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THE SYSTEM OF GLOBAL INDICATORS OF SCIENCE AND TECHNOLOGY AND THE TRENDS OF DECLINING EFFECTIVENESS OF APPLIED RESEARCH IN THE REPUBLIC OF ARMENIA

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Abstract

On the global market, the development growth rates of various countries differ strongly from one another. This results in a modification of their function and significance in terms of regional development. The foundation is the rate at which intellectual capital is developing and materializing as it is realized in the field of research and development.

The objective of this study is to investigate the problems related to the structure and content of intellectual capital in Armenia, with the aim of forming the best balance of policy and practical measures implemented in the mentioned field, which will provide an effective development environment for the implementation of research and design works and their results. A detailed explanation of the essential actions necessary to accomplish the stated objective is provided. A substantive description of the priority steps aimed at achieving the stated goal is presented.

Key words: high-tech, applied research, intellectual property, experimental development, Human Development Index.

Introduction

While mankind was still in its infancy, the Greeks observed that everything is constantly changing and evolving, including nature, social order and its laws, and human relationships.

This phenomenon is characterized by the concept of "Pantarei" (Pantarhei is a simplified version of the teachings of the famous Greek philosopher Heraclitus of the late 6th century BC. He said “no man ever steps in the same river twice, for it's not the same river and he's not the same man.” That is nothing stays still, 'everything flows': everything and everywhere, like a river, is constantly in motion. There were views about the forces that ensure development and everyone began to understand that this force is man. It is that person who, through the use of his/her organizational abilities, transforms the environment and takes the lead in advancing social relations and the means of production.

It should also be noted that society adopted this concept quite late. This was due to the fact that the ways of development seemed to be obvious. One of them was called the **extensive path**, when the physical capabilities of the state are expanded for public needs, for example, the areas of pastures and arable lands, the number of livestock, etc. are increased. The second way is the **intensive development**, in which case, not the physical sizes and dimensions of the resources, but their qualitative characteristics are increased. In other words, a unit of arable land produces, for example, more wheat, and a unit of animals produces more milk, meat, wool, eggs, etc. In other words, in the case of intensive development, labor productivity increases. Let's discuss a specific example: suppose the yield of wheat from any land increases by X percent. How can this happen? It is clear that in such a case fertilizers, different types of herbicides, chemical substances were used, that is, certain results of science and scientific and technical activities were used. It should be noted that there are fewer opportunities for the world's natural resources to grow with every passing day, and they are no longer able to meet society's growing demand for consumer goods. In essence, there are no longer any opportunities for the planet Earth to realistically increase its production resources. Non-renewable resource extraction options have been drastically diminished. The enormous scale of the production increase is what has led to this situation. Only during the last 25 years,

the amount of raw iron consumed only in the last 25 years is comparable to the amount of metal ore consumed over the course of human development. It is not a coincidence that various nations are attempting to claim the resources of the Earth's poles in order to increase their mineral reserves, as well as the implementation of fantastic programs like, for instance, "Lithium importation from other planets or space objects," given that lithium is an efficient raw material for electricity generation. The realization of all this requires a certain period of time and greatly increases the cost of extraction and use of various types of raw materials. Getting artificial materials and raw materials through scientific processing is the main way to avoid all of this seemingly impossible task. Let's not forget that in terms of consumption and quality attributes, the types of raw materials obtained through innovative programs can be superior to the types of natural raw materials. Such an example is the production of natural and artificial rubber. It should also be noted that in human history, scientific and scientific-technical activity appeared when society was able to create additional output, that is, to create and accumulate more than it consumed. At the expense of surplus value, a certain class of people appeared who could engage in science and scientific and technical activities, as noted by one of the classics, Karl Marx, the Egyptian pyramids could be built only when surplus value was created in Egypt.

Scientific and scientific-technical activity is the driving force that can push the society forward at an accelerated pace. An example of this is the steam engine created by James White, which was interpreted by the same Karl Marx as: mankind benefited more in the year after White's invention of the steam engine than it had spent on all scientific research put together before White's invention of the steam engine.

Thus, discoveries and innovations have a vital importance and role in meeting the demands of the society. White's steam engine, which was the centerpiece of the third industrial revolution, was designed to meet seemingly impossible human demands. In particular, the replacement of manual labor made it possible to significantly increase the volume of products and services produced, which was the only way to meet the demands of the growing population.

In a broad sense, scientific and scientific-technical activities fundamentally change the economic and social environment of society, as well as have a significant impact on people and society's activities. In particular, the population of planet Earth grew particularly rapidly during the 19th century, a consequence of White's invention and use of the internal combustion engine. The use of various technical means (tractor, harvester and other agricultural means) significantly increased the agricultural sown area, which provided enough food to feed people and thus increase the reproduction of the population by hundreds of millions of people.

It is also known that the computer was recognized as the best technical tool of the 20th century, it also made it possible to create the Internet, which makes both production and socio-economic life incredibly easy and efficient. It can be said that through science and scientific and technical activities, both real and virtual worlds are currently operating on planet earth. Often the main developments and results of science and scientific and technical activities are obtained not for the achievement of civil achievements but for military purposes. In some states, although they are unable to develop and produce simple household goods, they produce sophisticated missiles and types of armaments and weapons. According to the calculations of some experts, it is possible to eliminate the planet Earth more than 2000 times

with the weapons created on the planet Earth. That is, science and scientific and technical activities contribute to the improvement of human life conditions on the one hand and become a threat to the existence of the planet Earth on the other hand.

