Science, Technology and Innovation (STI) Gap Assessment of Turkmenistan

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PART A. ANALYTICAL INFORMATION

NATIONAL POLICY PRIORITIES IN SCIENCE, TECHNOLOGY AND INNOVATION

In the modern world, the progress of any country is perhaps first and foremost determined by the degree of development in the fields of science and education. Key factors here include taking full advantage of the intellectual potential of society, including the utilization of advanced scientific achievements and technologies as well as the results of fundamental and applied research to maximize economic growth to propel the economy to a new qualitative level.

In the first few years after Turkmenistan gained independence the State's focus on science issues was somewhat weak as urgent tasks such as reforming the national economy and improving the mechanisms of state administration were more highly prioritized. However, in the last decade serious efforts have been made in Turkmenistan to make fuller use of the potential of science and education – of particular note in this respect are the following:

- In 2009 the Academy of Science of Turkmenistan was reconstituted;[1]
- In 2009, the Academic Institute of Postgraduate and Doctoral Studies with the Higher Attestation Committee was re-formed in seven areas in order to ensure the comprehensive training of scientific personnel involved in the complex task of reinvigorating domestic science and turning it into a genuinely productive field.
- In 2013, reforms to secondary school education were introduced and a gradual transition to a 12-year general secondary education system was launched;
- In 2014, the Technology Center was created and placed under the supervision of the Academy of Sciences of Turkmenistan. The center brings together an array of wind and solar installations, other infrastructure providing renewable energy sources, information and communication technologies, design bureaus, numerous research laboratories and institutions, a laboratory complex for nanotechnology, various educational institutions as well as other facilities;
- Academic and industrial science institutions have undergone significant developments including, although not limited to, scientists being assigned specific tasks to introduce new technologies and innovations for all sectors of the economy, develop scientific and technical creativity, applied research and establish the required fundamental basis to engage in modern scientific practices;
- In 2016, the Oguz Khan University of Engineering Technologies opened its doors for students in a number of priority areas for the country such as mechanical engineering, metal processing, metallurgy, natural sciences, nanotechnology and nanomaterials, informatics, computer technology, automation and control, radio engineering and communication systems as well as electronics.

[1] Founded on June 29, 1951 in Ashgabat on the basis of the Turkmen branch of the USSR Academy of Sciences. In 1998 it was liquidated. By the Decree of the President of Turkmenistan No. PP-5364 of 12.06.2009 “On the formation of the Academy of Sciences of Turkmenistan” it was restored as a state organization (at the same time, the Supreme Council for Science and Technology under the President of Turkmenistan was abolished).

The conceptual foundations, tasks and priorities of the State's scientific policy, which serves as the fundamental basis of national development programs, were officially released on 25 January 2018 by President G. Berdimuhamedov and are briefly detailed below:

- The sphere of science is considered in Turkmenistan as the most important factor in building up scientific and technical capacity and modernizing our country. In this regard, the leading role in the socio-economic development of the State is assigned to an innovative economy based on profound scientific and theoretical knowledge and extensive practical experience combined with the use of effective technologies.
- The main task of the scientific community of Turkmenistan is to advance domestic science to a qualitatively new, world-class level, to increase the practical impact of research and technical developments while focusing on solving urgent issues impacting both society and the State. The key role of chief coordinator of scientific research has been assigned to the Academy of Sciences, the nation's leading innovation-technological and applied science center.
- Currently, one of the priority directions of state policy is the integrated development of science and effective application of its achievements in the national economy while simultaneously building up the intellectual potential of Turkmenistan society. Advancing domestic science will lead to further increases in the technical and economic potential of the country, creating opportunities for progressive growth and development in a raft of areas for the citizenry.
- Being a powerful transformative force for social development, science plays an important role in the life of the country and serves as a key opening the door for Turkmenistan's integration into the ranks of the advanced States of the world. It is this assigning of special, strategic importance to the intensive development of domestic science that drives Turkmenistan's significant and focused efforts to improve both science's qualitative growth and ensure that the large-scale reforms being carried out in the country have fundamentally sound scientific justifications.
- In recent years, the country has created a functionally reliable legal framework for domestic science to operate within while also adopted resolutions aimed at improving and developing supporting infrastructure. In accordance with the new Constitution of Turkmenistan, citizens are granted the right of freedom of scientific and technical creativity. The articles of the Basic Law of the country elucidate that the State encourages such creativity and the dissemination of its positive results, promotes the development of science, and the expansion of international cooperation in this area.
- As the main scientific center of the country, the Academy of Sciences of Turkmenistan is charged with ensuring the development of fundamental and applied research while also increasing the scientific and engineering potential of the population. The intellectual elite of the nation is called upon to nurture the next generation of would-be scientists by attracting talented youth to scientific work.
- The State has also recognized that it is necessary to involve scientists in the analysis of imported machinery and equipment for its compliance with international standards and suitability to the specific conditions of the country. Representatives of the scientific

community are also widely involved in the analysis of the planning, implementation and subsequent development of projects where their opinions are taken into account. This is done in concert with the broad application of scientific data and proposals in the formulation and implementation of state policy to promote the interests of the population.

