration. The Armenian Statistical Committee reported that over 3,000 IT specialists emigrated in 2023, citing better salaries, improved working conditions, and greater career opportunities abroad as key reasons[23]. The average salary in Armenia's IT sector, approximately $1,800 per month, remains significantly lower than in countries like Germany ($5,500) and the United States ($7,500), making it difficult for local firms to retain top talent[24]. Brain drain directly affects Armenia's innovation capacity, as fewer skilled professionals remain to drive research, product development, and technological advancements. While government-led talent retention initiatives, such as the Armenian National Engineering Laboratories (ANEL), aim to provide competitive opportunities, their reach remains limited. Strengthening incentives, improving local working conditions, and fostering international partnerships for remote work could help mitigate these challenges.

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[19] World Intellectual Property Organization webpage (last access 25.01.2025, 15:30)
https://www.wipo.int/edocs/gii-ranking/2024/am.pdf?utm

[20] European Investment Fund webpage (last access 01.03.2025, 10:10)
https://www.eif.am/

[21] World Economic Forum webpage 2024 (last access 03.03.2025, 17:05)
https://www.weforum.org/reports

[22] The 2023 Armenian Startup Ecosystem Report, Armenian Ministry of Economy (last access 01.02.2025, 12:50)
https://startupcentraleurasia.com/uploads/startup-ecosystems/October2022/9Uh9S69APeDBul03QqMl.pdf

[23] Armenian Statistical Committee, Reports 2024, (last access 18.01.2025, 10:45)
https://www.armstat.am/en/

[24] Online statistics portal "Statista" (last access 27.01.2025, 13:35)
https://www.statista.com/statistics/1388289/cee-average-gross-salary-in-the-ict-sector/?utm

One of the most pressing concerns in Armenia's technological ecosystem is the lack of synergy between academic institutions and the tech industry. Despite a strong educational foundation in STEM fields, research commercialization remains low. According to UNESCO, only 7.4% of scientific research conducted in Armenia in 2023 was converted into commercial applications, compared to 28.9% in South Korea and 18.5% in the United States[25]. Many IT firms in Armenia rely on imported expertise rather than collaborating with local universities for R&D, limiting knowledge transfer and innovation capacity. The World Intellectual Property Organization (WIPO) has highlighted those countries with stronger university-industry collaboration, such as Switzerland and Sweden, consistently rank higher in global innovation performance[26]. Creating stronger partnerships between universities and businesses, expanding internship programs, and increasing state-backed R&D funding are essential for closing this gap.

The challenges outlined above underscore the structural limitations hindering Armenia's technological ecosystem. Addressing these issues requires comprehensive policy reforms, increased investment, and stronger collaboration between the public and private sectors. In the next section, we will explore strategies for overcoming these barriers and strengthening Armenia's position as a competitive regional technology hub. To address the key challenges identified in the previous section, a comprehensive strategic approach is required to enhance Armenia's technological ecosystem. The proposed solutions focus on policy improvements, investment expansion, human capital development, and international collaboration, aligning with global best practices and Armenia's specific needs.

Bureaucratic inefficiencies and regulatory barriers remain a significant obstacle to startup growth and foreign investment in Armenia. To improve the business environment, the government should:

- Introduce fast-track registration for startups and tech companies, reducing administrative delays.
- Simplify intellectual property (IP) laws to encourage innovation and attract foreign investors.
- Create a regulatory sandbox for emerging technologies such as artificial intelligence (AI) and blockchain, allowing businesses to experiment in a controlled environment before full-scale deployment.

Countries that offer targeted tax incentives for technology firms see higher R&D investment and faster sectoral growth. For example, Estonia and Ireland provide corporate tax breaks for startups engaging in high-tech innovation, leading to increased investment and business expansion. Armenia can adopt similar policies, such as:

- Providing tax exemptions for early-stage startups for the first 3-5 years of operation.
- Granting R&D tax credits for companies investing in technological research and innovation.
- Offering payroll tax reductions for tech firms hiring STEM graduates.