Based on socio-economic and military-political ideology, different ideologies and practices regarding science and scientific-technical activities have been formed and are operating in different countries. Each state, based on its capabilities, in order to survive and develop, should be able to correctly assess its place and role in the given region (world) and use the achievements of science to increase the well-being of the population and ensure economic growth.

The best way to achieve this is the implementation of sufficient volume of expenses for the implementation of scientific and technical developments and the introduction of innovations.

Researchers are regarded as specialists whose work advances theories, develops concepts, models new research tools, and creates computational techniques. Additionally, master's degree candidates and students are included in the research. The Organization for Economic Co-operation and Development (OECD) defines research as creative work undertaken to increase the stock of knowledge, including knowledge about people, culture and society, and the use of that knowledge to develop new applications. Research and development (R&D) includes activities that organizations undertake to innovate and introduce new products and services. It frequently marks the beginning of the development process. Based on the findings of the first stage, mass production of new goods and services is organized in the second stage. When the domestic market of the target nation is fully stocked with the specified goods and services, the third stage of their development—their export to other nations—begins. The fourth stage is the period of "death of the product or service" - it is withdrawn from production and market. Depending on the quality of innovative product or service developments, the marketing studies conducted and how they meet consumer needs, "product life cycles" can be short-term or long-term (prospective). This circumstance determines the profitability (or loss) of the creation and sale of the product or service.

Typically, the objective is to expand the company's revenue stream and introduce new goods and services to the market. With no other options available to them, consumers are forced to buy them at a high "additional" cost, which ensures the increase in profits of those businesses that followed the path of innovations. This strategy is due to the dominant position of a newly created product or service in the market of newly created products and services (the principle of "picking the cream").This consists in taking the risk of realizing the production of innovative products and services and spending on innovations in comparison with "ordinary" companies, with the aim of increasing the share of innovative products and services in the market.

You cannot separate how you feel about money from it. No matter how experienced or inexperienced the decision-maker is in economics, he must make an effort to think irrationally and predictably in order to make better investment decisions. Experimental development and basic and applied research are both included in R&D [1].

1. Without any specific application or use, basic research is theoretical or experimental work done primarily to learn more about the underlying causes of phenomena and observable facts.

2. Applied research is undertaken in order to acquire new knowledge, which is mainly carried out for a specific practical purpose.
3. Experimental development is systematic work based on knowledge gained from research and (or) practical experience aimed at obtaining or improving new materials, products or devices.

Given the pace of technological advancement, R&D is essential for organizations to remain competitive. It will allow companies to create products that are difficult for their competitors to duplicate. At the same time, R&D efforts can lead to improved organizational productivity [1].

An intellectual capital-based consumption and production system is known as a knowledge economy. It specifically refers to the capacity to profit from scientific breakthroughs and applied research. Intellectual capital is the value of a company's employees' knowledge, skills, business training, or any proprietary information that can provide a company with a competitive advantage. Intellectual capital is considered an asset and can be broadly defined as the collection of all information resources at a company's disposal that can be used to generate profits, acquire new customers, create new products, or otherwise improve the business. It is the sum of employee expertise, organizational processes and other intangible values that contribute to the company's bottom line [2. 3]. Because of this, in the modern world, intangible assets—which include research and development outcomes, which are nothing more than the value of intellectual work (capital), or, in other words, scientific thought—have a much larger share in the assets of organizations of this type. developed innovations and other studies that have found use in the real world and are very profitable for the organization.

As an illustration, the assets of the well-known company Coca-Cola are estimated to be worth about 160 billion dollars, with intangible assets accounting for the majority (more than 85%) of that total. In other words, the company's manufacturing equipment, transportation infrastructure, warehouses, and physical structures are worth many times less than the market value of the intangible assets used by the particular company.

Many people, for various reasons, are afraid of increasing the funding of innovative products and services, because the market has its rules of the game, and the consumer has his "whims", which can often change unexpectedly, thereby rejecting the consumption of this or that innovative product in the market. Those risks are dangerous and misleading, they must be overcome (to be demystified), turning finances into investments, savings and the ability to manage economic opportunities through smart spending [2].

A developed nation with a comparatively high level of economic growth and security is considered to have a developed economy. The amount of technological infrastructure, industrialization, per capita income or gross domestic product, and population standard of living are all common metrics for determining a nation's level of development. If the gross domestic product per capita is high, but the state has poor infrastructure and income inequality, it cannot be considered a developed country [4].

The Human Development Index (HDI) summarises a nation's health, education, and literacy levels into a single figure. It can be used to evaluate the degree of development in a nation. The Human Development Index (HDI) of the United Nations looks at three aspects of living standards: literacy, educational attainment, and access to medical care. That information is quantified from 0 to 1. The HDI index is greater than 0.8 in the majority of developed nations [4, 5].

Fig. 1 shows the Human Potential Development Index (HDI) for the Russian Federation, Armenia, Georgia, and Azerbaijan for the period 2000–2021.