- The State will continue to make efforts to systematically strengthen the material and technical base of the Academy of Sciences of Turkmenistan and other tertiary education institutes to widely involve young people in research activities and to master new scientific fields that serve the requirements of the present day. Solutions to issues impeding the modernization of all sectors of the national economy and providing meaningful scientific substantiation to large projects that are of great importance for the nation's industrial development are the key priorities and to which the State will do its utmost to contribute.
- Scientifically grounded developments in industry directly influence the potential of the national economy. When making his address, President Berdimuhamedov noted this and said that the State would focus on the need for new developments in this area. Scientists around the country should take the most active part in ensuring international quality standards as their role is significant in the development of Turkmenistan's agro-industrial sector and the training of highly qualified agronomists and other specialists.

The continuation of the general direction of state policy in the fields of science and education was further outlined in another presidential speech on 12 June 2019 where President Berdimuhamedov noted that "science is the power of the State." The further goals and objectives of this policy are also briefly presented below:

- The development of human society is directly related to science and education. As is the case in the developed countries of the world, science and education in Turkmenistan are the key means of building the potential and capabilities of the State and the driving force of society;
- In recent years, the material and technical base of science and education in Turkmenistan has been radically strengthened. Approximately US$16 billion were allocated to strengthen this base and this saw the construction of 623 kindergartens, schools, colleges, institutes, universities and other facilities equipped with modern equipment and technologies. Funds invested in science and education are already yielding positive results and, using the latest advances in science and technology, modern industrial plants and factories are being built in the country, environmental and international projects are being successfully implemented, environmentally friendly waste-free production and economic clusters are being created and both invaluable advanced scientific experience and the use modern technologies are proliferating;
- New technologies today are the primary developmental drivers of the world economy. Therefore, scientific research is already being carried out in industrial-innovative and information-technological areas by Turkmenistan's new scientific and educational institutions where much work is being done to train highly qualified engineers and future scientists in such important areas as new materials technology, nanomaterials, chemical technologies, mechatronics as well as in robotics and innovation. Additionally, various government

programs are being successfully implemented to create an electronic industry, produce local products that can replace imports while simultaneously increase export volumes;

- State policy is increasingly attaching importance to the digitalization of the economy. In order to move to a digital economy, the country is improving its computer systems and modernizing communication facilities, automating production processes, creating information systems and introducing electronic document management, all of which serve to strengthen the economy. To complement these efforts, it is also envisaged to develop and implement projects in the field of information technology, organize marketing and consulting services, increase the number of both information technology centers and educational institutions training specialists for the digital economy. The tasks of training highly qualified personnel in accordance with the digitalization program necessitated establishing specialized secondary schools focused on in-depth studies in chemistry, biology and other relevant disciplines;
- Turkmenistan possesses not only abundant natural resources but also rich biological diversity. In-depth studies of issues involving agriculture, medicine, the pharmaceutical and food industries, the development of molecular biology, genetics, bioengineering and biomedicine revealed that the training of specialists in these areas is also extremely important for the country's economy. Advances in growing crops, rearing animals, creating new varieties and hybrids using modern methods of biotechnology and establishing the production of various food products and medicines are all an integral part of the country's future economic development. Effective research work is being carried out to create new, highly productive seed types for crops suited to the soil and climatic conditions of the country while still preserving valuable species of flora and fauna found in the region;
- The president’s address also noted that it is necessary to continue the development of the scientific basis for the use of mineral waters, therapeutic mud and the local medicinal plants which have significant curative properties. While the production of high-quality medicines from local raw materials is currently still being established, the purposeful and thorough development of medical science testifies to the perceived value of introducing scientific achievements into production processes.
- Specific tasks have been set to study in-depth the processing of organic and inorganic substances, minerals, hydrocarbon resources and the creation of new materials for construction, industrial, textile and social purposes using the country's existent natural resources. This process has also been extended to include the creation of new types of agricultural fertilizers and enhance the selection and breeding processes used for crops and livestock which includes the planned creation of a genetic bank of flora and fauna to create new ecological zones;
- At the state level, the Government continually works to modernize, improve infrastructure and management systems, improve efficiency as well as strengthen the material, technical and legal foundations of the education sector as an integral part of the economy. This has resulted in a consistent increase in the number of students enrolled in secondary vocational and higher education institutions along with the opening of new disciplines in the country's universities. To further encourage this trend the State has improved the conditions for training students from Turkmenistan in the most prestigious advanced foreign universities by negotiating

intergovernmental agreements and educational contracts for specialists involved with in-demand sectors of the local economy;

- In order to stimulate interest in science among school children as well as reveal and then develop their talents, the State has opened specialized schools focused on fields as diverse as foreign languages, exact sciences, natural, humanitarian, musical, military and sports as well as children's art schools and more advanced schools of art. In accordance with the economic digitalization program, special disciplines are now to be included in the school curriculums. The curricula of secondary and higher schools must take into account the innovative nature of the development of the national economy. Hyakimliks (municipalities) of etraps (districts) and cities were instructed to create training and production centers for the development of secondary school students with economically valuable special skills. In addition, in order to further modernize and improve the financial and economic state of tertiary education institutions, a paid form of education was introduced and emphasis placed on intensifying international educational cooperation, meaning administrations had to gradually transfer such institutions to full cost accounting.

