Science, Technology, and Innovation in

KAZAKHSTAN

The Atlas of Islamic-World Science and Innovation

Yunus A. Çengel
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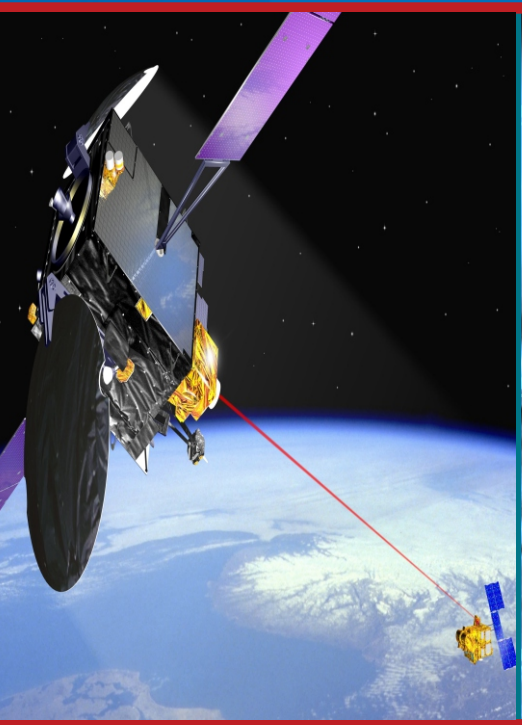

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Contents

Atlas of Islamic World Science and Innovation
KAZAKHSTAN COUNTRY CASE STUDY

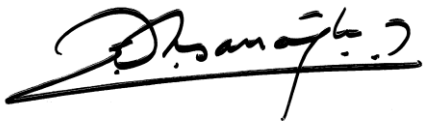
Foreword from His Excellency Prof. Ekmeleddin İhsanoğlu, Secretary-General of the Organisation of Islamic Cooperation

The Kazakhstan report is the third in the series of country case studies prepared under the Atlas of Islamic World Science and Innovation project. The report provides a sound overview of the Science, Technology and Innovation (STI) landscape in Kazakhstan and assessment of the efforts of the government of Kazakhstan for the promotion of science, technology, and innovation as instruments for transformation to knowledge-based society and sound economy in the country.

While acknowledging the positive trends in Science, Technology and Innovation in Kazakhstan and the Government's strong commitment, the report identifies areas which can be further improved. I am confident that the relevant authorities in Kazakhstan will give due consideration to the recommendations of the report regarding the diversification of economic activity, strengthening efforts for Human Capital Development and commercialization of research. Kazakhstan has the opportunity and potential to join the world leaders in innovation. Kazakhstan can realize this potential through concerted efforts involving all the stakeholders including the private sector.

I am pleased to take note of the signing of a Memorandum of Understanding between SESRIC and the National Agency for Technological Development JSC of Kazakhstan (NATD) for cooperation and coordination on their respective activities in order to implement the recommendations outlined in the Kazakhstan Country Case Study.

I thank all the partners of the Atlas Project including Islamic Development Bank (IDB), Ministerial Standing Committee on Scientific and Technological Cooperation (COMSTECH), Qatar Foundation (QF), Islamic Educational, Scientific and Cultural Organization (ISESCO), British Council, International Development Research Centre (IDRC) and Nature for their constructive inputs. The invaluable contribution of the Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC), the National Focal Point of Kazakhstan and Research Partners in the preparation of this report deserve our appreciation.



Executive Summary

This report analyses the state of science, technology and innovation (STI) in the Republic of Kazakhstan and provides an assessment of how effectively the existing national innovation system (NIS) develops and supports the country's innovative capabilities. Getting its independence in 1991, Kazakhstan is a former Soviet Union Republic with rich natural resources. Although the Soviet Union era has left Kazakhstan with a powerful scientific heritage in basic sciences, the long period under the Soviet central planned economy with dominance of state owned companies slowed the efforts of the country to become an innovative society.

The report makes use of the outcome of three in-country fieldworks visits that took place in June 2011, February 2012 and May 2012. During these visits, the research team made interviews with high level policy makers, attended conferences, collected data and conducted questionnaire with the participation of more than 100 scientists, experts and business leaders.

As a country with abundant natural resources, Kazakhstan is still facing challenges in transforming its economy into knowledge based economy. The strong heritage of basic sciences which the country gained during the Soviet era could be a positive factor in distinguishing Kazakhstan from the other former Soviet Union republics in the region, if supported by a well-built culture of entrepreneurship.

Although the Government gives special attention and high priority to increasing the country's capacity in STI, there is still room for improvement through the involvement of all stakeholders in STI legislation process; avoiding the top-down approach, and considering the needs of the market.

An important component of national STI systems in this highly globalized world is international cooperation, and this report is hoped to set the stage to identify the potential areas for such cooperation.

1. Mapping

Chapter 1 presents an overview of history of science, technology and innovation in Kazakhstan through analysing key actors in the national STI system, STI Policy Infrastructure and outputs from the STI system. It presents the portrait of STI highlights since the country's independence until the present day. Chapter 1 also looks at the key players of STI governance in Kazakhstan.

2. People

Chapter 2 focuses on the state of human capital in Kazakhstan in the 21st century. It highlights the remarkable educational reforms and investments as well as the proliferation of education services through public and private universities, colleges, distance learning and international educational exchanges. It also highlights the problems and challenges facing Kazakhstan in training its specialists and providing accessible system of vocational and technical education. Chapter 2 also highlights the issues of promotion of healthy lifestyles and women's participation in education and employment.

3. Places

Chapter 3 surveys the geographic spread of STI related activities across Kazakhstan. Although the country has a vast land area where natural resources spread throughout, the old and new capitals- Almaty and Astana - are still the main cities where research and development (R&D) activities are concentrated. It highlights the STI related activities in each region and the regional policy tools implemented as part of the National Innovation System (NIS).

4. Business

Chapter 4 outlines the STI related activities in various economic sectors, the public and private investment in R&D activities and the factors influencing these activities. The High dependence of the economy on natural resources sector is among the critical challenges facing the government in its efforts towards diversifying and increasing the innovative activities. More efforts are still to be made for fully adoption to free market economy. State-owned companies are still major player in the market and the lack of consumer demand is still one of the main obstacles to business sector development.

5. Culture

Chapter 5 looks at the patterns of the development of science and technology culture in Kazakhstan after the independence. It highlights the government efforts, the role of religion in the development of science culture, changing norms of public engagement and the difficulties facing Kazakhstan in facilitating a cultural transformation towards the importance of science and its role in the socio-economic development of the country.

6. Sustainability

Chapter 6 examines the sustainability in Kazakhstan's development path. In particular, it highlights contribution of renewable and non-renewable energy resources to the country's development. This chapter also presents recent undertakings in the area of waste management and environment friendly development.

7. Collaboration

Chapter 7 considers the main channels of international knowledge flows in Kazakhstan and describes the existing legal and institutional framework to support international cooperation for innovation. The chapter also examines the potential of current integration processes to foster innovation between Kazakhstan and other Member Countries and institutions of the Organisation of Islamic Cooperation (OIC). The role of non-OIC countries and international institutions concerning the international dimension of innovation in Kazakhstan are also highlighted.

8. STI Indicators

Chapter 8 presents an overview of the current situation in Kazakhstan in the field of science, technology and innovation (STI). In particular, the chapter highlights and examines the major statistical indicators on research and scientific development, such as human resources, R&D expenditures, patent applications and research institutions. The main data source of these indicators is the Agency of Statistics of Kazakhstan, which hosts more than 50 indicators on science and innovation both at the provincial and national level.

9. STI Sectors

Chapter 9 presents an overview of ten STI sectors in Kazakhstan ranging from Agriculture and Food Processing Industry to Transportation. It also highlights the latest STI initiatives in the country which are aimed at diversifying the economy with a view of not solely being dependent on the income from its natural resources.

10. National Innovation System

Chapter 10 presents a detailed review of the National Innovation System (NIS) of Kazakhstan through highlighting the main relevant actors and legislations. Although the Government of Kazakhstan has, since its independence, established a number of institutions and adopted new regulations to create suitable environment for STI, more efforts are still needed to be undertaken to achieve the goal of knowledge-based economy. The chapter concludes with existing challenges in achieving a fully functional national innovation system.

11. Prognosis

The last chapter summarizes the key findings of the report, including the results of the surveys and interviews. This final chapter highlights the strengths and weaknesses of Kazakhstan's STI system. It also presents a set of recommendations and proposals with a view to enhancing the capacity of the STI system in Kazakhstan.

1 MAPPING

Kazakhstan plays an important role in the world politics due to its critical geographical position on the border of two continents, Europe and Asia, and also between key participants of international relations, the Russian Federation and China. Kazakhstan has the world's ninth-largest geographic area with substantial mineral and other natural resources such as oil and gas.

Kazakhstan is in a state of transition, from an economy based on the traditional heavy industry and commodities sectors, which helped the economy enormously to grow for over a decade, to a more sustainable economy based on science and technology.

This chapter describes the portrait of STI highlights since the country's independence until the present day. It briefly describes the inputs and outputs of the STI system and the key players of STI governance in Kazakhstan.

1.1. A Brief History of Science, Technology, and Innovation

Science in Kazakhstan started to gain momentum more than 80 years ago, when Kazakh scientists conducted research on the prediction and comprehensive development of mineral reserves, mathematics, physics, and chemistry.[1] Given the difficulties during the Soviet era, scientists faced many challenges, and the full potential of the country could not be realised. After the independence we see that there are significant positive changes in this context.

Kazakhstan suffered a decline in its economy due to a loss in demand of its heavy industry products by the Soviet Union after its independence in 1991. Even in the middle of such hard times, the President of the Republic of Kazakhstan issued a decree of "About measures improving the organization of science and scientific and technical potential of the Republic", to assess the potential of Kazakhstan in STI and gave new direction to the young Republic. The decree was followed by new reforms on copyrights and patent laws.

The speeding up of privatization and surging commodity prices gave a boost to the economy but it did not change the direction of the Kazakhs. Kazakhstan pays special attention to changes in the global economy and tries to set its economy onto a track of transition to an innovative and socially oriented type of sustainable development.

Although the first steps in restructuring the system of science and education have been taken, it is still early to talk about concrete positive results.

[1] Alibek, Ken (microbiologist), Atakhanova, Kaisha (genetic biologist), Dadambayev, Yedil (physician), Kudaibergenov, Kanat (mathematician).

The Interdisciplinary Plan of Scientific and Technological Development of the Country (IPSTDC), which was approved in 2010, has paramount importance to take advantage of traditional industries in order to maximize the national welfare of the Republic of Kazakhstan, as well as to build the platform for the development of new industries, based on emerging new scientific knowledge and technological areas.

The IPSTDC states that currently, most of the research and development (R&D) projects have been realized in the agriculture sector (3,040), metallurgy (790), and oil and gas sector (79). These projects are noteworthy in terms of accelerating the industrial - innovative processes of Kazakhstan in the main priority sectors of economy determined in the State Program of Accelerated Industrial-Innovation Development for 2010-2014. In general, there is still a disproportion between research, development, design, and production. In Kazakhstan, only 6.4% of institutions are involved in R&D and almost half of these are conducting only basic research.

The main obstacles in the path of transition are the low market potential for high technology products, the level of administration of intellectual property legislation in the country, which still does not meet international standards, lack of a system that provides private capital access to the domestic and world markets of high-tech development, challenges in an entrepreneur's transfer of rights to create new industries on the basis of foreign patents and licenses, and establishment of grounds for the commercialization of Kazakh (as well as the world's) technological development with stakeholders participation. The state of STI in business and factors affecting business innovation will be discussed in much fuller detail in Chapter 4.

Kazakh authorities are trying to overcome these challenges by increasing the funding for science, increasing the Gross Expenditure on Research and Development (GERD) to 1% of Gross Domestic Product (GDP) by 2014, ensuring the flow of investments into science from the private sector, and creating an effective system of commercialization of innovations.

Summary of Economic and Social Data in Kazakhstan

Indicators	2008	2009	2010
GDP Growth (Annual %)	3.3	1.2	7.3
Foreign Direct Investment, net inflows (% of GDP)	10.7	11.5	7.2
GERD (% of GDP)	0.22	0.23	0.16
GNI per capita (PPP, current $international)	9,710	10,140	10,770
Population (million)	16,1	15.9	16.3
Unemployment, (% of total labour force)	6.6	6.6	5.8 (est.)
Inflation, GDP deflator (annual %)	20.9	4.7	19.5
Poverty headcount ratio at national poverty line (% of population)	12.1	8.2	8
Internet Users (per 100 people)	11	17.9	33.4
Mobile Phone Subscribers (per 100 people)	95.13	106.03	118.87
Literacy Rate (% (population aged 15+)			100[2]

Source: World Bank, UNESCO, ITU, UNICEF and SESRIC

The individual achievements of Kazakh scientists in the fields of biotechnology, alternative energy, metallurgy, polymer chemistry, and medicine are comparable with world achievements and also globally significant, for instance a vaccine against bird flu that is adapted to the conditions of

[2] It refers to the most recent year available during 2005-2010.

Kazakhstan, wound healing drugs made on the basis of human cytokines and DNA microarrays for the diagnostics of infectious diseases. There are only a few countries[3], which have developed their own vaccine against this disease. Another example is Kazakhstan's school of basic research in plasma physics that has been established at the global level. In collaboration with many foreign research centres, experimental and theoretical studies are carried out in high-energy particle physics, nuclear physics and radioecology, and cosmic ray physics.

However, the overall level of fundamental developments in the Republic is not yet sufficient enough to compete with the world science. Meanwhile, investment in basic research development can provide a new momentum for wealth creation in the oil and gas, petrochemical, mining, metallurgical, chemical, biological, and space industries.

1.2. Key Actors in Kazakhstan's STI System

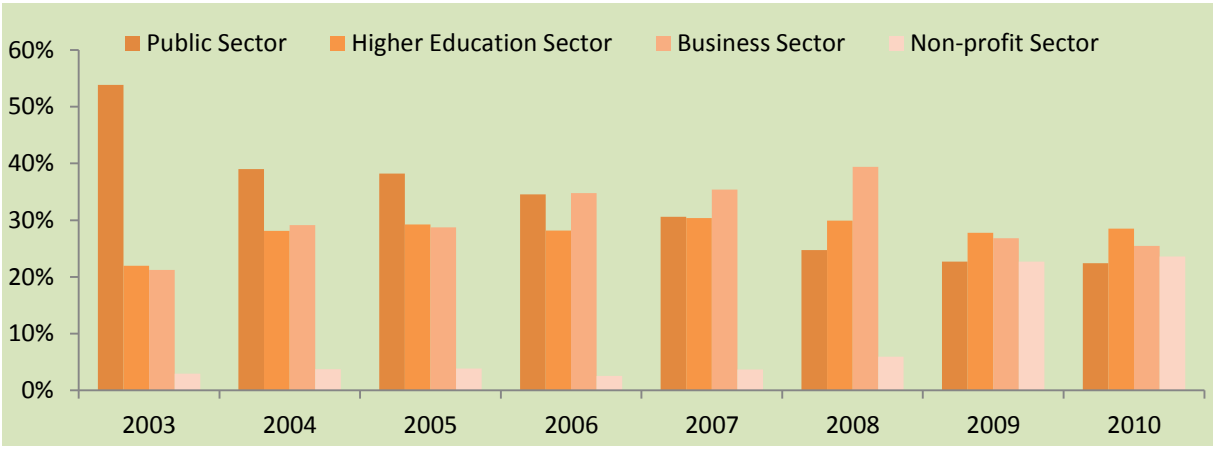
Government, government-linked organizations, public and private organizations all have different and important role in Kazakhstan's STI system. In order to build an effective national STI system in Kazakhstan, new state programs have been designed to provide high-quality support for the country's innovators. The State Program of Industrial-Innovative Development targets to create favourable conditions for scientific and technological breakthroughs in Kazakhstan through providing grants, developing innovative infrastructure, establishing science – technological foresight centres and regional offices of commercialization. Bridging science and industry and also the implementation of scientific achievements in the business environment are under the government attention.

1.2.1. Research Organizations

For Kazakhstan and as for any other country, adhering to the course of knowledge-based economy, the building of human capital is vital. In this regard, Kazakhstan is giving special attention to the development of science and research sector, R&D finance, and skilled researchers.

From 2000 to 2010, the number of research organizations increased by 39%; number of higher

Figure 1.1: Organizations by Activity Sector



Source: The Agency of Statistics of the Republic of Kazakhstan

educational institutions increased by 2.8 times, design engineering and technological organizations by 1.7 times, industrial organizations by 2.2 times and others by 2.7 times.[4] In 2010, Kazakhstan had 424 research organizations. 31.4% of all science organizations in 2010 were research institutes, whereas

[3] Russia, USA, China, Britain, and France
[4] The Agency of Statistics of the Republic of Kazakhstan

design, engineering, and technology organizations accounted for only 6.1%. The detailed analysis and figures on organizations engaged in R&D activities by type are presented in Chapter 8.

On the other hand, the distribution of the organizations performing research activity has changed since 2003 (Figure 1.1). In 2003, public sector had the highest share (54%) and non-profit the least (3%), while in 2010 most of the sectors have more or less the same share. In 2010, the higher education sector accounts for 28.5%, the business sector for 25.5%, the non-profit sector for 23.6%, and the public sector for 22.4%.

Yet, along with increased research organizations throughout the country, attempts to connect research and industry, investment for commercialization projects with the participation of foreign scientists and researchers and effective linkage of science and the national economy are required as stated by Akhmetov Bakhytzhan, Rector of Kazakh University of Innovation and Telecommunications Systems. He stated, "Due to weak interaction among universities, scientific and research institutes and industry, research institutes do mostly not know the needs of industry. Thus, the country faces inadequate development of scientifically supported industry. It also destabilizes the process of scientific research while causing the outflow of qualified personnel from Kazakhstan".

1.2.2. Public Sector

The national STI policy is an integral part of Kazakhstan's socio-economic policies, expressing the state's positive attitude towards STI and defining the goals and plans of public authorities on the way towards knowledge-based economy.

The national STI policy is aimed at achieving the following objectives:

- Creating conditions for increasing innovative activity of entrepreneurs,
- Developing well-functioning infrastructure for better scientific research,
- Developing the cooperation between research centres and businesses,
- Improving the mechanisms of diffusion and transfer of knowledge,
- Supporting the advancement of innovation and technological developments.

The Technology Commercializing Project (TCP), for instance, was designed to change and improve the way science is conducted and contributes to the social and economic development in Kazakhstan. The project is aligned with the Government's efforts to diversify and improve the regional and international competitiveness of the national economy. The TCP is well positioned to link the scientific research and business sectors, thereby contributing to improved innovation and commercialization outcomes.

By using merit-based selection procedures, the Project is expected to help rebuild and restructure segments of Kazakhstan's R&D base. The Project will also help to link this rejuvenated R&D capacity to integrate with national and international technology markets.

1.2.3. Private Sector

Kazakhstan has very limited number of industrial companies involved in innovation, according to the official data of the Agency of Statistics of the Republic of Kazakhstan. The government has set a goal of private-sector financing of 50 percent of the nation's R&D budget by 2012, in comparison with 7 percent in 2005. A related goal calls for the private sector's share of the R&D budget to increase eventually to 67 percent. More detailed analysis will be presented in Chapter 4 Business.

1.2.4. Strategic Sectors

Kazakhstan's government gives special importance to healthy growth of public goods and increased welfare in designing the STI policies.

In addition to significant investments in health and education sectors, the government's efforts are concentrated on the development of the following priority sectors:

- Traditional Industries: oil and gas, mining and smelting, and the atomic and chemicals industry,
- National and the state companies demand: engineering, construction industry, and pharmaceuticals,
- Development of non-commodity sector and sectors focused mainly on the export: agriculture, light industry, and tourism,
- Sectors classified as "economy of the future", which will play a dominant role in the global economy over the next 15 to 20 years: information and communication technologies, biotechnology, alternative energy, and space.

1.3. STI Policy Infrastructure

The role of Kazakhstan's government in economic development is not limited to policy-making, maintaining macroeconomic stability, and the regulation of businesses. It also takes responsibility on a strategic and coordinating role in economic processes. For the implementation of these functions, it is employing development institutions, technology parks, design offices, and special economic zones.

In accordance with the Resolution of the Government of Kazakhstan, dated August 6, 2009, "About Approving the List of Institutions of Innovation Development" the following five institutions of innovation development were identified:

1. Joint Stock Company (JSC) "National Agency for Technological Development". The Agency was established to increase the overall innovation activity in the country, including the promotion of high-tech and knowledge-intensive industries.

2. JSC "Science Fund". The main objective is promoting the initiation of priority R&D activities, as well as financial support for research teams, organizations, and companies involved in promising R&D activities, which have a high potential for the Republic of Kazakhstan.

3. JSC "Engineering and Technology Transfer Centre". It assists in the implementation of industrial-innovative development of Kazakhstan, modernization of technological and managerial levels of domestic enterprises.

4. JSC "KazAgroInnovation". It promotes the technological development of agriculture in Kazakhstan through effective asset management of scientific and innovation processes.

5. JSC "Kazakhstan Centre of Modernization and Development of Housing and Communal Services". It is responsible for conducting analysis and research and the implementation of innovative technologies in the field of public utilities.[5]

The State Program of Accelerated Industrial-Innovative Development (SPAIID) is designed to provide a supportive environment for scientific and technological breakthrough in Kazakhstan. In this context,

[5] Interviewee list, including representatives of these organizations, mainly nationals, is in Appendix 2.

the SPAIID of Kazakhstan established 4 design offices to satisfy the needs of four different enterprise segments (agricultural, mining, transport and petroleum engineering).

The development of technology parks, which fill a gap between the academic and business environment, is another STI infrastructure initiative that is taken by the government. The President of Kazakhstan points out "Special Economic Zone Park of Innovation Technologies" as one of the "points of the growth" of innovative technologies in the Republic of Kazakhstan. Since 2004, eight regional technology parks have been established (Table 1.1)

Table 1.1: Technology Parks Established Since 2004

Techno Park	Priority Directions
"Algorithm" Technology Park (Uralsk)	Oil and gas sector, mechanical engineering, petro chemistry, instrument engineering
UNISCIENCTECH Technology Park (Karaganda)	Mining and smelting sector, mechanical engineering, chemical industry, ecology and energy efficiency
Almaty Regional Technology Park (Almaty)	Transport machine building, construction material, iron and steel industry, petro chemistry
Regional Technology Park of Astana (Astana)	Agroindustrial complex, mechanical engineering, petro chemistry, ecology and energy efficiency
Technology Park of KazNTU (Almaty)	Oil and gas sector, mining and smelting sector
Regional Technology Park of South-Kazakhstan (Shymkent)	Petro chemistry, construction material, manufacture and processing of agriculture productions, processing of hydrocarbon crude
East-Kazakhstan Regional Technology Park Altay (Ust-Kamenogorsk)	Energy efficiency, ecology, new construction material, creative technologies
North-Kazakhstan Regional Technology Park «Kyzylzhar» (Petropavlovsk)	Resource and energy saving, environmentally-friendly technologies, new construction materials, information technologies, creative technology, technology and astrophysical research

Besides, Park of Nuclear Technologies was established in August 12, 2005 by the decree of the Government of Kazakhstan in order to develop nuclear technologies used in the industry.

1.4. Human Capital & Funding: Critical Drivers of STI

1.4.1. Human capital

Kazakhstan's science reforms are directly connected to multidimensional issues pertaining to the position of science personnel as in other countries. Changes in the staff headcount include two stages of transformation of science. The first period is characterized by the rise of interest in science positions (2000-2006); the number of scientific staff including researchers, technicians, indirect workers and others, in this period reached its maximum in 2006, with almost 20 thousand people[6]; and unexpected decline during the second stage (from 2007 to 2009) accompanied by a reduction in the number of workers engaged in R&D. Since 2010, a period of stabilization with an increase in the number of scientific personnel has been experienced.

[6] The Agency of Statistics of the Republic of Kazakhstan

The analysis shows that between 2000 and 2010, the number of employees carrying out R&D, with respect to the economically active population, remained unchanged at 0.2%. During the same period in Kazakhstan, the number of personnel in higher education system has almost remained same, although the number of newcomers has slightly decreased from 3147 in 2006 to 3041 in 2010.

In 2010, the number of employees engaged in R&D in Kazakhstan was 1,036 per million people, which is significantly less than Russia (3,319 per million people in 2007), Finland (7,832), Iceland (6,807), Sweden (5,416), Japan (5,287), USA (4,605), Norway (4,587), Australia (3,759), Canada (3,597), and France (3,213). Compared to the OIC member countries[7], Kazakhstan lags behind Tunisia (3,240), Jordan (1,934 in 2008), Turkey (1,715), Iran (1,491), and Azerbaijan (1,218 in 2009).

The increase in R&D expenditure per capita over the last decade is an important indicator of the scientific and technical potential of the country. In Kazakhstan, the figure amplified by 2.5 times during the period 2000-2010 to US$ 27 per capita, however it is still less compared to other countries such as US$ 70 in Russia, US$ 1103.8 South Korea, US$ 132 in Turkey, US$ 103 in Tunisia, and US$ 89 in Iran[8]. The detailed analysis and figures on Total Number of R&D Personnel and per capita spending are presented in Chapter 8.

1.4.2. Funding

The Law on "Science and State Science and Technology Policy of the Republic of Kazakhstan" is an important component of legislation of STI with a focus on critical issues such as core funding of research institutes and universities, the research grant system and the creation of research universities. The grant system is extensively used and can provide scientists with a high level of mobility. Grants may be received by organizations and individual scientists or experts, where competition and adoption of decisions on funding is carried out by the scientists themselves. With increased funding for science, the expansion of international cooperation is considered to be quite promising for further development of national scientific system. International cooperation reveals new opportunities for research projects. As funding procedures becomes more transparent and objective, many of the obstacles to get funding disappear through the competition.

The implementation of the aforementioned modalities is expected to provide a sustained source of human capital in science which will contribute to the scientific development of the country and create a competitive environment.

Table 1.2: The Dynamics of GDP and Expenditures on R&D for 2006-2010

Indicator	2006	2007	2008	2009	2010
GDP (billion US$)	81.04	104.88	133.41	115.27	148.05
GERD (million US$)	196.79	218.75	289.21	265.01	227.34
GERD in GDP (%)	0.24	0.21	0.22	0.24	0.16
Public R&D Expenditures (million US$)	69.8	37.5	47.4	35.9	38.0
Public Expenditures in R&D in Total Domestic R&D Expenditures (%)	35.5	17.2	16.4	13.6	16.7

Source: The Agency of Statistics of the Republic of Kazakhstan[9]

[7] SESRIC Report, Education and Scientific Development in the OIC Member Countries 2012/2013.
[8] SESRIC Report, Education and Scientific Development in the OIC Member Countries 2012/2013.
[9] Calculations are based on the yearly average exchange rate obtained from Kazakhstan National Bank, www.nationalbank.kz

The distribution of domestic expenditure on R&D by source of funds shows that government funding of science increased by almost 3.6 times, which led to an increase in the share of budgetary funds for the financing of science, during 2000 to 2005. But since 2006, the share of government fund on R&D has declined, and in 2010 it was 16.7%.

Table 1.3: R&D Expenditures per capita (2006-2010)

Indicator	2006	2007	2008	2009	2010
Gross Expenditures on R&D (million US$)	196.8	219.0	288.9	264.3	227.1
Population (million people)	15.4	15.6	16.1	16.2	16.4
GERD per capita (US$)	12.8	14.0	17.9	16.3	13.9

Source: The Agency of Statistics of the Republic of Kazakhstan

The second most important source of funding for science in Kazakhstan is private funds. Taken together, these two sources of funding, government and business funds, covered nearly 96% of the cost of technological innovation in 2010, while foreign sources accounted for about 1%.

Table 1.4: Sources of Technological Innovation Funding

	2006		2007		2008		2009		2010	
Indicator (million US$)	Total	as % total	Total	as % total	Total	as % total	Total	as % total	Total	as % total
Gross Cost, total	**634.7**	**100**	**681.7**	**100**	**942.9**	**100**	**413.8**	**100**	**1,598.2**	**100**
Distribution										
Republic Budget	51.4	8.1	35.6	5.2	46.6	4.9	33.7	8.1	37.4	2.3
Development Institutions Funds	0.1	0.0	0.2	0.0	12.8	1.4	4.6	1.1	20.0	1.3
Local Budget	18.4	2.9	1.5	0.2	0.3	0.0	2.6	0.6	0.3	0.0
Equity Capital	542.8	85.5	576.1	84.5	805.0	85.4	366.4	88.5	1,489.2	93.2
Foreign Investments	21.9	3.5	68.4	10.0	78.2	8.3	6.5	1.6	14.8	0.9
Venture Funds	…	…	…	…	…	…	…	…	0.01	0.0
Loans and Credits	…	…	…	…	…	…	5.7	1.4	36.4	2.3

Source: The Agency of Statistics of the Republic of Kazakhstan[10]

Kazakhstan has enough resources for STI funding as Professor Malik, Doctor of Technical Science, has stated. Since becoming independent from the Soviet Union, Kazakhstan has implemented a number of innovative reforms in STI financing, including encouraging the rapid growth of research centres and public/private universities. However, as discussed in chapter 4 and 10, whether Kazakhstan invests sufficiently on STI, distributes public resources in a manner that encourage innovation and uses available resources in an effective manner are the dimensions that need to be addressed in order to assess the current funding mechanism of STI.

[10] Calculations made based on the yearly average exchange rate obtained from Kazakhstan National Bank, www.nationalbank.kz

1.5. Publications & Patents: Fruitful Products of STI

1.5.1. Publications

By number of scientific publications, Kazakhstan is at the world average (1 article per 9 scientists). The number of published papers has gradually increased from 500 research papers in 1991-1995 to 1,680[11] in 2006-2010, indicating the positive development in this area. The research activity of local scientists on international publications has increased by 3 times in comparison to the early years of independence. Simultaneously, a sharp increase in the number of citations of published works (from 1,500 to 6,500), and significantly higher relative citation impact prove a positive trend in Kazakhstan's scientific output.

In October 2011, Thomson Reuters has announced a three-year national agreement with the Republic of Kazakhstan's National Center for Scientific and Technical Information which ensures access to the most comprehensive source of citation information for multiple institutions for 322 academic, research and government institutions across the country. The agreement is the largest for Thomson Reuters Web of Knowledge platform in Central Asia and provides researchers throughout Kazakhstan access to the world's leading citation databases[12].

1.5.2. Quality and Impact of Research

Kazakhstan's main partner countries in scientific publications are Russia, USA, Germany, Japan, and the United Kingdom (together they account for more than 50% of the joint publications) indicating close cooperation with the critical partners in order to improve different areas of science, technology and innovation system in Kazakhstan. Chapter 7 elaborates more on the state of international collaboration.

Scientific papers published in international journals are mostly in the fields of physics & astronomy and chemistry (Figure 1.2). The most cited scientific papers are in physics, biology, space, and ecology. Among the articles written with international partners, the most cited are on the subject of high-energy physics.

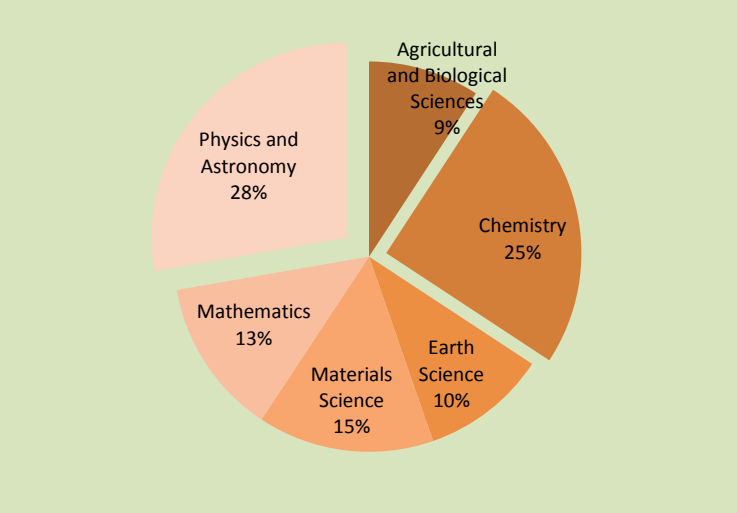
Since independence, international journal research publications by local scientists have increased by 3 times. An analysis done in 2009 on international publications of Kazakh researchers using the Scopus database for the period 1991-2008 shows that 3,883 scientific papers had been published in international journals and the articles received 10,312 citations.[13]

[11] The Agency of Statistics of the Republic of Kazakhstan

[12] http://www.knowledgespeak.com/newscategoryview.asp?category=Research%20Support%20Tools&id=15019

[13] Each article was cited 2.6 times, on average.

Figure 1.2: Distribution of Kazakhstan Scientific Publications (2006-2010)



Source: The Agency of Statistics of the Republic of Kazakhstan

1.5.3. Patents

One of the most important indicators of the effectiveness of R&D is patenting activity. Even though there is an upward trend in all types of patents, these numbers are low especially when compared to developed countries and when taken in terms of number of patent applications per population. The patent activity, i.e. number of patent applications, dropped from 2,270 in 2007 to 1,989 in 2010. It is necessary to point that almost 85% of these patents are given to national holders. However, as the number of patents issued more than doubled, the rate of issuance climbed to 30.1% in 2010 compared to rate of issuance of 9.4% in 2007. More details on patents are presented in Chapter 8.

2 PEOPLE

"What will our children and grandchildren be - the way we want to see them in that remote future - when they are our age? Will they be well-off, well-fed, healthy and well-educated? Will they live in a prosperous and democratic society? Will they live in peace? Will they feel safe, safe as to themselves and to their children? Will they be able to feel safe walking along the streets, feel safe for their property? Indeed, will they succeed to a strong state and to friendly relations with their neighbours, whether remote or close? It is today that we must answer these seemingly simple but pretty important questions."

Nursultan Nazarbayev
Message to the People of Kazakhstan
Astana, October 1997[14]

In his address to the people of Kazakhstan, President of the Republic of Kazakhstan Nursultan Nazarbayev highlighted that Kazakhstan needs to implement a set of tasks in ten directions in order to strengthen economy, improve social welfare and achieve socio-economic development. Among them, arguably the most important, he emphasized on the qualitative growth of human capital in Kazakhstan as the key to enhance the innovation system. "Education and healthcare is basic in improving the human potential", he said.

Since the transition economy of the former Soviet Union, Kazakhstan has defined education as a priority of the socioeconomic development and made extensive reforms directed towards modernizing education through introducing advanced techniques and technologies in the education process, improving the quality of pedagogic staff, expanding access to education for youth. Yet, regardless of the current educational reforms, Nazarbayev highlights a significant aspect, 'Education should provide young people not only the knowledge, but also the ability to use it in the process of social adaptation.'

This chapter focuses on human capital in Kazakhstan in the 21st century. It discusses the notable educational reforms and investments as well as the proliferation of education through public and private universities, colleges, scholarships, distance learning and international educational exchanges. It also explains the problems Kazakhstan faces to train its specialists and provide continuously developing and accessible system of technical and professional education. The promotion of healthy lifestyles and women's participation in education and employment are similarly examined.

[14] From message of the President of the country to the people of Kazakhstan, Strategy 2030

2.1. A Free Spirit – The Kazakh People

As one of the Turkic states in Central Asia, in 2010 Kazakhstan has the 62nd largest population in the world with 16.3[15] million culturally and ethnically diverse people mainly due to mass immigrations to the country during Stalin's rule. Within 131 ethnicities, Kazakhs (derived from an ancient Turkic word meaning 'a free spirit') represent nearly 63% of the total population. Rest is made up of 24% Russian, 3% Uzbek and 2% Ukrainian[16].

After the independence, Kazakhstan found itself as an independent republic without any economic and social plan to adjust for the world economic conditions. Facing the reality of post-Soviet economic challenges, a lot of men and women mostly involved in the public sector became jobless. Education and health sector, which were at high level during the Soviet times, speedily worsened as fewer people were able to meet the expenses of medical care and educational fees.