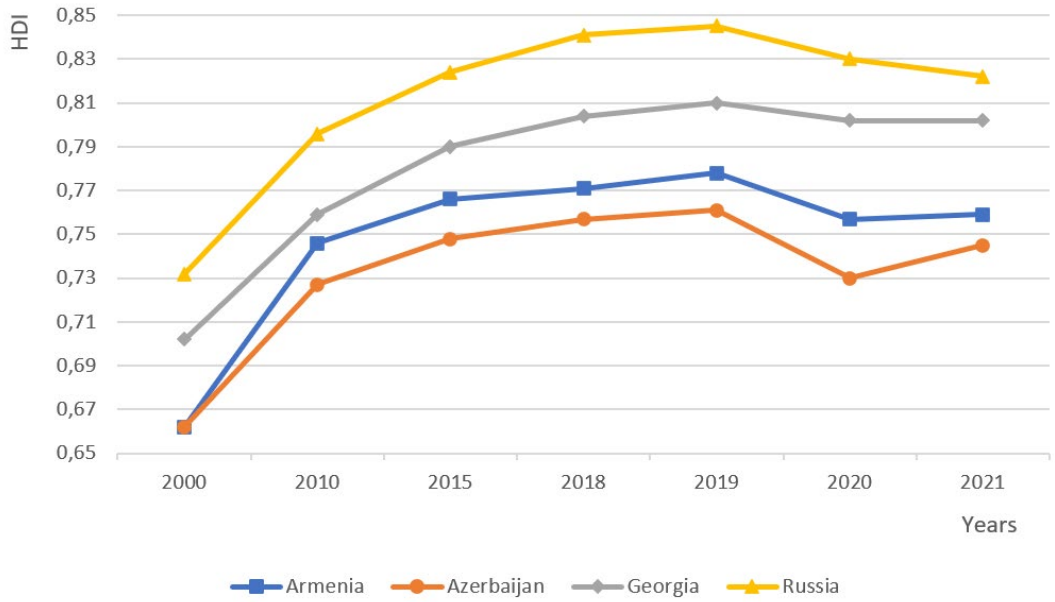

Fig. 1 Dynamics of Human Potential Development Index (HDI) of Armenia, Georgia, Azerbaijan and the Russian Federation for 2000-2021

It is obvious that Armenia is inferior to the Russian Federation and Georgia in terms of the Human Potential Development Index (HDI), but it is ahead of Azerbaijan, whose financial capabilities are incomparably greater than those of Armenia.

The Human Development Index (HDI) is not the only metric used to evaluate the economic health of a nation. Future research will be required to ascertain the effects of investment programs on enhancing the effectiveness of research, design, and construction, as well as on enhancing the institutional environment, developing infrastructure, stabilizing the macroeconomic situation, and fostering organizational continual competitiveness [6].

A debate between GDP and HDI, as well as other measures characterizing people's well-being (for example, Gross National Happiness concept is assumed that sustainable development should take a holistic approach to the concepts of progress and give equal importance in the debate between non-economic aspects of well-being), is not sufficiently substantiated whether it is possible to shift the policy vector from the struggle of competing paradigms to the field of obtaining information about well-being directly from the population [7].

Conflict Setting

Analysis of the export situation for Armenia's results of applied research and experimental development is required, as well as recommendations for improving the effectiveness of the work being done in this direction.

Research Results

Let's present the 2020 figures for the use of intellectual property income in US dollars for a few former Soviet Union nations (Tab. 1) [8].

Table 1

Intellectual property in several nations of the former Soviet Union for use in 2020 receipts in US $

Country	RF	Belarus	Kazakhstan	Georgia	Moldova	Tajikistan	Azerbaijan	Armenia
Receipts (US $)	6,809,070,000	3,211,793,000	146,184,000	54,890,640	26,640,000	22,670	0	0

The Organization for Economic Co-operation and Development and Eurostat collaborated to develop the high-tech export estimation method. It uses a "product approach" based on R&D intensity for product groups from Germany, Italy, Japan, the Netherlands, Sweden, and the United States rather than a "sector approach" (spending divided by total sales). Examples of high-tech industries are airplanes, computers, pharmaceuticals, electrical equipment, and most chemicals. Medium and low technologies include rubber, plastics, food processing, textiles, clothing, footwear. Technology exports have grown rapidly in Eastern European countries, although most of these countries, with the exception of Hungary and the Czech Republic, continue to focus mainly on low- and medium-low technology exports. Because industries that specialize in several high-tech industries can also produce low-tech products. In this regard, it is more convenient to use a method that takes into account only R&D intensity. However, it is very important to take into account such high-tech characteristics as "know-how", the potential of the organization's scientific staff, and the technologies recorded in invention patents [8].

In the European scientific and educational community, the following classification of science and technology fields is used [9]:

1. Natural sciences; 2. Engineering and technology; 3. Medical sciences; 4. Agricultural sciences; 5. Social sciences; 6. Humanities.

This classification was adopted based on the recommendations of the Science and Technology Sector Classification (FOS) created by the Organization for Economic Co-operation and Development (OECD) Committee on Science and Technology Policy and the UNESCO Recommendation on the International Standardization of Science and Technology Statistics [10, 11]. In the Republic of Armenia, when announcing tenders on contractual (thematic) and applied (experimental developments) topics, the authorized body of the government issues the relevant regulations that govern the fields and professions of scientific and scientific-technical activities.

Tab. 2 shows a comparison of the classification of the fields of science and technology used in the European Scientific and Educational Area and in the Republic of Armenia.

Table 2 demonstrates some of the differences between the classification of scientific and technological fields used in the Republic of Armenia and the European scientific and educational community. Contrary to the Republic of Armenia, the classification used in Europe's scientific and educational community specifically provides a section for "other sciences" for each field because it is unable to fully cover all aspects of the field. Additionally, the scientific directions that are part of the official classification documents used in the European Scientific and Educational Area are defined for each department (for the Department of Natural Sciences, for instance, the following scientific directions are defined: Earth sciences and associated environmental disciplines: Geosciences, Multidisciplinary, Mineralogy, Palaeontology , Geochemistry and Geophysics, Physical Geography, Geology,

Volcanology, Environmental sciences, Meteorology and Atmospheric Sciences, Climatic Research, Oceanography, Hydrology, Water Resources).