Thus, the priorities outlined by President Berdimuhamedov give a generalized picture of the policy direction of the government of Turkmenistan in the fields of science, education and innovation. The world's ongoing economic crisis makes necessary certain adjustments in the timing of some of the goals and objectives, primarily due to reduced funding, but overall the situation has not changed dramatically and many processes related to online resources and their use have actually significantly accelerated.

KEY POLITICAL DOCUMENTS ON STI

Currently, the country is carrying out program work to digitize all spheres of the national economy and introduce the latest scientific developments into production processes.

Since 2019, the country has been implementing the Concept for the Development of the Digital Economy in Turkmenistan which was approved by President Berdimuhamedov in November 2018. This program is scheduled to run through to 2025 and has the stated aim of further developing the national economy through its diversification and especially the expansion of the local electronics industry.

The key relevant document is comprised of 7 sections which reflect the current state of the nation's information and communication technology systems, the goals and objectives of the concept, ways and mechanisms of its implementation as well as its expected results. It is planned to implement the plan in three stages. The first stage was implemented in 2019, the second starts in 2020-2023, and the third in 2024-2025.

The central priorities of the concept include the strengthening of the basic foundations of the digital economy, especially internet support systems. Taking into account that this serves as a key condition for the development of innumerable industries, President Berdimuhamedov noted that it

is necessary to keep the issues of increasing the level of involvement of the population, entrepreneurship and the State in this area in constant sight.

As previously stated, in the modern era the progress of any country is largely determined by the effectiveness of its education system. Key factors here include the most complete use of the intellectual potential of society, including the utilization of any advanced scientific achievements available to optimally grow the economy to a qualitatively new level. This outcome has, especially in recent times, often proven to be directly related to the use of advanced technologies and effectively implementing the results of fundamental and applied research.

In this context, the Concept for the Development of the Digital Education System in Turkmenistan adopted on 15 September 2017, is aimed at creating an information-based educational environment and providing this effectively at all levels with sufficient technical equipment. This is of great importance to advance the digitalization of the national economy, enrichment the intellectual potential of the population as well as improving the overall quality of education and teaching methods.

Today, Turkmenistan has created favorable conditions for young people to receive a modern education and be trained to become highly qualified specialists. In accord with the development concept, through the efforts of specialists, faculty members, as well as students, a program for a network of digital education has been prepared and the required portals have already been developed in tertiary education institutions. Thanks to this widespread introduction of digital technologies remote lectures and video conferences with the participation of foreign partners are regularly organized in universities.

Besides the Concept for the Development of the Digital Education System in Turkmenistan, the country has also passed several laws and regulations that are noteworthy and also significantly contribute to the development of science and education.

The Law of Turkmenistan "On innovation activity".
The scope of this law covers the legal, economic and organizational relationships between the subjects of innovation and the factors arising in its implementation and applies to all subjects of innovation regardless of the specifics of each instance.

The Law of Turkmenistan on State science and technology policy
This law regulates the foundations as well as the procedures for the formation and implementation of the State's scientific and technological policy in Turkmenistan. It was envisioned that the law should create the most favorable conditions possible for the all-round development of science and technology on the basis of improving the real-world value of the scientific and technical activities of scientific workers and translating their results into the material production, social and spiritual spheres of society.

The Law of Turkmenistan "On scientific organizations"
This law determines the legal status, goals, objectives and powers of the nation's various scientific organizations, classifies their types and kinds as well as providing state-based regulation of their activities.

The Law of Turkmenistan "On the status of scientific workers"
This law elucidates the rights, duties and responsibilities of scientific workers, the criteria for assessing their qualifications as well as the duties of the state authorities and administrations of Turkmenistan to ensure that the guarantees of free scientific creativity and social protection of scientific workers are protected to increase the value of their scientific activity.

The Law of Turkmenistan "On scientific intellectual property"
This law, in accordance with the Law of Turkmenistan "On Property in Turkmenistan", regulates public relations issues arising in the field of scientific and technical activities involving the creation and use of scientific intellectual property.

Law of Turkmenistan "On the legal protection of algorithms, programs for electronic computers, databases and topologies of integrated circuits"
This law regulates relations pertaining to the creation, legal protection and use of algorithms, computer programs, databases and topologies of integrated circuits.

List of priority directions for the development of science and technology in Turkmenistan
This document contains the approved main priorities for the development of science and technology in Turkmenistan.

The Law of Turkmenistan "On science and technology parks"
This law regulates the legal, economic and organizational relationships associated with the creation and operation of science and technology parks.

