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HUMAN CAPITAL AND ITS INFLUENCE ON THE EVOLUTION OF NATIONAL INNOVATION SYSTEMS

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ABSTRACT

The innovation ecosystem is expressed in the form of a network system that plays an important role in the economic development of countries in the 21st century. It is necessary to consider the innovation ecosystem in a way as an innovative environment in creation of which all sides implementing innovative work and service processes- governmental and non-governmental organizations, commercial associations and, most importantly, human capital are involved. Human capital, which refers to the skills, knowledge, experience and creativity of individuals within society, is a key driver of innovation and a fundamental element in fostering a dynamic and sustainable innovation ecosystem.

The human factor encourages the generation of ideas, entrepreneurship, collaboration and knowledge creation, contributing to the development of innovative solutions and the economic and social progress of a region or country. The research study investigated the role and importance of human capital in the innovation ecosystem, which is a particularly important factor in the modern world of information and digitization, where the main focus is on the "brain product". The result of researchers who have studied the mentioned topic before, are analyzed during the research, and the statistical data is used as the main data supporting the hypothesis.

1. INNOVATION ECOSYSTEM

Since innovation is a concept related to entrepreneurship, its significant impact on the economy is undeniable. As Nicolas Valery (1999) points out in his article "Industry Gets Religion" published in "The Economist", it is possible to state that innovation became the religion of industry in the late 20th century and became the key for the business world to increase its market share and profits. He states that, along with innovation discourses, governments use innovative solutions in their interventions in the economy (Valery, 1999).

Jackson (2011) defined the innovation ecosystem as "complex relationships between actors and organizations whose goal is to enable technology development and innovation". Actors and organizations included in the definition are explained as follows: actors – financial resources (such as funds, equipment, facilities) and human resources (such as students, sector researchers, sector representatives), institutions (organizations) - business schools, engineering faculties, venture capitalists, institutions such as regional development agencies (Jackson, 2011).

However, in practice, there are many countries that cannot achieve the same results by building a similar ecosystem and implementing similar practices. In this case, the reasons why analogous situations do not produce the same results, or in other words, why ecosystem experiments remain ceremonial empiricism, should be explored. National innovation ecosystem can exist only with high functional contributions. The main purpose of importing technology to countries is not to develop, but to create, research and learn their own brands and technologies with the help of the national innovation system. Countries should approach this situation within the framework of national policy in order to increase their innovation competence. This, in turn, necessitates state intervention, that is, state financing of technological activities and state intervention in the market.

It is believed that countries prioritizing their national innovation ecosystems and integrating them into the broader economic landscape will gain momentum in achieving a competitive edge. This is because the national innovation ecosystem facilitates the "commercialization" of technological research outcomes, which arise from the collaborative efforts of the government, research institutes, universities, and industry (Lu, et al., 2014).

The National Innovation Ecosystem represents a conceptual model for examining innovation dynamics, focusing on the collaborative efforts of various entities such as government, businesses, universities/public research centers, and financial institutions. This framework underscores the importance of technology and information exchange among individuals, organizations, and institutions in driving the innovation process forward. The advancement of innovation and technology stems from intricate interactions among stakeholders within the ecosystem, including institutions, universities, and government research institutes. The concept of national innovation systems is employed to comprehend and facilitate fundamental transformations in organizing and overseeing the innovation process (World Economic Forum, 2020).

2. ECONOMIC MODELS USED TO ANALYZE INNOVATION ECOSYSTEMS:

2.1. Schumpeterian Model of Economic Growth:

Developed by economist Joseph Schumpeter, this model emphasizes the role of innovation and entrepreneurship in driving economic growth.

Key components of the Schumpeterian model include:

- Entrepreneurship: Entrepreneurs play a central role in the innovation process by introducing new products, technologies, and business models to the market.
- Creative Destruction: Innovation leads to the displacement of existing products and industries, creating opportunities for new firms and industries to emerge.
- Technological Change: Continuous technological progress is the primary driver of long-term economic growth, as new innovations increase productivity, efficiency, and competitiveness.
- Implications for Innovation Ecosystems: The Schumpeterian model highlights the importance of fostering a supportive ecosystem for innovation and entrepreneurship, including access to funding, skilled labor, research infrastructure, and supportive government policies (Schumpeter, 1934).