Table 2

Comparison of the classification of science and technology fields used in the European scientific and educational area and in the Republic of Armenia

European Scientific and Educational Area	Republic of Armenia
1. NATURAL SCIENCES	
1.1 Mathematics 1.2 Informatics and computer sciences 1.3 Physics 1.4 Chemistry 1.5 Earth and related environmental sciences 1.6 Biological sciences 1.7 Other natural sciences	1.1 Mathematics 1.2 Informatics and computer sciences 1.3 Physics and Astronomy 1.4 Chemistry 1.5 Earth and related environmental sciences 1.6 Biological Sciences
2. ENGINEERING AND TECHNOLOGY	
2.1 Urban planning and architecture 2.2 electrical engineering, electronics, information engineering 2.3 Machine building 2.4 Chemical technologies 2.5 Materials science 2.6 Medical device engineering 2.7 Ecology 2.8 Environmental biotechnology 2.9 Industrial biotechnology 2.10 Nanotechnology 2.11 Other techniques and technologies	2.1 Urban planning and architecture 2.2 Electrical engineering, electronics, energy, computer and information technologies 2.3 Mechanics 2.4 Machine science and machine building 2.5 Chemical technologies 2.6 Materials science 2.7 Medical device construction 2.8 Ecology 2.9 Biotechnology 2.10 Nanotechnology
3. MEDICAL SCIENCES	
3.1 General medicine 3.2 Clinical medicine 3.3 Health sciences 3.4 Medical biotechnology 3.5 Other medical sciences	3.1 General medicine 3.2 Clinical medicine 3.3 Medical biotechnology
4. AGRICULTURAL SCIENCES	
4.1 Agriculture, forestry, fish farming 4.2 Animal husbandry 4.3 Veterinary medicine 4.4 Agricultural biotechnology 4.5 Other agricultural sciences	4.1 Animal husbandry, veterinary medicine 4.2 Crop production 4.3 Soil science, agrochemistry, plant protection 4.4 Agricultural biotechnology
5. SOCIAL SCIENCES	
5.1 Psychology 5.2 Economics and business 5.3 Pedagogical sciences 5.4 Sociology 5.5 Right 5.6 Political sciences 5.7 Social and economic geography 5.8 Mass Media and Communications 5.9 Other social sciences	5.1 Psychology 5.2 Economics and business 5.3 Pedagogical sciences 5.4 Sociology 5.5 Right 5.6 Political sciences 5.7 Social and economic geography 5.8 Mass Media and Communications
6. HUMANITIES	
6.1 History, archaeology 6.2 Linguistics, literary studies 6.3 Philosophy, ethics, religion 6.5 Art 6.5 Other humanities	6.1 History, archaeology 6.2 Linguistics, literary studies 6.3 Philosophy, ethics 6.4 Theology, religious studies 6.5 Art

This is not defined in the Republic of Armenia. The inclusion of the 2.3 Mechanics in the "Engineering and Technology" classification applied in Armenia is also unacceptable (in the process of contractual (thematic) financing, taking into account the current level of high development of this direction in Armenia, it has a negative impact on the value-added sector allocated to the "Engineering and Technology" sector on the process of allocating scarce funds).

Payments and receipts for the use of intellectual property are exchanged between residents and non-residents in exchange for license agreements and permission to use proprietary rights (such as patents, trademarks, copyrights, industrial processes, and designs, including trade secrets and patents).

The receipts for the use of intellectual property in the world are increasing dramatically over the years (Fig. 2) [12].