Decree of the President "On increasing the efficiency of scientific research and training of highly qualified personnel"
This decree was adopted to ensure the effective development of solutions to urgent problems involving science and technology in priority areas of socio-economic development in Turkmenistan and to improve the level of training and certification of highly qualified scientific personnel.

In 2020 several other laws and regulations were adopted that support the implementation of digital systems in Turkmenistan and could be added to this list. For example, according to the instructions of the Government, a number of new departments and centers in various state structures were created on the basis of the ongoing general policy of "digitalization".

On 27 February 2020, the President of Turkmenistan passed a decree which instructed all ministries as well as businesses and individual entrepreneurs to adopt electronic document management systems and create their own internet sites, regardless of the form of ownership in the case of private sector entities.

In order to provide a legal basis for the actions arising from this decision, on 14 March 2020, the Mejlis (Parliament) of Turkmenistan adopted the Law of Turkmenistan "On Electronic Document, Electronic Document Management and Digital Services."

STI MANAGEMENT SYSTEM

Ultimately, innovation activities in Turkmenistan are by and large driven forward and directed by the President of Turkmenistan, the Mejlis, the Cabinet of Ministers, and the Supreme Kazyet (court). The responsibilities of the Cabinet of Ministers include the development and submission of proposals to the Mejlis on the main directions of the domestic and foreign policy of the State as well as programs concerning the economic and social development of the country; it carries out the State's management of economic and social developments, organizes the management of state enterprises, organizations and institutions as well as ensures the effective use and protection of natural resources.

Science management and the organization of scientific research in Turkmenistan is coordinated by the Academy of Sciences of Turkmenistan. The academy conducts competitions to encourage scientific works, organizes specialized and thematic scientific conferences and fora, conducts scientific research in its own right but also coordinates the scientific activities of the country's various educational institutions.

The Technology Center (Technopark) is a part of the Academy of Sciences and is the premier scientific platform equipped with the most advanced technologies. The center, with 10 different specialized laboratories, conducts scientific nano-, bio-, physicochemical, chemical and other research demanded by organizations and enterprises in Turkmenistan while also working to solve complex practical problems associated with modern production.

In addition to the Technology Center, the Academy of Sciences includes the Institute of History and Archeology, the Institute of Chemistry, the National Institute of Language, Literature and Manuscripts as well as the Institute of Seismology and Atmospheric Physics.

Along with the Academy of Sciences, 14 sectoral research institutes within various ministries and government departments, as well as 15 universities located throughout the country, are involved in the organization and management of scientific research.

Also worth highlighting at this point are the main public organizations and international projects that operate on a long-term basis and participate in Turkmenistan's innovation management:

Chamber of Commerce and Industry (CCI)

The CCI was created to promote economic development in Turkmenistan and the nation's integration into the world economic system through the formation of modern industrial, financial and trade infrastructure, the creation of favorable conditions for entrepreneurial activity and assisting in establishing trade, economic, scientific and technical relationships with foreign partners.

Central Asian Research and Education Network (CAREN)

CAREN is a regional project of the European Union that has been running since 2010 and, within its framework, a Turkmen scientific and educational network was created which provides high-speed internet access to scientific and educational institutions in the country. The main goal of the

project is to establish joint scientific and educational work between the universities of Central Asia and the European Union.

The Virtual Silk Road

This project is coordinated by the NATO Science Committee and provides participating countries with state-of-the-art satellite technology, equipment and free communication services as well as connectivity to the European Research Network. The primary target audience consists of employees of research organizations at universities.

FORMATION OF STI POLICY

According to a number of Turkmen experts, the post-industrial technological order has begun to form in Turkmenistan with the development of microelectronics, automated production, growth in natural gas consumption as a leading energy supply and an increase in the role of air and pipeline transport. Nevertheless, it seems that the system of financing this area of development in Turkmenistan is still far from perfect since it relies primarily on the capabilities of the State. Accordingly, it seems prudent to explore means whereby private commercial interests can contribute to education in the country in the coming years and create opportunities for private business to support private educational institutions. In this respect, there are already goals and incentives for attracting venture capital into the education system in Turkmenistan which has proven to be one of the fundamental mechanisms driving intellectual development in other countries.

Data from 2012 shows that the Government spent 3.1% of the country's GDP on education in Turkmenistan [2]. However, there is no detailed data on what portion of this amount was directed towards improving the quality of educational processes, for example, improving the qualifications of the teaching staff, introducing new technologies into the educational process or even how much of this 3.1% represents capital investments in the development of the material and technical base of educational institutions.

It is known that in many developed countries of the world, education costs are not only a priority item in state budget expenditures but also an indicator of the country's view of social responsibility. For example, in 2010 spending on education in Russia amounted to 4.8% of the country's GDP, in France it was 6.2% while in the United States it totaled 7%. In general, economically developed countries spend more than 6% of their GDP on education with many planning to increase this to 8%.[3]

However, the success of the country's economy on the innovative path depends not only on financing the development of infrastructure, organizing and financing research but also on those who conduct this research and those who manage it. The point here is that when determining budgetary expenditures, spending on science and innovation must be clearly separated from fundamental and applied research.