Armenia's startup ecosystem suffers from limited access to venture capital, with domestic investment significantly lower than in leading tech hubs. In 2023, total venture

[25] UNESDOC digital laboratory (last access 06.03.2025, 12:30)
https://unesdoc.unesco.org/ark:/48223/pf0000263132
[26] WIPO, Global innovation index (last access 05.03.2025, 13:25)
https://www.wipo.int/web-publications/global-innovation-index-2024/en/?utm

capital investment in Armenia was $65 million[27], compared to $1.5 billion in Estonia and $25 billion in Israel[28]. To address this, the government should:

- Create a state-backed venture capital fund to co-invest with private firms in promising startups.
- Expand existing funding initiatives such as the Enterprise Incubator Foundation (EIF) to provide larger grants and seed funding.
- Develop angel investor networks by providing tax incentives to individuals investing in early-stage tech startups.

Globally, technology hubs have played a critical role in accelerating innovation. For example, Silicon Valley (USA), Zhongguancun (China), and Bangalore (India) have thrived due to strategic investments in digital infrastructure and startup-friendly environments. Armenia has made progress with the TUMO Center for Creative Technologies and the Engineering City initiative, but further expansion is needed. To enhance the ecosystem, the government should establish dedicated innovation districts in Yerevan, Gyumri, and Vanadzor with tax incentives and high-speed digital infrastructure, strengthen incubators and accelerators to support early-stage startups and facilitate access to co-working spaces with subsidized office rents for small tech firms. Armenia's strong mathematical and engineering background provides a solid foundation for tech growth. However, only 27% of Armenian students pursue STEM-related degrees[29], compared to 45% in Singapore and 38% in Germany[30]. To improve STEM education, Armenia should:

- Introduce coding and digital literacy programs in primary and secondary schools.
- Strengthen university-industry partnerships by offering internships and research grants.
- Develop specialized AI, blockchain, and cybersecurity programs in universities.

The brain drain of IT professionals remains a critical issue. Countries like India and China have successfully implemented reverse brain drain programs, attracting skilled professionals back home. Armenia can implement similar strategies by:

- Launching a "Tech Diaspora Program" with financial incentives for returning specialists.
- Facilitating remote work opportunities for Armenian professionals abroad.
- Offering fast-tracks residency and tax benefits for expatriate tech entrepreneurs.

International collaboration is key to accelerating Armenia's technological ecosystem. In 2023 and 2024 several Armenian startups partnered with international firms, but most partnerships were with regional players rather than global tech giants. To enhance global cooperation, Armenia should:

- Establish R&D collaboration agreements with tech giants such as Google, Microsoft, and NVIDIA.

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[27] Tower International Consultants, Armenia's economy trends in the global context: 2023-2024 overview, (last access 19.01.2025, 12:30)
https://tower.am/armenia-economy-trends-2023-2024/?utm

[28] Crunchbase platform webpage (last access 30.01.2025, 11:15)
https://crunchbase.com/venture/israel-vc-backed-startup-funding-q4-2023/?utm

[29] Official website of Finport, an Armenian financial information portal (last access 04.02.2025, 17:15)
https://finport.am/full_news.php?id=50979&lang=3&utm

[30] Official website of the UNESCO Institute for Statistics (UIS) (last access 08.01.2025, 12:55)
https://databrowser.uis.unesco.org/

- Encourage joint ventures between Armenian startups and global companies.
- Facilitate international knowledge exchange programs for Armenian researchers and engineers.

Countries that successfully integrate into global research networks receive higher funding for innovation projects. In 2023, Armenian institutions received $12 million in international research funding, compared to $150 million for Estonia[31]. To increase funding, Armenia should:

- Expand participation in EU programs such as Horizon Europe and Erasmus+.
- Encourage Armenian researchers to apply for grants from the World Bank and OECD.
- Provide government support for international patent applications and IP protection.