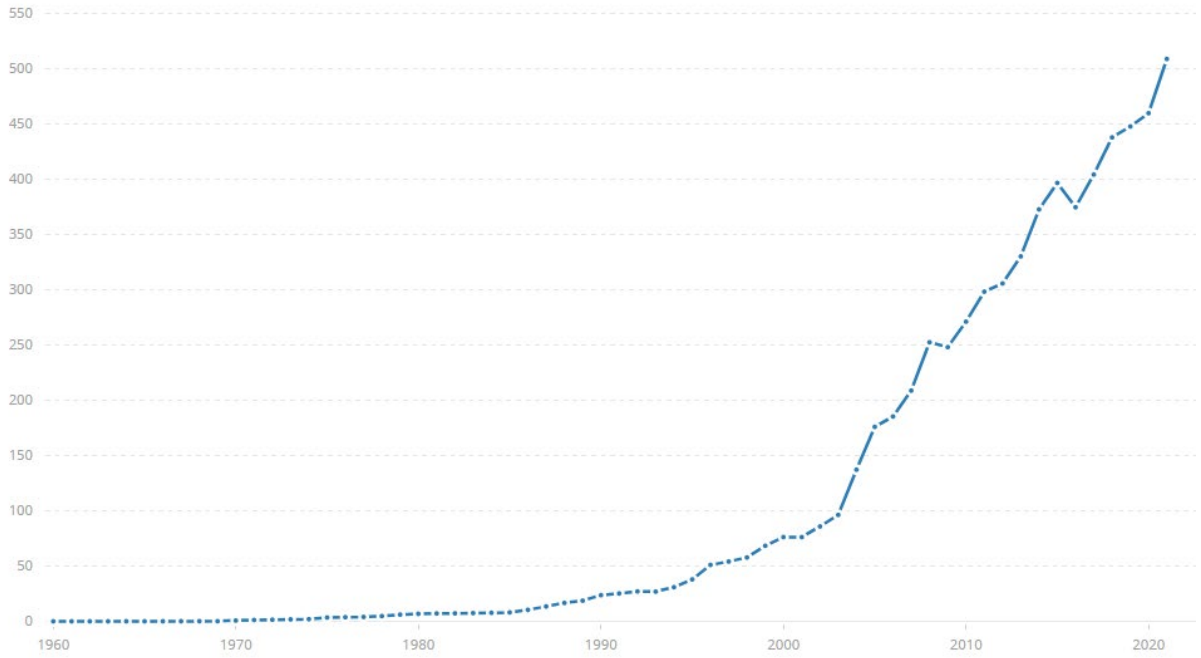

Fig. 2 Charges (revenues) for the use of intellectual property in the world in 1960-2021 (billion US$)

This most important indicator is zero in the Republic of Armenia (Table 1). The maximum receipts for the use of intellectual property in Azerbaijan were in 2012 - 28.18 million US $, in Georgia - in 2021 - 61.629 million US $.

The reasons for the emergence of this situation are diverse and varied, from legislative problems to inefficient management mechanisms of the sector.Only the fact that in 2016-2022 Value-added universities operating in Armenia have received as many invention patents as the Shushi University of Technology operating in Artsakh, which shows the depth of the deplorable situation [13].

2007-2021 share of high-tech in industrial products exported in the world in 2021 in 2020, it decreased by about 1.8 percent, reaching the level of 2008. level (Fig. 3) [14].

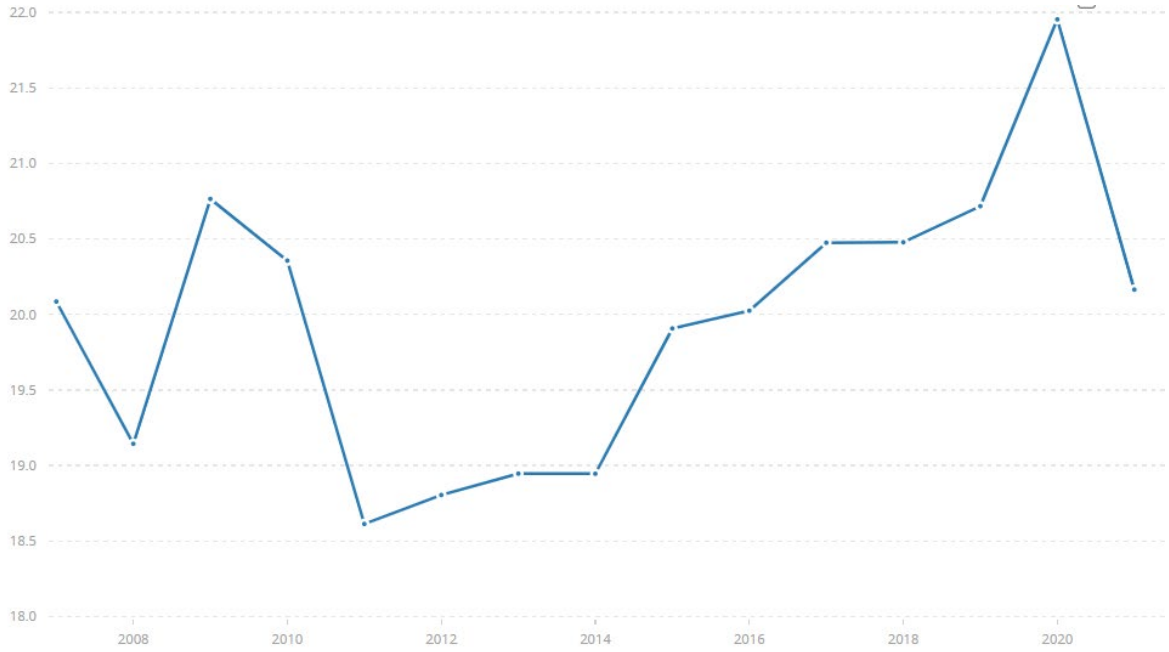

Fig. 3 High technology share in exported industrial products in the world in 2007-2021 (%)

In contrast, during the same period in 2021 compared with 2020, global exports of goods and services increased by 24.4 percent, from 22.59 trillion US dollars to 28.11 trillion US dollars (Fig. 4) [15].