The troubles of 1990s were overcome through implementing necessary policies by the state. The state proximately increased employment opportunities via reorganizing the oil industry and advancing the higher education through attracting more international scholars and students to the country, investing on infrastructure, offering more opportunities for emerging talents and allocating research funds on a more competitive basis. Further, Kazakhstan provided widespread admittance to education through special scholarships for successful students and children of deprived families in exchange for compulsory state service for a number of years. Following the economic upturn drove by oil revenues, in 2004 Kazakhstan introduced a comprehensive National Programme of Health Care Reform and Development for the period 2005–2010. Overall, oil resources, huge territory as well as changes from planned to market economy and from absolute state control to democracy made Kazakhstan one of the best progressive countries in the former Soviet Union.

Yet, along with an increased financial allocation to the education and health sector, substantial modifications are required in the organization, management and provision of those services, in addition to enhancing of educational access and primary health care. More importance will need to be placed on the quality and efficiency of services, and forming a system of monitoring and evaluation could play an important role in realizing these objectives.

2.2. National Policies for Education

The promising and steadfast decisions of education reforms in Kazakhstan play a key role in shaping the human capital of the country, which is in a transition to a democratic society and market economy. Government expenditures on education have relatively been increased since 2005. Only 3.4% of GDP was spent on education in 2006, compared to 4.1% spending in 2010.[17] Over the past five years, the amount of funds allocated to primary and secondary education have increased in nominal terms by 2.7 times. However, despite a steady growth of oil and gas revenues of the state, public spending for education is still low.

In 1999, 75.3% of citizens aged between 5 and 24 years were covered by educational programs and the literacy rate reached 99.5%[18]. Since 1996, Kazakhstan has made a significant progress in increasing the number of educational participants. Particularly two policies, the development of new procedures for admission to tertiary education through Unified National Test (UNT) and financial measures to assist students, almost doubled the enrolment in tertiary education during 1999-2005[19]. According to the

[15] World Bank
[16] Statistical Yearbook of Kazakhstan, 2009
[17] The Agency of Statistics of the Republic of Kazakhstan
[18] http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx
[19] Reviews of National Policies for Education: Higher Education in Kazakhstan 2007, pg.58

2009 UNESCO Report, Kazakhstan ranked the first among 129 countries in the world in terms of access to education.[20]

Table 2.1: Education for All Development Index (EDI)

On data of the World Report of UNESCO on Education for All monitoring for 2009						
<<Overcoming an Inequality: Important Role of Management>>						
Rating	States	IDE	Coverage of Elementary Education	Level of Literacy of Adults	Gender Index	Part of Children completed 4 grades
1.	Kazakhstan	0.995	0.990	0.996	0.993	1.000
2.	Japan	0.994	0.998	0.992	0.998	0.990
3.	Germany	0.994	0.996	1.000	0.992	0.989
4.	Norway	0.994	0.981	1.000	0.996	0.999
5.	Great Britain	0.993	0.996	0.998	0.989	0.990
6.	Italy	0.992	0.994	0.988	0.991	0.995
20.	South Korea	0.984	0.985	0.991	0.967	0.993
41.	Belarus	0.969	0.899	0.997	0.987	0.992
45.	Malaysia	0.965	0.999	0.915	0.952	0.993
78.	Turkey	0.909	0.914	0.881	0.873	0.969
129.	Chad	0.408	0.604	0.257	0.440	0.332

Another area of national education policies was in private education. The government formed a regulatory framework that allowed the establishment of private universities and institutes. While in the early 1990s, Kazakhstan had only 39 public tertiary education institutions, in 2007, Kazakhstan had 109 private institutions enrolling almost half of the total student population.[21] Today, the number of the public universities is 57 compared to 91 private universities. By the rapid growth of private sector, Kazakhstan has become one of the countries in the world with the highest level of private funding.

One of the major directions of Kazakhstan is to integrate the higher education system into the world educational structure. Since 2009, the Ministry of Education and Science of Kazakhstan has been working on European Credit Transfer System (ECTS). The government makes significant efforts in order to solve the convertibility problem of Kazakh higher education diplomas, the recognition of Kazakh diplomas at international level and the involvement of local universities in international rankings. However, the major step towards the internationalisation of higher education in Kazakhstan has been the country's decision to adopt "Bologna Process" taking place in European Union. In 2010, Kazakhstan signed the Bologna Declaration, which has a critical role in international positioning of higher education system. There are few international universities in the country as Kazakhstan

[20] Education for All Global Monitoring Report 2009: "Overcoming Inequality: Why Governance Matters", UNESCO, pg.248
[21] Reviews of National Policies for Education: Higher Education in Kazakhstan 2007, pg. 84

Institute of Management, Economics and Strategic Research (KIMEP) based on Western education system and 40% owned by the government. The Kazakh-British Technical University and the Kazakh-American University, where the language of instruction is English, represent joint projects between Kazakhstan, the UK and the USA, respectively. In terms of accreditation and quality assurance, the Kazakhstan progress is noteworthy. In 2007, only three universities had international accreditation, but in 2010 seven universities including two national universities had international accreditation[22].

The Presidential Bolashak Scholarship Programme was established in 1994 by the government of Kazakhstan in order to train its specialists and to support the gifted youth to study abroad both at the graduate and undergraduate level. Since its inception in 2007, the Presidential Bolashak Scholarship Programme has benefited more than 2,500 individuals, who studied in more than 20 countries. Currently, the fellows have the opportunity to study in 630 leading universities from 32 countries. At the present stage scholarship focuses on masters and doctoral training programs, as well as training of technical and medical personnel, which are in demand for the country. In 2006, the Bolashak Programme has identified 13 priority areas, which are public administration, education, health care, space sciences, industrial and innovation development, rural territories development, housing construction, e-government, clusters (metallurgy, transport logistics, textile and food industry, tourism, oil and gas engineering and construction materials), science, public safety, social and cultural development and civil aviation.

Table 2.2: Top Ten Fields of Study of Bolashak Students, 2005

Field	Number of Students	Percentage of Total Students
1. State Management and State Policy	347	20.5
2. Computer Sciences and Computer Facilities	307	18.1
3. Economic Sciences	165	9.7
4. Innovative Management and Technologies	161	9.5
5. Power and Oil and Gas	158	9.3
6. Medical Sciences	107	6.3
7. Social and Humanitarian Studies	39	2.3
8. Astronomy and Space	37	2.2
9. Architecture and Construction	36	2.1
10. Law and International Law	35	2

Source: Reviews of National Policies for Education Higher Education in Kazakhstan, OECD and World Bank

More than 150 organizations of Education and Science have direct contacts with partners residing abroad. More than 10.5 thousand of foreign students from 45 countries visited Kazakhstan. More than 25 thousand of Kazakh people study in 30 countries of the world on their own expenses. However, besides the exchange programs and international agreements, Kazakhstan needs to equip the graduates with necessary skills required in the global economy, increase the quality of higher education in the country and attract international students and professors in order to be more

[22] http://www.nac.edu.kz/index.php?option=com_content&view=category&layout=blog&id=36&Itemid=57&lang=ru

competitive in the global world. As Dr. Shukayev, docent at Kazakh National Technical University has stated, Kazakhstan should support students, researchers and scientists working with a great enthusiasm to develop science and innovation culture of the country.

2.3. Demands for Specialists: Vocational Education

Currently, there are 596 colleges and 325 vocational schools, which train technicians and service specialists in Kazakhstan with a number of 603,800 students enrolled in 185 specialties. However, in 2006, only 107 professional schools (54,000 students) and 122 colleges (109,000 students) trained technical specialists, meaning that only one in four young Kazakh was studying the most needed technical specialities.[23] Still Kazakhstan has a challenge to train highly qualified personnel. The poor development of infrastructure, shortage of engineering teachers and the poor infrastructure of professional schools and colleges are the major problems in the professional education sphere of Kazakhstan.

Due to the low qualification of Kazakh specialists that cannot meet the requirements of the modern labour market, let alone the requirements of an innovative economy the country is trying to build, a growing number of foreign specialists are working in the country. In 2000, over 10,000 foreign people were working in Kazakhstan whereas it exceeded 30,000 in the first nine months of 2006.[24]

Knowing the importance of Technical and Vocational Education for the development of Kazakhstan, the government implemented the State Program of Technical and Vocational Education Development for 2008-2012. The National Council for the development of engineering and vocational education has also been established together with regional and industry councils on the issues of workforce training in the priority sectors of the economy. Through these councils, various regional forums on "Vocational Education and Business: Dialogue of Partners" were organized, where 33 agreements on bilateral cooperation in the field of training were signed between large companies and local authorities. At present, there are 16.8 thousand agreements[25] between educational institutions and companies, through which students are granted 97 thousand job opportunities for practical training and internship. In 2010, the system of vocational education became a party in the Turin Process with 29 European countries and participates in international comparative studies conducted by the European Training Foundation (Turin).

As part of financial support mechanism, advanced college students under the government order receive a bursary[26]. In 2011, the amount of bursary for this category of students increased from 9,375 tenges to 12,188 tenges (from US$ 64 to US$ 83). In addition, over the last three years 5.2 billion tenges (US$ 35.3 mln) was contributed to the material and technical needs of 183 technical and vocational schools. Accordingly, in 2010 out of 157 thousand full-time technical and vocational education graduates 45,425 graduates increased their level of qualification.

By 2015, it is planned that the share of educational institutions for technical and vocational education, which is equipped with modern teaching facilities, will amount to 75% whereas in 2011 it was 40.7%. The funds will be used to purchase agricultural, motor transport, building, metallurgical and other educational equipment. Within the same context, a special role in the innovation process of vocational education is given to "Nazarbayev University" with its basic principles that stress on academic freedom, autonomy, integration of education, science and industry, international cooperation in education and science. The University aims at becoming a national brand of Kazakhstan and likewise,

[23] http://www.investkz.com/en/journals/49/381.html
[24] http://www.investkz.com/en/journals/49/381.html
[25] http://www.edu.gov.kz/ru/activity/srednee_professionalnoe/socialnoe_patrnerstvo/
[26] Government Resolution of February 7, 2008 № 116

by 2015 it is planning to train highly qualified specialists and young scientists through public-private partnership.

2.4. Gender Friendly Development

Following the collapse of the Soviet Union in 1991, economic fluctuations led to significant changes in social relations as social services were severely cut, and the assurances of lifelong support from the state were removed.[27] In the very beginning of the independence, unemployment was extensive, day-care was missing, and health care and higher education were at high cost, which affected women population seriously. This posed a question with regards to the gender policies of Kazakhstan; was gender equality being replaced with more "traditional" gender roles?

Contrary, since mid-1990s, Kazakhstan has paid much attention to gender issues as an important and integral part of the state policy and developed and implemented a series of policies and action plans in order to promote gender balance. In 1999, the government acknowledged the "National Action Plan on Improving the Status of Women" identifying women's health, active participation in labour force, economic advancement and preventing discrimination against women as a priority focus. The Concept of Gender Policy in the Republic of Kazakhstan in 2003 and the Concept of Gender Policy and the Millennium Development Goals in Kazakhstan in 2004 responded to some concerns regarding the development of a more comprehensive policy framework and institutional approach to promoting gender equality in the short term (until 2010) and long term (2030). By 2006, the President, issued a decree founding a National Commission on family affairs and gender policy in order to implement and monitor the regulations as well as to ensure that women's rights are protected in the development of policies and enforcement of laws.[28]

The population of women in Kazakhstan was 8.476 million in 2010, which represents 52% of the total population.[29] In 2009, the number of the workers, who were carrying out scientific researches and development, was 16,304 people and 53.1% of which was women. These numbers bring optimism with regard to the future of gender balance in research careers. In 2009, women provided 61.8% of all dissertations that characterizes their high intellectual potential. The proportion of women among candidates of science was 64.0% and 51.5% in doctors of science. Through the proliferation of education at all levels and gender sensitive policies, women started to outnumber Kazakh men in education. In 2008, the largest number of doctoral and master's theses defended by women.[30]

At all levels of education, Kazakhstan has significantly greater share of female teachers than OECD countries and Russia, in the pre-school education, the share of female teachers is 99.4% whereas it is 96.8% in OECD countries. In primary education the share of female teachers is 98.2% while 79, 0% in OECD countries. At the level of secondary education, Kazakhstan has the share of 85.8% compared to OECD countries and Russia, 52.1% and 80.2% respectively. Concerning initial vocational training, the rates are 59.9% in Kazakhstan and 50.3% in OECD countries and the share of female teachers at the level of higher education is 63.3% in Kazakhstan, while it is 35.9% in the OECD countries.

2.5. Healthy Generations

In health sector, Kazakhstan faced various challenges as other countries of the former Soviet Union comprising oversized and inpatient-oriented system of health facilities and a drop in health financing

[27] http://www.adb.org/sites/default/files/pub/2006/cga-kaz.pdf
[28] http://www.women.kz/portal/media-type/html/user/anon/page/default.psml/js_pane/P-106d922b635-10004
[29] The World Bank
[30] Medicine (130), economy (128), teaching (113), technical education (69), philology (66), law (51), chemistry (41), history (33) and political science (18)

in the early transition years.[31] Yet, in a rapid economic and social development, in 2004 Kazakhstan initiated a comprehensive National Programme of Health Care Reform and Development for the period 2005–2010 in order to recover its health system and services.

Though following the collapse of the Soviet Union life expectancy declined dramatically from 68.81 years in 1990 to 64.4 years in 1996, it then increased to 65.89 in 2005, which was still three years short of its 1990 level (WHO Regional Office for Europe 2007). Today, the life expectancy of Kazakhstan is 68.[32] According to the official statistics, the life expectancy of males was 63.5 years, while for females was 73.3 years in 2010. In the mid-1990s, Kazakhstan had one of the highest levels of government employment in the world and health personnel accounted for approximately 40% of government employees.[33] However, since 1990, the ratio of health care workers to population has declined due to privatization of the health sector. Likewise, due to an insufficient number of new graduates, Kazakhstan has been facing problems in recruiting qualified staff, especially in remote and rural areas. The training of health care personnel is one of the key challenges for Kazakhstan's health system (Government of Kazakhstan 2007). Thus, government developed various measures to tackle the problem; the Concept for the Educational Development of Kazakhstan until 2015 is among them. The concept foresees modifications to the training of all professionals with higher education that also have an impact on medical education. A concept for the reform of medical and pharmaceutical training for 2006–2010 has been drawn up and in 2007 new standards for the training of medical and pharmacy students were enacted.

Kazakhstan has also revised its health care financing, strengthened primary health care and introduced healthy lifestyle activities. Since 2002, budgetary allocations to the health sector have increased significantly both in absolute figures and as a share of GDP. It increased from 1.9% in 2002 to 4% in 2010. Together with considerable changes in the organization, management and provision of health services, Kazakhstan will embrace a better healthy future.

Due the growing acknowledgement of the role of science and technology in solving human problems - in particular infectious diseases-, developing countries establish new forms of management that consider emerging opportunities in the globalization of scientific knowledge. Kazakhstan, in this regard, tries to review its medical system through bringing into line the mandates of existing institutions with biomedical research priorities of the country. Kazakhstan attempts to create synergies between biomedical research, medical practice and outreach. However, as Dr. Rakhimov, Professor at Tashkent Pharmaceutical Institute stated that Kazakhstan has only a single centre for biomedical research (Institute of Pharmacology and Toxicology) and Kazakh universities are lacking financial support for fundamental and applied research. In this regard, he mentioned, Kazakhstan needs to increase funding on biomedical research to develop, create and implement new drugs into clinical practice.

[31] http://www.euro.who.int/__data/assets/pdf_file/0007/85498/E90977.pdf (pg.xiii)
[32] The World Bank, World Development Indicators (WDI) Online
[33] Kulzhanov M, Rechel B. Kazakhstan: Health system review. *Health Systems in Transition*, 2007; 9(7): 1–158.

3 PLACES

Kazakhstan with a land of 2,717,300 square km, the largest in Central Asia, is the biggest landlocked country in the world. Kazakhstan is divided into 14 provinces and two cities Astana and Almaty, its old and new capitals. Baikonur city is located just south of the Baikonur cosmodrome that is being leased to Russia until 2050. Regional authorities are financed directly from national budget and most of the decisions are taken by the central government.

The vastness of the country reflects itself by way of diversity of the regions; from the newly established city of Astana to the world's largest dry steppe, from snow-covered mountains to deserts. As a result, centres of economic activities are spread widely throughout Kazakhstan. Hence, the Science Technology and Innovation capacity varies among regions.

Distinct geography of Kazakhstan provides unique experimental facilities. For example, Prof. Sadykov T.H. from Institute of Physics and Technology of Almaty mentioned that the location of the cosmic ray research facility situated in Tien-Shan Mountains (3340 m above sea level) provides unique data in physics of particle interactions with matter. Research conducted on station allows detecting and investigating solar flare particles and modulation effects of galactic cosmic rays.

Figure 3.1: Regions in Kazakhstan

3.1. Comparative Analysis of the Level of Innovative Capacity

In terms of economic activity, Kazakhstan can be analysed in five major regions. Locations of different industries are tied to mineral deposits, major cities and water resources.

In the North, development of grain farming, mining of iron ore and coal, machinery, petroleum products and ferroalloys and energy are significant. The most dominated sectors in Eastern part of Kazakhstan are non-ferrous metals, energy, engineering and forestry. Western Kazakhstan is the largest oil and gas producing region, not only in Kazakhstan, but also in the Commonwealth of independent States (CIS). Basic branches of Central Kazakhstan are - ferrous and nonferrous metallurgy, machinery and animal husbandry. In Southern Kazakhstan cotton, rice, wool, grain, fruits, vegetables, grapes are produced besides non-ferrous metallurgy, instrument, light and food industries, fisheries and forestry.

Table 3.1 shows a set of useful regional information such as gross regional product and the share of innovation production[34] as a percentage of gross regional products at the end of 2010.

Table 3.1: Production Volume by Region in 2010

	Gross Regional Product (billion US$)	Gross Regional Product per head (US$)	Industrial Production Volume (billion US$)	Innovation Production Volume (million US$)	Share of the Innovation Production in Gross Regional Product, %
Kazakhstan	146.9	8,935	82.2	941.3	0.641
Akmola region	3.9	5,342	1.2	47.2	1.206
Aktobe region	7.8	10,055	6.5	66.5	0.851
Almaty region	6.6	3,542	2.5	3.5	0.053
Atyrau region	18.9	35,614	21.2	0.9	0.005
West-Kazakhstan region	7.1	11,624	6.7	-	-
Zhambyl region	3.1	2,943	0.8	2.7	0.088
Karaganda region	12.5	9,257	7.0	101.1	0.808
Kostanai region	5.8	6,624	3.1	11.5	0.198
Kyzylorda region	5.7	8,145	5.5	-	-
Mangistau region	9.7	18,422	11.2	1.6	0.016
South-Kazakhstan region	7.7	3,002	2.1	33.3	0.431
Pavlodar region	7.3	9,804	5.7	492.7	6.735
North-Kazakhstan region	3.1	5,293	0.6	19.7	0.635
East-Kazakhstan region	8.6	6,163	4.4	7.5	0.087
Astana city	12.2	17,490	0.8	0.1	0.001
Almaty city	26.8	18,945	2.9	85.5	0.319

Source: The Agency of Statistics of the Republic of Kazakhstan

[34] According to methodology document of Agency of Statistics of Republic of Kazakhstan, Innovative products are defined as a products which have undergone in the past three years of varying degrees of technological change. Carried out observations provide that estimates of several levels of novelty of new products: products, new to the world, new to the country, new to the region; rationalised.

According to the gross regional product per capita, Kazakhstan can be examined in four groups as can be seen in Figure 3.2. Atyrau and Mangystau regions take leading positions due to the mining industry, crude oil and natural gas. The share of mining industry in the gross regional product is more than two-thirds for Mangystau region and is about half for Atyrau.

Two metropolitan cities, Almaty and Astana, do not lag behind in terms of regional performances. The services provided by government agencies, financial institutions and the large-scale real estate transactions are the major sources of gross regional product. More specifically, trade in Almaty and construction in Astana appears to have significant weight.

The second group is composed of five regions (West-Kazakhstan, Aktobe, Pavlodar, Karaganda and Kyzylorda), specializing in the production of raw hydrocarbon materials. Karaganda and Pavlodar are traditionally industrial regions, where there is a greater development of processing plants compared to the extractive industries.

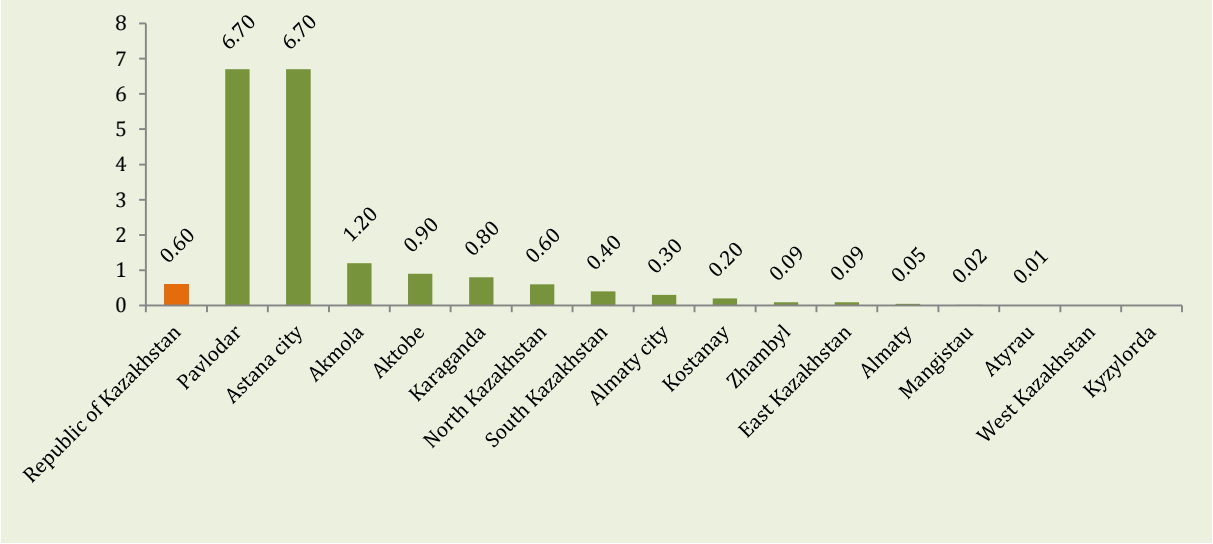
Figure 3.2: Gross Regional Product per capita, US$ in 2010

Source: Calculated on statistical compilations of the Statistics Agency of Kazakhstan, Regions 2011, Astana, 2011.

The third group is represented by four regions, which provide agricultural production in the country (Kostanay, North Kazakhstan, Akmola, and East Kazakhstan). East Kazakhstan is a region with advanced non-ferrous metallurgy and agriculture with a specialization in animal husbandry.

In the fourth group, there are regions of southern Kazakhstan with a relatively low level of industrial development and high population. When innovative products share in the gross regional product concerned, there is a different picture in terms of regional performance, Figure 3.3.

Figure 3.3: Share of Innovative Products in GRP in 2010, %



Source: Compiled by the Statistics Agency of Kazakhstan

In terms of innovative products' share in the gross regional product, Pavlodar region and Astana city are the leaders with equal rates of 6.7%. This is explained by the presence of one of the largest economic territorial-production complex in the CIS located in Pavlodar region. It creates great potential for various innovative products development. Companies manufacture export-oriented products such as alumina, ferro alloys, petroleum, coal and electric power. Capital's innovative development is directly related to the operation of an industrial park, in which projects are being implemented under the State Program of Accelerated Industrial-Innovative Development. A special economic zone "Astana - new city", which was established in 2000, offers investors a favourable environment for the construction of industrial, housing and social facilities. In addition, a regional centre for innovation was established in the Capital to expand the industrial park.

In terms of the share of innovative products, the following regions have relatively low rates: Akmola (1.2%), Aktobe (0.9%), Karaganda (0.8%) and North-Kazakhstan (0.6%).

All other regions[35] specialize exclusively in oil and gas production and have the highest rates of gross regional product in the country. On the contrary, the share of innovative products is very low and as a result these regions have poor innovation activity.

3.2. Regional Policy Tools

There are several tools implemented in Kazakhstan for regional STI system such as, Technology Parks, Social-Entrepreneurial Corporations (SEC) and regional branches of national companies. In this section, we are going to review implementations and analyse the effects of these tools.

Technology parks are among the first regional policy tools implemented in Kazakhstan. The country has formed two-tier system of technology parks - National S&T parks and Regional Technology parks. The national industrial parks are focused on creating new industries in Kazakhstan, which should help to ensure the future competitiveness of Kazakhstan's economy. The national scientific and technology parks include; Park of Innovative Technologies (Alatau), the National Industrial Petrochemical Technology Park (Atyrau), Park of Nuclear Technologies (Kurchatov, East Kazakhstan)

[35] Mangistau, Atyrau, East Kazakhstan, Kyzylorda

and Space Monitoring Technology Park (Almaty, Astana and Priozersk). Over the past decade, more than 10 technology parks have been created in Kazakhstan.

Box 3.1: Regional Parks

1. "Industrial Park" Algorithm" LLP in Uralsk;
2. "Industrial Park UNISCIENTECH" LLP in Karaganda;
3. "Almaty Regional Industrial Park (RIP)" LLP in Almaty;
4. "Regional Industrial Park in Astana" LLP in Astana;
5. "Industrial Park KazNTU (K.I. Satpayev)" JSC in Almaty;
6. "RIP in South Kazakhstan" LLP in Shymkent;
7. "East Kazakhstan RIP" Altay" LLP in Ust-Kamenogorsk;
8. "North Kazakhstan RIP" Kyzylzhar" LLP in Petropavlovsk.

Regional parks are created to identify, disclose and develop the innovative capacity of the region. At the regional level, the backbone components of the parks are regional industrial enterprises, and scientific and academic organizations. The regional technology parks provide a gradual increase of technological level of the economy and create conditions for small and medium-tech and knowledge-intensive business. Eight of the regional technology parks are listed in Box 3.1. In developed countries, science and technology parks (STP) tend to be very close to universities. For instance, in Western Europe, 83% of STP is located either on college campuses (72%) or adjacent to them (11%). Conversely, in Kazakhstan, only three out of ten techno-parks are located in universities; Kazakh National University (KAZNU), named after Al-Farabi; Kazakh National Technical University (KNTU), named after K. Satpayev, and East Kazakhstan State Technical University (EKSTU), named after D. Serikbayev. The remaining parks operate in large cities or industrial centres. About 60% of the industrial parks are located in cities such as Almaty, Astana, Atyrau, and Karaganda, while others operate in medium and small cities, such as Ust-Kamenogorsk.

Technology parks provided business incubation services for 36 projects in 2010 and 40 projects in 2011. One striking figure is that 85% of the applications are submitted from Almaty and Central regions, which shows the huge room for improvement for Regional Parks.

Unfortunately, Kazakhstan has not reaped the desired benefits of technology parks yet in terms of increased STI activity. The main factors are the lack of entrepreneurship and low domestic market demand[36]. In the upcoming years, technology parks could become the most important element of Kazakhstan's national innovation system, since these can be used among the tools to successfully implement for modernization of old technologies, increasing productivity, and the production of high-tech products.

Social-Entrepreneurial Cooperation (SEC) is among the actions in regional STI. They are based on the principal of Public Private Partnership (PPP), by providing entrepreneurs easy access to government resources. The main task of SECs is social and economic development of the region by reinvesting all their income in the region. Recently, management of SECs were transferred to regional authorities (akimats).

Entrepreneurship Development Fund (DAMU), with 46 billion tenges (US$ 313.6 mln) budgets in 2011, has branches in all akimats and it is responsible for the implementation of DAMU-Regions Programme with goals of narrowing regional disparities through providing support for SMEs in regional priority sectors.

With the participation of the National Agency for Technological Development (former National Innovation Fund JSC), Kazakhstan has established and successfully operated 4 Design Bureaus;

[36] *Innovation Performance Review of Kazakhstan*, United Nations Economic Commissions for Europe, 2012.

transport engineering and agriculture engineering in Astana, mining and metallurgical equipment in Ust-Kamenogorsk, and oil and gas equipment in Petropavlovsk. These design bureaus provide services on improvement of quality of the equipment used and final products. For example; Design Bureau of transport mechanical engineering jointly with 'ZIKSTO' JSC conducted development of grain handling hopper cars, assisted to their testing and certification in Russia.

In another example, Design Bureau of mining and smelting equipment developed design technology documentation on industrial mine fans for 'Kazzink' Ltd. Product of those mine fans was arranged by 'Ritam-Pavlodar' Ltd. Jointly with 'Turbomash' (Ust-Kamenogorsk city). The first shipment of fans received first royalty of 800 thousand KZT (US$ 5,454).

In general, three design bureau developed design technology documentation on 150 products, adopted design technology documentation to 53 international products, created 5 experimental patterns, arranged testing of 4 experimental patterns.

3.3. Distribution of STI Assets & Industries in Different Regions

Table 3.2 shows the distribution of higher education institutions across Kazakhstan since 2005. The number of institutions decreased in almost every region except Astana City and Aktobe Region. Almaty city has lost the highest number of higher educational institutions compared to the other regions. It should be noted that, after the amendments to educational law which brought new classification of higher education institutions, some institutions have lost their status.

Table 3.2: Number of Higher Educational Institutions

	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Kazakhstan	**181**	**176**	**167**	**143**	**148**	**149**	**146**
Akmola region	8	7	7	6	6	6	6
Aktobe region	7	7	6	6	7	8	8
Almaty region	4	4	4	2	2	2	2
Atyrau region	3	3	3	3	3	3	3
West-Kazakhstan region	7	7	7	4	4	4	4
Zhambyl region	5	5	6	5	5	5	5
Karaganda region	15	15	13	14	13	13	13
Kostanay region	9	8	7	7	7	7	7
Kyzylorda region	6	6	6	5	5	5	4
Mangistau region	3	4	4	3	3	3	3
South-Kazakhstan region	19	17	11	12	12	12	14
Pavlodar region	4	4	4	4	4	4	4
North-Kazakhstan region	4	4	4	3	3	2	2
East-Kazakhstan region	10	10	9	9	10	10	10
Astana city	11	13	13	12	12	13	14
Almaty city	66	62	63	48	52	52	47

Source: The Agency of Statistics of the Republic of Kazakhstan

Almaty again stands out as housing almost 50% of Kazakhstan's R&D institutions, Table 3.3. Besides Mangistau and South-Kazakhstan regions, it is also interesting to notice that Astana has doubled the number of organisations involved in R&D in only 5 years, as the new capital digs its feet even firmer into the ground.

Table 3.3: Number of Public & Private Organizations Engaged in R&D

	2005	2006	2007	2008	2009	2010
Kazakhstan	**390**	**437**	**438**	**421**	**416**	**424**
Akmola region	8	8	8	8	7	7
Aktobe region	15	17	17	16	15	16
Almaty region	8	9	14	12	7	10
Atyrau region	8	10	10	11	12	12
West-Kazakhstan region	36	35	35	35	34	33
Zhambyl region	9	13	12	11	12	10
Karaganda region	11	13	16	10	10	10
Kostanai region	51	51	46	40	29	28
Kyzylorda region	10	15	16	13	14	15
Mangistau region	7	6	6	7	9	14
South-Kazakhstan region	4	6	7	7	6	8
Pavlodar region	10	12	12	11	10	9
North-Kazakhstan region	5	4	5	5	5	5
East-Kazakhstan region	15	14	15	11	10	9
Astana city	23	30	35	41	43	42
Almaty city	170	194	184	183	193	196

Source: The Agency of Statistics of the Republic of Kazakhstan

Many new scientific and technological relations are developing in the commercial sectors, particularly in the areas of oil and gas. For example, the country's petrochemical complexes have attracted foreign investment and management. Various western companies actively seek investment opportunities in information technology and try to increase their presence in Kazakhstan.

Large-scale projects generally take place in newly created technology parks. Small regional innovation centres act mainly as technology transfer centres operating in the form of a business incubator and/or business centre for small and medium size enterprises. Kazakhstan is in the process of creating a network of national research and engineering laboratories in universities. Five national and fifteen engineering laboratories have been established at universities up to day.

Following is a brief description of each region.

Astana City

The key industries established in Astana are trade, communication, transport and construction. State is planning to increase human capacity and scientific development of the city in near future. As

pointed out earlier, the city is among the very few regions in Kazakhstan where number of higher education institutions and number of organizations engaged in R&D has shown steady increase.

In order to attract investors and develop new competitive industries, a special economic zone (SEZ) operates in the "Astana - new city". The advantages of SEZ are the presence of a special legal regime and simplified mechanism to do business. Astana – new city is also hosting a newly established Nazarbayev University. The aim of Nazarbayev University is to address the country's industrial-innovative development issues, and to this end, the university acts as a key high-tech research university in SEZ.

Astana's Regional Technology Park focuses on the cultivation of small innovative companies in the following areas of the economy; metallurgy, chemical, oil refining and petrochemical industries, environmental technologies, building materials industry, agriculture, etc.

In order to increase the share of enterprises involved in innovative activity in the field of engineering, the "Design Bureau of Transport Engineering" was also established in the new capital. Astana city municipality has established "Astana Innovations" JSC for improving innovation in the capital. Astana innovations is conducting several projects such as; OpenWIFI, E-Ambulance and School of future.[37]

Almaty City

Almaty has the most powerful scientific and research potential in the country. It accounts for 46.6% of the scientific organisations of the country, 52% of the total number of employees performing in R&D, 53.7% of the total expenditures of research, 35% of the expenditures on information and communication technologies, and 36% of performed scientific and technical work. The economy is basically focused on trade, finance, education and other services.[38]

Almaty city is one of the largest industrial and agricultural centres of the Republic of Kazakhstan especially in the field of mechanical engineering and metalworking. The only company in the CIS operating in electro dialysis desalination plant is Almaty Electromechanical Plant. Pharmaceutical and food industries are among the other important sectors of the region. Industrial crops, vegetables and fruits, as well as rice and tobacco are the main agricultural harvests of the region.

The main priority areas of science in Almaty are the fields of nuclear science, biomedical science and technology, research in the field of natural resources, agricultural science and technology, and environmental protection. In recent years, the emphasis in science has been associated with the increased activities of national research centres. Eight of the nine national research centres are located in Almaty.

An important area of industrial-innovative development in Almaty is the development of innovation infrastructure. The Special Economic Zone Park of Innovative Technologies, located in Almaty, has been given the status of "special economic zone". The main objective of its establishment is the promotion of knowledge-intensive industries in the city. Two regional technology parks are located in the higher education institutions in the old capital, Al-Farabi Kazakh National University and Kazakh National Technical University named after K.I. Satpaev. Also, several centres have been established to enhance the competitiveness of the enterprises in the region, such as the Centre for Technology Transfer, the Information and Marketing Centre, the Foundation for Support of Innovation, the Engineering Centre, and the Trade and Exhibition Centre.

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[37] For more information: http://ain.kz/en/

[38] These figures and the rest of the numbers in this chapter were gathered through the Agency of Statistics of Republic of Kazakhstan. For tables; please refer to Appendix.

Akmola Region

Even though production of innovative products in 2010 increased by 6.7 times and became KZT 6,959 mln (US$ 47.2 mln) compared to the production in 2009, there are only five enterprises in Akmola region with innovative activities and this accounts for only 0.7% of the total number of companies. Expenditures on the technological innovation of enterprises increased by 2.3 times and reached KZT 911.4 mln (US$ 6.2 mln) in 2010 comparing with 2009. The number of personnel engaged in R&D also increased to 615 persons.