2.2. Porter's Diamond Model:

Developed by economist Michael Porter, this model identifies four interrelated factors that shape a nation's competitive advantage and innovation ecosystem.

Key components of Porter's Diamond model include:

- Factor Conditions: The availability of factors of production such as skilled labor, infrastructure, capital, and natural resources.
- Demand Conditions: The nature and sophistication of domestic demand for goods and services, which drive firms to innovate and improve their competitiveness.
- Related and Supporting Industries: The presence of strong and competitive upstream and downstream industries that facilitate innovation, knowledge spillovers, and collaboration.
- Firm Strategy, Structure, and Rivalry: The extent of domestic competition and the strategies adopted by firms to compete in the global market, which stimulate innovation and productivity improvements.
- Implications for Innovation Ecosystems: Porter's Diamond model emphasizes the importance of a holistic approach to building innovation ecosystems, addressing factors such as education and skill development, infrastructure development, industry collaboration, and competition policy to enhance national competitiveness and foster innovation-led economic growth (Davies and Ellis, 2000).

These economic models provide frameworks for understanding the dynamics of innovation ecosystems and the factors that drive innovation, entrepreneurship, and economic development. By applying these models, policymakers, business leaders, and researchers can identify opportunities to strengthen innovation ecosystems and promote sustainable growth and prosperity.

3. MAPPING NATIONAL INNOVATION ECOSYSTEM

Mapping the superstructure of national innovation systems involves understanding that it comprises multiple interrelated systems working in tandem. Unlike a single cohesive entity, there's typically no centralized direction due to the complexity and vast amount of information involved, making accurate and entirely rational planning challenging.

Governments often rely on a variety of experts and advisory groups to develop national-level strategies and plans. The outcomes of these exercises can vary widely in their utility and foresight. While some advisory groups may be influenced by self-serving interests aimed at shaping national policy for personal gain, others may produce innovative and forward-thinking recommendations (Lundvall, 2010).

Ultimately, the selection of members for strategy and planning roles emerges as a critical function of the executive branch, as it significantly impacts the direction and effectiveness of national innovation strategies.

Measurement and evaluation of national innovation systems are directed towards four types of knowledge or information flows:

- Mutual linkages between institutions, primarily focusing on joint research activities and other technical collaborations.
- Interactions between institutions, universities, and the public, including research institutes, joint research, patenting, joint publications, and more informal connections.
- Dissemination of knowledge and technology through institutions, including industry adoption levels for new technologies and dissemination through machinery and equipment.
- Mobility of personnel, both within and between technical teams, focusing on the movement of personnel between the public and private sectors.

Efforts to link these flows to a firm's activities enhance high-level technical collaboration, technology diffusion, and improve innovation potential, resulting in products, patents, and productivity gains for institutions (Lundvall, 2010).

The Global Innovation Index 2023 (GII) serves as a barometer of global innovation trends, offering insights into the innovation landscape amidst a backdrop of economic uncertainty. The report ranks the world's most innovative economies among 132 nations, shedding light on their strengths and areas for improvement. Furthermore, it identifies and highlights the top 100 science and technology innovation clusters, providing valuable localization of innovation hotspots around the globe.

In the Global Innovation Index 2023, Azerbaijan has been ranked 89th among countries categorized as upper-middle-income economies. This ranking provides a snapshot of Azerbaijan's innovation performance relative to other nations in a similar income bracket. It highlights Azerbaijan's position within the global innovation landscape and offers insights into areas where the country can focus on enhancing its innovation ecosystem and competitiveness (World Intellectual Property Organisation, 2023).

The Doing Business report is grounded in research that explores the development of effective institutions. It delves into the mechanisms behind institutional change, emphasizing the significance of historical context. The report underscores the importance of designing institutions

that complement existing frameworks, human capacities, and available technologies. By understanding the drivers of institutional change, policymakers can work towards creating environments conducive to economic growth and development.