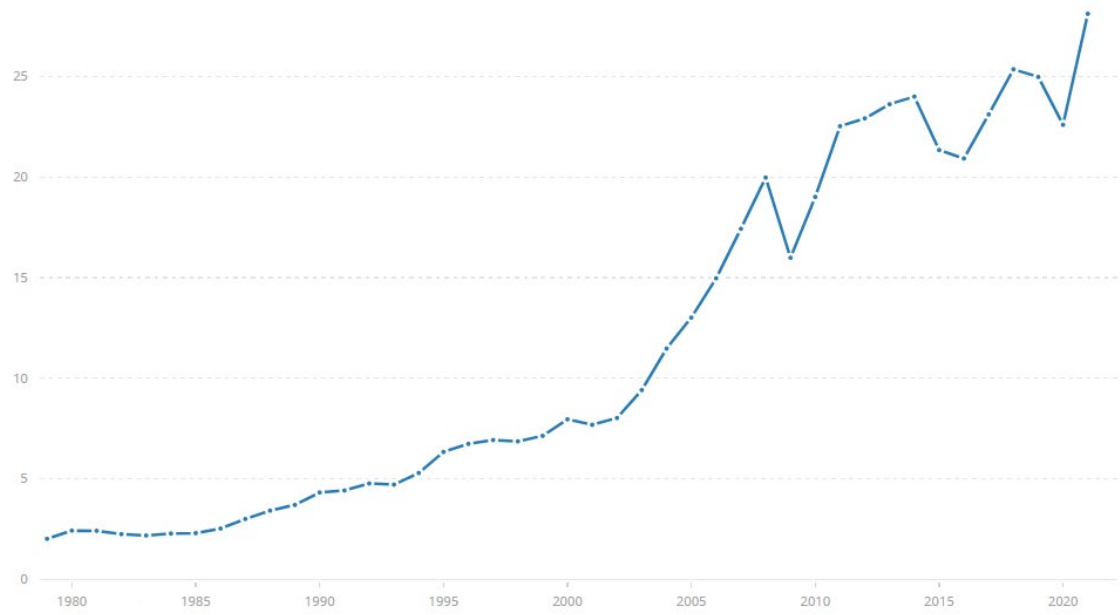

Fig. 4 Export of goods and services in the world 1978-2021 (trillion US$)

The high-tech sector among the industrial products exported from Armenia decreases from 10 per cent in 2019 to 6 per cent in 2021 (Fig. 5) [16].

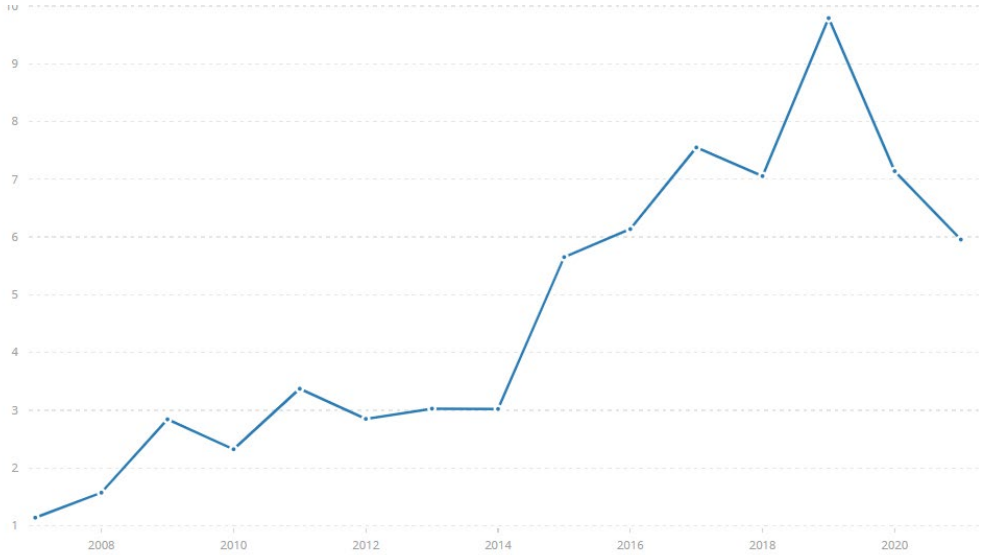

Fig. 5 High technology share (%) in industrial products exported from Armenia in 2007-2021

The volume of high technologies exported from Armenia, according to the UN analysis, 2007-2021. the average value for the period was 17.59 million US $ (maximum: 2019: 45.57 million US $, minimum: 2010: 4.73 million US $). In 2021 that figure was 37.56 millio dollars. Data for the comparison of indicators (million US dollars) for the average maximum, minimum, and 2021 volumes of high technology exports are presented in Fig. 6 and come from Armenia, Georgia, and Azerbaijan [17, 18, 19].