[2] Knoema. World Data Atlas (https://knoema.ru/atlas/Туркменистан/topics/Образование/Финансирование-образования/ Государственные-расходы-на-образование-percent-от-ВВП).

[3] N. V. Kharina. Vocational education in Russia: problems, solutions/Scientific journal “Scientific and Pedagogical Review. Pedagogical Review”: Tomsk: 2013, No 1.

As for the human resources dedicated to science, even the most generous funding and favorable working conditions will not bring the desired results if there are no people who can put forward ideas born of new paradigms, defend them despite resistance or ridicule and then spend the necessary time in laboratories to test their innovation. Therefore, the issue of training, retraining and retaining personnel is among the most important issues facing Turkmenistan's scientific community as these individuals form a key cornerstone of innovative development.

The attainment of this critical quality of the human resources involved in science will require an appropriate social structure which, in developed countries, is provided by the real sectors of the economy with its new scientific, technical and technological base.

It is perhaps unsurprising that the program for the radical reform of the education system, including vocational and secondary schools as well as tertiary institutes, received such widespread attention in the country. Computers and modern educational programs are being installed even in kindergartens, which, like the schools for older students are being significantly upgraded throughout the country.

The country today urgently needs qualified professional personnel who are able to take responsibility to try to deliver a brighter future for the people and help lead them forward into an increasingly complicated world. Turkmenistan is training future specialists within the country, opening new universities and specialized institutes as well as taking advantage of overseas opportunities where an ever-increasing number of students go to study every year.

Given the current intensive development of private business in Turkmenistan, the relationship between the State and the private sector is of particular importance and is reflected in the article of the "Law on Innovation" dedicated to the promotion of innovative business. The orientation of Turkmenistan towards innovation is made manifest in the intensive growth of investments in research and development as well as in the technological and organizational innovations which lead to increased economic returns. Among the priority areas of this drive for innovation are information, communication and electronic technologies as well as technologies involved in the production of new materials, including nanotechnologies, bio- and medical technologies.

INSTRUMENTS, IMPLEMENTATION AND COORDINATION OF STI POLICY

The implementation of Turkmenistan's program for socio-economic development for 2018-2024 is designed to further accelerate the development of the country's economy.

The activation of investment policy is systematically transforming Turkmenistan into an industrially developed state, new jobs are being created, measures are being taken to strengthen the country's innovative, economic and intellectual potential and to further improve the social and living conditions of the population.

The content of the program is based on modern scientific knowledge and innovations where innovative instruments of production policy include entrepreneurship and a willingness to press

forward and satisfy consumer demands as well as an orientation towards the introduction and dissemination of innovative ideas and methods throughout the economy.

Today, Turkmenistan is intensively working towards establishing import-substituting enterprises, including joint ventures with foreign firms while simultaneously increasing the volume of exported goods. This testifies to the development of innovative and intellectual activity, which is facilitated by national legislation on the protection of intellectual property and is harmonized with international norms.

Innovative approaches in industry and humanitarian spheres are the results of the country's modern state science and technology policy which is being implemented in specific large-scale scientific, educational, and industrial projects. These strategic projects are closely intertwined with the identified priority areas of science and technology.

Measures have also been undertaken to attract talented youth to science and to increase the effectiveness of science and education. It must be noted here that the scientific potential of the country today can effectively pursue new relevant knowledge and find application for advanced technologies and science in practice. An innovative approach also involves passing the research baton from generation to generation which requires intensive training of new scientific personnel and combining the energy of the young with the experience of the established in science.

In broad terms, the tools of innovative development used in the country can be divided into three groups, namely economic, organizational and organizational-economic. Among the economic instruments, it is necessary to single out the budgetary funding for science and innovation which the State distributes through the Academy of Sciences. The financing of sectoral research institutes, however, is based on mixed funding from both the national budget and private entities for implementation of scientific activity. University science is largely funded from the state budget since there are no private universities in the country yet. It should be noted here that the gradual transition to a system of paid university education, which has been underway since 2018, will increase the share of non-state funding of science in universities.

For several years, some priority sectors (such as agriculture and the agro-processing of products) and for small and medium-sized businesses there has been a system of preferential lending at 1% per annum through state-owned commercial banks for the purchase of modern machinery and loans for up to 10 years at 5% for the purchase of components and necessary materials.

Funding for the training and retention of scientific personnel is carried out by all participants in the innovation process - the Academy of Science, its institutes, the system of sectoral research institutes and the country's universities, primarily through the formation of state orders. However, it must be noted that, unlike in a number of other countries, tax incentives have not yet been used as a tool for enhancing innovation in the country.