By implementing these strategic solutions, Armenia can overcome investment gaps, regulatory inefficiencies, talent retention challenges, and weak international integration. A coordinated policy effort focusing on startup-friendly regulations, infrastructure investment, STEM education, and global collaboration is essential for transforming Armenia into a regional leader in technological innovation.

While this study provides a comprehensive analysis of Armenia's technological ecosystem, there remain several areas that require further exploration to refine policy recommendations and better understand the sector's long-term development. One important direction for future research is assessing the long-term impact of recently implemented policy reforms. Tax incentives for R&D, startup-friendly regulations, and investment incentives are still relatively new in Armenia, and their effectiveness needs to be measured over time. Comparative studies with countries that have successfully reformed their technology ecosystems, such as Estonia or Israel, could also provide valuable insights into best practices that may be applicable in the Armenian context.

Another critical area of study is the decentralization of Armenia's tech sector. At present, technological development is heavily concentrated in Yerevan, with limited spillover effects into regional cities and rural areas. Future research should explore ways to foster technological innovation beyond the capital, including the impact of regional tech hubs, incubators, and digital infrastructure projects. Examining the role of local governments in promoting digital transformation in smaller cities could also be beneficial in identifying scalable solutions.

Additionally, Armenia's ability to adopt and integrate emerging technologies, such as artificial intelligence, blockchain, and fintech, remains an open question. More research is needed to determine which technological specializations offer the greatest potential for Armenia's economy and how targeted policies can support their development. Countries that have successfully positioned themselves as leaders in niche technology fields often benefit from strategic government support, strong educational programs, and private-sector investment. Understanding how Armenia can follow a similar path could provide a roadmap for long-term competitiveness.

Another pressing issue is talent mobility and brain drain. Many skilled Armenian tech professionals seek opportunities abroad, often due to better salaries, career prospects, and access to cutting-edge research. While some initiatives have been launched to encourage repatriation, such as remote work programs and incentives for returning professionals, there

[31] The official website for Horizon Europe (last access 08.03.2025, 17:50) https://ec.europa.eu/programmes/horizon-europe

is still limited data on their effectiveness. Further research should explore the factors influencing tech migration and identify more targeted strategies to retain and attract high-skilled workers.

Investment trends and funding mechanisms also require deeper investigation. While Armenia has seen an increase in venture capital activity in recent years, the availability of early-stage funding remains a challenge. Studying the structure of investment flows, the role of government-backed seed funds, and potential public-private investment partnerships could help design more effective financial support systems for startups and tech enterprises.

Finally, more work is needed to understand how digital transformation can support other sectors of the economy. The integration of technology in agriculture, manufacturing, and services has the potential to boost productivity and diversify Armenia's economic base. Likewise, the role of digital government initiatives in improving public services, education, and healthcare warrants further exploration. As the country continues its digitalization efforts, measuring the social and economic impact of these initiatives will be crucial in ensuring that technological progress translates into broad societal benefits.

Conclusion. This study has explored the key factors influencing the development of Armenia's technological ecosystem, highlighting both the challenges and strategic opportunities. The findings suggest that while Armenia has significant potential in the tech sector (owing to its strong STEM education base, emerging startup culture, and strategic geographical location) several structural barriers continue to hinder its full growth.

1. Current State of the RA Technological Ecosystem: Armenia's technology sector has grown steadily. However, venture capital investment remains low, and tech employment is concentrated in Yerevan, limiting regional development. The country's Global Innovation Index ranking, while improving, still lags behind leading digital economies.
2. Key Challenges: The major obstacles identified include limited investment opportunities, regulatory complexities, difficulties in retaining skilled talent, and weak collaboration between the academic field and industry. These barriers slow down innovation and make it difficult for startups to scale.
3. Strategic Solutions: The research highlights several policy measures to strengthen Armenia's technological ecosystem, including streamlining regulations, offering tax incentives, establishing venture capital funds, expanding tech hubs, and enhancing STEM education. International collaboration, particularly in research funding and global partnerships, is also crucial for long-term growth.
4. Impact and Policy Implications: If implemented effectively, these strategies could accelerate Armenia's digital transformation, increase high-value job creation, and improve the country's competitiveness in global technology markets. However, policy coordination, continuous evaluation, and adaptive measures will be necessary to ensure their success.