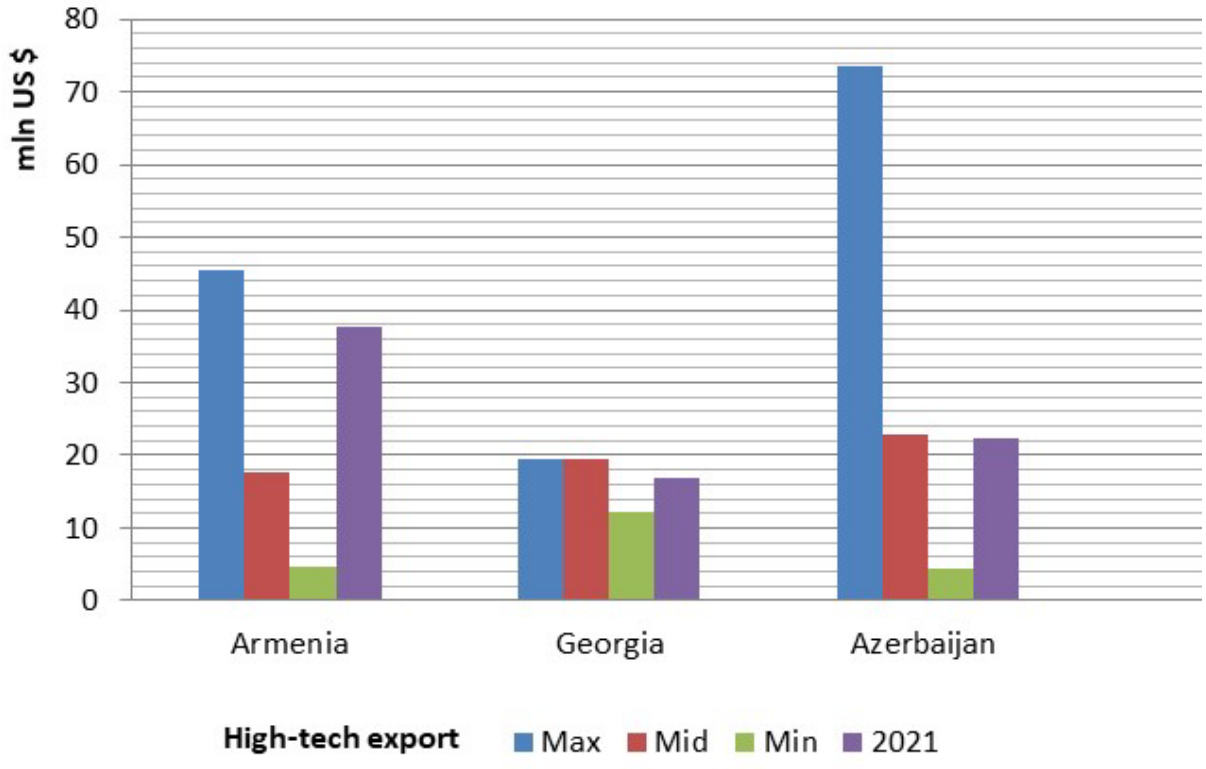

Fig. 6 Benchmarks of maximum, average, and minimum volumes of exported high technologies from Armenia, Georgia, and Azerbaijan in 2021 (million US dollars)

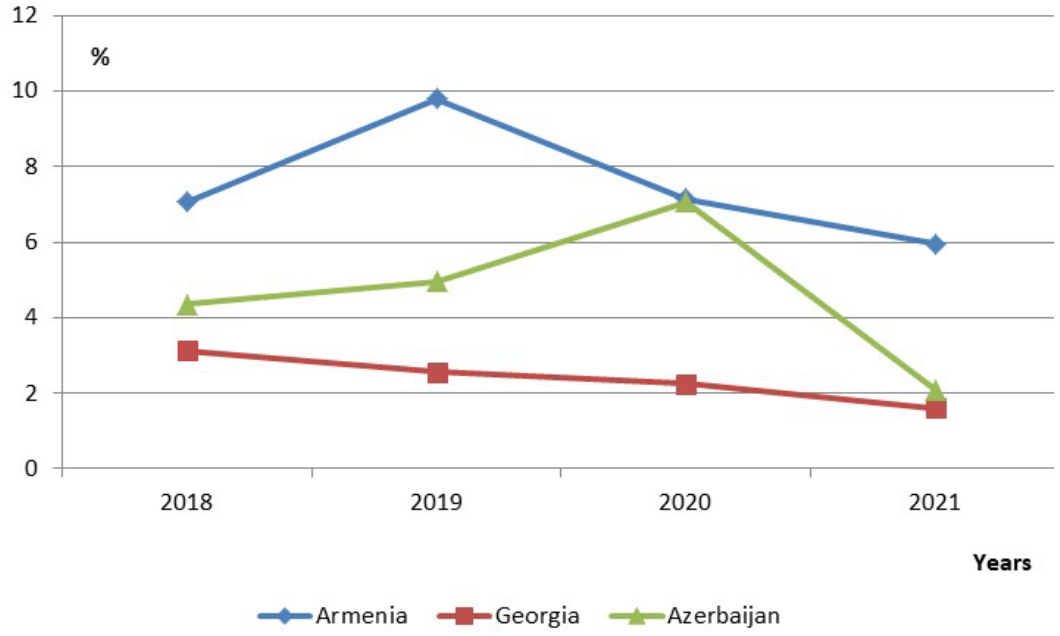

Fig. 7 Comparative changes in the high-tech sector in yearly exported industrial products from Armenia, Georgia and Azerbaijan in 2018-2021 (%) [16, 20, 21]

It can be seen from Figures 6 and 7 that the trend of decreasing high-tech share in exported volumes of industrial products is present in all three Transcaucasian republics.

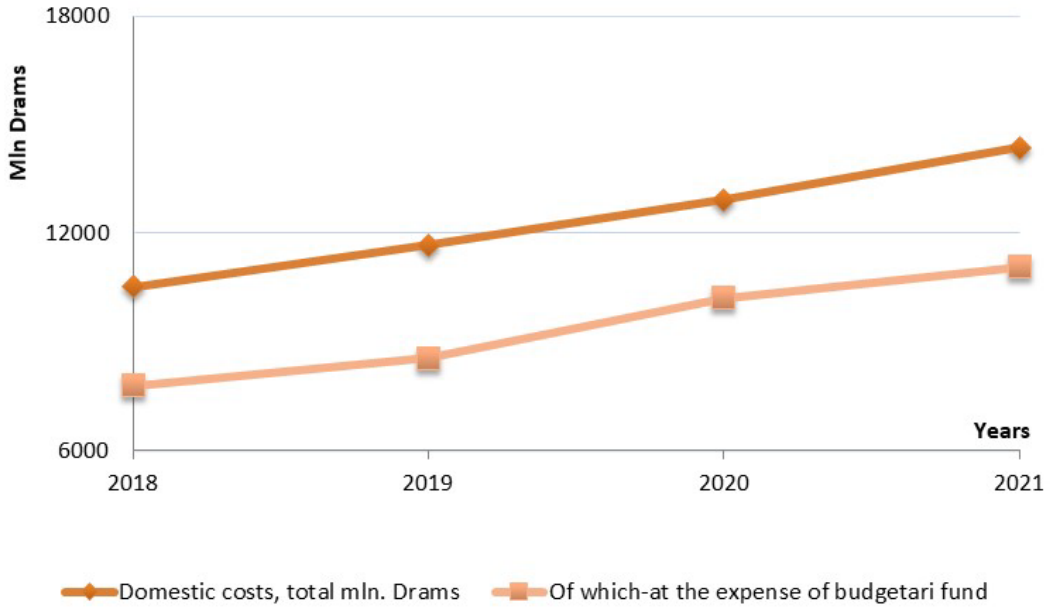

Fig. 8 The dynamics of continuous yearly growth of expenditures on R&D in the Republic of Armenia (million AMD) [22]