The construction and development of innovation infrastructure are carried out through the coordination of work entrusted to the Academy of Sciences. Certain important innovative programs are coordinated by various ministries and departments (for example, coordination of the

program for the digitalization of the economy is entrusted to the Ministry of Communications and Communications). The establishment of high-tech enterprises and the creation of start-ups is carried out in both the public and private sectors of the economy. In the Academy of Sciences, these tasks are addressed by the Technopark while in the private sector such work falls to a number of enterprises, such as the IT park, Turkmen Transit and others. It should also be noted that several international organizations, such as UN funds, projects of the European Union, USAID, the European Bank for Reconstruction and Development, and the World Bank effectively contribute to process of introducing modern technologies to Turkmenistan's economy and population.

In recent years, public-private partnerships have begun to develop rapidly in the country to facilitate innovative activities. For example, 33 projects are being implemented (at a total cost of US$1.75 billion) within the framework of the State Program approved in May 2018 to increase the volume of Turkmenistan's exports. New industries are being created to develop the chemical and manufacturing sectors, various light industries as well as in the fields of mechanical engineering, agriculture, food and pharmaceuticals. This program is 81% funded by the private sector and 19% by the state. Another program where more than half of the costs are covered by the private sector, the State Program for the Production of Import Substituting Goods in Turkmenistan, provides for the implementation of 81 projects (at a total cost of US$ 176 million) to locally produce items that are currently imported.

Programs for start-ups and business angels today are primarily supported and implemented by the Academy of Sciences with additional assistance from private sector enterprises (chiefly the IT sector). A number of so-called mentoring companies, together with their international partners, participate in the implementation of start-up programs. As a final note to this section and as has been previously mentioned, since the country does not yet have any non-state universities, the staffing of innovative activities in universities is largely provided by national budget funding.

OVERVIEW OF SOME OF THE DETRIMENTAL EFFECTS OF COVID-19 FOR INNOVATION IN THE COUNTRY

Turkmenistan is one of the few countries in the world where, thanks to timely preventive measures taken at the state level, it was possible to slow down the onset of the disease when it emerged and this avoided widespread infection. All public and private entities are operating as usual, although in July-August the holding of events involving large crowds was significantly reduced and general preventive measures are still strictly observed.

At the same time, the COVID-19 related closure of many countries' economies that are closely tied to Turkmenistan led to certain trade difficulties and a significant decrease in the prices and volumes of supplies in March-May 2020 of hydrocarbon resources significantly reduced foreign exchange earnings during this period. For the first half of 2020, the country's GDP grew 5.9%, which was lower than the indicators for previous years (the average for 2017-2019 was 6.3%). However, the continued GDP growth, albeit at a lower level, is expected to continue in the second half of 2020.

In early August 2020, at an expanded meeting of the Cabinet of Ministers, the " National program to reduce the difficult circumstances prevailing in the world economy on the country's economy

and sustainable development of the national economy for 2020-2021 " was adopted. This is, in essence, Turkmenistan's anti-crisis development program to combat the advent of COVID-19 and takes into account the likely significant decrease in both income and costs over the next two years. Within the framework of the program, the president of the country proposed to significantly reduce expenditures in the state budget and the expenditures of state organizations and companies The president envisaged that the savings thus created will be directed to support the country's businesses as well as to provide medical institutions with the extra medicines, protective equipment and diagnostic capacity required in times of such a pandemic. Related to this, in the context of containing the outbreak, the goal of increasing the volume of online sales for many goods and services, in particular, products of the textile and other light industry has been set. This approach has been mirrored in the field of education where the use of webinars and online conferences has significantly increased irrespective of whether this involves purely domestic participants or involves foreign experts.

Due to the decline in oil and gas prices on the world market and the changing structure of the economy of Turkmenistan, both of which have depreciated the national currency, the manufacturing and service sectors have strongly focused on foreign export markets to offset this as best as possible. In parallel, public policy has also been heavily focused on the digital transformation of the economy, which has manifested itself in the opening of new technology universities, the transformation of government and regulatory institutions to more readily implement innovation, promote e-government and e-commerce promotion, and so forth.

With the involvement of international experts, projects for the creation of new ecosystems and the development of start-up platforms began to be more actively implemented. The Ministry of Industry and Communications of Turkmenistan, which oversees the digital transformation program, has begun regularly holding competitions for IT projects among young people to further this goal.

In this environment, where both the market and the government are encouraging new innovative projects and services, especially IT projects, the demand for IT professionals is growing rapidly as is the number of IT enterprises (from 45 to 95 companies in the last two years).

Thus, the implementation of state programs in the field of innovation and the factors external to the country that have so suddenly appeared, in general, have led to the acceleration of the implementation of innovation policy and there are no indications that state policy and the pace of its implementation in the field of innovation will change significantly.

PART B. MAIN PROBLEMS AND ISSUES IN STIMULATING INNOVATIVE DEVELOPMENT

The survey conducted on the main problems of innovative development in Turkmenistan involved 11 people from the public sector (Ministry of Finance and Economy of Turkmenistan, Ministry of Labor and Social Security of the Population of Turkmenistan), public associations, business representatives from a number of industries (IT, trade, educational centers) and international companies in the field of education, computer technology as well as the oil and gas sector. In general, it should be noted that on many issues the assessments of government officials and representatives of the private sector and international organizations differed significantly.