As of the latest Doing Business report, Azerbaijan holds the 34th rank with a Doing Business score of 76.7. This score reflects Azerbaijan's performance in terms of business regulation and the ease of doing business within the country. A higher score indicates a more favorable business environment, while a lower rank suggests areas where improvements can be made to enhance the ease of doing business and attract investment (World Bank, 2020)

Azerbaijan serves as a notable example of how a country within the Eastern Partnership (EaP) has successfully developed an e-government system within a relatively short timeframe. The country initiated the "National Strategy for the Development of the Information Society in the Republic of Azerbaijan for 2014-2020" with the aim of addressing legal barriers hindering the introduction of digital services. Subsequently, in March 2018, the e-Government Development Center was established by Presidential Decree under the supervision of the State Agency for the Provision of Services to Citizens and Social Innovation. This center is tasked with coordinating the implementation of e-government services, enhancing the management of publicly available information, and raising awareness about the availability of e-services.

Through collaborative efforts, Azerbaijan launched a new unified portal for all e-government services (www.digital.gov.az) in 2018. This portal offers access to over 440 different digital services catering to various segments of the population, including both legal entities and individuals. This initiative demonstrates Azerbaijan's commitment to advancing digitalization and improving public service delivery through effective e-government solutions (Civil Society Forum, 2019).

4. THE ROLE OF HUMAN CAPITAL

Innovation ecosystems are essential for the advancement of smart, sustainable, and inclusive growth, which were the primary focus areas of the EU countries' 2020 strategy. It is widely acknowledged that achieving these goals is impossible without the cultivation of knowledge, skills, and values, collectively known as human capital. High-quality education and training, the spread of knowledge across production and service sectors, the promotion of creative industries, and the development of research-intensive economies are all critical components of building robust innovation ecosystems. Human capital, measured by indicators such as GDP per capita, stands out as the primary driver of economic growth. Therefore, many development objectives emphasize the importance of enhancing education and skills within innovation ecosystems (Hawkes and Ugur, 2012).

Human capital plays an important role in the formation and success of the innovation ecosystem. An innovation ecosystem is an interconnected network of individuals, organizations, resources, and institutions that collaborate and interact to create and commercialize new ideas, technologies, and products.

The impact of human capital development on innovation and, consequently, on the competitiveness of the economy has been emphasized by numerous researchers in many publications. More than 100 years ago, Schumpeter highlighted the importance of knowledge for innovation. Later, Drucker emphasized the importance of investments in human capital for the competitiveness of countries through innovation.

Human capital plays a crucial role in shaping the pace of technological advancement within a nation. It serves as a fundamental determinant of the country's technological progress. Human capital contributes to the acceleration of technological advancement through two main avenues: the creation of novel innovations and the adoption of more advanced technological solutions through imitation. The extent of imitation can be gauged by comparing the productivity levels of the leading technological country with the potential productivity of the nation in question.

Human capital is perceived in two distinct ways within economic discourse. Firstly, it is regarded as an autonomous factor of production that enhances productivity without necessarily altering the existing level of technology. This perspective is highlighted in the works of Lucas (1988) and Mankiw et al. (1992). Secondly, human capital is viewed as a crucial input in the innovation process, serving as a complement to technology. Scholars such as Benhabib and Spiegel (1994), Romer (1990), and Nelson and Phelps (1966) emphasize this perspective, suggesting that investments in human capital facilitate the development and adoption of new technologies, thereby contributing to economic growth and innovation (Lucas, 1988; Mankiw and et al.; Benhabib and Spiegel, 1994; Romer, 1990; Nelson and Phelps, 1966).

Building on the foundational work of Nelson and Phelps (1966), these scholars posit that human capital primarily serves to enhance a country's level of technology through two main mechanisms: the adoption of superior foreign technology and the creation of domestic innovations. In essence, human capital is not viewed as a substitute for technology but rather as an essential component for driving innovation forward (Nelson and Phelps, 1966).

In their empirical approach, Benhabib and Spiegel propose that a country's technological level is influenced by both imitation and innovation activities. They measure a country's capacity to innovate based on its stock of human capital, which is quantified by the average years of schooling within the labor force. The potential for imitation is approximated by the existing gap between the technological level of the leading productivity nation and the less advanced technological level of the country in question (Benhabib and Spiegel, 1994)

It's noteworthy that their research reveals a significant impact only of human capital levels on the growth of total factor productivity. In contrast, the growth of human capital does not demonstrate a direct effect on economic performance. Their analysis focuses on levels rather than growth rates, as data on literacy and income proxies are available only for a single cross-section.