The region's economy is based on agribusiness and processing. Akmola region is the major industrial centre of Kazakhstan in the manufacture of agricultural machinery and equipment for livestock and fodder production. A large joint-stock company "biological product" operates in Stepnogorsk that produces microbial products and feed additives. Akmola region is surrounding Astana city and has potential of combining local agribusiness with human capital of Astana in developing biological technologies.

Aktobe Region

In 2010, the number of enterprises involved in innovative activities in Aktobe region increased to 27. In the area of innovation, the level of activity was 6.1% and 24 organisations created and used new technology. Fixed Assets used in R&D increased by 22.1% to KZT 647.5 mln (US$ 4.4 mln), along with an increase in the number of personnel engaged in R&D from 157 to 195 persons comparing with 2009.

Aktobe region has a unique mineral resource base. Its territory has about 10% of hydrocarbons, oil, gas and gas condensate, in Kazakhstan. All the domestic stocks of chromium and significant percentage of nickel, titanium and phosphate reserves of the Republic lie in the region.

The Regional Technology Park "Aktobe" and Republican State Enterprise "Aktobe Agricultural Experiment Station" are located in the region. The Transportation and Logistics Centre in Aktobe (LLP "Aktobe-centre") covers a total area of 20.5 thousand pallets.

Almaty Region

The region is characterised by continuous decline in the number of enterprises related to innovative activities. Number of companies decreased from 20 in 2006 to 7 in 2010 and the level of activity in innovation decreased from 2.9% to 0.9%. On the other hand, the number of personnel engaged in R&D increased by 72.5% to 759 persons.

Newly established SEZ "Khorgos-Eastern Gate" is located on the border with China and is expected to benefit from trade opportunities with big neighbour. Main activities of the SEZ are logistics, food production and textiles. The establishment of the industrial zone "Arna" in Zarechny, "Taldykorgan" in Taldykorgan, and "Almaty - Zhihaz" in the Ili region probably will contribute to the creation of modern and innovative productions in future.

Atyrau Region

In 2010, the number of enterprises involved in innovative activities in the Atyrau region became 9, the level of activity increased from 2.9% to 3.7% and enterprises with R&D departments increased from 10 to 15, comparing to 2009.

Atyrau region is the oldest oil and gas producing region of Kazakhstan and the region's economy is almost totally based on oil and gas sector. Currently, the Republic of Kazakhstan opened more than 250 fields, of which 62 are located in the Atyrau region. Tengiz is one of the largest oil fields, which reserves from 750 to 1,125 million tons of oil. The scientific potential of the Atyrau region is represented by five Research Institutes and two universities.

The Atyrau region contains the SEZ "National Industrial Petrochemical Technology Park". This SEZ is expected to become more active after the production of petrochemical complex, which will produce polyethylene and polypropylene. The Atyrau Business Incubator currently manages 25 projects.

Zhambyl Region

In 2010, the level of enterprises with innovation activities rose to 7.8%, growing to 31 companies. The volume of innovative products reached KZT 723.8 mln (US$ 4.9 mln), which is three times less than 2009, and the number of personnel engaged in R&D fall to 344 persons.

Zhambyl region is a unique base of phosphate raw materials. Its territory holds 71.9% of reserves of phosphates, 68% of fluorspar, 8.8% of gold and 0.7% of uranium. The area is rich in nonferrous metals, barite, coal, cladding, semiprecious stones and construction materials. Other significant sectors in the region are leather, footwear and agriculture. Climatic conditions enable the production of various industrial crops, vegetables and fruits. Also, natural grasslands are ideal for the development of sheep farming.

There are also a few research institutes in the region, such as MH Dulati, Taraz Innovation and Humanities University of BPH, the "Research Institute for Plant Biology, and the National Centre for Biotechnology", MES. The Kazakh Research Institute of Water Resources (LLC "KazNIIvodhoz") is the leading national research centre in agricultural science. Experimental farms and regional veterinary stations are also hosted in Zhambyl region.

East Kazakhstan Region

In 2010, the number of enterprises involved in innovative activities reached 60 and the volume of innovative products became KZT 13.9 billion (US$ 94 mln), almost a two-fold rise from the 2009 level. R&D departments in the enterprises decreased from 120 to 105 units. The number of organisations performing R&D did not changed, from 34 to 33 units, but the number of personnel engaged in R&D increased up to 1,852 persons.

In the East Kazakhstan region, non-ferrous metallurgy is developed. The region has large fields of granite, marble and semi-precious stones as well.

Work continues on the formation and development of innovation infrastructure in the region with the Regional Industrial Park (RIP) "Altay" in Ust-Kamenogorsk and a specialised branch of the Park of Nuclear Technology in the city of Kurchatov. RIP Altay is located in the campus of East Kazakhstan State University. Since the region is the centre of non-ferrous metals, priority sector of Altai Technological Park is non-ferrous metallurgy. Other sectors of interest are engineering, IT and material science for construction.

To create an enabling environment for innovative entrepreneurship, the Zone of High Technology Park is in the process of implementation. A concept draft has already been developed and approved. The Park will include a centre for metallurgy, which will increase the production efficiency through reducing energy consumption and improving recovery in the concentrates by using the best practices of the world. Also it will have Design Bureau whose goal will be to develop experimental design project that improves technology and equipment for the development of a mining and smelting complex.

West Kazakhstan Region

In 2010, the number of enterprises involved in innovative activity decreased to 9 units from 12 in 2009. And the level of activity of innovation in the west Kazakhstan region was 4.6%.

In the West Kazakhstan region, one of the world's largest oil field, Karachaganak, and gas condensate is located. Agriculture and animal breeding plays a major role in this region. Sheep, horse and camel breeding is widespread.

There are two significant research institutes in the region, LLC SRI Micrographics and LLP Gidropribor. Regional industrial park, LLC "Industrial Park Algorithm" was established in collaboration with JSC Centre for Engineering and Technology Transfer, JSC RIC Gradient, JSC Research Institute Gidropribor RSCE and West-Kazakhstan Agrarian Technical University. "Industrial Park Algorithm" focuses on the cultivation of small innovative companies in the following key areas of the West – Kazakhstan; oil and gas engineering, mechanical engineering, instrument engineering, petrochemicals, environmental technology, and alternative energy.

Karaganda Region

Karaganda Region's innovation activity of industrial enterprises in 2010 reached 7.0%, and their number increased to 67 companies.

Karaganda region is rich in copper and tungsten, as well as large fields of coal, lead, zinc, iron, manganese and rare metals. Based on the needs of the metallurgical industry, production of chemicals is also significant. In the region, food industry consists of meat, flour mill plants and confectionary plant "Karaganda Sweets".

Karaganda Region has a regional LLC Techno-park "UniScienTech", Institute of Photochemistry and Institute of Organic Synthesis and Coal. Priority sectors of UniScienTech are mining, chemical engineering, new material science and environment protection. Technopark offers business incubation and microstructure analysis laboratory services for enterprises. Karaganda region continues to utilize major investment projects in developing the Industrial Parks.

Kostanay Region

The number of organisations that perform R&D activity has increased slightly and became 15 in 2010.[39] At the same time the number of R&D staff decreased to 344, but the volume of scientific and technical work increased by 17.3% to KZT 270.1 mln (US$ 1.8 mln).

Kostanay region is a source of raw materials for metallurgical enterprises in Kazakhstan. The area is a major manufacturer and supplier of spring wheat. Also, dairy and cattle breeding is highly developed in this region.

Agriculture, mining and processing industries are the top sectors of the region. In accordance with the development plan 2015, Agricultural complexes such as Meat, Milk, Poultry, Grain and Oilseeds are planned to develop in the region.

Kyzylorda Region

The level of innovation activity of enterprises in 2010 reached 6.1% (1.5% in 2009), their number increased to 17 companies (4 companies in 2009). Number of personnel engaged in R&D in 2010 increased by 19 persons to 98 persons.

Kyzylorda region has Kumkol oil and gas field along with large reserves of iron ore. The main trend in the field of agriculture is the cultivation and processing of rice. Research Institute of Rice is the major science institute of the region. A work on creating an industrial zone in Kyzylorda region is underway to accelerate economic development of the region and to assist in improving the business environment.

[39] It was 14 units 2009.

Mangistau Region

In 2010, the Mangistau region faced a decrease in the activity of enterprises in the domain of innovations to 1.1%. Over 90% of Gross Regional Production is attained through oil and gas sector. In order to overcome raw material orientation of the region and to increase innovation, several institutions such as JSC "KazNIPImunaygaz", JSC "NIPIneftegas" , Research Institute LLC "Caspian engineering & Research" and LLC "Design Institute OPTIMUM" were established.

The research conducted in RGP "Caspian State University of Technology and Engineering" is mostly focused on oil and gas industry. Centre of Engineering, created in collaboration with German university of Fraunhofer, can significantly enhance scientific development.

Special economic zone, "Seaport Aktau", was created to enhance the production of import-competitive goods based on new technologies. Priority sectors for SEZ are household appliances, chemical and rubber products, metal work and machinery. Its location provides good logistical advantage for export oriented SMEs.

Construction of the Caspian Energy Hub has been launched. It is based on the concept of "power town", which involves the creation of an integrated multi-functional centre of advanced technologies for oil and gas industry.

Pavlodar Region

The level of innovation activity of enterprises in 2010 increased from 3.8% to 5.1%, and their number from 19 to 26 companies comparing with 2009. Number of R&D departments in enterprises increased to 38. The volume of scientific and technical work reached KZT 335.8 mln (US$ 2.3 mln). The number of organisations that have utilised new technologies, increased to 43, which was 12 in 2009.

Science and Technology Park of Pavlodar State University has been recently established to focus on activities in petrochemicals and related fields. Their main focus is on the integration of education, science and production, and development and implementation of innovative projects.

North Kazakhstan Region

In 2009, number of enterprises involved in innovative activity in the North Kazakhstan region reached 11, it was 10 in 2009. The level of activity in the field of innovation at the end of 2010 declined from 2.6% to 2.4%. The volume of innovative products in 2010 increased by 4.7% to KZT 2.9 billion (US$ 19.5 mln). The number of organisations that have utilised new technologies, increased from 1 to 5.

Processing industry represent more than three-quarters of GRP. The LLC "Regional Technology Park in the North-Kazakhstan Region" operates in the region and companies of techno-park cooperate with leading research institutes and companies in the Russian Federation on innovative development projects.

Ministry of Industry and New Technology of the Republic of Kazakhstan together with JSC "Centre for Engineering and Technology Transfer" agreed on the establishment on JSC "Munaimash", Special Design and Technological Bureau LLC "DB oil and gas engineering", to improve the production and development of competitive technology in oil and gas sectors.

South Kazakhstan Region

The share of enterprises involved in innovative activity in 2010 became 3.4%. The number of organisations that have utilised new technologies has increased to 42 units (15 units in 2009). The volume of innovative products, compared with 2009 increased by 9.9% to KZT 4.9 billion (US$ 32.9 mln).

With 2.5 million people, the South Kazakhstan has the largest population among the regions and its economic activity is diverse. SEZ Ontustik, located in Shymkent, is focused on promotion of cotton-textile industry in the region.

Regional industrial park in South Kazakhstan aims to enhance innovative activities. The main objective of the industrial park is to promote the development of innovation infrastructure, high technology industries and technology transfer.

4 BUSINESS

4.1. The Structure of Kazakhstan's Economy

Kazakhstan has a market economy since it gained independence in 1991. As it is not a very long time for a nation's transition from central planned to free-market economy, most of the private companies in Kazakhstan are relatively small. Even though it is estimated that private sector accounted for almost 70% of GDP and employment in 2010, dominance of state owned corporations in the economy is undeniably large, especially in terms of STI activities of enterprises.

The share of manufactured goods and services in GDP is 44.2% and 52.8% respectively. The production of goods in the past years has brought the state US$ 64.4 billion. Agriculture, hunting and forestry, fishing, fish farming brought US$ 6.4 billion, the industry US$ 47.1 billion, construction US$ 10.9 billion, the production of services US$ 77.3 billion, and the net taxes on products USS$ 7.6 billion.

4.1.1. Trade Partners and Relationships

Kazakhstan has consistently pursued an open foreign trade policy since 1991. In 2011, foreign trade turnover of Kazakhstan reached to US$ 113.2 billion; compared with 2010, that represents an increase by 41.8%.

Foreign trade became much more diversified recently but the share of trade with traditional partners, the Commonwealth of Independent States (CIS) and Baltic countries, is still significant. Traditional partners make up about 59% of exports and up to 63% of imports. The main trading partner is Russia and CIS countries. In addition to historical ties, the Customs Union between Belarus and Russia, began operating in July 2010, is a driving factor for high trade volume among these countries. Apart from the CIS countries, Kazakhstan is increasingly developing trade relations with Germany, Turkey, Switzerland, Czech Republic, Italy, China, USA, UK, South Korea and others.

Kazakhstan has a relatively small export volume of the high technology products, which totalled 1.80 billion U.S. dollars in 2009. Kazakhstan occupies second place among CIS countries- following the Russian Federation.

4.1.2. Foreign Direct Investment

The economy of Kazakhstan has attracted 154.9 billion U.S. dollars in foreign investments[40] between 2005-2012[41]. In 2012, the gross inflow was about 27 billion U.S. dollars, which represents a 14.9% increase compared to 2011 flow (US$ 23.5 billion). This growth can be attributed to the business environment conducive for investment. All commercial entities are considered as residents of

[40] Gross inflow of direct investment in Kazakhstan from foreign direct investors
[41] National Bank of Kazakhstan; UNCTAD, UNCTADStat

Kazakhstan for tax[42] purposes and therefore they are subject to same regulations. This principle is also applied to foreign companies since they are treated as local companies.

During 2012, the main investor countries were Netherlands (US$ 8.5 billion, 31.5 %), China (US$ 2.4 billion, 8.8%), Switzerland (US$ 2 billion, 7.4%), USA (US$ 1.9 billion, 7.3%), UK (US$ 1.3 billion, 4.8%) and France (US$ 1.2 billion, 3.2%). In addition, significant amount of foreign direct investments comes from Belgium, Italy, Russia, Canada and Germany.

The growth of FDI and production of oil and gas condensate contributed to the increase of oil and gas sector share in GDP. Rising world prices for hydrocarbons has also stimulated the oil companies to increase their production and volume of oil exports from Kazakhstan. Shares of oil and gas condensate reached to 63% in the total volume of Kazakhstan's export and this reflects almost 22 times increase in terms of value over the past 15 years. Overall, more than 85% of crude oil in the country is exported. The major importers of Kazakhstan's oil are the EU, the CIS and China.

The gross outflow of direct Kazakhstan investments to foreign countries amounted to US$ 3.1 billion in 2012. Adding the outflows during 2004-2011, the gross total amounted to US$ 36.9 billion.

4.2. State of STI in Business

In recent years, administration and legal codes have been changed in order to increase business activity. Specifically, minimum capital requirements have been reduced and starting-up of new companies has been facilitated. On the other hand, as Prof. Zharkinbekov Temirkhan Niyazovich, Director of Institute of Geology and Oil and Gas Business at Kaz NTU underlines, the global financial crisis of 2008-2009 was a threat to overall progress in STI. The crisis has complicated the implementation of government goals and led to a reduction in spending by private sectors on research and development (R&D).

Reduction in the level of innovation products reflects the negative effect of the global financial crisis, decreasing to 0.66 percent of GDP in 2010. It seems that, one of the main obstacles on the road to higher R&D activity in business is the low demand by enterprises to R&D activity and structure of industrial production in the Kazakh economy. Its economy faces excessive preponderance of importing finished goods from abroad.

Table 4.1: Key Indicators of Innovation Activity of Enterprises in Kazakhstan (2006-2010)

Indicators	2006	2007	2008	2009	2010
Number of innovative enterprises	505	526	447	399	467
Level of activity in innovation, %	4.8	4.8	4.0	4.0	4.3
Share of innovation products in GDP,%	1.53	1.19	0.69	0.51	0.66

Source: The Agency of Statistics of the Republic of Kazakhstan

Aggregate expenditure on technological innovation in 2010 rose by almost 4 times compared to the previous year and reached to KZT 235.5 billion (US$ 1.6 billion). Acquisition costs of machinery and equipment amounts 26.7% of the total expenditures. Shares of R&D in new products and manufacturing processes and the acquisition of new technologies are 10.9% and 7% respectively. This level of expenditure on acquisitions indicates a tendency to be dependent on the industrialized

[42] Corporate Income Tax (CIT) rate for 2009-2013 is 20% of taxable income. Value Added Tax (VAT) is 12%. Social tax, which ranges from 7% to 20% depending on the amount of taxable income of resident workers., should also be paid by the employer.

countries. Thus, by structure of expenditure on technological innovation, indicators of Kazakhstan are closer to the "modest innovators" group, which are dominated by cost of purchasing machinery and equipment, while for the advanced countries, R&D takes 80% of the expenditure. However, it should be kept in mind that business in Kazakhstan is in the process of modernizing the production capacities and upgrading the technology.

The main players who will take the next step in the technological and innovative development of the country are the entrepreneurs. New entrepreneurs can get support starting from filing the application for funding all the way through the release of the finished products. Business incubation program has existed for 2 years in Kazakhstan. For example, one of the projects carried out in Astana is the city Wi-Fi communication. Together with the administration of the city within the concept of Smart Astana (Smart City), the project initiators are realizing "Open Wi-Fi" in Astana. The project "Open Wi-Fi" aims to create urban networks in public places that provide access to the Internet via wireless technology. Now citizens can get free Wi-Fi in almost every part of the city.

The priority areas of post-crisis economic modernization in Kazakhstan are industrialization, innovation and regional economic development policy. President Nazarbayev has identified industrial development as "our chance in the new decade, new opportunities for the development of the country". The focus of innovation policy for the upcoming years will be promoting economic efficiency of enterprises through the technology transfer, technical modernization, and improvement of business-processes and introduction of new managerial technologies.

4.3. Factors Affecting Business Innovation

Under Interdisciplinary Plan of Scientific and Technological Development of the Country, government is planning to support[43] developers performing R&D activities such as research institutes, universities, local businesses, investors, etc. The Law 'On State Support of Industrial and Innovative Activities' (adopted in 2012) establishes the legal, economic and institutional basis to stimulate industrial innovation and to determine the measures of the state support.

Business Roadmap 2020 is leading to an increased economic competitiveness for SMEs. This ten year initiative aims to increase export potential and create employment opportunities by providing subsidized loans. The interest rate of 12% is significantly lower than the market rate and loan limit of almost $20 million U.S. dollars is sizeable. Since most of the firms in Kazakhstan are relatively small, initiative is not implemented in its full extent. For example, in 2010 the loans were mainly used to help companies recover from the financial crisis. The 2015 goals of the Roadmap include; increasing share of the manufacturing sector to 12.5% of GDP, raising the share of non-primary exports to 40% and increasing labour productivity 1.5 times.

The 30 Corporate Leaders of Kazakhstan initiative is another government policy tool implemented in order to develop capacity in non-extractive sectors that provides up to 50% co-financing to selected projects. Initiative also includes loan guarantees and tax incentives for selected projects. It was launched in 2007 with a competition to assess the project submissions by entrepreneurs in Kazakhstan. Construction of a new metallurgic factory with a capacity of 10 million tons of steel per year by Arcelor-Mittal is one of the major projects under this initiative.

It should be noted that application procedures for some of the government programmes can take up to six months. Another handicap of Kazakhstan is that only a small percentage of SMEs are involved in activities that are eligible for financing.

[43] Grants, engineering, service, business incubation, etc.

Majority of the funds used in innovation projects come from internal resources of the enterprises, 93.2%, followed by the state budget funds 2.4% and foreign investment 1%. Government-owned enterprises have a dominant role in innovative activities. The total expenditure of enterprises in technological innovation in 2010 was KZT 219.4 billion (US$ 1.49 billion).

JSC National Agency for Technological Development (NATD, former - JSC "National Innovation Fund") provides project financing. NATD became the first Kazakh Fund which aims to participate in the creation of venture capital institutions with local and foreign capital investing in technology innovation business.

According to new regulations, natural-resource-based companies have to increase R&D to 1% of their revenues. National Welfare Fund, Samruk-Kazyna, will allocate 10% of its net profit for innovation projects. Kazakhstan also attracted US$ 20 billion of foreign investments in non-oil sector of the economy that can provide inputs for industrial programmes, infrastructure and joint ventures. All these tools can create much needed capital support.

Recent reforms provide tax deduction, up to 150% of R&D expenditures, but it should be noted that these are ex post payments so it does not provide much needed initial support for most of the small start-ups.

Kazakhstan gives special importance to the utilization of science and technology for the development of some priority sectors. In this regard, the reforms are directed towards increasing university research and introducing the grant system based on priorities.

An indispensable condition for the development of effective science lies on reliable intellectual property rights. Law on Copyrights and Patents can also be listed as steps taken towards solving the problems in scientific support to industry.

4.4. Nurturing an Entrepreneurial Culture

Building a network of organizations plays an important role in entrepreneurial culture as an organizational network is an integral part of successful strategy for technology commercialization. As commercialization is the process which connects the outputs of R&D transformation with practical employment of R&D for the purpose of launch of new and modified products as well as services or processes, the centres of commercialization can be a bridge between science and business.

However, system of commercialization in Kazakhstan is at early stages of development. The main activities of commercialization centres can be divided into two categories; promotion of innovation activity and the commercialization of innovative projects.

The number of quality projects is very limited at the moment. Thus, in 2010, NATD began working on the creation and development of technology commercialization in the Republic of Kazakhstan in order to implement the SPAIID 2010-2014.[44] Therefore, formation of a network of commercialization support establishes three types of structures, National Centre of commercialization, regional support centres of commercialization and commercialization offices at research institutions.

Commercialization offices are created as a unit in research organizations, and report directly to the Director or the Rector. And during the early stages, they receive assistance from the Regional Support Centres of commercialization. Innovation can be stimulated by linking the centre of commercialization, universities, businesses and other stakeholders of the innovation environment. According to Prof. Isembergenov Malik Turegalievich Head of Radio Engineering, Electronics and

[44] National Centre of Technology Commercialization was established within the National Innovation Fund in Astana.

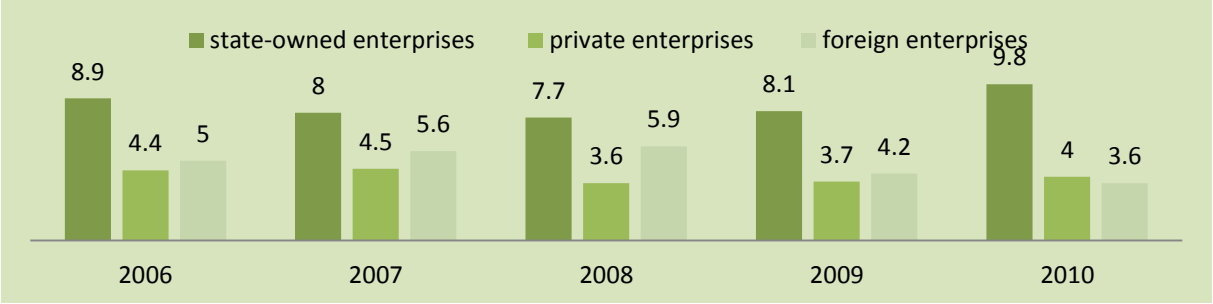
Telecommunications Department at Kazakh National Technical University, lack of interest from enterprises and bureaucracy are the main reasons for poor linkage between university and industry. He argues, enterprises can hugely benefit and gain competitive strength by introduction of power electronics in the production cycle. On the other hand, it is also argued that research institutes do not know the needs of industry for which these enterprises are willing to pay for. This stems from the fact that there is no organized way of implementation of scientific results in the national economy. In the light of all this input we believe that the linkage can be strengthened through surveys in order to identify supply and demand in STI. Thus, the centre of commercialization creates an information pool for all participants in the innovation process and their innovative competencies. By this way, knowledge producers and industry can be aware of each other's demand.

To foster entrepreneurship in a country, encouraging business incubators, angel investors and venture capitalists is also highly important. These investors provide small businesses with start-up concessional facilities, communications equipment, office equipment and the necessary equipment. In addition, business incubators provide entrepreneurs a range of services such as secretarial, accounting and legal services, and also help them to get funds for the development of the idea and entering the local market. National Agency for Technological Development (NATD) is partner with five domestic venture capital funds[45] that were established jointly with local investors in a public-private partnership.[46] The Fund is also partner with the top five foreign venture capital funds[47], covering Europe, the USA, and Southeast Asia. The strategic goal of creating joint venture funds is to provide access to the advanced Western technologies and their transfer to Kazakhstan. Creation of joint venture funds is also a good opportunity to enter the world's leading technology companies. By working with leading venture capital funds of the world, the Fund seeks not only to attract the financial capital of foreign investors, but also to create a network of cooperation with high-tech companies and create new opportunities for Kazakh scientists.

4.5. Challenges

In 2006, the proportion of innovation-active state-owned, foreign and private enterprises was 8.9%, 5% and 4.4% of the total number of enterprises, respectively. In 2010, the share of innovation-active state-owned enterprises increased to 9.8%, while there was a decline in the proportion of innovation-active foreign and private enterprises to 3.6% and 4%, respectively. The growth rate was 110% for innovation-active state-owned enterprises, whereas the share of innovation-active foreign companies significantly decreased by 28% during the period 2006 - 2010. The share of private enterprises has remained almost unchanged, Figure 4.1.

Figure 4.1: The Share of Innovative Enterprises by Ownership



Source: Compiled by the Statistics Agency of Kazakhstan

[45] Their sizes range from US$0.25 mln to US$4.5 mln.

[46] JSC Venture Fund "Centras", JSC Venture Fund "Delta Technology Fund", JSC "High Technologies Fund Areket" and JSC "Logycom perspective innovations"

[47] Wellington Partners III Technology Fund LP, Central Asia Small Enterprises Fund "CASEF", Mayban Jaic Asian Fund, Venture Fund Vertex III Fund L.P, Flagship Ventures Fund.

Table 4.2 shows the movement of technological advances and software in enterprises during 2006 to 2010. The ratio of expenditure on R&D and purchase of machinery and equipment remained resilient and more money was spent on the purchase of the finished products and technologies, which is the main way for technological modernization. However, the structure of the new technologies transfer shows the reverse situation. The share of R&D transfer was 50 to 70%, whereas the share for the finished equipment transfer stays at a relatively low proportion, 4.2% in 2007.

Table 4.2: The Structure of Purchasing and Transfer of New Technologies, % (2006-2010)

	The Structure of the Purchased New Technologies and Software					The Structure of the Transferred New Technologies and Software				
	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
Rights to patents, licenses for the use of inventions, utility models, production pieces	20.5	5.4	25.1	50	30.6	2.7	3.3	38.9	21	11.8
Results of research and development	9.1	0.7	0.7	3	12.8	72.3	17.9	52.8	74.4	66.1
Know-how, technology transfer agreement	1	0.9	2.4	0.6	1	0.5	0.1	-	0.6	-
Purchase of equipment	52	41.7	55.7	-	-	11.8	1.2	4.2	-	-
Others	17.4	51.3	16.2	46.3	55.6	12.7	77.5	4.2	4	22.1

Source: Compiled by the Statistics Agency of Kazakhstan

Thus, there are a few companies engaged in scientific research and their costs are still small in absolute terms. Much of the spending belongs to the major companies with state participation.

It should be noted that unproductive entrepreneurship dominates in Kazakhstan. As known, innovation is a lengthy and expensive process. In this regard, having few resources, local entrepreneurs prefer capitalization through reallocation of existing wealth, rather than new investment in their own research and development. This type of entrepreneurship, however, sooner or later proves to be ineffective and might lead to lower competitiveness of the country. That is why contribution of small and medium businesses to the development of innovation is not significant, despite the growth of the main enterprise development indicators.

Considering these problems, it is required to establish and implement new public policies to support small businesses towards innovation. The policies should primarily aim at fostering productive and effective entrepreneurship on a competitive basis.[48] In Kazakhstan, it is also necessary to create a management system helping less-productive sectors to become more productive. Moreover, the State should enhance economic and legal conditions of business environment, introduce new incentives for self-development and encourage competitiveness of small enterprises.

[48] The current tools of financial support are mainly focused on the medium and large enterprises.

5 CULTURE

Located in the heart of Eurasia, Kazakhstan is at the crossroads of ancient civilizations, transportation corridors, the East and the West, the South and the North. After a seventy-year Soviet rule that eradicated the traditions throughout the 20th century, modern Kazakhstan is experiencing a period of national revival with new approaches to the development of science and technology (S&T). S&T related strategies, priorities and activities are changing in Kazakhstan as the government endeavours the promotion of the S&T infrastructure as fast as possible and the private sector gradually increases its investments in the expanding economy. The dedicated commitments of the President of the Republic of Kazakhstan and increasing availability of financial resources to support the national S&T infrastructure are the indications of the changing attitudes towards science and innovation in Kazakhstan.

5.1. Supporting Science

With its cultural and historical uniqueness captivating the culture of East and West, Europe and Asia, Kazakhstan is trying to find national models together with the spirit of time and expressing the national character of the Kazakh nation at the same time. To create a new national research system, the government has consecutively initiated educational programs, innovative know-how methods, recent models of science management, and new forms of financing through grants and targeted programs that both reflect the world experience and correspond to the multi-cultural profile of Kazakh people.

International co-operation is successfully developing and until now various agreements promoting S-T-based development projects are signed with more than 30countries. In 2011, 27 international projects were executed supporting researchers and scientists. Additionally, the salaries are significantly upgraded to encourage scientists. On the 20th anniversary of the Independence of Kazakhstan, Almaty hosted the First Forum of Scientists of Kazakhstan with the participation of the President of the Republic of Kazakhstan where policies to attract young people to science, ensure sustainability in human resources in S&T, create an appropriate environment for talented young scientists as well as increase the number and amount of scholarships for postgraduate students through the "Bolashak" program were discussed and promoted.

All these efforts indicate the willingness of the Kazakh decision-makers to link education, research and commercial interests for enhancing the S&T ecosphere in Kazakhstan.

5.2. Religion in Kazakhstan: Modern and Moderate

Kazakhs embraced Islam during the sixteenth century. Today, the majority of the Kazakh population are Muslims. Given the nomadic life-style of the Kazakh society and the religious suppression during the Soviet era, the practice of Islam has gone through several transformations and stages. After the

independence and with the support at the highest level of the government, Kazakhstan removed all religious limitations inherited from the Soviet Union and established an independent Muslim Religious Authority for the benefit of all practitioners of Islam.

The beauty of the resurgence of Islam in Kazakhstan is that it is flourishing in the modern Kazakh lifestyle with an emphasis on tolerance. The 1993 Constitution of Kazakhstan ruled out the existence of religious political parties to separate religion from politics. As the fundamental message of Islam, the prevalence of moderation attracted the Kazakh people, especially the young generation, to the practice of Islam as well as to the genuine understanding of the messages of the Holy Quran as exemplified by the Prophet Muhammed (Peace Be Upon Him). In the last two decades since the independence, the prevalence of religious freedom has also contributed immensely to the significant positive changes in the socio-economic development in Kazakshtan.

The Khazret Sultan Mosque in the new capital Astana was built to house 7,000 people. In 2010, Islamic Bank, Al-Hilal, has been established as the first Islamic Bank of Kazakhstan following an agreement between Kazakhstan and United Arab Emirates. In 2011, Kazakhstan chaired the 38th Session of the Council of Foreign Ministers (CFM) of the Organisation of Islamic Cooperation (OIC), and also hosted the 3rd meeting of the Health Ministers of the OIC Member Countries in Astana. These are all outstanding opportunities for Kazakhstan to re-connect with the Ummah, the great global community of 1.5 billion Muslims.

5.3. Government Assistance to Science and Technology

The patterns of the development of S&T culture among Kazakh people have been remarkably consistent with the national policies. The Kazakh government organizes diverse set of activities to promote the proliferation of the S&T culture throughout the country. Some examples include:

- *Competition of Innovative Business Plans "NIF $50K"*

This is a television show aimed at active young talents in Kazakhstan to develop their innovative business projects. The main characters of the show are the authors of innovative ideas. The format of the show provides opportunities to many innovators all around the country to present their ideas. The winner will be supported by the prize of US$ 50,000 to build a business.

- *Competition of Innovators*

This competition is also a television show aiming to support the activities of engineers. Through the show, engineers present their technical solutions to factories with a view to increase their effectiveness and productivity. The competition has 2 nominations: "The Best Rationalized Solution of the Year" and "The Best Support System for Innovation in the Enterprise".

- *Innovation Congress and Exhibition of Innovative Projects*

The "Innovation Congress" is a major annual event and a central part of the Astana Economic Forum attended by prominent politicians, officials and economists. It is co-organized by the Ministry of Industry and New Technologies, NATD and the Association of Eurasian Economic Club of Scientists.

- *Exhibition of Innovative Projects in the SEZ PIT under the Auspices of the Head of State*

Under the auspices of the 20th Anniversary of the Independence of Kazakhstan, April 2011 was dedicated to the innovation and industrial breakthroughs of the country. The role and importance of science and new technologies in the reformation and economic diversification of Kazakhstan was especially emphasized. The exhibition presented an information technology park, industrial facilities and advanced research institutions where new production lines have been equipped with the most advanced scientific standards and requirements.

- *Innovation Forum and Exhibition of Innovative Projects Dedicated to the 20th Anniversary of the Independence of the Republic of Kazakhstan*

The NATD in collaboration with the Ministry of Industry and New Technologies organized an exhibition of innovative projects under the name "The Wave of Innovation" and a business program with the theme "Innovative Kazakhstan: Looking into the Future after 20 Years of Independence" in December 2011. "The Wave of Innovation" brought together the best innovative projects from all regions and sectors of the Kazakh economy including four areas: Innovation (S&T) development, commercialization of locally developed technologies, localization of foreign technology, and innovation start-ups.

- *National Competition of Journalistic Materials from a Perspective of Innovation "Orleu Akparatty"*

The competition was organized with the aim to involve the media in the promotion of innovation and improvement throughout the country. A journal was issued and distributed free of charge throughout Kazakhstan to targeted groups including central and local government offices, state-owned enterprises, social organizations and other companies taking part in the National Innovation Policy.

- *Internet Portal on Innovation "innovus.kz"*

The Internet portal on innovation "innovus.kz", a specialized information system, was launched in 2010. The portal was designed to improve the interaction between different actors of the National Innovation System. The portal enables remote interaction among various organizations/individuals searching for partners and investors/contractors, hosts electronic publications and webinars.

The promotion of above listed programmes indicates the response of Kazakhstan to the growing need of S&T for its development. In other words, Kazakhstan places STI at the centre of its development agenda; however, as almost all the interviewees pointed out creating links between knowledge generation and enterprise expansion is one of the most important challenges faced by Kazakhstan. Promotion of close cooperation among business, academia and government seems vital for Kazakhstan to create and maintain its own innovation culture.

5.4. Decline of STI Personnel

After being independent, Kazakhstan developed a network of scientific institutions as well as a base for fundamental science. Scientific schools were formed in the area of metallurgy and non-ferrous metallurgy, mining, physics, mathematics, space research, chemistry, biochemistry, human physiology, various areas of biology and medicine, geography, botany and agriculture. However, the economic crisis and the sharp drop of production sector during 1996-2001 led to declines in science funding from the state budget that negatively affected the volume of R&D especially in the area of industry. The number of employees in S&T organizations severely declined. Many talented young scientists preferred to work in financial institutions to afford their livelihood. On the other hand, when compared with many CIS countries, Kazakhstan preserved a significant part of its industrial research, design organizations, and scientific and engineering associations during the heavy crisis. Kazakhstan corresponded to the crisis by creating new governance, giving more emphasis to science, considering the experiences of countries such as Finland, the United States and Republic of Korea. In July 2001, Kazakhstan enacted a law on science responding to the new realities of Kazakhstan. The new law changed the principles of funding and managing research projects.

6 SUSTAINABILITY

Kazakhstan, one of the major oil-producing countries of Central Asia, has developed an extensive corpus of environmental laws and initiated a system of non-compliance response in order to make environmental law work[49]. This chapter will discuss the issues regarding sustainable development in Kazakhstan.