The tables below present the results of the survey. For the purpose of assessment of the results, the scale of 1 till 5 was chosen, with 5 being the highest appreciation.

Table 1. Respondents opinions on which sectors of the economy have a high potential for technological modernization and innovative development

No. Economic sector/industry	Percentage of respondents who indicated the sector (the number of answer)
1 Digital technologies (IT) (10)	**90%**
2. Oil and gas sector (9)	**81%**
3. Energy (8)	**72%**
4. Communication and telecommunications (8)	**72%**
5. Transport (7)	**63%**
6. Chemical industry (5)	**45%**
7. Geology and mining (5)	**45%**
8. Agro-industrial complex (3)	**27%**
9. Medicine and pharmacology (3)	**27%**
10. Textile industry (2)	**18%**
11. Light industry (1)	**18%**

Table 2. Respondents opinions on the effectiveness of science, technology and innovation (STI) policies and policy instruments in promoting STI in the country

1.	National authorities attach great importance to the development of science, technology and innovation (STI).	4.18
2.	National ST&I priorities and strategic directions for STI development are well articulated and widely reported.	4.00
3.	Officially proclaimed national ST&I priorities correspond to sectors and enterprises with high innovation potential.	4.36
4.	There is a clear division of responsibilities between government agencies with the mandate to manage STI.	3.91
5.	There is good coordination in the functioning of the various government agencies charged with STI management.	3.55
6.	The functioning of the main research institutions in the country is well managed and administered.	4.09
7.	The authorities allocate sufficient public funds to support STI activities.	3.82
8.	The policy instruments used to support ST&I-related activities are effective and well managed.	3.45

Table 3. Opinion about the basic conditions and business environment in the country: how much they contribute to innovative development

No Aspects of the Environment	Medium Rank
1. The authorities are making efforts to reduce administrative barriers to doing business	4.83
2. The authorities attach great importance to the development of SMEs, and SMEs have access to various forms of state support	4.36
3. Entrepreneurship is encouraged and the authorities support the development of an entrepreneurial culture	4.55
4. It is relatively easy for entrepreneurs to start and develop a new business	4.09
5. Enterprises collaborate with research and academic institutions to commercialize the results of their research and development	3.73
6. Universities encourage the creation of start-ups and branches to commercialize innovative ideas	3.82
7. Intellectual property rights of innovative entrepreneurs are well protected by law and regulations	4.00
8. Innovative entrepreneurs and SMEs have access to public funds to support the early stages of commercializing their ideas	3.45
9. There are adequate private funding sources to support innovative entrepreneurs and SMEs in the early stages of business	3.00
10. SMEs have relatively easy access to bank loans and other commercial finance to grow their businesses	3.73

As to the results of other survey questions, such as the question 4 “In your opinion, what are the main existing problems, obstacles and bottlenecks that hinder innovative development in your country”, the following could be concluded.

From discussions with the experts, it became apparent that at the state level the existing regulatory and legislative framework is no longer viewed as the prime source of the problems associated with the development of science and education or implementing innovative results (as most issues here have been resolved or are being resolved satisfactorily). At the same time, experts noted a few bottlenecks and issues that still required additional attention and redress, namely:

- Innovative entrepreneurship in several sectors of the economy is at an early stage of development, it requires the creation of better overall conditions, methodological and material support in the creation of start-ups, mentoring companies and venture funds.
- State-owned enterprises and organizations are generally well staffed and there is a system for their retraining, however, for a number of innovative enterprises in the private sector, vocational schools and universities do not train such personnel making them to order the training of such specialists abroad through the system of the Ministry of Education or private endeavors.
- Even though the majority of experts indicated there were good opportunities in the country to start small and medium-sized enterprises, they noted that it is difficult to find funding

sources in the private sector to support innovative ideas where there is a high level of commercial risks (effectively, a shortage of so-called venture capital);

On the results of the survey question 5. “In your opinion, what are the most important changes (in legislation, in the development and implementation of policies, in the framework conditions, etc.) that need to be made to enhance innovative development in the country?”, the opinion of experts has been that in general, Turkmenistan has already created an adequate regulatory and legislative framework that meets the development objectives. The experts, therefore, proposed the following changes and additions to further enhance innovative development:

- Development of by-laws and instructions that clarify or simplify the application of existing laws in practice (for example, the Law “On Innovation Activities”, the Law “On Science and Technology Parks”) would streamline procedures in this area.
- To accelerate the introduction of innovations in the private sector of the country's economy a new law “On innovative entrepreneurship” was suggested. Such a law would aim to provide start-up companies with certain benefits for the successful implementation of new ideas in practice as well as the creation of venture funds based on private capital;
- The experts also proposed the establishment of a state program to enhance innovative developments with the involvement of both public and private funds for its implementation.