The state plays an important role in the cultivation of human capital in the national innovation ecosystem. Some countries (such as Taiwan, South Korea, Singapore, which previously did not have a say in the industry, but today are leaders in the world market with innovative products, as well as IEEs) are trying to form a national innovation ecosystem by investing in education, vocational training and lifelong learning initiatives. Arusha in Tanzania, Ahmedabad in India, or Kibera slums in Nairobi, Kenya lack many of the amenities that characterize Silicon Valley. Despite this, they managed to create vibrant, local innovation ecosystems. Countries like Azerbaijan and Turkey can develop this by investing in human capital with the necessary planning and innovation policies they should adopt. In addition, they should promote policies that attract and retain talent, support entrepreneurship, and foster a culture of innovation and creativity. By recognizing the importance of human capital and investing in its development, countries can position themselves for long-term economic growth and competitiveness in the context of global innovation.

It is stated in the "Azərbaycan 2020: Gələcəyə Baxış" İnkişaf Konsepsiyası, 2012" development concept that the transition from a traditional economy to a knowledge-based economy should be established as the foundation from now on, and for this purpose, adequate development of human capital, which is decisive, should be emphasized.

Human capital plays a pivotal role in nurturing and advancing a national innovation ecosystem through various means, including:

- ✓ Knowledge creation and R&D;
- ✓ Entrepreneurship and innovation;
- ✓ Adoption of new technologies;
- ✓ Problem solving and creativity;
- ✓ Transfer of knowledge;
- ✓ Cooperation and networking;
- ✓ Education and development of soft and hard skills;
- ✓ Research and academic institutions;
- ✓ Leadership and management;
- ✓ Innovation culture;
- ✓ Digital literacy

In his research, Cof (2012) assessed the innovation ecosystems of five countries based on six key variables: market, capital, people, culture, infrastructure, and policies. Within this framework, the variable of "human" encompasses enterprising individuals who contribute to the innovation ecosystem (Cof, 2012).

In their study, Fukuda and Watanabe (2008) analyzed the development of technology policy in Japan and the United States over the past 30 years and developed a model of how countries can assess their innovation ecosystem. In this model, they considered the variables of infrastructure, investments, talent pool, supply for innovation input and demand for innovation output (Fukuda and Watanabe, 2008). "Thinking brain" was one of the main elements of the mentioned research.

Tabanski and Israel (2015) analyzed Israel's innovation ecosystem from a cybersecurity perspective in their research works. The country's main strategy, performance indicators, culture, human resources, private sector in the country, legal conditions and universities were analyzed in the mentioned research work. Israel's innovation ecosystem, government programs, private/public sector activities, cooperation between the public and private sectors, investments in human resources, demand in the private sector, and the importance of research funds have also been analyzed in other studies. (Frenkel, et al., 2011).

Khorsheed (2014) aimed to provide a general framework for the national innovation ecosystem and identified eight variables in his study: research centers, government, institutions, associations, financial providers, knowledge transfer centers, social networks and entrepreneurs (Khorsheed, 2014).