6.1. State of Energy Resources

Kazakhstan is rich in power resources, which are oil, gas, coal and uranium stocks. Constituting about 70% of Kazakhstan's exports, oil and gas exports are both the main financial source for the country needs and the locomotive of its economy. Oil is transported via pipelines to Russia, China and Baku in Azerbaijan at Black Sea.

Kazakhstan, with 3 % of world's reserves, has the 12th largest confirmed reserves of oil in the world. About 62 % of Kazakhstan's territory is oil and gas bearing. And there are currently 172 oil and 42 condensate deposits in its lands. More than 90% of the oil stocks in Kazakhstan are concentrated in 15 of its largest fields.[50] It has around 17 billion tons of recoverable resources of hydro carbonic raw materials. More than half of its renewable resources, 8 billion tons, are located in Caspian Sea.

In terms of gas stocks, Kazakhstan ranks 14th in the world and 4th among the CIS countries after Russia, Turkmenistan and Uzbekistan. 98% of all stocks of gas are in bowels of the Western Kazakhstan with territorial access to Mangistau, Atyrau region, West Kazakhstan and Aktobe region.

Kazakhstan is in the top ten countries having coal stocks. The major part of coal-fields is concentrated in Central (the Karaganda and Ekibastuzsky coal basins) and Northern Kazakhstan (Tourist's Gajsky coal basin). Today, the coal sector of Kazakhstan provides more than 70% of its electric power.

Kazakhstan takes the second place in the world on uranium stocks. Creation of the full vertically-integrated complex of a nuclear-fuel cycle is conducted within the limits of the nuclear industry development, particularly on creation of all missing links of a cycle.

6.1.1. Leveraging one of the World's Largest Coal Reserves

Containing 4% of the global stocks of coal, Kazakhstan occupies 8th place in the world. Moreover, it is the leader country in terms of coal mining per capita. The main coal stocks are concentrated in 16 fields. Coal provides 70% of the electric power and accommodates heating needs of households in Kazakhstan. In near future, coal will still remain the most reliable strategic fuel that supports the

[49] "Avenues for Improved Response to Environmental Offences in Kazakhstan", OECD, 2009

[50] Tengiz, Kashagan, Karachaganak, Uzen, Zhetybaj, Zhanazhol, Kalamkas, Kenkijak, Karazhanbas, Kumkol, Buzachi Northern, Alibekmola, the Abyss Central and East, Kenbaj, Royal, half - in two big oil deposits in Kashagan and Tengiz.

development of electric power industry. As a result, its consumption in the industry and other sectors of the economy is expected to increase.

The total amount of coal export ranges from 22 to 27 million tons. The primary importer of coal from Kazakhstan is the Russian Federation. During the last years, the geography of coal export has considerably extended and Czech Republic, Estonia, Poland, Romania, Turkey and Ukraine became the consumers of the Kazakhstan's coal. Considering the industrial potential of coal, the coal export of Kazakhstan may further increase to 30-35 million tons in upcoming years.

Some measures must be taken for the maintenance of coal mining such as:

- modernizing mines operations with transition to the most up-to-date coal-mining technical level,
- having comprehensive plans for effective use of coal deposits,
- increasing the competitiveness of Kazakhstan's coal sector by introducing international standards.

With these in mind, the Ministry of Energy and Mineral Resources of the Republic of Kazakhstan passed an order on "maintenance of transition of coal branch on the international standards" in 2006. The further planning of development of the sector will depend on macroeconomic position of Kazakhstan and the adjacent countries.

While renewable energy is expected to only account for a small share of the energy mix for the foreseeable future, both the Kazakh government and private companies are paying greater attention to the environmental impact of coal production and power generation. Several of the major generation companies have installed state of the art filtering system and both the government and international financial institutions are supporting clean coal investments with funding.[51]

6.2. State of Water Resources

The Republic of Kazakhstan is rather poor in water resources in comparison to other European countries, but luckier than the countries in Central Asian region. Scarcity of fresh water is the biggest environmental challenge that hinders sustainable development of Kazakhstan.

With the large land area (2.7 mln square km), low population (16.4 mln people), and heavy snowfall, the local water resources should be adequate for the country. But Kazakhstan imports water due to the lack of related infrastructure. Beyond investing in water infrastructure, the water shortage problem can be alleviated through raising public awareness about water conservation, encouraging the use of low-water consumption irrigation systems in farming and improving the condition of its lakes and underground water.

It is estimated that more than 3 thousand centres pollute underground waters, which cover an area over several hundred square kilometres. The centres polluting underground water are mainly located in Aktoba region, East Kazakhstan, Zhambyl region, Pavlodar and Almaty region as the large enterprises in chemical; oil refining, phosphoric industry and nonferrous metallurgy sectors exist in these regions.

6.2.1. Innovations to Support the Development of Water Sector

Depending not only on internal water systems of the states but also on condition of Aral Sea, water savings and rational use of water resources are among the main priorities for Kazakhstan. In this regard, various efforts are being tried such as:

[51] http://silkroadintelligencer.com/2011/06/01/coal-to-remain-kazakhstans-top-energy-source/, last visited on 21.12.2012

- using a standard-legal base for water use,
- concluding bi- and multilateral contracts and agreements on rational usage of transboundary water resources,
- applying water saving up technologies in irrigation and transportation,
- working on coast protection (i.e. restoring the consequences of flooding, earth flows and degradation of river banks,
- carrying out spot inspection checks to reveal the infringers of water use and apply corresponding penal sanctions,
- using environmental impact assessments for the new and modernized enterprises.

As a part of interstate cooperation, the intergovernmental agreement among Kazakhstan, Kyrgyzstan and Uzbekistan about the usage of water resources was signed. Within the implementation of the Caspian ecological program in Kazakhstan, there are 10 thematic initiatives on sea level fluctuations and biodiversity preservation.

Effective use of water resources by industrial enterprises and all sectors of economy should be based on innovative technologies using smaller quantities of water. Introducing automated control systems in the relevant phases of water utilization and instituting state policy on rational use and protection of water resources should also be among the priorities for decision makers in Kazakhstan.

6.3. State of Renewable Energy Resources

Kazakhstan is well aware of the importance of sustainability and preservation of the environment. The presence of an environmental protection institution at the ministry level is an indication of that. At the international levels, the country is heavily involved in Green technology programs initiated by UN, UNDP and OIC. Close cooperation with developed countries is needed in order to establish favourable conditions for developing countries to adopt Green technologies.

Renewable energy sources (RES) are prioritized in last few years by Kazakhstan as one of development courses of a power complex. Strengthening process of their introduction by state and several private entities testifies this fact. However, formation of steady system of RES in Kazakhstan requires considerable financial and technological investments and without direct participation of the public sector, the renewable power production will remain at a very low level.

The public awareness of sustainability and the Green applications is not at a high level, but increasing. The country considers itself to be at a starting stage in this area, but it plans to start investing on it in the near future. There is a need to increase funding for Green projects and man power in Green technologies with adequate competencies. Kazakh Green Bridge Initiative as a potential model for regional development in sustainable energy, Wind Power Development Programme, which sets a 4% target for wind power by 2020, and the five-year Plan for Energy Efficiency to cut national energy consumption by 10% in 2015 from 2008 levels are the best examples of clean energy initiatives in Kazakhstan.[52] In this regard, it should be noted that Astana, the capital city of Kazakhstan, was awarded to organize and hold the World Exhibition EXPO-2017 in November 2012[53]. Organization of this exhibition with the theme "Energy of Future" has an influential impact for development of green economy in Kazakhstan.

The share of renewable energy in the country's energy use is less than 1%, and the Kazakhstan uses almost entirely fossil fuels. With high annual growth rate (about 7%), this poses a risk to the

[52] http://www.iea.org/newsroomandevents/news/2012/october/name,32163,en.html, last visited on 21.12.2012
[53] http://www.expo2017astana.com/en

environment and sustainability. Air pollution is already a problem in major cities that use coal for heating.

In 2009, the Law titled "About Support of Use of Renewed Energy Sources" established legal, economic and organizational bases of RES stimulation for electric generation and heating. According to the Strategic plan for development of Republic of Kazakhstan till 2020, the share of alternative energy sources in total power consumption should be 1.5 % by 2015, and more than 3 % by 2020.

RES in Kazakhstan has a great potential. For example, according to some researches, the total hydroelectric potential of Kazakhstan is estimated around 170 billion Kw/h per year, whereas currently yearly hydroelectric production is near 7.4 billion Kw/h. The growth can be brought by completing several large hydroelectric power station projects in upcoming years.[54]

Kazakhstan has also a big potential in terms of wind power.[55] A research of United Nations titled "Program of Development of Wind Power" shows the presence of over 50 thousand sq. km of land where mid-annual wind speed is more than 6 km/s. The most considerable wind energy resources are in Zhungarsky corridor, generating 17 thousand in kw-h on sq.

"Science Fund" JSC and Parasat Holding has started financing research on wind power energy projects, in particular wind-mill electric generating unit of "Buktukov-4" with automatically changing surface area. These installations, irrespective of speed and a wind direction, generates electric energy of the set capacity and do not collapse at storms. Two large-scale wind energy projects, Zhanatassky and Shokparsky, began in March 2011. Other wind power energy projects that are planned to be completed by 2014 are wind power energy complex of Zhungarsky gate near the Sheleksky corridor and wind power energy complex in Ulansk area of East – Kazakhstan region.

In spite of the fact that Kazakhstan is located in northern hemisphere, the potential of solar energy in the territory of Kazakhstan is around 1.3 to 1.8 thousand in kw-h on 1 sq. m per year. Solar energy can be used not only for electric power generation but also for heating by spot introduction of solar installations in the areas far away from central electric grid. Until 2015, system of solar installations with a total capacity of 91 МВт, mainly in Almaty area, is planned. At the same time, production of silicon and the photo-electric elements, which are used in the development of solar power panels, are undertaken in Kazakhstan.

JSC "Science Fund", "Parasat" and "Temir and Tas" together developed a sample of a non-polluting hydrodynamic heater that passed pilot tests and was used for building heating of Aktas village in Karaganda region. Costing half of the traditional heaters, these heaters are also used in the governmental buildings in Astana..

One of the cheapest energy sources is heat pump installations which result in 3-7 times more thermal energy than it consumes on a compressor drive. The thermal pump is the device allowing to use the energy saved up in environment (ground, reservoir, air), for needs of heating and cooling. "Science Fund" JSC and Parasat Holding financed establishment of thermal pumps assembly line in Ust Kamenogorsk on the basis of techno-park "Altay".

"Institute of Physics and Technology (PTI)" developed the technology of reception of polycrystalline silicon under the short scheme that reduces power consumption for silicon production compared to traditional "Siemens" method. The invention is patented by European Union and test of the technology has been conducted in National Laboratory of Renewed Energy Sources (NREL) in USA.

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[54] Mojnaksky hydroelectric power station with 300 МВт capacity, Kerbulaksky hydroelectric power station 49.5 MW, Bulaksky hydroelectric power station 68.25 MW.

[55] It is estimated from 0.929 to 1.82 bln. Kw/h per year.

Manufacturing factories of metallurgical silicon, Kaz Silicon in Ushtobe and Silicium Kazakhstan in Karaganda, were opened and building facilities for the further processing of metallurgical silicon in Ekibastuz and Astana is planned. Scientists of «Physic - Technical Institute» developed technology of reception of thin-film silicon coverings with use of silenced technologies of reception of mono-crystal silicon.

6.4. Thinking Strategically about Climate Change

Kazakhstan continues fighting against global consequences of climate change with the help of new technologies. In this regard, Kazakhstan conducts research projects on vulnerability of its economy to climate change, and also on possible actions for adaptation to the expected change.

The major strategic directions of action should be reconstruction and modernization of existing systems of heat supply with the combined development of renewable energy sources. These effective power saving technologies will allow Kazakhstan essentially to reduce the share of organic fuel in power generation and to reduce emissions of greenhouse gases.

Dealing with waste problem since Soviet era, Kazakhstan needs to develop a general waste management system urgently. The oil developments at the Caspian Sea region should also be monitored closely to avoid environmental catastrophes.

7 INTERNATIONAL COLLABORATION

Kazakhstan has become one of the important players in the world political arena due to its strategic geopolitical position covering an extensive territory[56] between two continents, Europe and Asia, its significant energy resources and its high potential for exporting industrial and agricultural products. Hence, the future of the Kazakhstan is closely connected with further integration into international markets and active engagement in global political affairs. To realize this goal, the basis of cooperation in the areas of science, technology and innovation (STI) should also be strengthened. The collaboration geography in the spheres of education and science extends every year. In more than 35 countries of the world, there are about 19 thousand Kazakh students, 86% (16.4 thousand) of which are in higher education institutes of the Russian Federation.

The main ways for education abroad are the international student exchange programmes, grants of the governments of the foreign states and the international organizations, private means and the international grants by the presidential scholarship programme: "Bolashak". Meaning "Future" in Kazakh, "Bolashak" has 200 partner universities in 27 countries and highly contributes to facilitating internationalization through mobility. Since its establishment in 1994, the number of graduating scholars has increased from 187 to 1,259 in 2010. In 2011, approximately 1,058 scholars received their Bachelor, Master and PhD degrees from leading universities in the world. The government has decided to emphasize science related studies more in the programme, which will definitely improve the future capacity and infrastructure of science and technology (S&T) related sectors in Kazakhstan.

To further accelerate the process of internationalization and to reach international standards in higher education, the Nazarbayev University (NU) was opened in Astana in 2010. Aiming to promote a qualitative leap forward in the preparation of the next generation of national technical and scientific elites and to assist the industrial-innovative development of the country, the main focus of the NU is science and engineering, though other programs are also offered to students. The University College London, University of Wisconsin-Madison and University of Singapore are some of the international partners of the NU.

The "Scientific Development Programme in Kazakhstan for 2007-2012" includes 15 specific S&T sub-programmes, including international S&T cooperation. Since 2007, the National Centre for Scientific and Technical Information (NC-STI) has been a member of the International Centre for Scientific and Technical Information (ICSTI) along with 21 countries. Being one of the largest information centres among the post-Soviet Union countries and the initiator of a set of scientific breakthrough projects in Kazakhstan, the NC-STI provides workshops and seminars to researchers on the areas facilitating their integration and communication with the global S&T network. In 2011, Prof. Bakytzhan

[56] In terms of area, it holds 9th place in the world.

Turssynovich Zhumagulov, Minister of Education and Science, and Dr. Yerbol Zinaddinovich Suleimenov, President of the NC-STI, signed a three-year national agreement that will bring Thomson Reuters *Web of Knowledge* to 322 academic, research and government institutions across the country. Under this agreement, researchers throughout Kazakhstan will gain access to the world's leading citation databases, enabling them to quickly search and discover high impact literature in all science areas. In addition, the powerful analysis tools within the platform will enable institutions across the country to evaluate and benchmark their own research with that of the peers around the world, and to identify possible opportunities for future collaboration.

Since 2010, more active work on development of the international cooperation in the field of science and technology has begun. Following the results of the Innovation Congress, it was decided to establish the International Innovative Club (IIC) that includes the leading experts from countries with advanced national innovative systems. The working body of the IIC became the Annual Innovative Congress. The international cooperation in research, science and technology is regulated by the 31st clause of the "Science Law" of Kazakhstan. The cooperation is being realized on the basis of the international agreements and contracts, the number of which exceeds 140 as of 2012. Some of these agreements directly target innovation.

Having responsibilities including international cooperation, the National Agency for Technological Development (NATD, former JSC-NIF) has signed 39 official documents. These documents also include 14 Memoranda of Understanding establishing close cooperation with leading institutions, think-tanks, public bodies, innovation companies in order to improve different areas of science, technology and innovation system in Kazakhstan.

NATD closely interacts with organizations across many countries including Belgium, Finland, France, Germany, Malaysia, Republic of Korea, Russia, Turkey, United Kingdom and United States. The United Nations Economic Commission for Europe (UNECE), European Union (EU), World Innovation Foundation (WIF), Organization for Economic Cooperation and Development (OECD) are some of the international organizations which Kazakhstan cooperates with.

7.1. Collaboration within OIC

As described by President Nazarbayev, Kazakhstan is polyethnic and multiconfessional state completely supporting the global process directed on development of dialogue between civilizations and religions. In this regard, Kazakhstan gives special importance to participate actively in international and regional organizations. Since 1995, Kazakhstan is a full member of the Organization of Islamic Cooperation (OIC) which is the second largest inter-governmental organization after the United Nations with 57 member countries spread over four continents. It's also worth mentioning that the Law "On Ratification of the Charter of the Organization of Islamic Cooperation" signed on 15 February 2012 was an important historical step securing the legal status of Kazakhstan as a full-fledged member and confirming the political commitment and intention of Kazakhstan to develop and strengthen cooperation with the OIC.

To overcome the challenges impeding the progress of the Islamic world, Kazakhstan is strongly determined to actively participate in the activities of OIC, take necessary initiatives to unleash the huge potential of the Muslim world and promote closer ties between OIC and other international organizations.

Since its independence, Kazakhstan has launched a number of key international initiatives aimed at strengthening global cooperation and harmony. Highlighting the importance of rapprochement of cultures and dialogue of civilizations, participants of the 32nd Council of Foreign Ministers (CFM) of

OIC, held in Yemen in 2005, supported Kazakhstan's initiative on promoting inter-faith dialogue by hosting the triennial Congress of Leaders of World and Traditional Religions in Astana.

Until 2010[57], Kazakhstan has been the chairman of the Conference on Interaction and Confidence-building Measures in Asia (CICA) which is an inter-governmental forum for enhancing cooperation towards promoting peace, security and stability in Asia and the rest of the world. It also helped to organize the first ever CICA-OSCE joint forum in Istanbul in June 2010.

Kazakhstan was elected as the 2010 Chairman of the Organization for Security and Cooperation in Europe (OSCE) which is the world's largest regional security organization with a comprehensive approach to security encompassing political, military, economic, environmental, and human aspects. The given mission has been successfully completed by carrying out the Astana Summit in December 2010. The summit also initiated multidimensional dialogue on peace, stability and international safety issues, economic and humanitarian cooperation between the OIC and OECD.

Through the unanimous support of OIC member states, the 38th Session of the Council of Foreign Ministries (CFM) was decided to convene in Astana on 28-30 June 2011. Kazakhstan became the second[58] Central Asian country holding the chairmanship of the CFM since the foundation of OIC, which is a direct evidence of the recognition of Kazakhstan to carry forward the OIC's Vision of Moderation and Modernization.

Kazakhstan strictly followed the set of priorities reflected in the Concept and Programme of the Chairmanship of OIC CFM. Beyond hosting the 7th World Islamic Economic Forum and the 3rd Islamic Conference of Health Ministers in Astana, the OIC-EU meeting in New York, the extraordinary meetings of the OIC Executive Committee in Istanbul (17 August 2011), New York (23 September 2011) and Jeddah (30 November 2011) were held under the Chairmanship of Kazakhstan.

7.1.1. Patterns of Cooperation with OIC Institutions

Since becoming a member state of the OIC, Kazakhstan has gradually developed its interaction with the General Secretariat, subsidiary organs, specialized institutes, affiliated organs and standing committees of the Organization to further strengthen its relations with the Muslim countries, expand the platform of initiatives, attract financial resources, and participate in the social, economic, scientific and technological activities in the Islamic world.

Special importance has been given to cooperation with the Islamic Development Bank (IDB) which is a specialized multilateral financial institution of the OIC. The IDB Project and Grant Financing Program, which includes several economic and infrastructure projects in Kazakhstan, was realized for the period 2001-2012.. With the assistance of experts from the Islamic Development Bank, Kazakhstan adopted a Law on Islamic Finance in February 2009. This document, a pioneer of its kind in the post-Soviet space, has created preliminary conditions for further implementing the Islamic principles at banks and other financial institutions in Kazakhstan. The adoption of this law allowed Kazakhstan to introduce a new form of financial and banking services based on Islamic principles, which direct financing on an interest-free basis and based on common moral and ethics.

Attracting sources not only in the form of financial streams but also in the form of knowledge, technologies and innovation is critical. Establishing cooperation with Islamic Educational, Scientific and Cultural Organization (ISESCO) gives Kazakhstan the chance to successfully realize national projects such as preservation and restoration of monuments of cultural heritage, exchange of

[57] During the Third CICA Summit that was held in Istanbul, Turkey on 8 June 2010, the Chairmanship has passed from the founding Chairman Kazakhstan to Turkey.
[58] The first Central-Asian country was Tajikistan where the 37th Session of CFM had been convened.

experience in studying and teaching of languages.. ISESCO's recent nomination of Almaty - during the 38th Session of CFM - as the capital of the Islamic culture in Asia for 2015 has given a notable impetus to the expansion of cultural and humanitarian ties with the OIC member countries.

Recognizing the growing economic and trade potential of Kazakhstan, its candidacy for membership in the Bureau of General Assembly of the Standing Committee[59] for Economic and Trade Cooperation (COMCEC-Turkey) was supported at the 26th Session held in Istanbul in 2010 and Kazakhstan has been elected as the Vice-Chairman representing Asia region[60] for three years. The General Assembly is the decision making body of COMCEC giving Kazakhstan the opportunity to speak within the limits of the Bureau about Islamic banking and finance, which opens doors to financial resources, including Gulf countries. Additionally, on the side-lines of the 27th COMCEC Session, the First Meeting of the Executive Committee on the Implementation of the OIC Action Plan for Cooperation with Central Asia took place under Kazakhstan's presidency of CFM. It approved a number of concrete measures to accomplish the objectives of this initiative.

The Standing Committee for Scientific and Technological Cooperation (COMSTECH-Pakistan) is one of the authoritative organizations in the field of the S&T cooperation. Interaction with international partners in the sphere of S&T will allow the Kazakh universities to conduct fruitful research on a higher scientific level and to promote the role and status of the researchers. The priority scientific research areas in Kazakhstan are nano- and bio-technology, mining, metallurgy, extraction of natural resources, nuclear technologies, renewable energy, space technology, remote sensing and geographic information modelling of environment, seismological activities and estimation of global meteorological and climate conditions, especially in the context of environment. Within the framework of the COMSTECH programs, the International Scientific Centre on Nanostructure Researches including a unique spectroscopic complex, which allows conducting researches in nanomaterial and nanotechnology, was established under the Institute of Physics and Technology in Almaty.

Among the subsidiary organs, considerable potential for cooperation exists with the Statistical, Economic, Social Research and Training Centre for Islamic Countries (SESRIC) based in Ankara, Turkey. So far, Kazakhstan benefited from the training programs and workshops organized by SESRIC in the fields of statistics (agriculture statistics, quarterly national accounts), quality improvement and plant protection in cotton agriculture, project risk management, and tobacco control.

7.1.2. Patterns of Cooperation with OIC Member Countries

Enhancing cooperation with OIC Member Countries in education, science and technology is important for Kazakhstan. With its inherent growth potential, Kazakhstan's dynamic involvement in the OIC also offers benefits in terms of expanding trade and economic cooperation among member countries.

Kazakhstan is also enhancing its relations with the Arab countries, especially with Saudi Arabia, which can attract and promote investments and the credits that are crucial for further development of the Kazakh economy. Kazakhstan also intends to benefit from the immense experience of the Arab countries and companies in oil-extraction technologies. As Middle Eastern countries are interested in importing products, such as wheat, meat, rice, various mineral and metals that Kazakhstan can provide, trade is another fruitful area that accelerates the growth of Kazakhstan economy. Among the

[59] In order to coordinate and boost its action, align its view points and stands, and be credited with concrete results in various fields of cooperation -political, economic, cultural, social, spiritual and scientific- among Member States, OIC has created different committees, nearly all, at ministerial level, a number of which are chaired by Heads of State.

[60] The full report of the 26th Session is accessible through:
http://www.comcec.org/UserFiles/File/26.%C4%B0sedak/26.%20isedak%20kitaplar%C4%B1/Ingilizce%20BASKI.pdf

Arab countries, cooperation with the United Arab Emirates is mainly carried out in the fields of banking activity, direct investments and investigation, extraction and transportation of oil and other energy sources.

Bilateral relations between Kazakhstan and Iran are regulated by 26 various agreements covering a number of areas. In the long term, Iran is expected to become one of the largest importers of Kazakhstan's agriculture products. The seaport in Aktau, reconstructed through the efforts of two countries, is expected to allow carrying out sea transportation of considerable quantity of oil, grain, livestock, industrial goods and equipment across Caspian Sea between Kazakhstan and Iran.

Based on MOU signed with the Multimedia Development Corporation (MDEC) of Malaysia in 2010, negotiations have been started regarding the possibility of management of Special Economic Zone Park of Innovation Technologies by the MDEC.

Kazakhstan strongly supports the comprehensive international effort to bring lasting peace and economic development in Afghanistan and is the only Central Asian country that has the Assistance Program on Reconstruction of Afghanistan. The action plan includes restoring agricultural seed supply, building schools and hospitals, bridges, supporting projects related to water supply, infrastructure development and delivery of commodities and materials. Another important step was the decision by the Government of Kazakhstan to allocate $50 million to implement the Agreement on Cooperation in Education with the Afghan Government. Under this agreement, Kazakhstan will educate 1,000 Afghan citizens from 2010 to 2014. Within this agreement, Kazakhstan has been accepting 200 students from Afghanistan annually in order to provide them training in the universities of Kazakhstan in specialties such as healthcare, agriculture, law enforcement, border control, engineering, teaching and education sciences.

7.2. Regional Collaborations

Being a former country of the Soviet Union, having a common language, similarities in culture and education systems, Kazakhstan has a similar STI structure with the OIC Member Countries of the Central Asian Region. Founded in December 1991, the Commonwealth of Independent States (CIS) is the main organization promoting regional cooperation among its nine member states[61]. There are several CIS committees working in the fields of science, technology and innovation cooperation. The ambitious goals set by the CIS towards an integrated innovation scheme have been stated in the "Inter-State Programme in Innovation Cooperation of the CIS Member States until 2020".

Since 1992, the International Science and Technology Centre (ISTC) facilitates international science projects and assists the global scientific and business community to source and engage with Russian and CIS institutes that develop or possess an excellence of scientific know-how. In this regard, it provides scientists of Kazakhstan various opportunities for cooperation with their peers and research organizations from other CIS countries, Canada, EU, Japan, Republic of Korea, Norway and USA. Four of the projects of ISTC, amounting nearly $3 billion, were organized in Kazakhstan during 2009-2011 through the Competency Building Programme of ISTC, which aims to enhance the skills of scientists and experts in developing and implementing commercialization projects. There are also bilateral agreements between Kazakhstan and CIS countries in various fields such as student exchange programmes, high technology projects, etc. National Agency for Technological Development JSC is also a member of the Russian Technology Transfer Network (RTTN) and cooperates with a number of science and techno-parks in Russia and Belarus.

[61] Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, and Uzbekistan.

The 5th Forum of Leaders of Frontier Regions was held in Aktobe on 22 September 2008 with the participation of the Presidents of Kazakhstan and Russian Federation. The Ministry of Education and Science took part in the exhibition "High Technologies in Regions of Frontier Cooperation", in which the new technologies developed in the universities and R&D organizations were presented.

In the business forum titled "Investment Opportunities of Frontier Regions of Kazakhstan and Russia", the Agreement on Scientific and Technical Cooperation was signed between JSC National S&T Holding Parasat, JSC Centre of Engineering and Technology Transfer (Kazakhstan) and New Power Projects National Innovation Company (Russia).

With the aim of establishing economic integration through a full-fledged common market, some[62] of the members of the CIS including Kazakhstan have established the Eurasian Economic Community (EurAsEc) in 1991. On 9 June 2009, the heads of member states signed documents to found the EurAsEC Centre for High Technologies (CHTS). The Centre's activity focuses on devising scientific-technical programmes and innovation projects, and analysing the status of the normative legal framework regulating relations in the field of S&T, R&D and innovation.[63] As the EurAsEc is expected to coordinate the efforts of the respective innovation systems of the EurAsEc States through outlining the Concept of Eurasian Innovation System[64], the NATD of Kazakhstan strongly promotes integration within the EurAsEc. Additionally, Kazakhstan is a member of the Eurasian Patent Information System (EAPATIS). EurAsEC is also working on establishing a common energy market and exploring the more efficient use of water in Central Asia.

Separate from the Eurasian Union, establishment of the Customs Union among Kazakhstan, Russia and Belarus in January 2010 marked a major change in the path of regional integration with important implications for Kazakhstan. The documents to establish a "common economic space" leading to a single market for goods, investment and labour were approved by the respective leaders of Kazakhstan, Russia and Belarus in January 2012.

The national economy as well as the market of the Customs Union is considered by the government as the basis to build a modern, diversified, highly technological, flexible and competitive economy with a high value-added component. This is the central goal of the National Strategy Kazakhstan-2030 and the Strategic Development Plan of Kazakhstan-2020. These two strategic programs are the frameworks of the mid-term 2010-2014 State Program of Accelerated Industrial-Innovation Development (SPAIID), which combines a number of regional development and sectorial programs as the strategy to enter the 50 most competitive nations and 30 corporate leaders in the world. In order to facilitate swift and efficient development of the Customs Union among Russia, Kazakhstan and Belarus, the Program also determines the roles of all development institutions, national companies, industrial zones, technological parks and free economic zones

7.3. Patterns of Cooperation with International Organizations

7.3.1. EU Framework Programmes

The European Union (EU) and Republic of Kazakhstan have been partners since the independence of the country though the main underpinning document, "Partnership and Cooperation Agreement (PCA)"[65], adopted in 1999. As the cooperation potential has not been fully realized, the President

[62] Belarus, Kazakhstan, Kyrgyzstan, Russia and Tajikistan are member states of EurAsEc while Armenia, Moldova and Ukraine hold the observer status.

[63] EurAsEc Today, 2011, Eurasian Economic Community Integration Committee Secretariat (http://www.evrazes.com/i/other/EurAsEC-today_eng.pdf)

[64] Intergovernmental decision "On Creation of a Concept of the Eurasian Innovation System", 11 December 2009

[65] http://eeas.europa.eu/delegations/kazakhstan/documents/eu_kazakhstan/pca_kazakhstan_en.pdf

signed the Decree on the State Programme "Path to Europe"[66] in 2008 to pursue deeper engagement. To further strengthen the relations, the PCA of 1999 was replaced by the "Joint Statement"[67] endorsed by the EU-Kazakhstan Cooperation Council in 2009. Initially focused on trade and investments, the bilateral dialogue has been gradually extended to other priority areas of cooperation including education, energy, environment, SMEs, justice, security, border management and transportation. Beyond developing bilateral relations, the EU and Kazakhstan also cooperate in the framework of a regional approach which includes all the five Central Asian countries. "The European Union and Central Asia Strategy for a New Partnership" was adopted in 2007.

In addition to the assistance under the Development Cooperation Instrument (DCI), Kazakhstan participates in several on-going regional and thematic programmes. Since 1991, the EU funded more than 300 projects costing around €140 million. According to the Central Asia DCI Indicative Programme[68] of EU for the period 2011-2013, €30 million of the DCI budget is allocated for Kazakhstan to implement projects related to science, technology and innovation directly or indirectly.

After the formation of International Association for the promotion of cooperation with scientists from the independent states of the former Soviet Union (INTAS) in June 1993, the speed and flexibility of cooperation with the EU on S&T have been accelerated. In line with the INTAS Program, more than $200 million have been invested in various spheres through the Technical Assistance to the Commonwealth of Independent States (TACIS) programme of the EU, which specializes on maintenance of networking of the scientific organizations of the country with their partners in Europe.

Kazakhstan also participated in mobility programmes of EU such as Trans-European Mobility Programme for University Studies (TEMPUS) and Erasmus Mundus Programmes. Involving more than 40 projects of TEMPUS aiming to modernize the education system, the standards of Kazakhstan universities have highly improved in the last decade.

In 2010, Kazakhstan joined Bologna Process of the EU, which is a stepping-stone towards establishing a three-level degree system of higher education in accordance with international standards, prioritizing the international accreditation of universities, improving both the quality of training and access to tertiary education and increasing funding at all levels.

International Cooperation Network for Eastern European and Central Asian Countries (INCO-NET EECA) is a partnership financed by the 7th Framework Programme of the European Union on STI development (FP7) between the countries of the EU and Eastern Europe/Central Asia (EECA)[69]. The EU and EECA countries have significant potentials both in terms of the strong academic community and of worldwide leading S&T institutes in a variety of scientific disciplines. Linking the scientific potential and resources, INCO-NET EECA is of utmost importance for the political, economic and social development and stability of both regions.

The IncoNet EECA project aimed to facilitate a coordination of S&T policies building on common interest and aiming at mutual benefit in order to strengthen the cooperation between the EU and EECA. In 2012, the pilot projects will be realized in Kazakhstan and Moldova.

In March 2012, the Commission of experts for the IncoNet EECA project conducted a preliminary research in the field of development of science and innovation in Kazakhstan. The research group consisted of politicians and senior experts from Austria, Germany, Poland, and France. During the

[66] http://www.kazembassy.org.uk/path_to_europe_state_programme.html
[67] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/er/111290.pdf
[68] http://eeas.europa.eu/central_asia/docs/2010_ca_mtr_en.pdf
[69] Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

visit, experts met representatives of key state bodies, national companies, scientific institutes, universities and NGOs in Astana and Almaty.

7.3.2. Other International Organizations

The European Bank of Reconstruction and Development (EBRD) invested more than €11 billion in Kazakhstan for 152 projects in order to promote economic diversification and long-term sustainable growth needed for generating a favourable environment for science, technology and innovation.

Kazakhstan has been a partner of the Asian Development Bank (ADB) since 1994. As of 31 December 2012, Kazakhstan has received more than US$ 3 billion making it ADB's 12th largest borrower according to the Factsheet of the ADB[70]). The areas covered by the cumulative loan commitments are: Transportation & ICT (51.34%), public sector management (19.87%), finance (16.89%), agriculture & natural resources (5.56%), education (2.58%), water supply & municipality infrastructure (1.37%) and multi-sector (2.38%). To guide its operations in Kazakhstan during 2012-2016, the ADB is preparing its new country partnership strategy (CPS) which mainly focuses on upscaling the status of Kazakhstan on the income ladder. It will also be closely aligned to the government's Development Strategy 2020. To stimulate economic growth and reduce poverty in the poorest parts of the country by improving access to regions, the Government of Kazakhstan embarked on an ambitious roads development program in 2010[71] – the Western-Europe-Western China (WE-WC) International Transit Corridor Project (part of CAREC) that covers improvements to the 2,840 km road corridor linking Europe to Western China through Kazakhstan and Russia. Overall, about 65 percent of the total amount of the project is co-financed by the International Bank for Reconstruction and Development (IBRD), the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), Japan International Cooperation Agency (JICA) and the Islamic Development Bank (ISDB).

In 1992, Kazakhstan joined the World Bank. The Kazakhstan Partnership Program Snapshot[72] of the World Bank reported that the Bank has provided 39 loans to the country amounting to $5.6 billion, about 70% of which have been disbursed. The World Bank is working closely with the Ministry of Industry and New Technologies and assists the development of financial and technical support mechanisms for stimulating R&D, innovation, enterprise modernization and development of value chains. The Technology Commercialization Project[73] approved by the World Bank in 2008 aims to accelerate the creation and commercialization of intellectual property and improve the country's participation in knowledge based industries. The importance of attracting investment for commercialization projects with the participation of foreign scientists and researchers were also underlined in most of the interviews conducted. Additionally, World Bank has been working with the Ministry of Economy since 2008 on coordinating business environment reforms to improve the economy's Doing Business ratings.

Kazakhstan also takes part in realization of different programs of other international organizations and institutes like UNESCO, ACTR/ACCELS, UNDP, the World Case, USIS, SOROS Fund, UNICEF, IREX, the British Council in Kazakhstan, etc.