The research findings have significant implications for policymakers, investors, educational institutions, and technology firms. Strengthening Armenia's technological ecosystem requires a coordinated approach that includes regulatory improvements, investment in infrastructure, talent development, and international cooperation. One of the most immediate applications of this research is in shaping government policies that foster innovation and entrepreneurship. By streamlining regulations, simplifying bureaucratic procedures, and offering targeted tax incentives, policymakers can create a more supportive environment for startups and tech companies. These measures can attract both local and foreign investors, encouraging the growth of high-tech industries.

Investment in venture capital and infrastructure is another crucial area where these findings can be applied. Establishing national venture capital funds and expanding angel investor networks can provide startups with the financial resources they need to scale. In addition, developing technology parks, co-working spaces, and innovation districts can foster collaboration and create an environment where startups, research institutions, and established companies can interact more effectively. These efforts would help Armenia build a stronger foundation for long-term technological and economic development.

Human capital development is also essential for sustaining the growth of the technology sector. Strengthening STEM education in schools and universities can ensure that future generations are equipped with the necessary skills for high-tech industries. At the same time, initiatives aimed at attracting Armenian tech professionals from abroad (such as competitive salary offers, career development programs, and research funding) can help mitigate the ongoing brain drain. Stronger ties between the academic field and industry can further enhance workforce readiness, with universities playing a key role in preparing students for careers in technology-driven fields.

On an international level, strengthening partnerships with global tech firms, universities, and research institutions can accelerate Armenia's integration into the global innovation ecosystem. Participating in international research grants and funding programs, such as Horizon Europe or World Bank technology funds, can provide Armenian institutions with the financial support and expertise needed to drive innovation. Expanding Armenia's presence in global digital trade networks can also help local tech companies enter new markets, increasing exports and economic diversification.

The broader economic and social impact of a strong technology sector cannot be overlooked. A more developed technological ecosystem would contribute to GDP growth by creating high-value jobs, increasing productivity, and fostering innovation across multiple industries. Advancements in AI, cybersecurity, and data-driven sectors could position Armenia as a leader in specific niche markets. Additionally, digital transformation across public services, education, and healthcare could lead to improved quality of life and more efficient governance.

By applying these research insights, Armenia can build a resilient and competitive technological ecosystem that not only supports its economic development but also enhances its role in the global digital economy. The next step is to explore future research directions that can further refine strategies and provide new perspectives on technology sector growth in Armenia.

By addressing these research gaps, Armenia can develop a more refined and evidence-based approach to strengthening its technological ecosystem. As the global digital economy evolves, ongoing research and adaptation will be essential to maintaining competitiveness and fostering sustainable growth.

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Համառոտագիր

Տեխնոլոգիական արագ զարգացման ժամանակաշրջանում, ուժեղ տեխնոլոգիական էկոհամակարգի զարգացումը դարձել է տնտեսական աճի, նորարարությունների և գլոբալ մրցունակության հիմնական խթանը: Երկրները, որոնք հաջողությամբ զարգացնում են տեխնոլոգիական էկոհամակարգեր, ստանում են բարձր արտադրողականություն, աշխատատեղերի ստեղծում և կյանքի որակի բարելավում: Հայաստանի դեպքում, իր աճող տեղեկատվական տեխնոլոգիաների ոլորտով, ամուր կրթական հիմքերով և ակտիվ սփյուռքի