Analyzing the dynamics of continuous growth of expenditures on R&D in the Republic of Armenia by years (Fig. 8), it can be concluded that the problem should be solved by increasing the efficiency of management of the science field.

Conclusion

A thorough investigation is required to determine the causes of the republic's ongoing decline in applied research productivity over the past few years, which has occurred despite an increase in the amount of state funding for science, technical research, and related fields. The obvious actions listed below are advised until the study's findings are known:

1. Sharply increase the share allocated to applied research in science and scientific and technical programs in the country, setting clear output requirements.
2. To ensure the transparency of the implementation of scientific and scientific-technical program tenders and the availability of the decisions made. In the process of organizing tenders, reduce the limit of the influence of the human factor to a maximum of seven percent.
3. Through legislative changes, create equal starting conditions for scientific organizations to participate in basic funding programs, regardless of the structure of ownership.
4. To exclude the application of restrictions to persons carrying out science and scientific and technical activities, except for the cases when this is done by law.
5. The fields and professions of scientific and scientific-technical activities with appropriate classes should be defined by the government, specifying the scientific directions included in them for each department. In the "Engineering and Technology" field, the "2.3 Mechanics" section should be moved to the "Natural Sciences" field and included in the "1.3 Physics and Astronomy" section. Set a minimum allocation threshold for each direction.

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ԳԻՏՈՒԹՅԱՆ ԵՎ ՏԵԽՆՈԼՈԳԻԱՆԵՐԻ ԳԼՈԲԱԼ ՑՈՒՑԱՆԻՇՆԵՐԻ ՀԱՄԱԿԱՐԳԸ ԵՎ ԿԻՐԱՌԱԿԱՆ ՀԵՏԱԶՈՏՈՒԹՅՈՒՆՆԵՐԻ ԱՐԴՅՈՒՆԱՎԵՏՈՒԹՅԱՆ ՆՎԱԶՄԱՆ ՄԻՏՈՒՄՆԵՐԸ ՀԱՅԱՍՏԱՆԻ ՀԱՆՐԱՊԵՏՈՒԹՅՈՒՆՈՒՄ

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Տարբեր երկրների զարգացման աճի տեմպերը համաշխարհային շուկայում խիստ տարբերվում են միմյանցից: Տարածաշրջանային զարգացման կտրվածքով դա հանգեցնում է նրանց դերի և նշանակության փոփոխության: Հիմքում՝ մտավոր կապիտալի աճի տեմպերի փոփոխության արագությունն է, որն իրականացվում և նյութականացվում է հետազոտությունների ոլորտում: Սույն աշխատանքում հեղինակները փորձել են հետազոտել Հայաստանում մտավոր կապիտալի կառուցվածքին և բովանդակությանը առնչվող հիմնախնդիրները՝ նպատակ ունենալով ձևավորելու նշված ոլորտում իրականացվող քաղաքական և գործնական միջոցառումների լավագույն հարաբերակցություն, որով կապահովվի իրականացվող հետազոտական և նախագծակոնստրուկտորական աշխատանքների և դրանց արդյունքների կիրառման համար արդյունավետ զարգացման միջավայր: Ներկայացվել է նշված նպատակին հասնելուն ուղղված առաջնահերթ քայլերի բովանդակային նկարագիրը:

Բանալի բառեր. բարձր տեխնոլոգիաներ, կիրառական հետազոտություն, մտավոր սեփականություն, փորձարարական մշակում, մարդկային ներուժի զարգացման ինդեքս:

СИСТЕМА ГЛОБАЛЬНЫХ ИНДИКАТОРОВ НАУКИ И ТЕХНОЛОГИЙ И ТЕНДЕНЦИИ СНИЖЕНИЯ ЭФФЕКТИВНОСТИ ПРИКЛАДНЫХ ИССЛЕДОВАНИЙ В РЕСПУБЛИКЕ АРМЕНИЯ

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Темпы роста развития разных стран на мировом рынке сильно отличаются друг от друга. С точки зрения регионального развития это приводит к изменению их роли и значения. В основе - скорость изменения темпов роста интеллектуального капитала, которая реализуется и материализуется в сфере исследований. В данной работе авторы попытались исследовать проблемы, связанные со структурой и содержанием интеллектуального капитала в Армении, с целью формирования наилучшего соотношения политических и практических мероприятий, реализуемых в данной сфере, чтобы обеспечить эффективную среду для развития исследовательских и проектно-конструкторских работ а также внедреня полученных результатов. Сформулированы первоочередные задачи, необходимые для достиженя указанной цели.

Ключевые слова: высокие технологии, прикладные исследования, интеллектуальная собственность, экспериментальные разработки, индекс развития человеческого потенциала.

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