7.4. Collaboration with Non-OIC Member Countries

Since its independence, the Kazakh government has shown considerable progress in its policy of diversifying partnerships in bilateral and multilateral directions. In this regard, Kazakhstan seeks ways and means to enhance its collaboration with all countries.

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[70] April 2013 Factsheet: http://www.adb.org/publications/kazakhstan-fact-sheet
[71] The Kazakhstan Partnership Program Snapshot, World Bank,April 2012
[72] April 2012 issue: http://www.worldbank.org/content/dam/Worldbank/Experts/expertdocuments/Kazakhstan-Snapshot.pdf
[73] http://go.worldbank.org/BPD32DW8S0

Kazakhstan-Korea business forum was organized in Seoul in March 2012 by the Ministry of Industry and New Technologies of Republic of Kazakhstan and National Export and Investment Agency "Kaznex Invest". The business forum has collected more than 100 representatives from the largest Korean companies including Hyundai, LG, LOTTE, Kepco, KOLON, POSCO, Samsung, SK C&C, and Woolim Construction.

The Ministry of Industry and New Technologies of the Republic of Kazakhstan and the Ministry of Economy and Education of the Republic Korea have signed 10 agreements for investment projects with a cost exceeding US$ 7 billion. The projects cover petrochemical industry (building a gas chemical complex in Atyrau region, creation of R&D centres and manufacturing of chemical foam of the sewed polyethylene), electric power industry, mechanical engineering, construction and consultancy.

In accordance with the MoU signed with Korea Institute of Science and Technological Evaluation and Planning (KISTEP) in 2010, the NATD JSC conducted The First National Scientific-Technological Foresight in the Republic of Kazakhstan. Continuing technological cooperation with Korea, Innopolis Foundation (former Daedeok Innopolis) and NATD established offices of Kazakhstan-Korea Technology Cooperation Centres in Astana and Daedeok Innopolis in 2011.

Considering the signed agreements in the field of petrochemistry, Korea became the leading investor within the framework of the State Program for the Accelerated Industrial-Innovation Development (SPAIID) of Kazakhstan.

In Asia-Pacific, Kazakhstan have also cooperative programmes with Japan. The Japanese International Cooperation Agency (JICA) has involved in a number of projects covering biological variety, health and medical problems.

Kazakhstan has close cooperation with Germany as around 1% of population of Kazakhstan is of German origin. In 1999, Kazakh-German University (DKU), an international university in Almaty combining the variety of Kazakh and German educational elements was opened. Since 1990s, the German Society for International Cooperation (GIZ, formerly GTZ) has supported Kazakhstan in terms of various areas including educational and vocational training. GIZ currently implements the Reform of Education System in Central Asia and the Programme of Professional Education and Training in Central Asia I. The GIZ also supports some of the S&T projects trying to prevent drying up of Aral Sea along with other international partners[74] of International Fund for Saving Aral Sea (IFAS) whose executive committee is currently based in Almaty, Kazakhstan.

In the R&D field, Kazakhstan works closely with the United Kingdom (UK). Specifically, around 45% of the EU Framework Programme projects are funded by UK partners. In 2008, a Memorandum of Understanding (MoU) was signed between Kazakh Ministry of Education and Science and UK Partnership of Technical Vocation Education and Training (TVET-UK) to supply services in three areas: Curriculum development, college partnerships and sharing of UK best practices. Since 2001, Kazakh-British Technical University (KBTU), with a special focus on petroleum, chemical and IT engineering, has been accepting students. The KBTU also offer programmes in economics, finance and management. The International School of Economics and Social Sciences (ISE) of the KBTU is the only University of London International Programme (UoL) granting dual degrees in Kazakhstan. Apart from many universities in the UK, the KBTU has also university partners[75] from Canada, China, Germany, Italy, Malaysia, Republic of Korea, Russia, Singapore and Turkey. Bulgaria, France, Greece

[74] For other partners : http://www.ec-ifas.org/about/partners/
[75] http://kbtu.kz/?q=en/node/2115

and Spain are the other countries with which Kazakhstan cooperates in education, science and technology.

7.5. Unexplored Avenues and Challenges of Collaboration

With Baikonur Cosmodrome, founded in 1955, Kazakhstan is among the five countries having space launch facilities. As stated by President Nazarbayev:

"Baikonur is already an existing scientifically innovative world brand. On its base, we should form consistent and scientifically-innovative clusters. Considering prospects of the space branch, we should develop cooperation with Russia and other countries. National space programs are the indicators which show the level of development of the modern state."

The President also highlighted that the aspiration of people to healthy life should motivate researchers to concentrate more on medical research that increase the life expectancy. In this regard, the Centre of Life Sciences at the Nazarbayev University was established as a basis of national academic system for medical science and practice. The Centre is the platform for developing, implementing and also transferring of new medical technologies in the field of transplantology, artificial heart and lung, gene medicines, rejuvenation and radio surgery.

Further diversification of the economy, social and political stability, sustainability in natural resources, attraction of foreign capital, implementation of international technical, financial and business standards, accession to the WTO as a member of the Customs Union, promotion of corporate governance, greater transparency and accountability, education and administrative reforms – all are driving Kazakhstan to reach its strategic goals.

As declared by President N. A. Nazarbayev in his "State-of-the-Nation Address" in January 2011, Kazakhstan's foreign policy will "meet hopes and expectations of all our partners".

First of all, there is a need to overcome some barriers, such as:

- Political and financial support for international collaborations;
- Language and cultural barriers by enhancing the staff exchange under the mobility programmes;
- Facilitation of visa issues for parties, the foreign and Kazakh researchers;
- Enhancing participation of SMEs (public and private) in national and international programmes providing them with necessary co-funding;
- Identification and collation of reliable and detailed STI indicators in the country by the Agency of the Republic of Kazakhstan on Statistics; and
- Organization of trainings and awareness activities for the Kazakh scientific community.

8 SCIENCE, TECHNOLOGY AND INNOVATION INDICATORS OF KAZAKHSTAN

There is a positive momentum in the economic performance of Kazakhstan and one of the critical conditions for sustaining this momentum is the timely transition to innovation-based economy. Such a transition affects the interactions among science, technology, industry and finance. In order to create suitable conditions for production of competitive products and export growth, Kazakhstan initiated new *Strategy of Industrial-Innovation Development of the Republic of Kazakhstan for 2003-2015*. This *Strategy* aims to form state's new economic policy and focuses on achieving stable development of Kazakhstan by means of economic diversification and shifting from extraction to processing. At present, this *Strategy* was incorporated into the State Program of Accelerated Industrial-Innovative Development of the Republic of Kazakhstan till 2014.

This chapter presents an overview of the current situation in Kazakhstan in the field of science, technology and innovation (STI). It focuses on fundamental indicators of research and scientific development, such as human resources and organizations in R&D, R&D expenditures, patent applications and innovation statistics. The analysis is mainly based on the data set administered by the Agency of Statistics of Kazakhstan[76] which collects and disseminates more than 50 indicators on science and innovation, both at the provincial and national level.

8.1. Inputs to the STI System

8.1.1. Human Capital

Having an adequate level of highly qualified human capital is the primary condition to foster innovation and promote the scientific and technological development in any country. In the past, Kazakhstan was known for its scientific excellence and substantial scientific capacity. With 41,000 research scientists at its peak in 1990, Kazakhstan used to be an important centre of research and development in the Soviet Union[77]. However, as indicated in *Figure 8.1* only 16,578 R&D personnel continued to work in the sector in 2003, corresponding to a 60% fall compared to 1990. According to the joint OECD-World Bank Report on "Higher Education in Kazakhstan"[78] there are a number of reasons for this decline, including but not limited to;

[76] Agency of Statistics of the Republic of Kazakhstan, (2012), http://www.eng.stat.kz/digital/Science%20and%20innovations/Pages/default.aspx

[77] Narenova, M., et al., (2006), "National Policy in the Field of Higher Education in the Republic of Kazakhstan", unpublished background report and presentation prepared for the review team of OECD-World Bank 2007 Joint Report

[78] OECD, World Bank, (2007), "Higher Education in Kazakhstan", 168.

- Most research institutes inherited from the Soviet system were overstaffed. A process of gradual reduction in the number of researchers started only in 1992. Generally, the most talented and most entrepreneurial staff – left the sector and went into private business, which offered better opportunities and higher salaries.
- A significant number of researchers left the country to pursue careers abroad.
  As cited by the same report from Narenova et al, the termination of space research and military orders combined with older scientists eventually reaching retirement age and not being replaced by a younger generation also contributed to the decrease in staff numbers.

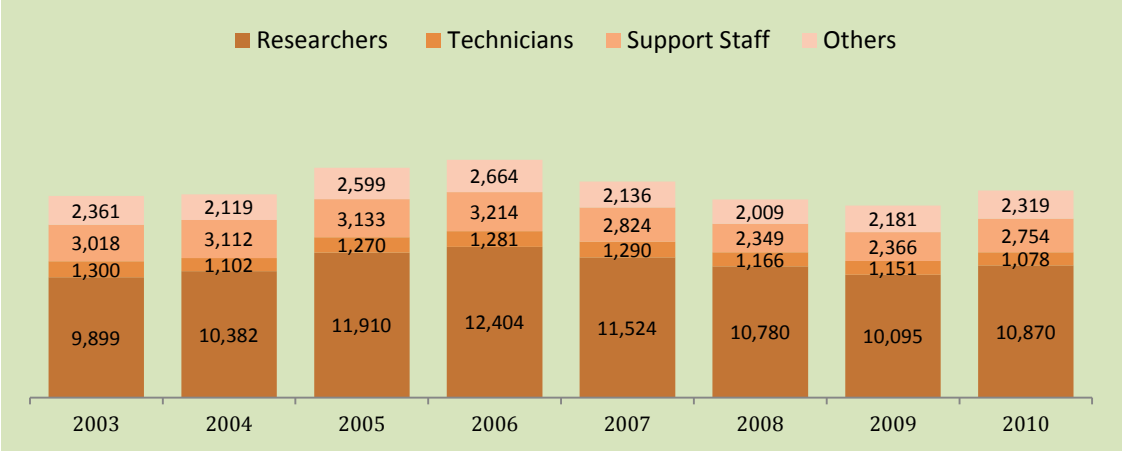
In 2006, the total number increased to 19,563 before dropping to 15,793 in 2009. The pool of R&D personnel, including researchers, technicians and support staff, recovered back to its 2005 level of eighteen thousand in 2011 (see Appendix *Table A.1* for further details).

Figure 8.1: Total Number of R&D Personnel, 2003-2011

Source: Agency of Statistics of Republic of Kazakhstan

Decomposing the total number of R&D Personnel by occupation revealed that share of researchers in total R&D personnel increased from 59.7% in 2003 to 63.9% in 2010 while both the number and share of other personnel engaged in R&D activities lost ground *(Figure 8.2)*. While for each technician there had been 2.3 support staff and 7.6 researchers in 2003, the ratio increased to 2.6 support staff and 10.1 researchers per technician in 2010. The deterioration in the ratio of technicians emerges as one of the impediments to commercialising R&D products.

Figure 8.1: Total R&D Personnel by Occupation, 2003 vs. 2010



Source: The Agency of Statistics of the Republic of Kazakhstan

Among all regions of Kazakhstan, nearly half of the R&D personnel resides in Almaty city, as shown in *Table 8.1. T*he share regressed from 52% to 48.3% during the period 2004-2011. Meanwhile, East-Kazakhstan region and Astana city, each inhabited around 10% of total R&D personnel in 2011 while their shares in 2004 were approximately 1.4% and 2.9%, respectively.

Table 8.1: Total R&D Personnel by Region, 2004-2011

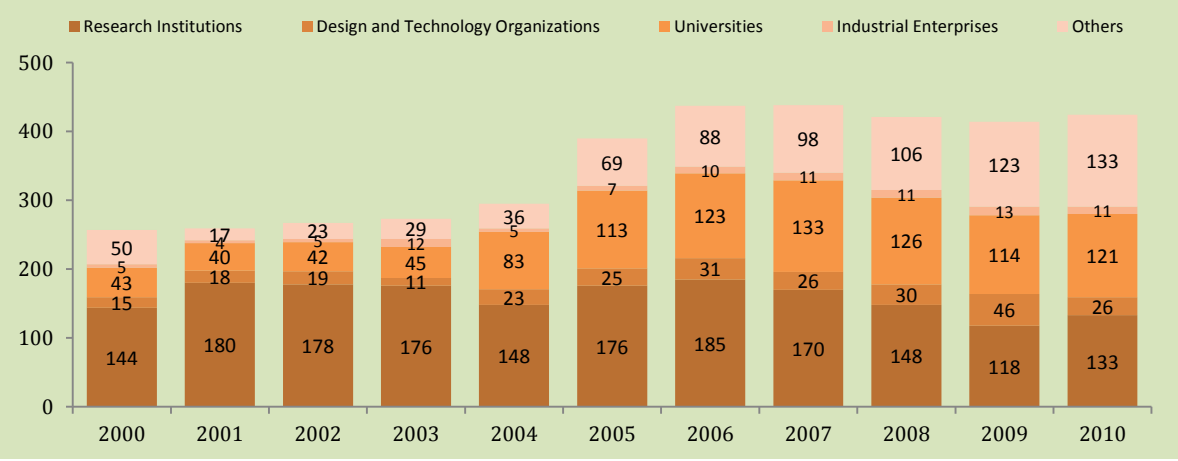
	2004	2005	2006	2007	2008	2009	2010	2011
Kazakhstan	**16,715**	**18,912**	**19,563**	**17,774**	**16,304**	**15,793**	**17,021**	**18,003**
Akmola region	659	591	579	468	559	555	615	798
Aktobe region	564	654	659	532	335	157	195	184
Almaty region	736	709	694	790	547	440	759	823
Atyrau region	633	631	654	681	633	554	582	609
East-Kazakhstan region	232	524	542	657	542	1,757	1,852	1,857
Karaganda region	230	378	399	436	333	735	875	794
Kostanay region	71	115	96	72	74	415	324	263
Kyzylorda region	604	741	822	801	841	79	98	147
Mangistau region	324	425	427	353	259	404	474	548
North-Kazakhstan region	281	230	216	147	200	136	106	77
Pavlodar region	56	205	197	187	181	258	187	280
South-Kazakhstan region	1,574	1,604	1,606	1,636	1,692	295	442	576
West-Kazakhstan region	1,220	1,635	1,812	1,140	1,039	170	459	500
Zhambyl region	341	378	459	417	414	474	344	155
Astana City	490	834	1,136	1,468	1,430	1,146	1,531	1,703
Almaty City	8,700	9,258	9,265	7,989	7,225	8,218	8,178	8,689

Source: The Agency of Statistics of the Republic of Kazakhstan

8.1.2. R&D Organisations

Compared to 2003, the total R&D personnel grew by 8.6% by 2011. Promising feature of R&D sector in Kazakhstan was a positive trend observed in the number of organizations engaged in R&D activities. As shown in *Figure 8.3*, R&D related organizations increased from 257 in 2000 to 424 in 2010 corresponding to a striking growth rate of nearly 65 % in a decade.

Figure 8.3. Number of Organizations Engaged in R&D Activities by Type, 2000-2010



Source: The Agency of Statistics of the Republic of Kazakhstan

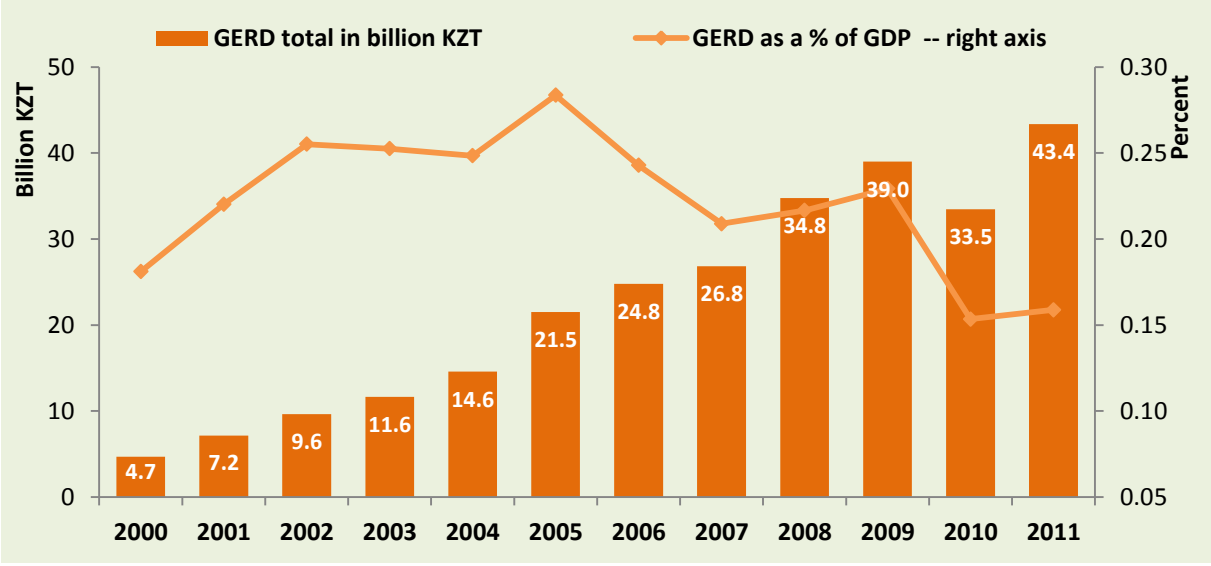
According to the classification of the Agency of Statistics of Republic of Kazakhstan, the research institutions was the only category of R&D organizations experiencing a decline compared to 2000. During the decade, socio-economic changes and administrative reforms had an impact on the fluctuating number of research institutions in Kazakhstan; to cite an example, a large network of research institutes belonging to the Kazakh National Academy of Sciences was transferred to the Ministry of Education and Science in 2004. The decline resulted in the share of research institutions to become 31.5% in 2011 while they accounted for as high as 56% of total R&D organizations at the beginning of the millennium. On the other hand, the number of universities nearly tripled from 43 to 121 and the share of universities increased from 16.7% to 28.5% during the same period.. Analyzing the annual changes, the biggest increments are observable for year 2004 and 2005 as 68 new universities joined the R&D sector in just two years.

8.1.3. Funding

Gross domestic expenditure on research and development (GERD) is defined as the total intramural expenditure on research and development performed on the national territory during a given period. As demonstrated in *Figure 8.4*, funding for STI in Kazakhstan was on a steady and encouraging climb from 2000 to 2011. Although a 5.5 billion KZT (US$ 37.3 mln) decline was observed in year 2010, GERD in 2011 (43.4 billion KZT, or US$ 296 mln) was above ninefold of the 2000 value of 4.7 billion KZT (US$ 32 mln).

Nevertheless, what is more important than the volume of GERD is its weight in the total expenditures or, in other words, in GDP. Accordingly, the R&D intensity (i.e. GERD as a percentage of GDP) is a widely used indicator of S&T activities. It reflects the innovative capacity of a country in that a higher R&D intensity indicates that relatively more resources are devoted to the development of new products or production processes.

Figure 8.4: Gross Domestic Expenditure on R&D, 2000-2011

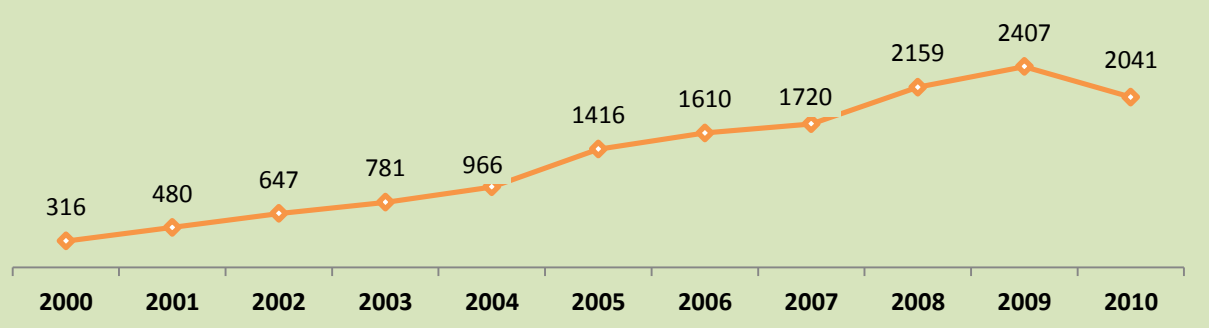


Source: The Agency of Statistics of the Republic of Kazakhstan

The R&D intensity of Kazakhstan was in the range of 0.15% - 0.28% for the period 2000-2011. As a percentage of GDP, gross expenditure on R&D from all sources reached its peak of 0.28% in 2005. Fluctuating around 0.20% during 2006-2009, it dropped to 0.15% of GDP by the end of 2010.

Although the population of Kazakhstan became 16.4 million by growing 10.1% over its 2000 value of 14.9 million, the immense rise in total GERD caused the GERD per capita to rocket by more than 500% from 316 KZT (US$ 2.2) in 2000 to 2041 KZT (US$ 14) in 2010 as seen in *Figure 8.5.* However, the GERD per capita of Kazakhstan in purchasing power parity (PPP) terms (US$ 22.9) was lower than that of Russia (US$ 165.4) and Belarus (US$ 105.3)[79].

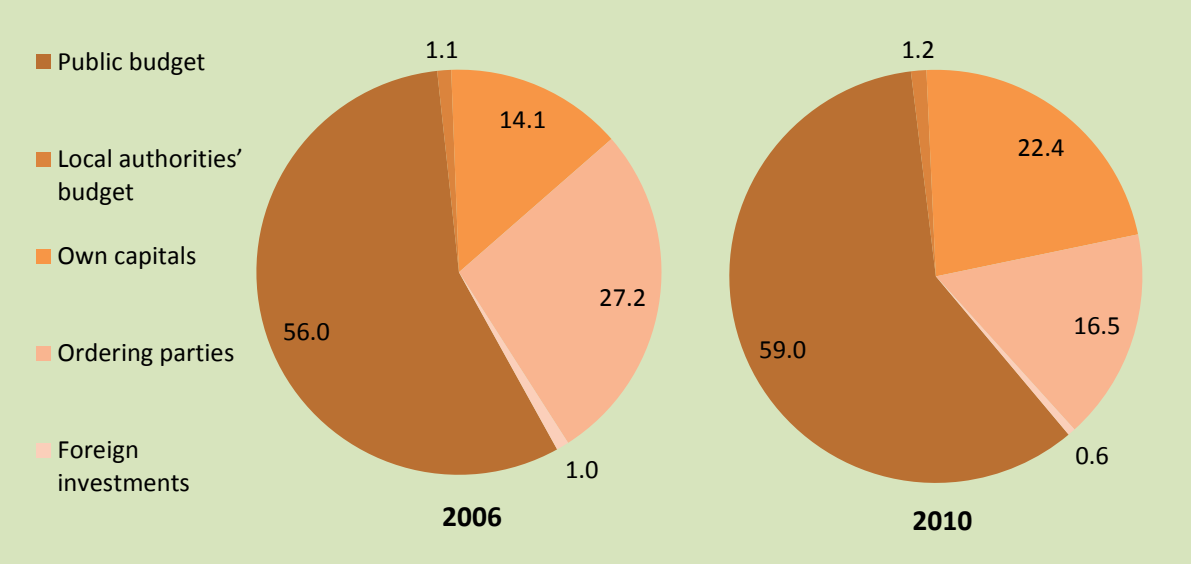
Figure 8.5: Gross Domestic Expenditure on R&D per Capita, 2000-2010, KZT



Source: The Agency of Statistics of the Republic of Kazakhstan

The public budget has been the most important source of financing R&D. On average, it accounted for nearly 50% over the past five years. In 2006, it was followed by ordering parties and own capital with shares 27.2% and 14.1%, respectively. *(Figure 8.6)* However, coming to year 2010, the order of importance changed: Own capital became the second source by financing 22.4% of the R&D expenditures and the share of ordering parties regressed to 16.5%. Meanwhile, local authorities' budgets and foreign investment, each have constituted for about 1% of the total funds. On the whole, all other sources of funding in comparison to public sources exhibited a relative weakness. This is a clear indication that the private sector R&D activities have been supported through public funding for the most part and the demand from the private sector for R&D activities has not yet reached a desirable level.

Figure 8.6. GERD by Source of Funds (%), 2006 vs. 2010

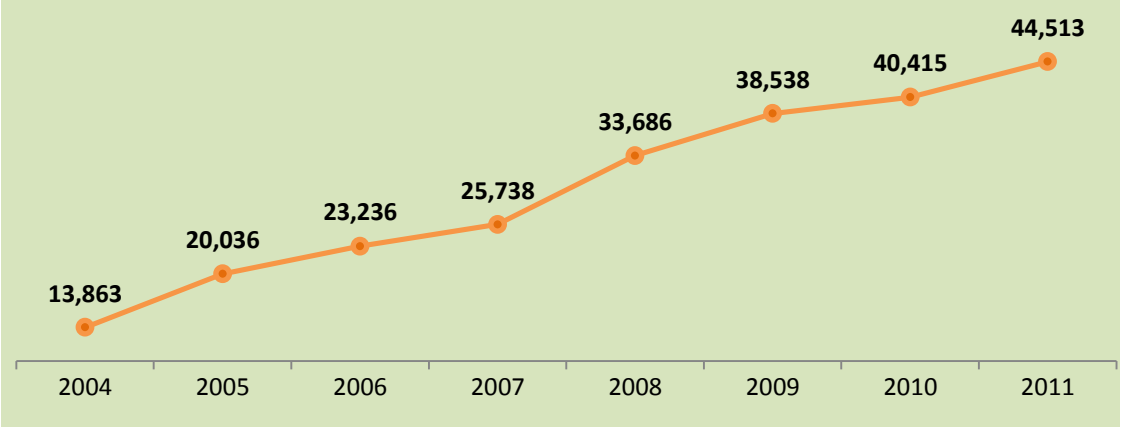


Source: The Agency of Statistics of the Republic of Kazakhstan

[79] UNESCO, (2010), "UNESCO Science Report 2010: The Current Status of Science around the World", 237.

During the period 2004-2011, internal current expenses for scientific and technical works displayed a continuous positive trend and rose to 44.5 billion KZT (US$ 303 mln) in 2011 with an average annual increase of 18% except for the jumps by 44.5% and 30.9% for years 2005 and 2008, respectively.

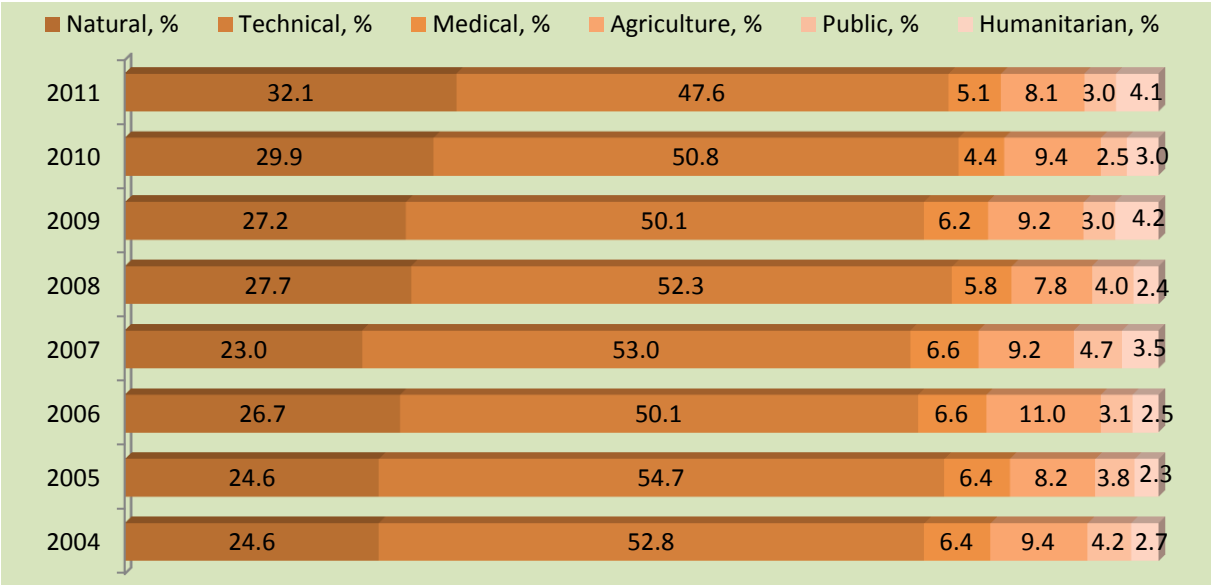
Figure 8.7: Internal Current Expenses for Scientific and Technical Works (million KZT)



Source: The Agency of Statistics of the Republic of Kazakhstan

Despite a 5 percentage point decline, technical areas of science have still spent nearly half of the internal budget, as demonstrated in *Figure 8.8.* They were followed by natural sciences expending one third of the budget in 2011 while it was one fourth in 2004. The agricultural sciences came third with a share around 8%. The medical sciences were the last area of which the share was higher than 5% whereas the public and humanitarian sciences together could only manage to get around 7%.

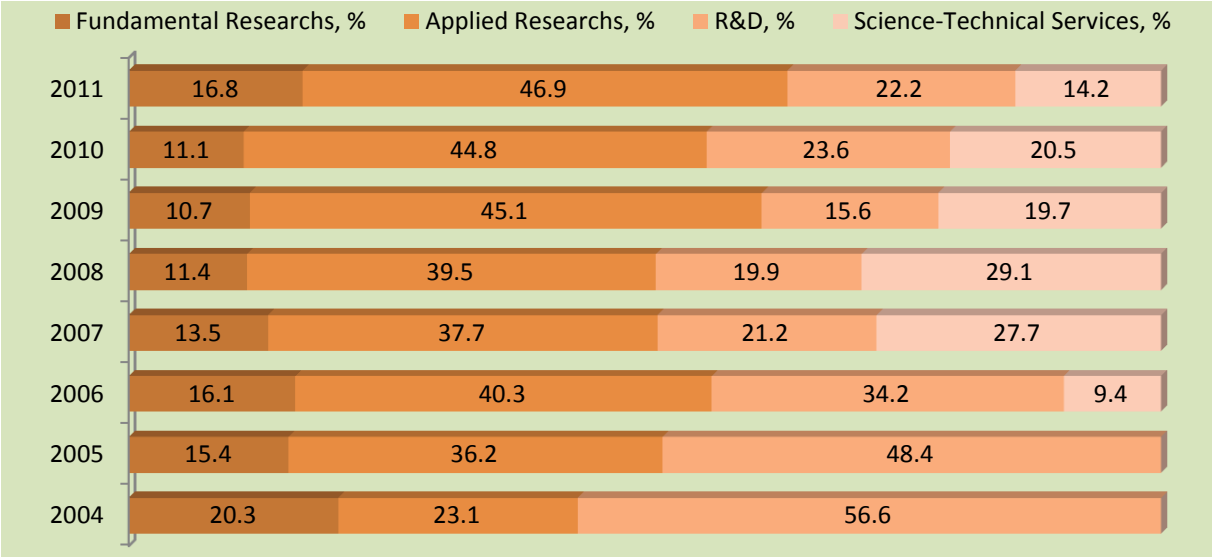
Figure 8.8: Internal Current Expenses for Scientific and Technical Works by Areas of Science



Source: The Agency of Statistics of the Republic of Kazakhstan

In terms of type of the scientific and technical work, it is evident from *Figure 8.9* that the applied research more than doubled the share it gets from the budget as the public R&D system has channeled more funds to applied research in recent years. This was at the expense of declines observed in fundamental research and especially in R&D works that began to get only one fifth of the budget while the expenditure on R&D works constituted 57% of the internal current spending in 2004.

Figure 8.9: Internal Current Expenses for Scientific and Technical Works by Type



Source: The Agency of Statistics of the Republic of Kazakhstan

Among the regions given in *Table 8.2*, Almaty city was the leading region with spending 16,288 million KZT (US$ 111 mln) despite its share in total GERD declined from 42.7% in 2003 to 37.6% in 2011. An expenditure level of 9,281 million KZT (US$ 64 mln) secured Astana city to hold the second rank after Almaty city. The case of Astana city is also worth mentioning in terms of its share in total R&D spending as it experienced an enormous jump from 0.8% in 2003 to 21.4% in 2011.

Table 8.2: Gross Domestic Expenditures on R&D by Region, 2003-2011 (million KZT)

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Republic of Kazakhstan	**11,644**	**14,580**	**21,528**	**24,800**	**26,836**	**34,762**	**38,989**	**33,467**	**43,352**
Akmola region	446	329	214	259	399	465	483	575	471
Aktobe region	258	48	208	366	343	498	492	627	628
Almaty region	233	258	280	309	557	486	537	705	1,008
Atyrau region	848	1,339	1,922	1,724	2,079	2,053	1,883	2,199	3,011
East-Kazakhstan region	1,759	1,932	2,095	2,275	2,736	4,273	5,589	5,099	4,176
Karaganda region	673	823	1,038	1,170	1,148	1,190	1,206	939	1,528
Kostanay region	53	139	167	186	234	214	361	215	251
Kyzylorda region	20	37	47	56	70	60	81	81	80
Mangistau region	1,899	1,594	1,732	2,263	2,598	3,426	3,138	3,065	5,151
North-Kazakhstan region	82	146	64	68	94	131	130	112	102
Pavlodar region	16	22	243	175	228	258	303	199	386
South-Kazakhstan region	117	233	431	427	420	385	358	451	441
West-Kazakhstan region	76	159	254	200	533	479	489	213	354
Zhambyl region	97	147	247	520	486	1,123	1,154	1,222	198
Astana city	95	401	1,968	1,991	2,388	4,768	4,449	4,446	9,281
Almaty city	4,971	6,975	10,619	12,813	12,520	14,952	18,336	13,320	16,288

Source: The Agency of Statistics of the Republic of Kazakhstan

8.2. Outputs from the STI System

8.2.1. Patent Statistics

Intellectual property rights, especially patents, play a key role in promoting a positive environment for innovation and scientific development. Beyond representing innovation capability of a country, patents strengthen the link between science and technology, as the outcomes of research translate into new products or services. In this regard, although not all inventions are patented, patent applications show the effectiveness of research and development in a country and consequently may be considered as a proxy for the degree of innovative capability in a country.

Being another key indicator of STI capacity, the dynamics of the number of patent applications received and issued for Kazakhstan is shown in *Table 8.3*. The -patent activity, i.e. number of patent applications, declined from 2,270 in 2007 to 1,989 in 2010. However as the number of patents issued more than doubled, the rate of issuance climbed to 30.1% in 2010 compared to rate of issuance of 9.4% in 2007.