ներգրավմամբ, տարածաշրջանային տեխնոլոգիական կենտրոն դառնալու մեծ ներուժ ունի: Սակայն, այս ներուժը լիարժեք իրականացնելու համար անհրաժեշտ է համապարփակ ռազմավարություն, որը կլուծի առկա խնդիրները և կօգտագործի նոր հնարավորությունները:

Այս հետազոտության նպատակը Հայաստանի տեխնոլոգիական էկոհամակարգի ընթացիկ վիճակի վերլուծությունն է, դրա հիմնական մարտահրավերների բացահայտումն ու կայուն զարգացման ռազմավարական լուծումների առաջարկումը: Լավ կազմակերպված տեխնոլոգիական էկոհամակարգն առանցքային նշանակություն ունի նորարարության խթանման, տնտեսական մրցունակության բարձրացման և երկարաժամկետ տնտեսական աճի ապահովման համար: Հաշվի առնելով Հայաստանի նպատակները՝ դառնալ տարածաշրջանային տեխնոլոգիական կենտրոն, անհրաժեշտ է գնահատել առկա քաղաքականությունների արդյունավետությունը և ուսումնասիրել նոր մեխանիզմներ էկոհամակարգի ամրապնդման համար:

Այս նպատակին հասնելու համար հետազոտությունում առաջ են քաշվել մի շարք խնդիրներ: Նախ, պետք է գնահատել Հայաստանի տեխնոլոգիական էկոհամակարգի ընթացիկ վիճակը, ուսումնասիրել դրա կառուցվածքը, հիմնական դերակատարներին և արդյունաբերության ցուցանիշները, ներառյալ SS ընկերությունները, հետազոտական ինստիտուտները և ստարտափները: Բացի այդ, պետք է բացահայտել հիմնական մարտահրավերներն ու խոչընդոտները, ուսումնասիրել այնպիսի արգելքները, ինչպիսիք են կարգավորող սահմանափակումները, վենչուրային կապիտալի պակասը և այլն: Առանձնահատուկ կարևորություն ունի նաև միջազգային լավագույն փորձի վերլուծությունը:

Բացի այդ, անհրաժեշտ է մշակել ռազմավարական քաղաքականության առաջարկություններ՝ կոնկրետ ռազմավարություններ առաջարկելով պետական կառույցներին, մասնավոր հատվածի շահառուներին և ակադեմիական հաստատություններին՝ Հայաստանի տեխնոլոգիական ենթակառուցվածքն ու մարդկային կապիտալը բարելավելու նպատակով:

Այս հետազոտության արդյունքների հիման վրա Հայաստանը կարող է ձևավորել ամուր և մրցունակ տեխնոլոգիական էկոհամակարգ, որը կխթանի երկրի տնտեսական զարգացումը և կուժեղացնի նրա դիրքը գլոբալ թվային տնտեսությունում: Հետագա քայլերն ուղղված պետք է լինեն նոր հետազոտական ուղղությունների ուսումնասիրությանը, որոնք կօգնեն կատարելագործել ռազմավարական մոտեցումները և նոր հեռանկարներ առաջարկել Հայաստանի տեխնոլոգիական ոլորտի աճի համար:

Բանալի բառեր. տեխնոլոգիական էկոհամակարգ, SS ոլորտ, հետազոտություն և զարգացում (R&D), կայուն աճ:

ПРОБЛЕМЫ ТЕХНОЛОГИЧЕСКОЙ ЭКОСИСТЕМЫ РА: ВОЗМОЖНОСТИ УЛУЧШЕНИЯ

АРСЕН ЭРКОЯН
МЕРИ МУРАДЯН

Аннотация:

В эпоху быстрого технологического прогресса развитие сильной технологической экосистемы стало ключевым фактором экономического роста, инноваций и глобальной конкурентоспособности. Страны, которые успешно развивают технологические экосистемы, получают выгоду от повышения производительности, создания рабочих мест и улучшения уровня жизни. Армения, с растущим IT-сектором, прочной образовательной базой и активным вовлечением диаспоры, имеет значительный потенциал стать региональным технологическим хабом. Однако для полной реализации этого потенциала требуется комплексная стратегия, направленная на преодоление существующих проблем и использование возникающих возможностей.