Conclusions

As noted by a number of experts, the fuel and energy sectors remain as the primary foundations of the economy of Turkmenistan (although not to the same extent as it was 15-20 years ago). This, as seen with other countries rich in raw materials, makes the economy of Turkmenistan vulnerable to the external market shocks and any disruptions to energy supply routes. Therefore, in the first years after gaining independence, Turkmenistan became increasingly aware of the need to diversify the national economy by development of multiple and diverse industries, such as in the fields of construction, textiles and high-tech. It was envisioned that this could be achieved by using the profits received from the export of oil, gas, and their processed products, a belief that continues to be made manifest in all program documents detailing state development plans and in the practical results of socio-economic development.

In this regard, Turkmenistan has simultaneously embarked on the creation of new real sectors of the economy to be competitive in the world economy while also undertaking the post-Soviet era privatization process to establish a market-based system with modern infrastructure.

The surveyed experts noted that with the acquisition of independence, the transition to a market economy in Turkmenistan has been strictly subject to state regulation, in contrast to the practices of other post-Soviet countries. A visible distinction of the “Turkmen” model of transition to a market economy was its phased implementation and the preservation of the leading role of the state in managing economic processes, investment policy and with strong state support for socially vulnerable segments of the population.

Despite the ongoing market transformations, the dominant role of the public sector continues to remain a characteristic feature of modern Turkmenistan (according to a number of expert estimates, approximately 60-65% of the country's GDP is still produced in the public sector) along

with legislation guaranteeing a high level of state regulation of the economy. The State retains almost complete control over the key sectors of the economy, namely oil, gas, energy, petrochemicals and chemicals, and it largely dominates the transport, logistics as well as the banking and finance system.

National and sectoral programs, concepts and plans currently being implemented (about 70 in total) in Turkmenistan were implemented to propel the economy to a qualitatively higher level using science, technology and innovation as key drivers. The emphasis is on improving economy, both its effectiveness and efficiency, while also preserving the nation's ecology is in line with the UN Sustainable Development Goals[4] 2030. Moreover, Turkmenistan has now become one of the first countries to adopt sustainable development goals to the national level by starting work on their implementation into state plans and strategies with the Government already approving 175 indicators for 148 objectives of 17 sustainable development goals.

Taking into account the discussion and the results of expert polls, it can be said that the country has a clear understanding of the vital need to move away from its limited economy, the need to accelerate the pace of diversification by gradually abandoning the export of non-renewable raw materials and embrace the development of higher value-added goods and high-tech industries, as is reflected in the focus of national programs regarding socio-economic development.

Nevertheless, the surveyed experts noted that the financing of such ventures in Turkmenistan is still far from perfect since it still relies primarily on the capabilities of the State and its budget, given the potential of the private sector is yet to be fully utilized. Encouraging private and commercial investors into education (private universities) more dynamically in the country in the near future was seen as highly desirable as was raising the awareness of private businesses to the opportunities present in non-state educational institutions. Moreover, it was indicated that there was an urgent need to attract venture capital into the education system in Turkmenistan, which is one of the fundamental mechanisms that has driven intellectual development in other countries in recent times.

The experts also noted that the development of the necessary human resources in science is also very important - funding and favorable working conditions will only go so far in bringing about the desired results, this needs to be coupled with scientists and innovators who are capable and willing to 'think outside the box' and challenge existing conventions. Therefore, according to experts, the issue of training and retraining of innovative personnel in the country is among the most pressing of issues as without a solution to that it is difficult to envision widespread, sustainable innovative development.

Attention was also drawn to the fact that one of the basic tasks to successfully develop national science and education systems lies in the active integration of the results of scientific achievements into production. As a result, the research conducted at the Technology Center of the Academy of Sciences is largely of an applied nature and focuses on the introduction of innovations in the development of the fuel and energy sectors. The particular focus here is on developing new energy-saving measures, the creation of new technologies for electricity production, exploration for new resources and improved production and use of existing hydrocarbon resources. However, the

[4] UN. Sustainable Development Goals (SDGs) (http://www.un.org/sustainabledevelopment/ru/sustainable-development-goals/).

center is clearly not enough by itself and there is a need for the State to provide the necessary conditions for private sector actors to establish a number of independent innovation development centers, business incubators, science parks, which are not yet present in the country.

The expected decline in funding for education and science comes as a result of the targeted allocations from the state budget of Turkmenistan due to a sharp drop in prices in world energy market prices in 2018-2019, a situation aggravated by the pandemic in 2020. This has forced Turkmenistan to reconsider its options towards its educational reform processes and scientific research and which, it seems, will inevitably mean more difficult times shortly.

As a final note, the surveyed experts also noted that Turkmenistan has a significant interest in using the practical experience of other countries that have rich reserves of mineral resources but have come to understand the inevitability of the transition in the near future to the use of renewable energy sources, as a result, Turkmenistan is quite aware of the need to develop its own scientific and technological base for its economy to accelerate the introduction of the innovations necessary to be competitive in the decades ahead.