Table 8.3: Dynamics of the Patent Activity in Kazakhstan

Types of Patent	Received Patent Applications				Issued Patents				Issuance Rate			
	2007	2008	2009	2010	2007	2008	2009	2010	2007	2008	2009	2010
Inventions	1838	1674	1705	1691	151	171	225	295	8.2	10.2	13.2	17.4
Utility models	106	82	105	89	42	56	58	81	39.6	68.3	55.2	91.0
Design samples	245	201	167	149	10	28	207	148	4.1	13.9	124.0	99.3
Selection achievements	81	179	130	60	11	1	20	74	13.6	0.6	15.4	123.3
TOTAL	**2,270**	**2,136**	**2,107**	**1,989**	**214**	**256**	**510**	**598**	**9.4**	**12.0**	**24.2**	**30.1**

Source: The Agency of Statistics of the Republic of Kazakhstan

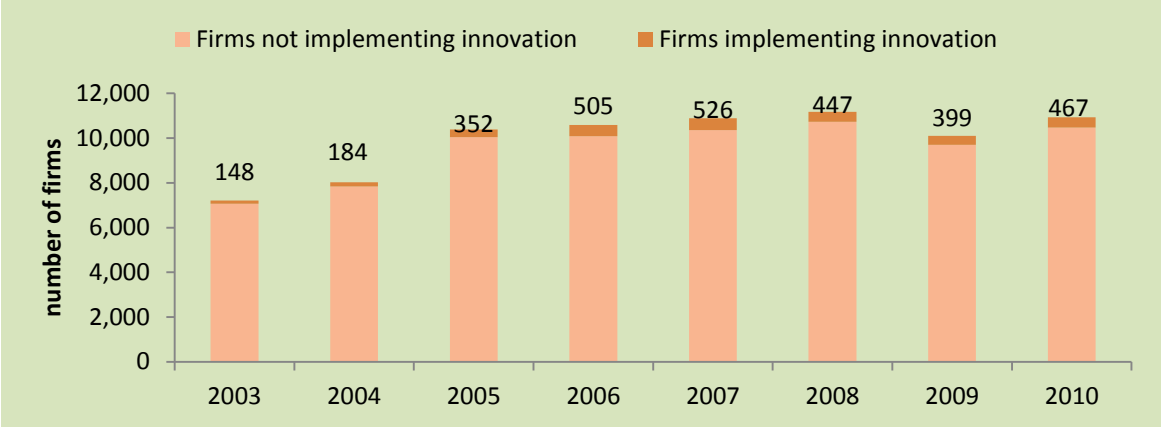
Regarding patent types, 85% of the patent applications in 2010 were inventions which were followed by design samples with a share of 7.5%. Utility models and selection achievements together accounted for 7.5% of the total application received. In terms of patents issued, inventions were again the dominant type though its share declined to 49.3%.. On the other hand, design samples constituted a higher share, 24.7% in the pool of issued patents as compared to its share in applications.

8.2.2. Innovation Statistics

8.2.2.1. Innovation Activities by Firms

Data on innovation activities in Kazakhstan have been collected through surveys carried out by the Kazakh National Statistical Office since 2003. Of the total respondents in 2010, 467 firms; 4.3% of the total, stated that they were carrying out innovation activities. That figure was only 148 firms in 2003 corresponding to no more than 2.1% of the total respondents (see *Figure 8.10).*

Figure 8.10: Firms Implementing/Not Implementing Innovation, 2003-2010



Source: The Agency of Statistics of the Republic of Kazakhstan

When the geographic distribution of firms implementing innovation is taken into account for 2010, the Zhambyl region came first as 7.8% of the total firms based in the region implemented innovation activities in 2010. The Zhambyl region was followed by the regions/cities of Karaganda (7%), East-Kazakhstan (6.4%), Aktobe (6.1%), Kyzylorda (6.1%), Almaty city (5.4%), and Pavlodar (5.1%). The rest of the regions/cities with data available in 2010 had firms implementing innovation within a range of 0.7% to 4.6% (*Figure 8.11*).

As to the percentage point change in the innovation activity level among the regions/cities of Kazakhstan between 2003 (or earliest year available) and 2010, except four regions/cities, the remaining cities showed a progress. While the change for regions/cities with a progress ranged between 0.1 and 5.4 percentage points, the change for regions/cities with a decline ranged between 1.1 and 4 percentage points (*Figure 8.12).*

Figure 8.11: Share of Firms Implementing Innovation in the Total Local Firms, by Kazakh Regions/Cities, %, 2003 (or Earliest) vs. 2010

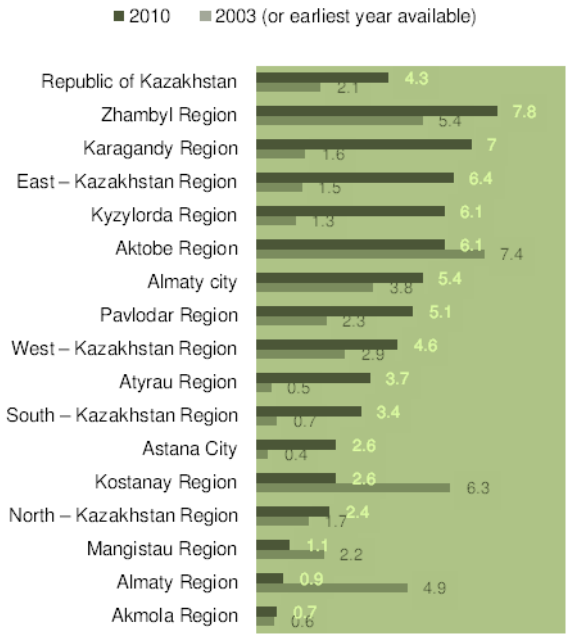
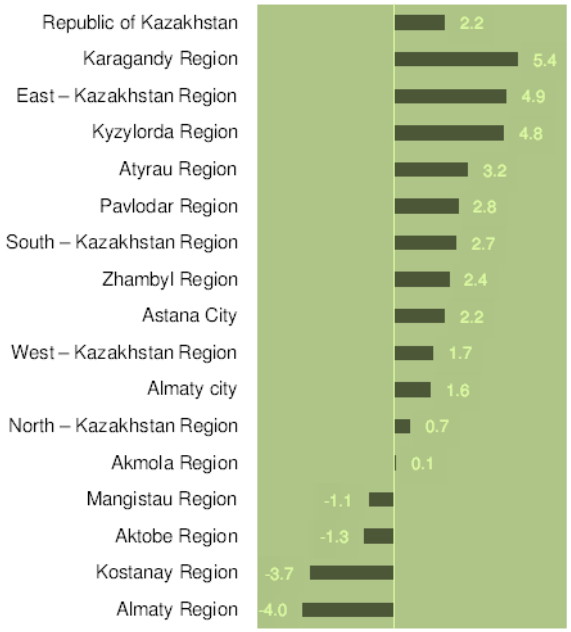


Figure 8.12: Change in Innovation Activity Level among the Kazakh Regions/Cities, % Points, from 2003 (or Earliest) to 2010



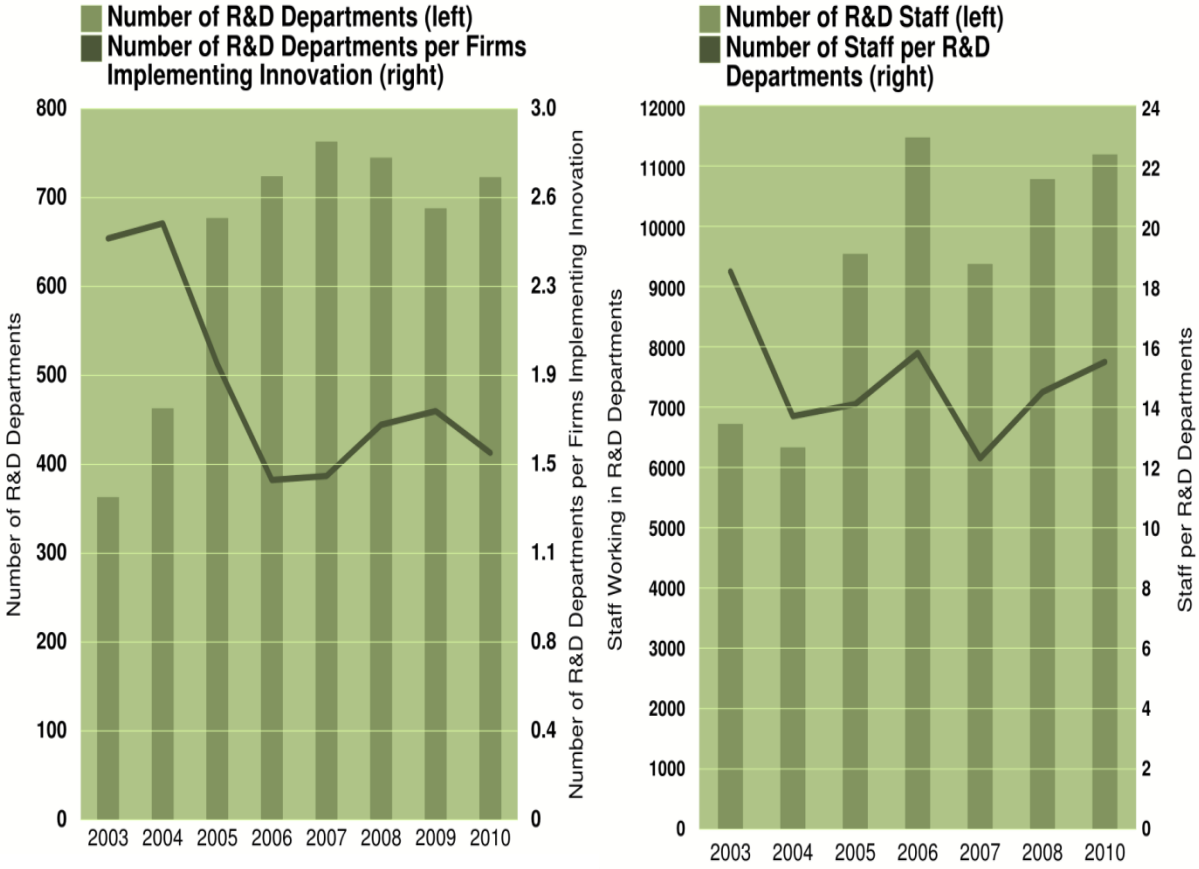
Source: The Agency of Statistics of the Republic of Kazakhstan

The number of departments engaged in research and development (R&D) activities within the respondent firms implementing innovation almost doubled from 363 in 2003 to 723 in 2010. Despite the increase, the number of departments engaged in R&D activities per firms implementing innovation decreased from 2.5 in 2003 to 1.5 in 2010 (*Figure 8.13*).

The number of staff working in departments engaged in R&D activities also increased by 66.5% from 6,721 in 2003 to 11,191 in 2010. However, parallel to the decrease in number of departments engaged in R&D activities per firms implementing innovation, the number of staff per departments engaged in R&D activities decreased from 18.5 in 2003 to 15.5 in 2010 (*Figure 8.14*).

Figure 8.13: Departments Engaged in R&D Activities within Firms Implementing Innovation, 2003-2010

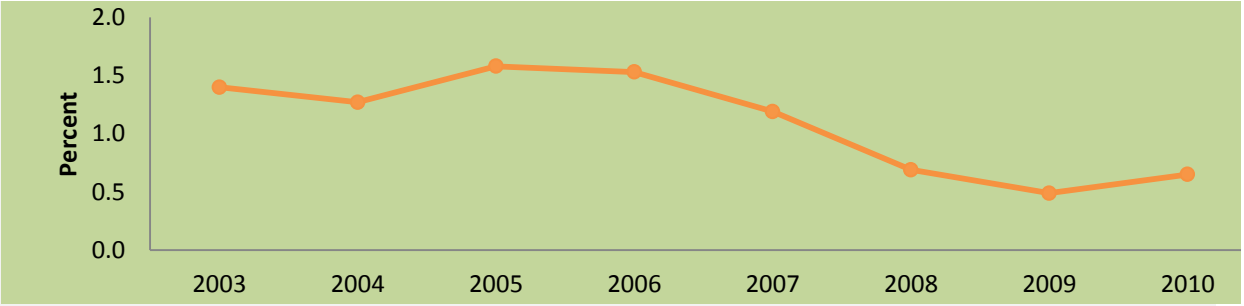
Figure 8.14: Staff Working in R&D Departments within Firms Implementing Innovation, 2003-2010



Source: The Agency of Statistics of the Republic of Kazakhstan

While there has been an increase in the total number of firms implementing innovation in Kazakhstan, the share of products manufactured through an innovation process in the gross domestic product (GDP) decreased from 1.4% in 2003 to 0.7% in 2010, with a record high of 1.6% in 2005 (*Figure 8.15)*

Figure 8.15: Share of Products Manufactured through an Innovation Process in Total GDP, %, 2003-2010

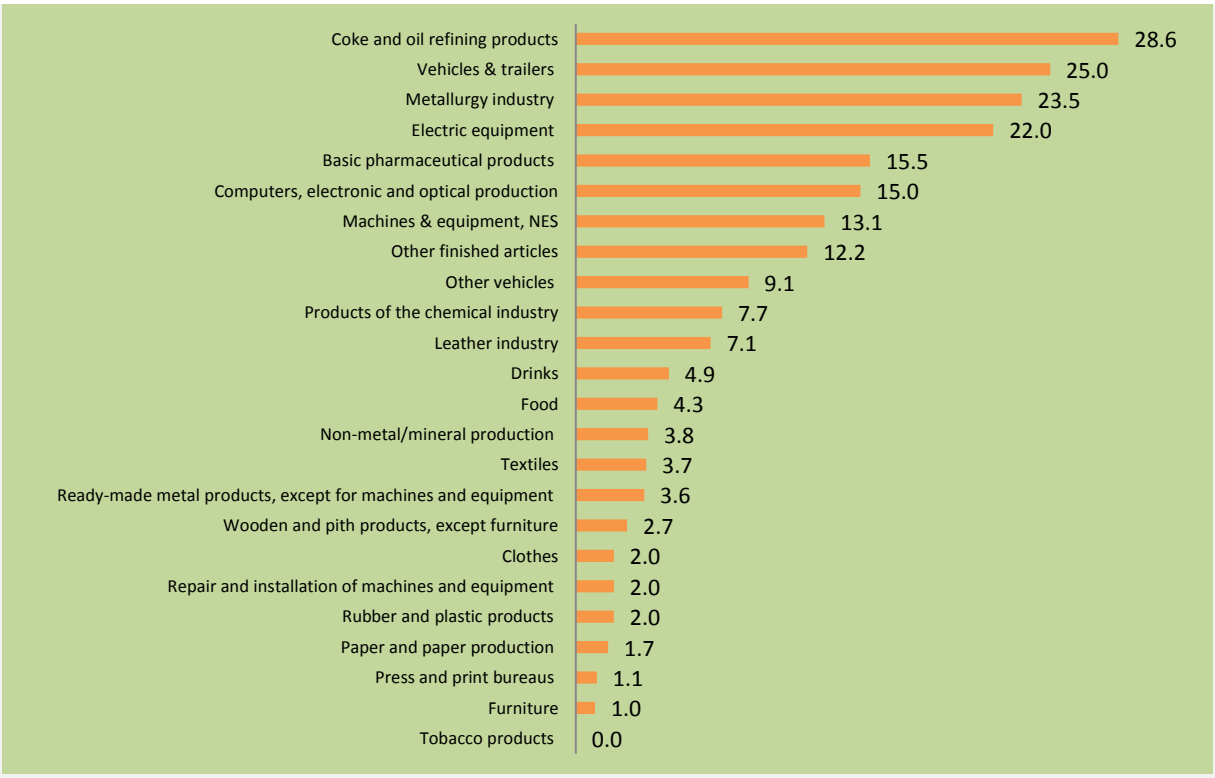


Source: The Agency of Statistics of the Republic of Kazakhstan

8.2.2.2. Innovation Activities by Manufacturing Firms in 2010

221 out of 4,800 respondent manufacturing firms (44% of total respondents) stated that they involve in an innovative activity, equivalent to 4.6% of the total in 2010. Manufacturing of electrical equipment, metallurgy industry, vehicles and trailers, and coke and oil refining products had the highest innovation activity ranging from 22% to 28.6% of their total respective sub-sector manufacturing firms *(Figure 8.16).*

Figure 8.16: Innovation Activities by Manufacturing Firms, % of Their Respective Sub-Sector Total, 2010

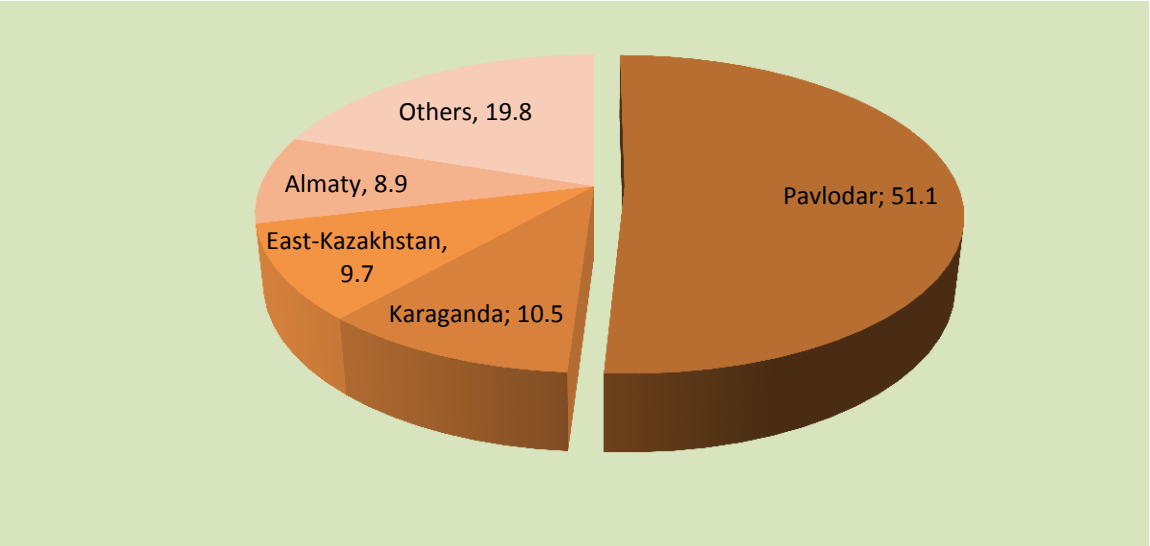


Source: The Agency of Statistics of the Republic of Kazakhstan

8.2.2.3. Volume of Innovation Based Products

The volume of innovation based products increased by 118.6% from 65 billion tenges (US$ 436 mln) in 2003 to 142.2 billion tenges (US$ 965 mln) in 2010. In 2010, the Pavlodar region alone provided 51.1% of the total volume of innovation based products in Kazakhstan, followed by the Karaganda region (10.5%), East-Kazakhstan region (9.7%) and Almaty city (8.9%). The volume of innovation based products in the remaining 10 regions/cities of Kazakhstan constituted about 20% of the total in 2010 (*Figure 8.17*).

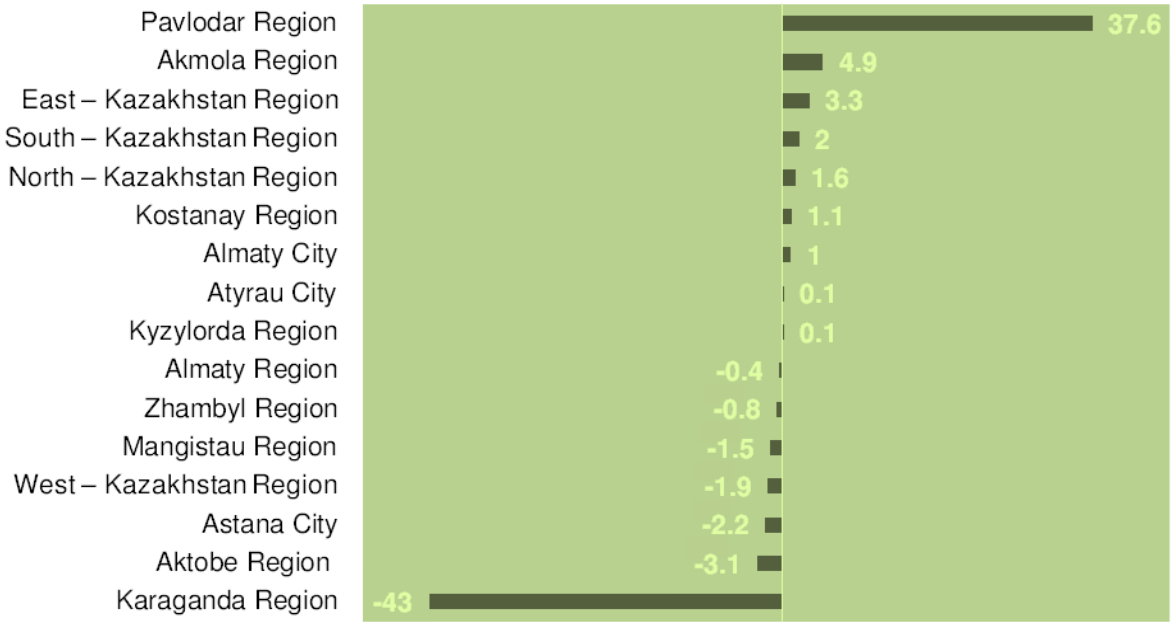
Figure 8.17: Shares of Regions/Cities in Total Volume of Innovation Based Products in Kazakhstan, %, 2010



Source: The Agency of Statistics of the Republic of Kazakhstan

When the contributions of regions/cities to the total volume of innovation based products are compared for 2003 (or earliest year available) and 2010 (or latest year available), it is observed that while Pavlodar, East-Kazakhstan, Almaty city, Akmola, South-Kazakhstan, North-Kazakhstan, Kostana, Atyrau, and Kyzylorda increased their contributions to the total volume of innovation based products (ranging between 0.1 to 37.6 percentage points), Almaty, Zhambyl, Mangistau, West-Kazakhstan, Astana city, Aktobe, and Karaganda recorded decreases in their contribution (ranging between 0.4 to 43 percentage points) (*Figure 8.18*).

Figure 8.18: Contribution Changes of Kazakh Regions/Cities in Total Volume of Innovation Based Products, % Points, from 2003 (or Earliest) to 2010 (or Latest)



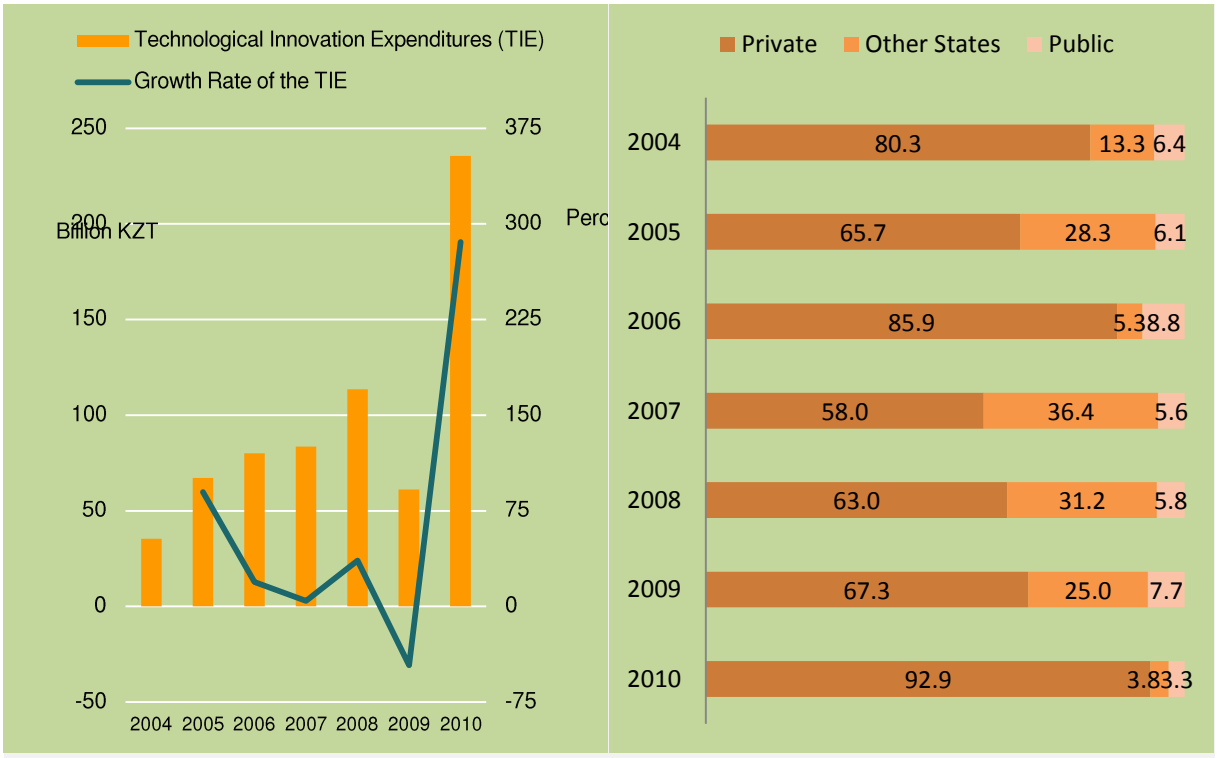
Source: The Agency of Statistics of the Republic of Kazakhstan

8.2.2.4. Expenditures on Technological Innovations

Between 2004 and 2010, the total expenditures on technological innovations increased by about 5.7 folds with an annual average growth rate of 37.2% reaching to 236 billion tenges (US$ 1.6 billion) in 2010 from 35.3 billion tenges (US$ 237 mln) in 2003 (*Figure 8.19).* As to ownership type regarding the expenditures on technological innovations in 2010, the private sector expenditures were at 92.9% as compared to the expenditures accrued by the public of 3.3% and expenditures accrued by other states of 3.8%. Actually, the private sector maintained its lead role concerning the expenditures on technological innovations between 2004 and 2010 ranging between 58% in 2007 to 92.9% in 2010. The record high share of the public sector in total expenditures on technological innovations was 8.8% in 2006 and in 2010 it retracted back to 3.3% as its record low level. The share of other states in total expenditures on technological innovations ranged between 3.8% (2010) and 36.4% (2007) (*Figure 8.20).*

Figure 8.19: Expenditures on Technological Innovations in Kazakhstan (left) and Growth Rate (right), Billion KZT and %, 2004-2010

Figure 8.20: Expenditures on Technological Innovations in Kazakhstan by Type of Ownership, %, 2004-2010



Source: The Agency of Statistics of the Republic of Kazakhstan

9 OVERVIEW OF SCIENCE, TECHNOLOGY AND INNOVATION SECTORS

This chapter presents a brief overview of ten critical sectors in Kazakhstan economy ranging from Agriculture and Food Processing Industry to Transportation. It also highlights the latest STI initiatives of the government of Kazakhstan towards diversifying the economy of the country with a view of reducing its dependence on natural sources.

9.1. Information and Communication Technologies (ICT)

In advanced economy countries, the ICT sector contributes to the GDP in an increasing rate. Based on the OECD data, the annual average growth rate concerning the contributions of ICT investment to GDP growth between 2000 and 2009 was recorded over 3% in Republic of Korea and Australia[80]. The ICT sector is also one of the fastest growing industries in Kazakhstan. In 2011, the share of ICT sector within GDP was 1.1%. Currently, it is planned to increase the share of ICT sector to 3.8% of GDP by 2014. The plan also includes achieving

- full digitalization of the local telecommunication networks;
- broadband internet subscription rate of 22%; and
- coverage ratio of more than 95% of the territory of Kazakhstan with digital TV access.

To reach the goal set for 2014, Kazakhstan develops its ICT sector step-by-step. These steps include, among others, infrastructure development, e-government development with establishment of basic components like broadband access and public electronic services.

Kazakhstan actively develops its human resources and stimulates the development of the industry through the government procurement in the SEZ Park of Innovation Technologies. As of today, the internet bandwidth doubled, wholesale internet prices dropped by 65%, and the internet users grew by 34%. The cities of Astana and Almaty introduced 3G mobile technology, broadband internet service along with digital satellite television.

The ICT development is one of the most important factors in improving the competitiveness of Kazakhstan's economy. This objective is keenly supported by the President Nazarbayev who stated that *"The competitive advantage in the struggle for investors should be advanced telecommunications*

[80] OECD Key ICT Indicators, Table 15: Contributions of ICT Investment to GDP Growth, 2000-09, http://www.oecd.org/internet/broadbandandtelecom/oecdkeyictindicators.htm

infrastructure. It is necessary to accelerate the introduction of the latest standard, 4G, while prices for communication services, the speed of the Internet should be competitive and affordable in the world".

Additionally, the National ICT Holding JSC "Zerde" is working to open a Research Institute of IT and R&D laboratories. The R&D labs of the institute will operate in the areas of robotics, convergent computing technologies, microprocessor, applied technologies, computer graphics, open source software, and information security. The JSC "Zerde", Huawei-Almaty Company together with the International University of Information Technologies also opened the R&D Laboratory of Open Systems and Cloud Computing in August 2011. The JSC "Zerde" furthermore signed agreements with MIMOS (Malaysia) and ETRI (South Korea) on joint actions for the development of ICT in Kazakhstan. The following four subsections summarises the new model of ICT in Kazakhstan.

9.1.1. Integrated Circuit Design and Production Technologies

In 2011, the global semiconductor market reached a value of about 304 billion USD of which 40.5% (123 billion USD) was dominated by China and Hong Kong alone[81]., Despite this global magnitude, the integrated circuit design and production technologies industry in Kazakhstan is still in its early development stages. A joint venture company was established with the equity participation of Elbit Systems and Delta IT LLC under the SPAIID and the Program for Modernization of Communications of Kazakhstan Military Forces. The company has been a member of the "Innovative Technologies Park" Special Economic Zone since 2007. Its main activities are:

- Manufacturing of electronic products, appliances and equipment;
- Implementation of modern software and hardware to provide technical and information security;
- Development and implementation of software;
- Conducting research and development activities in the field of information technology; and
- Development and production of military-technical systems of dual-use.

9.1.2. Wideband Technologies, Virtual Reality Software and Virtual Prototyping

In 2010, 8.9% of the Kazakh population had a fixed broadband subscription, which is above the world average of 7.8% but slightly below the Europe and Central Asia developing countries regional average of 9.1%. Given this background, the Program for Developing a New Model of ICT will enable the cooperation linkages between the government and telecom operators to develop a number of measures aimed at promoting broadband access with the use of WiMax, Fibre-to-the-home (FTTH), virtualization, CDMA-450 and 3G technologies. For the implementation of the program, the Kazakh government set ambitious targets in telecommunications, such as covering all cities with FTTH network architecture, decupling the number of FTTH ports, having an average connection speed of 40 Mb/s as standard bandwidth for end users.

Various advantages also come with the aforementioned goals. For instance, the introduction of FTTH-network architecture reduces the number of active network components owned by telecommunication operators, which saves on energy, distribution and repair costs. Also, productivity will increase as a result of centralized operation and management services. The new model of ICT will reduce IT staffing costs, unify pricing policy, improve quality of services offered, enhance the IT infrastructure for defence and security purposes, and reduce risk of data loss or corruption. Moreover, the transfer of all technical support functions allows standardizing and ensuring a consistent service level by the Government bodies. Wide broadband Internet connection for Kazakhstan can pave the way for the development of a wide range of innovative services such as cloud computing, remote electronic

[81] China's Impact on the Semiconductor Industry: 2012 Update, PWC (2012), http://www.pwc.com/gx/en/technology/chinas-impact-on-semiconductor-industry/assets/figure-6.jpg

processes, virtualization among many others. At present, a project is aimed at deploying public and private "clouds" that will provide computing platforms for resource allocation needs of the central government, territorial subdivisions and State agencies.

9.1.3. Grid Technologies, Parallel and Distributed Computing Software

One of the most important conditions for industrial and innovation based development is the introduction of high-performance supercomputing technologies. As of June 2012, there are only 4 supercomputers[82] in the OIC Region to take place in the Top 500 List that ranks and details the 500 (non-distributed) most powerful known computer systems in the world. Currently, despite not having ranked in the Top 500 List, Kazakhstan has two supercomputers, one in KazNTU University and the other one in Kazakh-British Technical University (KBTU).

In 2010, the Kazakhstan-Korean Centre of Information and Communication Technologies, based in the KazNTU, received the state-of-the-art equipment, including a supercomputer with a capacity of 17 teraflops/sec, more than 300 computers, cameras and high-tech classrooms in which teachers can give lectures interactively. The supercomputer is used both in education and computing/processing scientific data.

The supercomputer in the KBTU is used for similar purposes. At present, the supercomputer is the core of the high-performance computing network of the University, through which KBTU integrated with more than 70 research organizations in Europe and the USA.

On this basis, Kazakhstan joins the Global Grid Infrastructure which will be available for parallel programming technologies and calculations based on open platforms. This will attach the Kazakhstan Grid to European information infrastructure. Also, by installing a supercomputer Kazakh scientists get access to the worldwide computing resources, databases for international cooperation in various fields.

9.1.4. Design Technologies

During the visit of President of the Republic of Kazakhstan Nursultan Nazarbayev to Germany, the Strategic Cooperation Memorandum between JSC "Astana Innovations" and Fraunhofer Institute for Factory Operation and Automation IFF was signed. The main purpose of the memorandum is to expand and strengthen partnerships in the development of mutual technology transfer, scientific and technical cooperation, infrastructure development and digital engineering.

The establishment of the 3D Technology Centre has been supported by the local authority (Akimat of Astana city) and foreign partners. The main advantages of the 3D Technology Centre are the opportunity to virtually experience new equipment, assemble and disassemble equipment, design plants digitally, and train specialists. The Centre allows 3D visualisation of the city, where one can walk on the streets and visit the city sights that will be built within ten years. The Centre also allows working with potential clients in all sectors such as infrastructure, urban planning, engineering, agriculture, and medicine, etc.

9.1.5. Mechatronics

The National Science and Technology Holding "Parasat" together with the "Nazarbayev University" is working on robotics and developing robot technology in Kazakhstan. With the support of "Delta

[82] Three supercomputers with a rank of 85, 470 and 471 are in Saudi Arabia and one supercomputer with a rank of 397 is in United Arab Emirates (http://www.top500.org/list/2012/06/100)

Technology" Venture Capital Fund, Kazakhstan is also engaged in a project of industrial robots production for SMEs in furniture, stone-cutting and metalworking industries.

The objectives of the program are:

- Production and provision of robots and robotics service,
- Within "Nazarbayev University", establishment of a scientific and educational base for industry development and testing of robotics and robot-technology innovations;
- Training highly skilled experts in the "smart robots" development field,
- Training base for the organization of production (or assembly) from components supplied by leading "home robots" companies (Hanool Robotics, South Korea).

9.1.6. Production of Display Unit (Monitor) Technologies

Kazakhstan has established a new plant for manufacturing tablets, televisions and monitors in the "Seaport Aktau" Special Economic Zone. The production capacity of the plant will be shifted to tablet computer manufacturing in the future. The tablets will be equipped with preinstalled software and support Kazakh alphabet. The targeted clientele consists of Kazakh consumers, the CIS, Eastern European, and Middle East countries.

9.2. Energy

9.2.1. Electricity

Kazakhstan has large reserves of energy resources[83]. The total designed capacity of all power stations in Kazakhstan is 18,331 MW. About 70% of electricity in Kazakhstan is generated from coal, 14.6% hydro, 10.6% gas and 4.8% oil. As a percentage of total electricity consumption, industrial consumption accounts for 75%, households 10.6%, transportation 2.2%, and others 12.2%.

As Kazakhstan is mainly dependent on coal to generate electricity, innovations in clean coal technology should be followed very closely to reduce the environmental impact of power generation and maintain coal as an affordable source of energy in the immediate future. For this purpose, current R&D efforts have been concentrated globally in three areas[84]:

1. Technology Improvement
   a. Combustion
      - Supercritical & Ultra-supercritical Cycles
   b. Gasification
2. Carbon Capture & Sequestration
   a. Pre-Combustion
   b. Post-Combustion
   c. Oxyfuel
3. Technology Integration
   a. Conventional & Renewable Technologies: Coal-Solar

In the areas of technology improvement, modern supercritical and ultra-supercritical power plants[85] are capable of producing the same amount of power with one-third less fuel and one-third less

[83] Oil, gas, coal, and uranium.
[84] Berkley, M., Cruz, E., Vatanakul, M., Hynes, R., Stickler, A., (2010), "Innovation Avenues for Coal Derived Power Essential for the Future", 31st World Energy Congress, Montreal-Canada.
[85] The tradeoff with super and ultra-critical cycles is that the equipment must be capable of withstanding greater temperatures and pressures, increasing capital costs, as stated by Berkley et al.

emissions. From this aspect, supercritical combustion offers reduced fuel costs as a direct result of higher efficiencies; significant reduction in carbon dioxide (CO_2) emissions; increased availability relative to existing subcritical technology; capital costs comparable with traditional subcritical plants; integration with proven and emerging pollution and greenhouse (GHG) capture technologies[86]. Another technology improvement is gasification, a process in which coal is not burnt. Unlike traditional combustion processes which fully oxidize carbonaceous fuels to generate heat; modern coal gasifiers convert coal into syngas[87]; syngas is then cleaned and burnt in place of coal to make electricity[88].