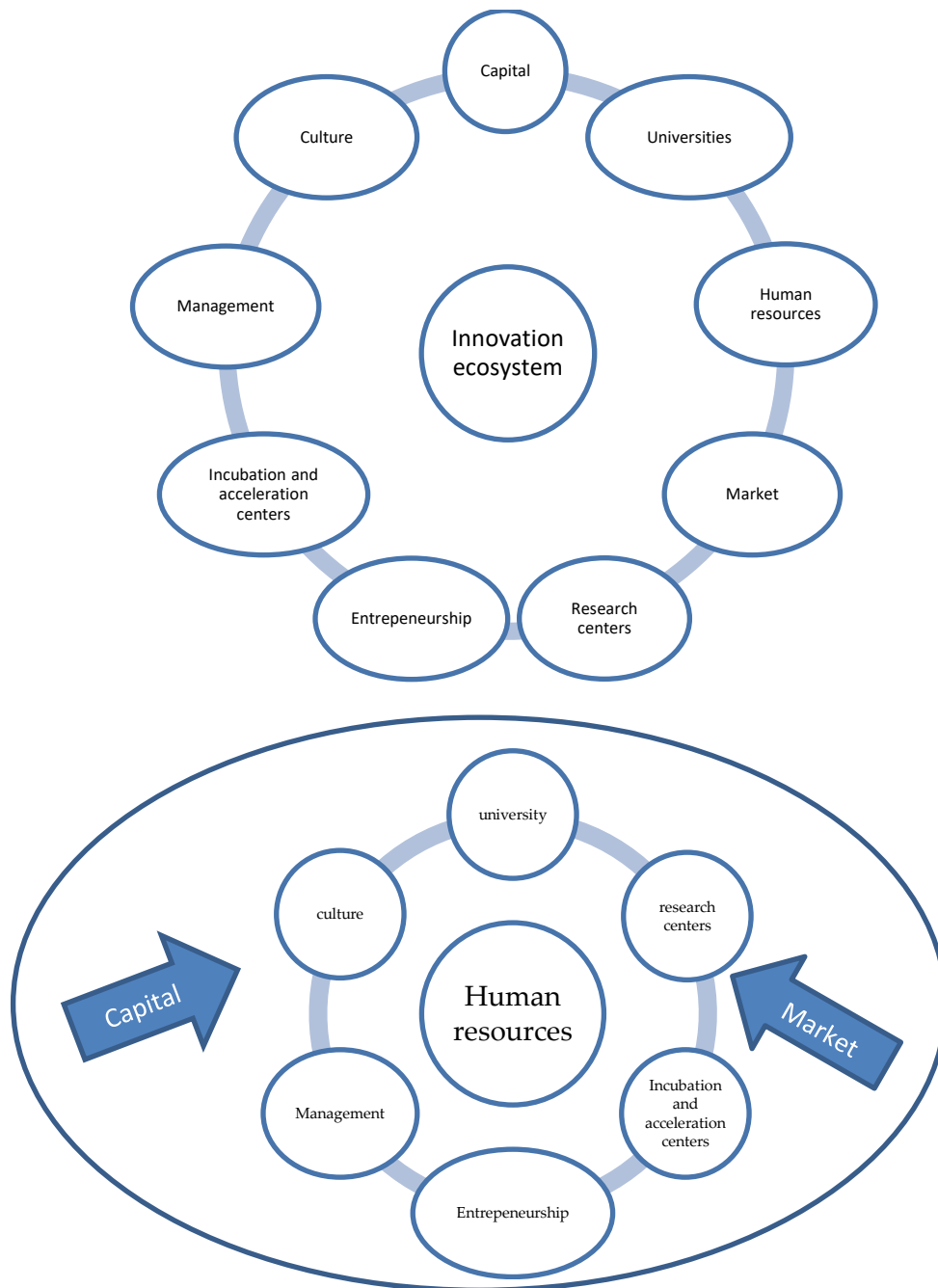


Figure1. Comparative analysis of the components of the national innovation ecosystem and the human resource-centered innovation ecosystem

Universities are key factors in the ecosystem. In addition to directly participating in innovation activities, they are also important in providing human resources and creating an innovation culture.

5. TECHNOLOGY CENTERS ESTABLISHED TOGETHER WITH UNIVERSITIES IN AZERBAIJAN

The responsibilities of the education system Education qualities are indicators of an individual's breadth of knowledge and to some extent, their practical skills. However, a significant portion of knowledge in the knowledge economy comes from learning by doing and extends beyond traditional education.

If we look at the experience of the neighboring country Turkey, since 2012, it has been ranked in the "Most Innovative and Most Entrepreneurial 50 Universities" prepared by TUBITAK. Azerbaijan does not have such a demand from universities at the national level yet. Universities see the innovations happening in the world, try to get out of the position of only education providers, and also prepare a strategic action plan in the direction of becoming research centers. Azerbaijan State University of Economics, Khazar University, Baku Engineering University, Azerbaijan Diplomatic Academy, and Azerbaijan State Oil and Industry University are universities that function as research centers and play a significant role in contributing to the country's innovation ecosystem. These institutions collaborate with the government and industry to establish innovative triad models, fostering research, development, and innovation in various sectors of the economy.

The eiLink (Education Industry Link) Research and Development Center was established at Khazar University in December 2015 with the support of the Azerbaijan branch of the Society of Petroleum Engineers (SPE). The primary objective of this research center is to become a leading entity in research across various fields and to deliver high-quality education. Working in collaboration with industry experts, the eiLink R&D center conducts research in areas such as Geological Exploration, Reservoir Engineering, Computer and Information Sciences, with a focus on Data Science, numerical simulations, and oil engineering (<https://khazar.org/az/item/1426>).