Цель данного исследования – проанализировать текущее состояние технологической экосистемы Армении, выявить ключевые проблемы и предложить стратегические решения для ее устойчивого развития. Эффективно функционирующая технологическая экосистема играет важную роль в стимулировании инноваций, повышении экономической конкурентоспособности и обеспечении долгосрочного экономического роста. Учитывая стремление Армении занять позицию регионального технологического центра, необходимо оценить эффективность существующих политик и изучить новые механизмы укрепления экосистемы.

Для достижения этой цели исследование ставит перед собой несколько задач. Во-первых, необходимо оценить текущее состояние технологической экосистемы Армении, изучить ее структуру, ключевых участников и показатели эффективности технологического сектора, включая ИТ-компании, исследовательские институты и стартапы. Также важно выявить основные вызовы и барьеры, проанализировать препятствия, такие как нормативные ограничения, нехватка венчурного капитала и другие факторы. Особое значение имеет изучение лучших мировых практик.

Кроме того, необходимо разработать стратегические рекомендации по политике, предложить конкретные стратегии для государственных органов, частного сектора и академических учреждений с целью совершенствования технологической инфраструктуры и человеческого капитала Армении.

Используя результаты данного исследования, Армения сможет создать устойчивую и конкурентоспособную технологическую экосистему, способствующую экономическому развитию страны и укреплению ее позиций в глобальной цифровой экономике. В дальнейшем важно исследовать новые направления, которые позволят совершенствовать стратегические подходы и предложат свежие перспективы для роста технологического сектора Армении.

Ключевые слова. технологическая экосистема, IT-сектор, исследования и разработки (R&D), устойчивый рост.

PROBLEMS OF THE RA TECHNOLOGICAL ECOSYSTEM: IMPROVEMENT OPPORTUNITIES

ARSEN ERKOYAN
MERI MURADYAN

Abstract

In the contemporary era of accelerated technological advancement, the development of a robust technological ecosystem has emerged as a pivotal catalyst for economic growth, innovation, and global competitiveness. The successful cultivation of technological ecosystems has been demonstrated to yield increased productivity, job creation, and improved living standards. Armenia, with its expanding IT sector, robust educational foundations, and vibrant diaspora engagement, harbors considerable potential to emerge as a prominent regional technological hub. However, to realize this potential in its entirety, a comprehensive strategy is required to address the prevailing challenges and leverage emerging opportunities. **The purpose** of this study is to analyze the current state of Armenia's technological ecosystem, identify its key challenges, and propose strategic solutions for its sustainable development. A well-functioning technological ecosystem is crucial for fostering innovation, increasing economic competitiveness, and ensuring long-term economic growth. In light of Armenia's aspirations to establish itself as a regional technology hub, it is imperative to evaluate the efficacy of prevailing policies and to explore novel mechanisms for fortifying the ecosystem.

To this end, the study delineates **several objectives**. First, it assesses the current state of Armenia's technological ecosystem and examines the structure, key players, and performance indicators of Armenia's technological sector. This includes IT companies, research institutions, and startups. Furthermore, the identification of significant challenges and barriers, as well as an analysis of obstacles such as regulatory constraints and insufficient venture capital, is imperative. It is imperative to assess global best practices. The development of strategic policy recommendations and concrete strategies for government agencies, private sector stakeholders, and academic institutions to enhance Armenia's technological infrastructure and human capital is also necessary.

By leveraging **these research findings**, Armenia can establish a robust and competitive technological ecosystem that drives its economic development while strengthening its position in the global digital economy. In the future, it is essential to explore additional research avenues that can further refine strategic approaches and offer novel insights into the growth of Armenia's technology sector.

Keywords: technological ecosystem, IT industry, research and development (R&D), sustainable growth