The Global CCS Institute, a centre of excellence for "carbon capture and storage" (CCS) knowledge, defines carbon capture and sequestration (or storage) as a technology to prevent large quantities of CO_2 from being released into the atmosphere from the use of fossil fuel in power generation and other industries. CCS involves capturing the CO_2 produced at large industrial plants from the burning of fossil fuel (coal, oil and gas), transporting it to a suitable storage site and pumping it deep underground. The three main processes being developed to capture CO_2 – post-combustion, pre-combustion, and oxyfuel – involve separating the CO_2 from the other waste gases. Absorption is done using a liquid solvent; a solid material; or membranes that can allow some gases through and not others. Once separated from other components of the flue gas, the CO_2 is compressed to make it easier to transport and store. It is then transported to a suitable storage site including depleted oil/gas fields or rocks which contain fresh or saline water (saline formations)[89].

The examples concerning combination of coal and solar technologies are globally on the rise due to the need to avoid the detrimental effects of coal to the environment and to sustain low energy dense renewable power against the demand in today's current electric markets. One such commercial example has been recently initiated in Australia[90].

9.2.2. Low Carbon Energy Technologies

Kazakhstan is looking for ways to use renewable energy sources for the protection of its natural resources. Wind and hydropower are considered as the most promising renewable energy sources. In Kazakhstan, currently only 0.5% of electricity is produced from renewable energy sources. According to the Electricity Sector Development Program, up to 1% of electricity production should be obtained from clean energy sources by 2014.

Wind

The Republic of Kazakhstan is in the wind belt of the northern hemisphere and there are sufficiently strong air currents on most of the country, primarily the Northeast, South-west directions, the area of Jungar gate and Chilik corridor. In some parts of Kazakhstan, the average wind speed is about 6 m/s or higher, which makes these areas attractive to wind energy development. According to estimations of experts, Kazakhstan's wind energy potential is assessed as 1,820 billion kW per year.

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[86] As cited by Berkley et al from the "Cleaner Coal Technology Programme, Technology Status Report", (Jan. 1999), UK Department of Trade and Industry.

[87] Combination of CO and H_2 is referred to as synthetic gas, generally shortened as *syngas*.

[88] Li, F., Fan, L.-S., (2008), "Clean Coal Conversion Processes - Progress and Challenges", Energy and Environmental Science, Vol. 1, 248-267.

[89] http://www.globalccsinstitute.com/ccs/what-is-ccs and http://www.globalccsinstitute.com/ccs/how-ccs-works

[90] Coal-fired power stations generate about 80% of Australia's electricity. The Australian project to build the world's largest solar/coal-fired power augmentation site involves the installation of a Compact Linear Fresnel Reflector (CLFR) solar thermal system capable of generating 44 MW electrical at peak solar conditions, by supplying extra steam to the power stations existing turbine, thereby displacing coal. The project will reduce carbon emissions by about 35,000 tonnes per year, which is 0.8% of emissions, at a cost of only AU$3 per tonne of carbon for the first year's emissions alone.

Solar

Electricity generation from solar power in Kazakhstan is also developing and can play an important role in the development of alternative energy resources. The sunshine duration is 2,200 to 3,000 hours per year, and the estimated capacity of solar radiation is 1,300-1,800 kWh per m^2 per year. Using solar energy is especially important for remote and isolated parts of the country. In this respect, Kazakhstan can take advantage of some innovations and even produce their own solutions based on the existing technologies to provide electricity to disadvantaged households[91]: (i) "Artificial Leaf" – an energy storage technology that uses solar energy to split water into hydrogen and oxygen to be stored in a fuel cell, making off-grid living feasible; (ii) "Thin Film Solar" – a technology that allows solar films to be printed in rolls, which greatly reduces both the cost and the installation, as well as opening up more opportunities for placement of these solar power producers (such as being integrated into the roofing materials of buildings); (iii) "Solar Windows" – A new electricity generating coating on windows can convert sunshine to energy, which also produces the world's smallest functional solar cells, (measure less than ¼ the size of a grain of rice!) and can be applied at room temperature, with no need for specialized production facilities; (iv) "Solar Balloons" – a way to use existing technology to harvest solar power on arrays of silvery balloons that can concentrate and direct solar energy onto solar cells using readily available (and relatively low-cost) components; and (v) "Micro-Inverters" – Inverters are usually an essential piece of a solar power system, which take the power from the panels, which is direct current (DC), and change it into alternating current (AC). Micro-inverters – much more affordable than the current ones – can be installed on each solar panel to dramatically increase the efficiency and decrease the installation time for solar power kits.

Hydroelectric

There are significant water resources in Kazakhstan, which are mainly concentrated in eastern and southern parts of the country. The annual capacity of Kazakhstan's all hydroelectric resources amounts to 170 billion kWh. Having 62 GW is technologically feasible, and 27 GW is economic potential of Kazakhstan.

The Strategy of Industrial and Innovative Development of Kazakhstan aims to reduce energy intensity by half until 2015. Therefore, the use of new alternative energy sources is an important strategic objective for Kazakhstan. Moreover, the plan puts emphasis on the development of wind and water energy sources.

Nuclear Energy Technologies

Nuclear energy is another alternative energy source for Kazakhstan. The uranium industry was formed in the country during the Soviet period. Kazakhstan's only nuclear power located plant in Aktau, a fast reactor with a capacity of 350 MW, was shut down in June 1999.

The Government of Kazakhstan plans to create a vertically integrated complex of nuclear fuel cycle. Uranium goes through a long chain of five stages from the mine field to plant: extraction, conversion, isotope separation, production of fuel pellets and assemblies manufacturing. Kazakhstan is progressively working on adding all the missing links of the nuclear fuel cycle. In Kazakhstan, there are two redistributions; uranium mining and production of fuel pellets and powders.

The Nuclear Industry Development Program in Kazakhstan was approved in June 2011. The program aims to develop the nuclear science and industry, enhance atomic energy to ensure the industrial and innovative development of the country, and protect public health and environment. In order to realize

[91] http://cleantechnica.com/2012/01/28/5-fresh-innovations-in-solar-technology/ and http://dsc.discovery.com/gear-gadgets/top-6-innovations-in-solar-power.html

this Program, Atomic Energy Agency of the Republic of Kazakhstan was established in May 2012. In addition to that, Mr. Serik Akhmetov, First Deputy Prime Minister, articulated the intentions of Kazakhstan to follow up on a program which calls for 4.5% of Kazakhstan's total generation to be generated by nuclear power plants by 2030[92].

9.3. Natural Resources

By variety and size of mineral resources, Kazakhstan is one of the leading countries in the world. Kazakhstan is among the top ten countries in the world regarding reserves of lead, zinc, copper, oil, chromium, iron, manganese, tin, gold, phosphate, boron and potassium salts[93].

Based on this background, mineral processing technologies are also considered within the Mining and Metallurgical Industry Program. Efficient use of mineral resources is ensured by the following conditions:

- Full and complete extraction of useful components
- Low-waste and waste-free use of raw materials in the production
- Deep cleaning process and use of waste products
- Land reclamation of waste deposits.

The most advanced mining and mineral processing technologies as well as increased control over rational utilization of mineral resources ranging from geological exploration to the metallurgical redistribution are introduced for effective development of the fields transferred to subsoil users.

Mr. Temirkhan Niyazovich Zharkinbekov, Director of the Institute of Geology and Oil/Gas Business at the Kazakh National Technical University, stated in an interview that the strengths of the sector are the technologies and machinery used in processing natural resources, nuclear power and instrumentation industries. Despite these strengths, Mr. Zharkinbekov mentioned that a number of processing plants and mills should be increased to meet the demand of the market and necessary strategies should be developed for the sustainability of the marketing power of the sector in case of global economic crises.

9.4. Chemicals, Biotechnology and Gene Technology

The chemical industry along with petrochemical, mining, metallurgical, and electric power industries has significant impact on social and economic development of Kazakhstan. Processing methods of raw materials allow solving many technological and economic problems, organizing manufacture of the goods with an advanced set of properties, raising labour productivity and reducing negative influence on environment[94].

One of the primary goals in the SPAIID is the development of competitive chemical products industry that is hi-tech, export oriented and high value-added innovative production.

The chemical production output volume of Kazakhstan in 2010 reached 102.4 billion tenges compared to 2009 figure of 16.9 billion tenges. This growth is a result of reinstatement of the chemical goods production.

[92] http://www.world-nuclear-news.org/NP-Kazakhstan_reaffirms_nuclear_power_commitment-1503127.html
[93] 2005 Minerals Yearbook, Commonwealth of Independent States, USGS (December 2007), http://minerals.usgs.gov/minerals/pubs/country/2005/myb3-2005-am-aj-bo-gg-kz-kg-md-rs-ti-tx-up-uz.pdf
[94] Korina, L., "Responsibility is not an additional burden", KazPravda (2007), http://www.kazpravda.kz/print/1168595631

Kazakhstan has significant scientific and technical potential in biotechnology related production. Development of existing scientific and technical potential of biotechnology industry was among one of the focuses of national scientific and technical program "Development of advanced technologies for cluster formation of biotechnology in the Republic of Kazakhstan for 2006-2008". The program aimed to develop highly efficient technologies in agriculture, health, environmental protection and the processing industry. Within the framework of this program among others, the NCB invited 26 prominent scientists from the USA, France, Japan, Malaysia, Great Britain, Switzerland, Australia, Korea, and the Russian Federation for lectures on biotechnology.

The Ministry of Education and Science has set two main objectives concerning the Biotechnology sector in the country. First is transforming the biotechnology sector of Kazakhstan into lucrative and high technology business; and, second is creating an entirely new management model in science with well-constructed chain of fundamental and applied science, experimental production and commercialization.

9.4.1. High-Scale Platform Technologies, Structural and Functional Genome Science

In the field of medical biotechnology, new molecular-genetic methods for diagnosis of hepatitis C, tuberculosis, human immunodeficiency virus have been developed. A method is developed for getting nano-capsular transdermal alpha interferon to treat infectious myocarditis. Kazakh and Russian scientists completed preclinical and clinical trials of the original microencapsulated form of live measles vaccine, recombinant human erythropoietin in tablet form.

The Centre for Life Sciences was established in December 2010 as a private institution of the Nazarbayev University. The Centre strives to transform medicine and healthcare in Kazakhstan through innovative scientific research, rapid translation of breakthrough discoveries, educating future clinical and scientific leaders, advocating and practicing evidence based medicine, and pursuing research in personalized and predictive medicine. The underlying goal of all these activities is to improve health and quality of life in Kazakhstan.

9.4.2. Transcriptomics, Proteomics and Metabolomics

The Institute of Molecular Biology and Biochemistry, named after M.A. Aitkhozhin, is recognized in the CIS as a leading research centre for molecular biology, molecular genetics and bioengineering. The staff of the Institute comprises of highly qualified professionals who have studied and been trained in the leading institutes of Russia and abroad.

The main scientific objectives of the Institute are:

- Structural and functional features of genome organization of higher organisms (plants, animals) and the molecular mechanisms of its expression
- Molecular mechanisms of the development and gene diagnostics of human diseases
- Molecular basis of plant defence response to infection by phytopathogens and molecular markers of plant resistance to them
- Cellular and genetic engineering of plants
- Molecular immunology and immunologic biotechnology
- Structure and regulation of key enzymes of plant metabolism
- Space biology and space biotechnology.

The researches on space biotechnology by the Institute created two varieties of potatoes: "Tokhtar" and "Orbit" with a high resistance to abiotic environmental conditions and regionalized in the South and South-East of Kazakhstan. Production tests were carried out in the Almaty region. The virus-free

minitubers of the developed "Tokhtar" potato varieties are ready for production to enable manufacture of diagnostic kits for potato viruses.

9.4.3. Recombinant DNA Technologies

The Laboratory of Molecular Genetics of the Kazakh National University, named after Farabi, analyses the genomic gene and mRNA encoding of the human alpha-fetoprotein. With the help of genetic engineering techniques in vitro-mutagenesis, a recombinant DNA construct carrying the protein alpha-fetoprotein under the control of transcriptional promoters and translational enhancer active in plant cells was derived. These studies extend the capabilities of producing recombinant proteins for medical use based on the cultures of animal cells, plants and microorganisms.

The main areas of research of the Laboratory of Molecular Genetics of Plants are:

- Creating genetically engineered designs for final products such as proteins, recombinant microorganisms, transgenic plants
- Developing technology for producing transgenic plants expressing genes of medical proteins
- Producing recombinant proteins with enzymatic and antigenic activity in bacteria and yeast culture
- Studying the mechanisms of transient expression of plant virus genes
- Studying the mechanisms of DNA repair in prokaryotic and eukaryotic organisms

9.4.4. Cell Treatment and Stem Cell Technologies

Scientists of four institutions[95] conducted studies on hematopoietic stem cells, which can possibly be used for treatment of myocardial infarction, various surgical diseases, and biotechnological purposes to create the accumulation of cell mass and differentiation of stem cells into heart tissue for cell therapy. Scientists also developed the model of administered bone marrow derived stem cells in rats with myocardial infarction. Extensive studies on the immune status, level of stem cells in blood and their activation in patients with human surgical pathology were conducted. In the field of biotechnology, scientists developed the best instructional techniques of extracting stem cells from the blood to grow them in laboratory conditions and transform them into full cardiac muscle cells.

Methods for the selection, evaluation, processing and cryopreservation of cord blood stem cells are being developed with the support of a grant from NATD. In future, it is planned to create a cord blood bank in Almaty under an international partnership model.

Another significant cooperation concerning stem cells is now carried out with South Korea. Development of cell therapy of cancer stem cells is one of three projects that will receive financial support from funds allocated by the Ministry of Knowledge and Economy of the Republic of Korea[96].

9.5. Machinery and Materials

The main objective of the engineering industry in Kazakhstan is to meet the needs of domestic market and expand the production of engineering products with high value-added. The SPAIID supports the technology development and innovation in the industry to increase the export of domestic products by provision of tax incentives for the implementation of R&D, technical regulations and human resources training in industry.

[95] Syzganov National Centre of Surgery, Institute of Molecular Biology and Biochemistry named after M. Aitkhozhin, Institute of Cardiology and Internal Medicine, and Biological Safety Research Institute under the Biotechnology Centre.
[96] http://www.kase.kz/news/show/1141202

Machine-building sector consists of 13 sub-sectors; i.e., railways, oil and gas, mining and metals, automotive, agricultural, and other electrical equipment. Following is the first four subsectors of machine-building engineering with the highest priority in Kazakhstan:

- *Machinery for oil and gas industry*: The development of domestic oil and gas equipment is a priority as oil and gas sector is the largest consumer of machine-building products. From this end, Kazakh firms develop a variety of complex equipment for drilling, work over, production, preparation, and transportation of oil and gas, which allows mastering the production of offshore platforms.
- *Machinery for mining and metallurgical industries*: The most promising groups of domestic production in the mining and metallurgical engineering are self-propelled drilling and cargo handling equipment.
- *Railway engineering*: Freight cars and locomotives are the major products of railway engineering.
- *Agricultural engineering*: The market of agricultural machinery and equipment in Kazakhstan is now almost entirely covered by imported products. The largest share of domestic producers in the segment of agricultural engineering is components and spare parts.

According to the Statistics Agency of Kazakhstan, in 2011 there were 253 large and medium-sized engineering enterprises of which 8 were manufacturers of computer, electronic and optical products, 19 were manufacturers of electrical equipment, 156 were manufacturers of other transport equipment, 6 were manufacturers of auto transport vehicles, trailers and semitrailers, and 17 were manufacturers of other transport equipment.

9.6. Nanotechnology

The development of nanotechnology has had a significant impact on a number of industries including mining, metallurgy, chemical industry, light and heavy industries, medicine and agriculture; and on the development of innovative technologies in Kazakhstan.

Kazakhstan is working with the Ioffe Physical Technical Institute, affiliated with the Russian Academy of Sciences, in order to establish highly efficient multistage solar cells based on nanotechnology materials. Also, Kazakh scientists work with the Russian nanotechnology company "Nanotechnology-MDT" to create large nanotechnology laboratories and factories, as well as to develop modern analytical equipment in the field of spectroscopy of nanoparticles and microwave plants for investigations in relation to electrical parameters of nanomaterial.

In 2011, RUSNANO[97], Kazyna Capital Management, VTB Capital and I2BF Global Ventures agreed on to establish the Russian-Kazakh Fund of Nanotechnology in Astana. The fund was established by the request of President of Kazakhstan, Nursultan Nazarbayev, and Prime Minister of Russia, Dmitry Medvedev, in order to promote innovation in Russia and Kazakhstan. The main activity of the Fund is the introduction of nanotechnology to the economies of both countries, to ensure the transfer of advanced technologies and the development of innovative activity in private sector.

9.7. Defence

The Government established the JSC "Kazakhstan National Engineering Company" in cooperation with foreign companies under a holding structure to unite the defence industry enterprises. The

[97] A joint-stock company established and owned by the government of Russia and aimed at commercializing developments in nanotechnology.

SPAIID also includes measures for the development of machine-building sector, including the defence industry enterprises.

"KADEX-2012", biennial international exhibition of weapons systems and military equipment hosted by the Ministry of Defence of the Republic of Kazakhstan in Astana, brought together more than 150 domestic and foreign companies, which gave a powerful impulse for the increase of cooperation with foreign military technology producers.

In this respect, military technology R&D in Kazakhstan in 2012 included activities with regards to the development of antiaircraft rockets, high-precision weapons, land force vehicles, navy segment components, and prototype production. Future R&D activities in the defence industry are planned for communication systems, electronic defence, unmanned aerial vehicles, military transport aircrafts, soldier self-defence systems, and high-precision defence instruments.

9.8. Transportation and Space Technologies

9.8.1. Land Transportation

Highway project development including construction and maintenance is financed solely by government sources. Yet, the plan is to expand projects to include the participation of private companies, particularly, in the form of concession schemes.

The large-scale development project of southwest roads connecting Western Europe and Western China through an International Transit Corridor is currently under construction. The main objective of this project is to increase transport efficiency and highway safety in the region, reconstruction and modernization of existing roads.

9.8.2. Civil Aviation

The Program on Modernization and Development of Land Infrastructure is currently being implemented to strengthen the infrastructure for civil aviation among others.

A set of measures on formation of the air space structure and a network of routes based on the requirements of the international standards are carried out. Key areas for the development of Kazakhstan air navigation system are identified as:

- Modernization of communication and surveillance systems
- Launch of automated air traffic control centres
- Intensive training for air traffic controllers and related human resources.

9.8.3. Aeronautics and Space

Kazakhstan has all the necessary prerequisites to become one of the leading space powers in the world by 2020. It has the world's largest and oldest space airfield "Baikonur" with achieved launches of humans to space[98] and functioning space missile weapon systems. The first artificial satellites to orbit the Sun, Moon, and Venus; spaceships including the ship companions were launched from the "Baikonur". The "Baikonur" complex consists of:

- Space rocket complexes: "Proton", "Union", "Zenith", and "Dnepr"
- Terrestrial outer-space communication management complex

[98] The other two countries with a documented achieved launch of humans to space (more than 100 km altitude) are the USA and China.

- Base elements of national space monitoring system including three reception centres for remote sensing satellites
- Basic elements of scientific and technological infrastructure including space beam stations, scientific laboratories, and an astronomical observatory.

In order to strengthen national security and defence and to develop space sciences and advanced technologies, the Space Agency of Kazakhstan designed a sectorial program for the development of space activities between 2010 and 2014 to create a full-fledged high-tech space industry.

Additionally, the large-scale joint -Kazakh-Russian project "Baiterek" has been launched and in a few years' time, "Angara", a space-launch vehicle currently under development, will be launched from Baikonur. Angara will gradually replace the ecologically dangerous "Proton" carrier.

Assembly and test facility at Baikonur will allow Kazakhstan to fully participate in the production of satellites, and subsequently Kazakhstan can start to develop and produce satellite systems independently. Besides, the assembly and test complex can provide testing services for foreign space-crafts.

9.9. Agriculture and Food Processing Industry

The average annual cereal production of Kazakhstan was 16.2 million tons between 2008 and 2010, which places Kazakhstan among the ten largest world grain exporters. The main importers of the Kazakh grains are the countries in the CIS, Near East, North Africa and European Union regions. Besides grain; olive, berry cultures, grapes, sugar beets and potatoes are agricultural products that are of significant value to Kazakhstan.

The livestock production industry is one of the main branches of the agricultural sector in Kazakhstan. Rich pastoral grounds and favourable climatic conditions set a good basis for the development of animal husbandry. As a result of state policies in livestock industry, there is a steady increase in livestock and poultry production.[99]

Kazakhstan mostly exports grain and processed grain products, rice, meat, fat/oil products, and confectionery[100]. Food processing industry of the country (meat, dairy, fish, flour, cereal and fodder, sugar, fat and oil) is one of the strategic sectors of the economy, which is designed to ensure the country's population with required quantity and quality of food. Companies in the food-processing sector produced 7% of national industrial output and 22% of the manufacturing industry in 2010.

To further enhance efficiency of the agriculture sector in Kazakhstan, the following could be considered:

- Scientific support for intensive technologies in agro-food industry, application of biotechnological methods in agriculture concerning food-processing industry and food security;
- Introduction and use of innovative approaches in agriculture, including participatory R&D methods for sustainable agriculture and natural resource management; and
- Development of resource-saving technologies in agriculture.

[99] In 2010, production of meat was 937,400 tons, of milk was 5,381,200 tons, of eggs was 3,720,300,000 units and of wool was 37,600 tons.

[100] As on 1 January 2011, the registered number of rural, wood and fish products manufacturing firms was 808 (161 large and 647 medium size).

9.10. Health, Pharmaceuticals and Safe Drinking Water

Between 2004 and 2009, amount of free medical aid increased from 90.5 billion tenges to 273.1 billion tenges. In addition to that, a uniform information system in public health services is also introduced in 50 public health service institutes.

The JSC "National Medical Holding" was set up in 2008 with the goal to create a globally competitive *Hospital of the Future.* The Hospital strives to provide Kazakhs and foreigners with a wide range of health services in international quality and security standards using the best medical technologies and up-to-date hospital management techniques. The holding also includes six innovative health institutions located within the territory of Astana's medical cluster:

1. National Research Centre for Maternal and Child Health
2. Republican Children's Rehabilitation Centre
3. Republic Diagnostic Centre
4. Republican Research Centre for Neurosurgery
5. Republican Research Centre for Radiation Medicine and Human Ecology, and
6. National Research Centre for Cardiac Surgery.

Kazakhstan has abundant natural resources in the form of medicinal plants and minerals for the production of new drugs. The number of endemic[101] medicinal plants in the territory of the Republic of Kazakhstan is more than 60, as stated by Dr. K. D. Rakhimov, Head of the Department of Clinical Pharmacology Course Evidence-Based Medicine, in an interview.

In the pharmaceutical industry of Kazakhstan, there are 79 companies and producers. The cumulative medicine market in Kazakhstan made a turnover of more than US$ 1 billion in 2010 with a constant annual growth trend. 85% of the product portfolio of domestic producers is generic drugs and the remaining 15% is original drugs. This creates an obstacle for pharmaceutical manufacturers to allocate enough resources for R&D because of low-profit margin of generic drugs. According to Dr. Rakhimov, Kazakhstan's international pharmaceutical competitiveness is limited to a single original drug – Arglabin, an antitumor drug. Information provided by Pytochemistry (September 2006), a research and production centre in Karaganda, indicated a 76% positive response rate from more than 770 patients treated with Arglabin as of July 2006.

A test centre was established in 2005 to analyse the quality of vaccines. Following that, in 2006 new institutions were created including a research laboratory for relative bioavailability concerning bioequivalence of generic drugs, preclinical toxicity, and pharmacological activity of drugs. The Laboratory of Pharmacological Tests conducts various tests to monitor the quality of medicines and medical devices in accordance with the requirements. However, the development of domestic

[101] Endemism is the ecological state of being unique to a defined geographic location, such as an island, nation or other defined zone, or habitat type; organisms that are indigenous to a place are not endemic to it if they are also found elsewhere. The extreme opposite of endemism is cosmopolitan distribution.

pharmaceutical industry should be taken one step further by establishing an Institute of Pharmacology and Toxicology where the locally produced drugs will be tested and examined in preclinical studies and will undergo rigorous selection and control procedures.

Obtaining safe drinking water, introduction of modern technologies for water use and water conservation at hydroelectric power dams are among the priorities Kazakh government. In 2010, the "Ak Bulak" program was initiated, which promotes development of the water sector by modernization of technical facilities and formation of adequate tariffs.

"Membrane Technologies SA" was established in 1996 to address the problems of water treatment. The firm works on the creation and implementation of water treatment equipment, and is a leading domestic manufacturer of desalination and associated equipment. "Membrane Technologies SA" provides equipment for water treatment of various capacities for Kazakh enterprises, and firms in other countries, such as Russia, Uzbekistan, Latvia, the Republic of Korea, Brazil and Oman.

Operations at the local water treatment plant have shown that good result is achieved when removing suspended particles with the help of a combination of hydro cyclone-strainers. Also, vacuum scanning technology eliminates the need to disable the filter for self-cleaning cycle. Focused washing and minimal amount of discharged water provide service flow. In this respect, a two-step technology for getting reagent less deep deionized water is designed and implemented. The design and implementation scheme of the sewage treatment can return more than 90% of the processed water to the production cycle.

10 NATIONAL INNOVATION SYSTEM

"By innovation, we understand activities leading to the tangible increase in productivity."
President Nursultan Nazarbayev

Given the fact that the oil and energy resources potential for export cannot last forever, innovation is seen as the only option for national prospect in Kazakhstan. The development of the National Innovation System (NIS) of the Republic of Kazakhstan is aimed at achieving sustainable growth through economic diversification, i.e. shifting away from its raw materials orientation. Identifying innovation as the main factor shaping the competitiveness of the national economy, Kazakhstan is aware that effective use of innovation for further development of economy and society is possible by the carefully designed National Innovation Policy. This chapter will briefly introduce critical components of the NIS of Kazakhstan.

10.1 Priorities of National Innovation System

Productivity is a key factor that largely determines the competitiveness of an economy. Increasing the share of enterprises using high technology in manufacturing products significantly enhances labour productivity in the economy. From this aspect, innovation is perceived as main ingredient of productivity increase in Kazakhstan. To become big players in their sectors, it is therefore vital for Kazakh enterprises to increase their productivity by introducing innovations and modern management techniques. At present, the priority areas emerge as the creation of new competitive industries, modernization of existing facilities in order to increase productivity and, of course, the introduction of modern management techniques.

In this regard, it is no surprise that productivity increase is among the main priorities of the state's industrial and innovation policy (Box 10.1). In line with the national strategy of diversifying economic activity and shifting from raw-material dominated economy is among the goals. The tools emphasized in innovative policy for achieving this stage are attracting more FDI and reinforcement of SMEs. Evidently, the main step is the development of NIS.

Based on these priorities, Kazakhstan started systematically developing its NIS in 2003 and has put 2015 as a deadline for creating a fully functioning system. To form the NIS, Kazakhstan focused on four major subsystems, where the state can effectively implement innovative policies through direct or indirect participation:

Box 10.2: Priority Sectors under SPAIID

- Petroleum Refining; Oil and Gas Infrastructure
- Mining Industry
- Chemical Industry
- Nuclear Industry
- Machinery
- Pharmaceutical Industry
- Construction Industry
- Agro- Industrial Complex
- Light Industry
- Tourism
- Information and Communication Technologies
- Biotechnology
- Space Activities

1) Scientific and technological potential – the foundation of innovation development. The scientific potential includes government research organizations, scientific organizations with national companies, private research institutes, academic staff, research material and technical base.
2) Innovative business activity – main driving force of sustainable economic growth. An innovative business environment includes various categories of persons and entities which are ready to participate in the management and funding of high risk/high return projects, as well as invest in conducting applied research and experimental development, commercialization leading to the manufacturing of new competitive products.
3) Innovation infrastructure – inter-related manufacturing, consulting, educational and informational structures, ready to provide a base and a set of related services for the organization of innovative enterprises.
4) Financial infrastructure – financing research and production, and educational processes in the field of innovation and technological development.

Kazakhstan does not adhere to the specific foreign development models and has its own way, which is formed by the historical socio-economic systems, economic development potential of the nearest neighbours and the maturity of its industry. The approach of Kazakhstan concerning development based on innovation is established on five approaches:

1) increasing coordination among all participants of the national innovation system – from institutions of innovative development to technology parks and innovators;
2) creating an industrial base, conforming to the realities of the modern world. The main course is to modernize the domestic industry;
3) developing a package of instruments and tools to stimulate quality supply on innovation;
4) introducing analytical support for assessment of STI progress;
5) improving domestic skills and innovation mentality of the country.

Despite the fact that the priority is currently given to technology transfer as the fastest and most effective way to modernize the industry, Kazakhstan should create its own scientific and technical potential with an objective to generate its own innovations.

10.2. Review of the National Innovation System

Kazakhstan's journey in building National Innovation System can be divided into two stages:

Stage I began with the adoption of the Strategy of Industrial-Innovative Development in 2003. The result is the formation of the institutional framework and key elements of the NIS. The Ministry of Industry and New Technology (MINT) is the responsible body for selecting priority sectors (Box 10.2) for middle-term development goals.

Stage II was marked by the rapid economic course of building an innovative economy with the adoption in 2010 of the State Program of Accelerated Industrial-Innovative Development (SPAIID) until 2014. The program aims to ensure a sustainable and balanced economic growth through diversification and increase in competitiveness. This stage is characterized by the strengthening of legal and financial infrastructure for innovation.

The national authorities that form the scientific, technical and innovation policy of the country are composed of the Presidency of the Republic of Kazakhstan, legislative authorities (Parliament of the Republic of Kazakhstan), and the executive bodies such as ministries and agencies. The Presidency ensures coordinated functioning and interaction of the public authorities and determines state policy guidelines in the development of national innovation system, scientific-technical and innovation policy by issuing decrees and orders.

10.2.1. The Role of Ministries

There are two main actors of the NIS: Ministry of Industry and New Technologies, and Ministry of Education and Science. As coordinator of the SPAIID of Kazakhstan for 2010-2014, the Ministry of Industry and New Technologies (MINT) shoulders key functional responsibilities concerning innovation issues in the country. The MINT's roles in NIS include making proposals to the government, and coordinating and monitoring the enforcement of legislations.

The MINT also favours the development of the country's economy through the introduction of scientific and technological developments and the formation of high-tech industries; stimulates innovation activity by ensuring institutional and economic conditions which attract investments for the implementation of state innovation policy.

The Ministry of Education and Science (MES) contributes to the NIS by providing funding, coordinating research in fundamental and applied sciences, developing the research infrastructure and assessing scientific projects. Creating scientific and technical products, assisting research results reach to the stage of commercialization and carrying out R&D for a prototype to confirm the results of applied studies are conducted by the Ministry. The MES is also responsible for overseeing most of the research institutes in the country.

10.2.2. Development Institutions

The *Higher Scientific and Technical Committee* (HSTC), established in 1999, is responsible for the R&D efforts in Kazakhstan. The HSTC is headed by the Prime Minister, and the MES serves the secretarial functions. Other members of the HSTC are state bodies, leading scientists and experts of various disciplines, representatives of the national management holdings, national development institutions, national companies, private business entities, and scientific associations, which are approved by the Government of the Republic of Kazakhstan. The main objectives of HSTC include forming strategic objectives and priorities aimed at the development of STI, developing proposals and recommendations, and approving scientific and technical programmes.

The *National Academy of Sciences* of the Republic of Kazakhstan was re-established in 2003 as a public association and was deprived of its traditional role as manager and resource provider of research institutes. The concentration of basic research mainly in the Academy of Sciences, which had been established and formed independently of the educational system, was remnant of the former Soviet system and cannot be observed in any other developed countries. Currently, the National Academy of Sciences takes participation in defining of priority directions of science development in Kazakhstan, prepares Annual National Report of Science and promotes achievements of science by the publishing of special academic publications.

The *National Scientific and Technological Holding "Parasat"* is a state-owned enterprise whose purpose is to implement breakthrough research and investment projects for advanced developments in various sectors of the economy. The activities of organizations within the framework of the Holding Company can be divided into the following main areas: R&D, prototyping, production, funding and management of the scientific, technical and development projects management of the scientific and

technical information, and computerization of education. Thus, the Holding covers all aspects of the scientific innovation activities - from data collection to research and then introducing the results in the production level.

The *National Agency for Technological Development* (former National Innovation Fund (NIF)) was established in 2003 under the MINT in order to increase the overall innovation activity in the country, including promotion of the development of high-tech and knowledge-intensive industries. In 2012, NIF was reorganized to the National Agency for Technological Development (NATD). The activities of NATD cover several sectors and include support for R&D, technology acquisition and patenting of entrepreneurs. The NATD provides funding for innovative projects in the form of non-controlling equity participation by paying special attention to potential of commercialization during selection process. In 2012 NIF was reorganized to the National Agency for Technological Development (NATD). The Agency today is responsible for development of innovation infrastructure (SEZ Park of Innovation Technologies, 8 regional techno-parks, 4 design offices), developing of the system of commercialization (regional offices of commercialization), development of venture capital ecosystem (venture funds), operating the State innovation grants programme (9 types of grant) and programme of business incubation, provide with direct funding to innovation projects, stimulating of innovation activity.

The *Science Fund* was established in 2006 and provides funding for applied research in priority sectors identified by the HTSC. The Fund is the link between research conducted by research groups and businesses for the structuring of innovation processes. The Fund offers both grants and loans to scientists desiring to commercialize the results of their research for a period ranging from 3 to 5 years. In addition to providing funding, the Science Fund also provides advisory services in legal and financial aspects regarding commercialization of R&D projects. Since July 2008, the Science Fund is a member of the National Scientific and Technological Holding "Parasat".

The "*KazAgroInnovation*", with funds of 20.7 million tenges (US$ 0.14 mln), in a relatively short period of time since its establishment in 2007 has been set up to implement systematic measures for scientific and technological development in agriculture sector with public support. Research that is aimed at solving specific problems and needs of the agro-industrial complex will be carried out by the company in association with R&D subsidiaries. Promotion of the technological development of agriculture in Kazakhstan through effective asset management of research and innovation processes will be the mission of JSC "KazAgroInnovation". Currently, the scientific institutes of JSC "KazAgroInnovation" successfully collaborate with international agrarian scientists.

The *National Space Agency,* officially established in 2007, is a central executive body of the Republic of Kazakhstan beyond the Government of the Republic of Kazakhstan, which exercises the state regulation of space activities and inter-sectorial coordination in the field of space activities. Its objectives include; formation and implementation of a unified state policy on space and space industry, and creation of market conditions for space technologies. So far, the Agency has successfully launched two communication satellites KazSat 1 and KazSat 2 and signed contract for the third (KazSat 3)[102].

The *Development Bank of Kazakhstan* (DBK), established in 2001, provides financial support to the private sector and state organizations by granting medium- and long-term loans. The bank is fully owned by Samruk-Kazyna[103] and has total assets of 890 million KZT (US$ 6.1 mln) as of 2011[104].

[102] The contract was signed between Kazakhstan's National Center of Space Communications and Russian Reshetnev Information Satellite Systems company.
[103] The State Investment Holding company, more information is available at http://sk.kz/
[104] Auditors' report for the year ended 31 December 2011 is available at http://www.kase.kz/en/emitters/show/BRKZ

The *Entrepreneurship Development Fund* (DAMU), founded in 1997, offers financial and non-financial support to SMEs and stimulates demand for the products and services of these enterprises. DAMU operates at regional and national levels and is wholly owned by Samruk-Kazyna. DAMU had fund of almost 46 million tenges (US$ 0.3 mln) at the end of 2011.

The *KazNex Invest* was established in 2008 with a mission to attract FDI and support national companies in export-related activities.