The Baku Engineering University (BEU) Technopark stands as the pioneering and dynamic structural unit among higher education institutions in Azerbaijan. Since its inception on November 8, 2016, the technopark has been actively engaged in various activities. Its primary objective is to enhance the reputation of the university as a competitive higher education institution on the international stage. Additionally, the BEU Technopark aims to foster an ecosystem that facilitates university-industry collaboration, providing modern infrastructure and research opportunities to relevant companies, researchers, and academic staff (<https://beu.edu.az/az/page/technopark-30>).

Baku Higher Oil School (BHOS) and Industry Partnerships: BHOS partners with government agencies and industry leaders in the oil and gas sector to offer specialized programs and research projects. These partnerships provide students with hands-on experience and industry-relevant skills, preparing them for careers in Azerbaijan's key economic sectors (bhos.edu.az).

6. ARTIFICIAL INTELLIGENCE

In the context of the innovation ecosystem, it's essential for Azerbaijan to adapt its focus in the ICT sector in response to global trends. While hardware manufacturing and distribution have become concentrated in a few global hubs, there are emerging technologies where Azerbaijan can invest and reap significant benefits.

Artificial intelligence, cloud computing, and social media represent areas of ongoing innovation with considerable potential. By directing efforts towards these domains, Azerbaijan can leverage its assets and capabilities to better integrate into the global economic system. This shift aligns with the principles of the innovation ecosystem, where resources and investments are strategically allocated to maximize returns and foster sustainable growth in line with evolving technological landscapes.

Artificial intelligence (AI) is indeed crucial for the future of governments, offering opportunities for improved efficiency, decision-making, and service delivery. Considering that

hardware manufacturing and assembly have become concentrated in other parts of the world, Azerbaijan may find it strategic to focus its ICT innovation efforts on AI. Unlike hardware, the barriers to entry for AI utilization are relatively low, making it accessible for countries like Azerbaijan to leverage its potential.

Investing in AI technologies can empower governments to streamline processes, enhance citizen services, and make data-driven decisions. By harnessing AI capabilities, Azerbaijan can modernize governance, improve public services, and stimulate economic growth. Moreover, prioritizing AI innovation aligns with global trends and positions Azerbaijan at the forefront of technological advancement in the governmental sector.

By leveraging AI in its university-government-entrepreneurship collaboration, ADA University's Center for Data Analytics Research demonstrates how AI technologies can drive innovation, economic development, and societal impact in Azerbaijan. Through interdisciplinary collaboration, education, and research, CEBA plays a pivotal role in advancing AI adoption, fostering entrepreneurship, and building a thriving digital ecosystem in the country.

7. CONCLUSION

In concluding the research findings, it's imperative to view human capital not merely as a component but as the very essence of the innovation ecosystem itself. As depicted in Figure 1, the circle represents the holistic national innovation ecosystem. Innovation is intricately linked to human cognition—a continuous process of ideation, experimentation, and adaptation. The establishment of a robust national innovation ecosystem hinges on the education, mindset, drive, and risk-taking propensity of the population. Therefore, the primary responsibility of the state lies in fostering a culture of innovation, nurturing creative thinking, and providing steadfast support to nascent ideas. This necessitates a concerted effort from incubation and acceleration centers, research institutions, and scientific facilities, all working collaboratively towards a common goal.

Ways to motivate skilled individuals to engage in national innovation endeavors could encompass the following incentives:

- **Competitive Compensation and Benefits:** Providing attractive salary packages and benefits can entice talented professionals to join and contribute to national innovation projects.
- **Professional Growth Opportunities:** Offering avenues for continuous learning, training, and skill enhancement can incentivize individuals to apply their expertise toward significant national initiatives.
- **Recognition and rewards:** Acknowledging and rewarding the contributions of individuals to national innovation efforts through awards, honors, or public recognition can serve as powerful incentives.
- **Access to resources and infrastructure:** Ensuring that skilled individuals have access to the necessary resources, research facilities, and infrastructure can motivate them to participate in national innovation projects.
- **Collaboration opportunities:** Facilitating collaboration and networking opportunities with other skilled professionals and organizations can incentivize individuals to contribute their talents to national innovation efforts.

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