The *Center for Marketing and Analytical Research* provides information on markets, global trends, and changes in external and internal conditions for specific products, industries, types of industries; conducts a series of studies with reputable and experienced international consulting companies in order to improve the business environment, and enhance the factors influencing the competitiveness of the economy.

10.3. Legislative Documents Concerning the NIS

Laws and regulations related to STI in Kazakhstan have changed quite a lot since the independence. For example; the document for the NIS "*The Strategy of Innovative Industrial Development of Kazakhstan for 2003-2015*" which was adopted in 2003 superseded with the adoption of SPAIID in 2010. In Box 10.3 is a list of other laws and regulations in the area of STI.

Box 10.3: Laws on STI

- "Law on Measures to Improve the Organization of Science and Development of the Scientific and Technical Potential in the Republic", issued in 1993;
- "Law on Copyright and Related Rights", adopted in 1996;
- "Patent Law", adopted in 1999;
- "Law on Science", issued in 2001;
- "Law on State Support for Innovation", adopted in 2001;
- "Law on Informatization", adopted in 2003

Despite some shortcomings, the Strategy became the initial document which contributed to the formation of an NIS for the Republic of Kazakhstan and the structural changes in the economy towards high value-added industries. The SPAIID on the other hand is more result oriented with strategic targets such as:

- GDP growth by 50% from the level of 2008 by 2020;
- Increasing the labour productivity by 50% and 100%, in manufacturing and other sectors respectively;
- Bringing the share of non-oil exports up to 40%;
- Reducing in the energy intensity of GDP by 10%; and
- Increasing the share of innovative enterprises by 10%.

These targets are very ambitious; however, they are attainable if provided with a proper public policy accompanied by further improvement of the regulatory/legislative framework and an assurance of the proper implementation of planned activities.

The first year in the implementation of SPAIID gave promising results with 152 new companies and 25,000 full-time jobs. 294 new companies with 161,000 permanent jobs opportunities are expected to be realized in the coming years.

Based on the SPAIID, there are sectorial programmes implemented by different ministries. For example, sectorial program for the development of information and communication technologies in the Republic of Kazakhstan for 2010-2014 has been developed by the Ministry of Communications and Information. The main objective of the Sectorial Program on ICT development is the transition to an information society and innovation-based economy, as well as the formation of competitive and export-oriented ICT sectors.

The new Law on Science, which aims to create a new national research system, was adopted on 18 February 2011. The law established a new model of managing science and research sector, delineated administrative and expert functions, introduced new forms of financing the science projects: grants, base and program funding. The Law brings out major changes to funding of research activities. For example, research grants are now available directly to individual scientists or their teams. Before the law, only universities or research institutes could access the grants. The *National Centre for State Scientific and Technological Expertise* has been established by the law with a mission to provide the review of scientific projects and programmes. The Centre will submit its results directly to the National Research Council.

The "Law on State Support of Industrial Innovative Activity" (2012) was adopted to ensure the legislative base of the NIS program, which provides state instruments and action-plan on stimulating innovation activity. The law establishes the basic goals, principles, directions and forms of state support of innovative activity, regulates the state's involvement in the creation of specialized innovation subjects, such as technology parks, technology incubators and innovation funds.

Below is the list of regulatory and legal framework introduced in Kazakhstan in order to establish and maintain the effective functioning of the NIS.

- "Law on State Support for Industrial-Innovation Activity";
- "Law on Science";
- Interdisciplinary Plan of Scientific and Technological Development till 2020;
- Decree on Creation of the Council on Technology Policy;
- Program for the Development of Innovation and the Promotion of Technological Modernization in the Republic of Kazakhstan for 2010 – 2014;
- Concept of innovative development till 2020.

Given that the Republic of Kazakhstan has established its legislative basis for the formation and development of the national innovation system, improvement of the relevant legislation and development of the appropriate policies and programs should be carried out on a regular basis; hence, there should be a review mechanism measuring the results and effectiveness of the laws.

10.4. Programmes

The goals outlined in the legislative documents concerning the NIS of Kazakhstan can be attainable by the implementation of several state programmes. One of those programmes, the Productivity 2020 Plan, was launched in 2011 in order to improve the competitiveness of industrial enterprises in priority sectors of the economy by increasing the productivity of labour. It offers long-term financing for the lease of modern equipment for technical modernization; and grants/consultancy services for increasing innovative capabilities of firms. The Institute for the Development of Industry is the main operator of the programme but long-term financing is provided by the Development Bank of

Kazakhstan, and grants and expertise is organized by the NATD. The implementation of the Programme "Productivity 2020" incorporates:

- Increasing the availability of financial resources to the private sector in the implementation of new investment projects aimed at industrial and innovative development;
- Attracting private sector funds, primarily financial institutions, to investment projects in non-oil sectors of the economy;
- Improving the financial and economic stability of the industry, primarily in medium and large businesses.

To increase the competitiveness of the firms, Kazakhstan should facilitate improving the management techniques and production technologies used by enterprises and modernizing existing industries along with creating new competitive industries.

10.4.1. Commercialisation

NATD is working on the creation and development of the system of commercialization of technologies in the Republic of Kazakhstan. The Fund established the *Coordination Centre of the Commercialization of Technologies* to encourage and assist research organizations and universities in the creation and launch of commercialization offices, identification of potential projects for commercialization, and development of the database on managing and commercializing projects, patents, potential investors, research organizations and enterprises, etc.

Commercialization offices are one of the components to support commercialization. In 2012, 15 offices of commercialization were set up in conjunction with the research institutes and universities.

According to Prof. Ramesh G. Kini, Director of 4E Centre at Kazakh British Technical University, Kazakh firms need to become more open and more patient about cooperating and collaborating with Kazakh universities. Currently, very few firms, if any, are seeking the sort of cooperation and collaboration that one might see in the advanced economies such as Japan, Australia, etc. He claims that if Kazakh firms approach universities with real, world-relevant and challenging problems, it can be the basis for moving towards a more world class research and development paradigm.

10.4.2. Venture Capital

NATD as one of the main actors of the national innovation system became the first Kazakh Foundation, which aims at establishing venture capital institutions with Kazakhstan and foreign capital participation to invest in the technology innovation business.

Additionally, NATD JSC is a partner of the top five foreign venture capital funds: Wellington Partners III Technology Fund LP, Central Asia Small Enterprise Fund – CASEF LLC, Mayban-Jaic ASEAN Fund, Venture Fund Vertex III Fund LP, and Flagship Ventures Fund LP.

The strategic goal of launching a joint venture fund is to provide access to advanced technologies to facilitate their transfer to Kazakhstan. By working with leading global venture capital funds, Kazakhstan can attract not only the financial capital of foreign investors, but also create a network of cooperation with high-tech companies and create new opportunities for the Kazakh science.

Launching regional and sectorial venture capital funds is one of the main directions of the venture capital investment development for the period 2010-2014. In addition, the NATD began in 2011 to create conditions for the development of venture capitalists, or the so-called "business angels", in Kazakhstan.

Although these tools are widely used as a global practice, there are a few venture capital funds that invest in Kazakhstan so far and their development is mainly provided with the support of the State. This process has considerably been intensified in recent years. In this regard, there is a need to create supportive conditions and the legislative framework i to facilitate the venture capital market develop independently and effectively.

10.4.3. Tax Incentives

Taxes breaks are among the most common tools used by governments in order to motivate the private sector in acting along with outlined priorities. Kazakhstan is also using these tools for boosting innovative capacity of the country. A distinctive feature of the national technology parks is the presence of Special Economic Zones (SEZ) with tax benefits and customs regimes.

A number of incentives are incorporated in the SEZ that will attract the attention of private firms:

- No corporate income tax and property tax;
- No customs for imports and exports;
- No trade barriers, restrictions on foreign share ownership;
- Possibility of building innovative companies;
- Low cost for renting office and industrial premises;
- Infrastructure (high-speed Internet access, IP-telephony, etc.).

For example, one of the SEZ with tax incentives is Park of Innovation Technologies (PIT) where 68% of total participants work in IT industry. As can be seen below, just over one year PIT has shown incredible growth in all aspects.

Table 10.1: Park of Innovation Technologies

Indicator	January 2011	March 2012
Number of companies operating at PIT, units.	24	74
Rented area by companies, sq.m.	2,000 (24%)	8,285 (100%)
Number of employees in companies,	12	~ 160

10.4.4. Government-Industry Partnerships

The task to improve Kazakhstan's Public-Private Partnership (PPP) was given by President Nursultan Nazarbayev in his Message to the Nation in 2011. Under the concept of PPPs comes a wide range of business models and relations between the State and private businesses. The PPP model can provide reduction of burden on the state budget by attracting domestic and foreign investment.

In addition, the use of business experience in creation, renovation, operation of state property would allow the State to obtain qualifications, experience, technology and know-how of the private sector. State will also be able to transfer some of the project risks.

The "30 Corporate Leaders of Kazakhstan" initiative, launched in 2007, can be cited among the Public-Private Partnerships. The objective of the initiative is to increase production capacity in priority sectors through innovative projects. The government provides up to 50% financing and takes a minority share in the projects. Projects can also benefit from sovereign loan guarantees, along with incentives in tax and customs.

10.4.5. Technology Parks

Innovative development involves joint efforts of science, business and government with their inherent potentials and aims. Kazakhstan has already implemented the common practice of "Technology Parks", based on the principle of integrating education, science and industry. In this sense, technology parks are aimed at utilizing the regional advantages as explained in Chapter 3. As a result of these changes, Kazakhstan is in a stage where it successfully develops innovative education and innovation infrastructure, forms the corporate culture and competitive environment in the universities.

10.4.6. National and International Links and Collaboration

As mentioned in Chapter 7, collaboration with foreign entities is realized by signing memorandums and agreements. At present, the number of interstate and intergovernmental level agreements in the field of education is more than 100. Another leg of international collaboration is the Kazakh students studying abroad and the most striking example in this area is the Bolashak Programme.

10.4.7. Other Programmes

The *Science Fund* provides financing to private companies undertaking scientific and innovative projects in coordination with scientific institutes. Funding is provided on a competitive basis and may take different forms, including both grants and loans. The Science Fund has settled 28 contracts with grantees, totalling 697 million tenges (US$ 5.2 mln). 417 million tenges (US$ 3.1 mln) were provided for 25 R&D projects and 280 million tenges (US$ 2.1 mln) for feasibility studies of three projects.

The MES conducted a coordination work on 47 basic research programs, formed on a competitive basis into 20 priority areas, 6 national research programs and more than 200 applications received on innovative projects developing new high-tech industries.

10.5. Challenges

Communication is a must-have in innovation development. There are two ministries responsible for the management of National Innovation System (NIS). This dual structure requires effective coordination among Ministry of Industry and New Technologies (MINT) and Ministry of Education and Science (MES) in areas related to innovation. To ensure flawless coordination among different stakeholders, the establishment of an entity could be taken into consideration, which should include not only government officials but also private sector representatives for enhancing its efficiency.

Despite several government programmes and initiatives in the innovation area, review and evaluation sides of these programmes are lacking; and hence developing an assessment of the system should be one of the next priority areas for Kazakh policy makers while designing the NIS components. During the assessment of the programmes, interactions between different regulations and government actions can be kept in mind for correct analysis of the outcomes.

Many components of the NIS are built by a top-down approach. This is a natural result of the strong presence of government in STI. Utilization of a bottom-up approach for system refinements can make the system function more smoothly.

The role of the government should gradually be transformed to become a guide in providing priorities and regulator over private sector. It should also enable exchange of information among stakeholders and facilitate the activities of entrepreneurs. Main government actions can be taken in areas such as; labour law, improving IT and communication infrastructure along with transportation suprastructure.

Kazakhstan should ensure the integrity and established functionality of all parts of the national innovation system to mobilize the accumulated investment and innovation capacity and adopt the innovative economy.

The important directions of development of innovative entrepreneurship in the near future should be creation of the system of training and retraining of personnel in the field of innovative business. This should include both undergraduate and postgraduate training, including overseas, as well as short courses, seminars, and roundtables to raise the skills of existing managers with the participation of State in funding such programs.

Kazakhstan is trying to increase the generation, implementation and commercialization of innovations by organizing contests to stimulate innovative activities of enterprises and the public. In order to increase public awareness on innovation processes, outreach and sensitization programs should be given utmost priority.

11 PROGNOSIS

The Kazakhstan Science, Technology and Innovation Report has benefitted from a number of field trips, interviews with relevant senior policy makers, workshops with the participation of scientists and policy makers, and thematic questionnaires with more than 100 experts, scientists and businessmen. This chapter presents a concise summary of the current landscape on science, technology and innovation in Kazakshtan with a set of policy recommendations to address the most urgent and fundamental problems as well as to expedite the positive momentum in moving the country towards an innovation-based economy.

11.1. Strengths and Weaknesses of STI System

11.1.1. Bright Spots

The very fortune of Kazakhstan is the robust government commitment to Science, Technology and Innovation, strong macro-economic policy and management frameworks, and high potential of rich natural resources. As presented in Chapter 10, the government of Kazakhstan has issued many decrees for the facilitation of an effective National Innovation System (NIS). These positive changes in the regulatory infrastructure will certainly improve the state of STI, if implemented efficiently; however policy makers should be aware of the fact that there is still room to bring about a more conducive environment for entrepreneurship and innovative business.

Currently, most of the existing rules and regulations are oriented towards technological research and innovation. Yet, the Kazakh government should consider non-technological[105] forms of innovation as well since these kinds of innovations are also critical for the overall performance of the economy.

In order to spur the development of new high-tech industries, a system of public institutions implementing government policies in innovation has been established. In this context, the country has first enacted an industrial policy as a result of which the 5-year program to promote innovation and technological advancement has been put into practice. This program is also aimed at developing a coherent policy in the management of scientific research and experimental development, and the formation of a strong National Innovation System with effective mechanisms of interaction among

[105] Organizational and Marketing Innovations.

government, business, and key actors in science and education, which, in turn, will ensure the competitiveness of the national economy.

Maintaining the sustainability of research programs is very much linked to a strong and continuous demand for innovation from all sectors of the economy. So far, the involvement of the private sector in realizing an innovation-based economy has not been at a desirable and adequate level. Furthermore, Kazakhstan needs to improve the efficiency of know-how generation in critical sectors and overcome the fragmentation within the innovation infrastructure.

11.1.2. Recent Revival of Investment in STI

The government of the Republic of Kazakhstan has adopted a wide range of policies and made substantial investments in support of innovation in, especially, recent years. For instance, plans for increased spending on innovation by large state companies may provide new impetus, including the decision to allocate 10% of the net profit of Samruk-Kazyna, National Welfare Fund, on innovation-related projects.

In 2011, the total amount of funding for science was 19.7 billion tenges (US$ 134.3 mln) and the proposed budget for 2012 is 41.8 billion tenges (US$ 285 mln). Kazakhstan intends to increase its expenditures on research and development as percentage of GDP to an average of 1% by 2014.

Table 11.1: Dynamics of GDP and Expenditure on R&D in Kazakhstan, 2006-2010

(Million US$)	2006	2007	2008	2009	2010
GDP volume	81,045	104,884	133,408	115,271	148,047
Gross expenditure on R&D, total	197	219	289	265	227
The share of R&D spending in GDP, %	0.24	0.21	0.22	0.24	0.16
Public R&D spending,	70	38	47	36	38
Share of public R&D expenditure in total domestic R&D expenditure, %	35.5	17.2	16.4	13.6	16.7

11.1.3. Track of Success

Following years of sustained national investment in research and innovation, Kazakhstan has started to record positive trends on main STI indicators. For instance, with 33.5 billion tenges (US$ 227 mln), R&D expenditure increased in absolute terms by almost 3 times in 2010 compared to the level of 2003. With 142 billion tenges (US$ 964 mln) in 2010, the volume of innovative products has increased 2.1 times compared to the level of 2003. Since the country's independence in 1991, not only there has been a significant increase in the scientific publications but also the share of national scientists in international publications increased by 3 times.

As a result of the recent global financial crisis, like many other countries, Kazakhstan revised its science and technology policies and enacted a number of government initiatives and measures for ensuring the sustainability of science and technology projects. Special financial supports have been extended for the development of innovative activities such as, new tax regulations and incentives for

domestic enterprises. Consequently, the demand for grants for the acquisition of technology doubled in 2010.

11.1.4. Emergence of an Entrepreneurial Eco-System

The participants of the Roundtable Discussion on "Attracting Private Sector Investment to Support Innovation in Kazakhstan"[106] articulated that the main difficulties in the business angel financing market are related to the inefficiency of information flow between business angels and entrepreneurs, and lack of professionalism. Towards addressing these challenges, it is recommended to establish business angel networks to bring financial, knowledge and information resources of different groups together in a pool with a view of attracting large selection of business ideas and thus, have access to high quality innovative proposals. These networks can facilitate the application of more formal procedures concerning selection of projects for investment.

The Kazakh business sector prefers to fund the traditional economic sectors. If the promising features and appeal of a wide range of innovative activities in other sectors can be demonstrated to private investors, necessary seed capital can be raised and diversification of the innovative processes can be achieved.

In this regard, the Session on "Private Investment in Innovation for the Development of Technological Entrepreneurship" of the Innovation Congress at the Fifth Astana Economic Forum discussed the effective development of business angel investment in Kazakhstan. As an exemplary case, the evaluation of innovative projects in initial stages for further funding by the *Business Angels Club of Kazakhstan* was discussed. This and other awareness-raising events will foster the facilitation of a functional platform for diversifying the innovative activities and higher involvement of critical stakeholders in innovation.

11.1.5. Opportunities to Exploit a Number of Emerging Areas

The R&D activities in the oil and gas industry are necessary to increase the efficiency of exploration work, enhance the ultimate oil recovery, improve quality control of field development, further the efficiency of field development with depleted reserves and hard-to enhance oil recovery.

In the mining sector, there is a need for technologies to be used for the discovery of new fields and mining, maintenance of drilling and blasting, attaching mines using polymeric resins, the development of modern extraction and enrichment methods.

Biotechnology sector is an emerging area with very high economic potential. The special strength of Kazakhstan is the development of veterinary drugs. A variety of diagnostic tests, vaccines, and drugs for use with livestock has been developed by Kazakh research institutions. More than three quarters of veterinary drugs have been produced locally. For instance, work on antibody-based diagnostic assays (ELISA) for animal pathogens is underway at the Agriculture University. Kazakhstan is also planning

[106] Organised by JSC "National Innovation Foundation" and infoDev, a global partnership program within the World Bank Group on 30 March 2012 in Almaty with an aim to increase the Kazakh market share of private investment in innovative projects. The round table was attended by heads of private commercial companies, international organizations and various businesses.

to start mass production of seasonal flu vaccines and, in case of epidemics, swine and bird flu vaccines in 2015.

The Space Programme is among the areas in which Kazakhstan can stand out. Kazakhstan has inherited an extensive space legacy from the Soviet Union. Although the Baikonur Cosmodrome, first and biggest among its kind, is located in the country, Kazakhstan can neither maintain nor develop it alone. Today, Baikonur is under a 50-year lease to Russia, and hence Kazakhstan has started building its own space centre close to Astana. Kazakhstan can benefit from the advancements in space programme by utilizing it to foster information and communication technologies, explore its natural resources and conduct environmental monitoring.

11.1.6. Unutilized and Abundant Natural Resources

The most important source of future economic growth for Kazakhstan is its high potential of rich natural resources, which not only provide the bulk of domestic demand for raw materials and oil, but also forms a large part of its foreign exchange earnings from exports.

Today, Kazakhstan uses the technologies inherited from the Soviet Union. As a result of the growing understanding of the importance of the R&D in the oil and gas industry, the government is taking some measures to revitalize innovation activity in this industry. For instance, the establishment of the Scientific-Research Institute of Geology as well as creation of a special association as part of "Samruk-Kazyna" JSC which will research mineral exploration technologies can be mentioned in this area. With these steps in place, Kazakhstan will be able to raise the innovation activity to the required level in order to ensure the sustainability of the raw materials and minerals sector.

On the other hand, despite all these measures, fuel supply issue can be solved only after the reconstruction of more national refineries. Currently the total capacity of the existing three refineries is at the level of 13.5 million tons. This will become insufficient in the long term. The work on modernization of refineries for a processing capacity increase to 16.8 billion tons, with a consequent product quality enhancement to Euro 4 and Euro 5[107], is in progress. The productive capacity growth of Kazakh refineries will make a positive influence on securing the energy sources of the country and it will reduce dependence on external market price fluctuations.

Kazakhstan has a vast territory with a large agricultural land area. Despite the severe conditions in many regions of the country, the existence of vast virgin land area offers opportunities for organic farming. Furthermore different climate zones offer an opportunity for a large variety of crops for cultivation. Being in close proximity to large markets such as Russia and China offers added benefits for sustainable agribusiness in the country. Highly competent workforce in agricultural research is strength for agriculture, but this scientific base needs to be replenished by attracting highly talented young people into the area by offering attractive incentives including scholarships. The water scarcity in the country continues to be a problem and is likely to be magnified when agricultural activity is enhanced. Finally, adequate funding should be allocated for the development and transfer of new agricultural technologies.

[107] Gasoline Production Standards.

11.2. Areas for Improvement

11.2.1. Low Domestic Demand

A major challenge for innovation policies in Kazakhstan is the weak domestic demand for innovation. In this context, one way of overcoming this obstacle is to enter foreign markets with a high demand profile for innovative products and diversify and reach new target markets other than Russia and China.

Kazakhstan so far utilized state procurement schemes and tax incentives to address this situation. However, promotion of free-market conditions and improving fair competition conditions can be more effective and less burdensome for the national government.

11.2.2. Concentration of Economy

Export of raw materials plays an important role in Kazakh economy. This sector fuelled the steady growth in the last decade and attracted large foreign investments into the country. While 60% of the total investments were made in oil and gas industry, investments in power, ferrous metallurgy and food industry constituted only about 8%. Such an unsustainable pattern of investment in fixed assets is primarily due to the quick and high return on investment in raw material sectors.

The "Kazakhstan Investment Attractiveness Survey" conducted by Ernst & Young in 2012 underlined the noteworthy progress in terms of foreign investor perception but also pointed out that underdeveloped transportation and telecommunications infrastructure along with weakness in education and training of workforce act as deterrents to foreign direct investments.

Currently, the scientific and technological developments in the priority sectors of the economy are concentrated in large state enterprises and private entities. The statistics show that 10 organizations account for the majority of the revenues and innovative activity in the oil and gas industry. This would make sense in order to set country in a direction, but there should be a flawless exit strategy. One method could be privatization of some of the state companies or breaking-up of conglomerates. Government can also take appropriate actions for establishing competitive market conditions.

Being a new entrant in free market economy, service sector is not up to the level of industrial nations. It is well-known that innovation is critically linked to the functionality of service sectors such as market research, legal and financial services. Public and private sectors do not have an adequate comprehension of the importance of science and technology institutions. These characteristics of the economy also limit the effectiveness of public policy tools.

11.2.3. Lack of Comprehensive Strategy to Develop Human Capital

Kazakhstan is becoming integrated into the global economy, with its positive and negative consequences, and therefore macro-economic policies should be designed to address the challenges of globalization, financial instability and increased competition in the international markets. The development strategy should be based on the strengthening of human capital as the main component of the innovation-driven economy.

Currently, Kazakhstan is trying to enhance its human capital in the field of science. There was a long-term downward trend in the number of specialists engaged in scientific, technical and technological

areas as these areas could not offer long-term career growth due to low wages and demographic structure of scientific community. After the independence, many prominent Russian scientists returned to Russia and remaining scientists had a high age average. Staffing statistics have recently shown an increasing trend– with 10,870 people engaged in R&D in 2010, corresponding to a 7.7% increase over 2009.

As a policy measure, raising the attractiveness of careers in science and R&D by introducing new incentives for students can increase the human capital pool. Strengthening the interaction between scientific community and the private sector, and enabling a competitive environment will increase the S&T potential of the academic institutions, and provide better avenues for implementation. Internships and temporary placement of scientists and researchers in innovative companies through government grants may induce linkages among academia and private sector. In terms of grants and loans, government should broaden the focus to include areas such as engineering and design. Additionally, availability of long-term grants for research institutions in a cost-matching scheme can increase the investment in the R&D projects by the private sector.

The lack of a significant number of people with entrepreneurial skills is a restrictive factor on bringing potentially high return ideas into the market. The shortage of managerial skills is another obstacle that innovative entrepreneurs face during the implementation phase of their ideas. With all these in mind, it would be wise to consider emphasizing entrepreneurship and management education for students.

11.2.4. Weak Tradition of Commercializing Research

The National Seminar on "Promotion of Scientific Research and Innovation for Economic Development"[108] in 2011, attended by representatives of the private sector, leading scientific/educational institutions, government agencies, and experts in commercialization and venture financing, aimed at providing the Kazakh scientists and entrepreneurs with knowledge and experience related to the mechanisms and methods of commercialization and their practical applications, as well as informing them about the opportunities for international cooperation in the commercialization and technology transfer. It was noted that the commercialization of science and competitiveness is a long-term process and the success not only requires appropriate skills and organizational procedures, but also requires the support and understanding at the highest levels of government. The Seminar also addressed issues of methodology and concepts of intellectual property management, venture capital financing and promotion of scientific research into the real economy.

Kazakhstan has inherited the old system of science and education after the collapse of Soviet Union. In that system, research is concentrated mainly in a state body, most of the R&D activities aimed at solving industry problems are carried out at the large public research centres, and large R&D institutions remain in the form of public ownership and are funded from the state budget. These factors cause certain difficulties in transforming the outputs of scientific institutions to the commercialised products to be sold in the new market environment and put a spoke in innovation wheel. Even after promising scientific results, entrepreneurs face challenges in commercializing new inventions because of the difficulties in innovation and bureaucracy within the context of patent

[108] The seminar was organised by the NATD- one of the largest national information analysis centres dealing with the problem of commercialization, and the UNESCO Regional Office in Almaty from 30 May to 1 June 2011.

application process. The government should consider simplifying all aspects of interaction, including IPR related issues, between entrepreneurs and government during market entry.

11.2.5. Lack of Feedback Mechanisms

The National Innovation System lacks the feedback mechanism to measure the impact of adopted laws and effectiveness of development institutions. Forming systemic assessment procedures will enhance the success rate for state initiatives and it will enhance the prudent use of public funds. This can be achieved through annual surveys of SMEs that analyse the effectiveness of state programmes, the reasons for lack of innovation and entrepreneurship in the private sector.

Surveys should not be only used to assess the state programmes but also to get guidance from the market. These surveys can facilitate flow of information and ideas from different regions and sectors. By integrating the outcomes of the surveys and innovation initiatives, effectiveness of private sector, in this context, can be boosted.

11.3. Recommendations

Kazakhstan has the opportunity and potential to improve its capacity to innovate and join the world leaders in innovation. To achieve this, Kazakhstan should ensure the effectiveness and coherence of all the constituent elements of the National Innovation System.

For successful implementation of these tasks, taking into account the trends in innovation in the country and the world, Kazakhstan may need to:

1) Enhance the practice of qualitative assessment of the activities of government agencies and development institutions.

2) Strengthen the role of universities and research institutions by improving their ability to transform ideas into innovative projects and focus their work on the needs of the industrial sector.

3) Increase public awareness, especially among children and youth, by initiating relevant programmes and projects such as; creation of modern exhibition halls, clubs and training centres in various fields of science and high technology, distribution of publications and materials of popular science books.

4) Focus on creating an environment conducive to the emergence of new enterprises.

5) Establish appropriate mechanisms for monitoring and evaluating performance of innovation programs and policies and take into account the results of such evaluations in the process of identifying new initiatives and implementation of corrective measures.

6) Review the basic definitions regarding innovation development in order to achieve a common understanding among all stakeholders of innovation that will further enhance confidence in national innovation statistics.

7) Maintain its increasing investments in information and communication technologies sector, particularly with a focus on human resources and entrepreneurship development programmes. In this respect, the Government of Kazakhstan should increase its support for the sector by opening new incubation centres equipped with support facilities for products and services marketing.

8) Increase awareness and utilization among the Kazakh scientists of super-computing facilities within the country and organise capacity building programmes in this field (also oriented towards graduate-level students) in cooperation with other OIC member countries with supercomputing and grid technology capabilities.

9) Support awareness and outreach programs on mechatronics and include the development of micro-, meso-, nano-and bio-mechatronic systems which interface with and control physical, chemical, biological and neurological processes in the current mechatronics curricula in Kazakh universities.

10) Adopt a comprehensive policy in the field of power generation which also encompasses the integration of conventional and renewable technologies such as coal-solar based power generation so as to assure higher efficiencies in power generation with lower costs and achieve lower levels of carbon dioxide emissions.

11) Increase the number of mine/ore processing plants and mills to meet the demand of the natural resources market and develop strategies to sustain the viability of the sector in times of uncertainty.

12) Increase the number of transcriptomics service sites which provide planning guidance, analysis, and training to Kazakh scientists. In the case of establishing more than one transcriptome service sites, each service site should be primarily dedicated to a particular research model to have the most significant impact in application of transcriptome technologies.

13) Identify translational applications of nanotechnology developed in Kazakhstan to other scientific fields; such as medicine and environmental sciences.

14) Develop its national software operating system and infrastructure for electronic and programming components to be used in military systems. In this context to establish a cyber-security task force to coordinate the counter cyber-attack programmes aiming to protect the strategic technological units ranging from civil aviation to power plants.

16) Increase the international competitiveness of the pharmaceutical industry by providing long-term incentives to Kazakh producers to allocate more resources to R&D.

Ensuring free market economy with a dynamic innovation capacity requires not only sound government policies and tools but also private sector initiatives. Being a young market economy, Kazakhstan has strong potential and should give special attention to effective partnership between public and private sector for generating an environment conducive to a functional knowledge-based economy.

APPENDIX 1

Sectorial Structure of GDP for Kazakhstan, 2009 vs. 2010

Sectors	2009	2010
Agriculture and Fishery	5.9%	4.4%
Mining Industry	17.4%	18.7%
Manufacturing Industry	9.6%	11.5%
Production and Distribution of the Electric Power, Gas and Water	2.0%	2.1%
Construction	9.1%	7.5%
Retail Trade	11.9%	13.2%
Transport	8.2%	7.5%
Hotel and Restaurant Business	0.8%	0.8%
Communication	3.3%	2.4%
Financial Sector	7.3%	6.2%
Real Estate	8.7%	8.6%
Professional, Scientific and Technological Activities	4.1%	3.9%
Government, Armed forces, Social services	2.0%	1.9%
Education	3.2%	3.1%
Health Care Services	1.7%	1.7%
Municipal, Social and Other Services	3.4%	3.5%
Other	1.4%	3.0%

Statistics on Science, Technology and Innovation

Table A.1. Total R&D Personnel, 2003-2010

Year	Total R&D Personnel	Researchers		Technicians		Support Staff		Others	
		Number	%	Number	%	Number	%	Number	%
2003	16,578	9,899	59.7	1,300	7.8	3,018	18.2	2,361	14.2
2004	16,715	10,382	62.1	1,102	6.6	3,112	18.6	2,119	12.7
2005	18,912	11,910	63.0	1,270	6.7	3,133	16.6	2,599	13.7
2006	19,563	12,404	63.4	1,281	6.5	3,214	16.4	2,664	13.6
2007	17,774	11,524	64.8	1,290	7.3	2,824	15.9	2,136	12.0
2008	16,304	10,780	66.1	1,166	7.2	2,349	14.4	2,009	12.3
2009	15,793	10,095	63.9	1,151	7.3	2,366	15.0	2,181	13.8
2010	17,021	10,870	63.9	1,078	6.3	2,754	16.2	2,319	13.6

Source: Agency of Statistics of Republic of Kazakhstan

Table A.2. Number of Organizations Engaged in R&D Activities, 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
TOTAL	**257**	**259**	**267**	**273**	**295**	**390**	**437**	**438**	**421**	**414**	**424**
Research Institutions	144	180	178	176	148	176	185	170	148	118	133
Design and Technology Organizations	15	18	19	11	23	25	31	26	30	46	26
Universities	43	40	42	45	83	113	123	133	126	114	121
Industrial Enterprises	5	4	5	12	5	7	10	11	11	13	11
Others	50	17	23	29	36	69	88	98	106	123	133

Source: Agency of Statistics of Republic of Kazakhstan

Table A.3. GERD by Source of Funds (%), 2006-2010

SOURCE	2006	2007	2008	2009	2010
Public budget	56.0	49.8	42.4	41.3	59.0
Local authorities' budget	1.1	1.1	1.1	1.3	1.2
Own capitals	14.1	18.0	22.5	17.0	22.4
Ordering parties	27.2	29.3	32.9	38.6	16.5
Foreign investments	1.0	1.7	1.0	1.0	0.6

Source: Agency of Statistics of Republic of Kazakhstan

Table A.4. Internal Current Expenses for Scientific and Technical Works by Areas of Science (million KZT)

	2004	2005	2006	2007	2008	2009	2010	2011
Total Current Domestic Expenditures	**13,863**	**20,036**	**23,236**	**25,738**	**33,686**	**38,538**	**40,415**	**44,513**
Natural	3,405	4,924	6,193	5,917	9,333	10,487	12,076	14,278
Technical	7,317	10,958	11,639	13,644	17,626	19,302	20,535	21,193
Medical	889	1,276	1,536	1,692	1,939	2,391	1,772	2,266
Agriculture	1,302	1,648	2,567	2,370	2,620	3,564	3,789	3,592
Public	583	768	711	1,209	1,360	1,175	1,015	1,343
Humanitarian	368	463	590	907	807	1,618	1,229	1,841

Source: Agency of Statistics of Republic of Kazakhstan

Table A.5. Internal Current Expenses for Scientific and Technical Works by Type (million KZT)

	2004	2005	2006	2007	2008	2009	2010	2011
Total Current Domestic Expenditures	**13,863**	**20,036**	**23,236**	**25,738**	**33,686**	**38,538**	**40,415**	**44,513**
Fundamental Researchs	2,810	3,090	3,744	3,468	3,847	4,108	4,490	7,476
Applied Researchs	3,207	7,249	9,354	9,692	13,320	17,374	18,088	20,864
R&D	7,846	9,697	7,944	5,455	6,705	6,009	9,536	9,867
Science-Technical Services	...	...	2,193	7,122	9,814	7,600	8,300	6,306
Other Works (Services)	...	...	...	...	...	3,448	...	...

Source: Agency of Statistics of Republic of Kazakhstan

Table A.6 Innovational Activity of Enterprises- Number of Respondents

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Republic of Kazakhstan	**7,212**	**8,022**	**10,392**	**10,591**	**10,889**	**11,172**	**10,096**	**10,937**	**10,723**
Akmola	468	466	542	555	575	579	589	764	728
Aktobe	54	308	368	384	430	442	397	440	436
Almaty	82	578	673	699	763	752	695	750	610
Atyrau	247	204	300	282	296	328	276	245	212
East-Kazakhstan	1,083	714	892	920	989	954	800	932	868
Zhambyl	92	328	332	351	363	385	320	400	401
West-Kazahstan	208	248	312	329	246	265	267	195	205
Karaganda	980	715	934	894	981	986	908	963	982
Kostanay	223	429	552	574	652	643	600	653	645
Kyzylorda	76	225	245	255	252	270	275	278	274
Mangistau	227	179	402	402	517	515	440	466	457
Pavlodar	428	675	581	541	542	530	500	514	515
North-Kazahstan	238	351	430	389	410	404	378	449	460
South-Kazakhstan	1,249	592	684	688	690	694	687	727	733
Astana city	196	264	725	717	732	833	705	695	707
Almaty city	1,361	1,746	2,420	2,611	2,451	2,592	2,259	2,466	2,490

Table A.7 Number of Innovationally Active Enterprises

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Republic of Kazakhstan	**148**	**184**	**352**	**505**	**526**	**447**	**399**	**467**	**614**
Akmola	3	1	8	12	12	7	7	5	7
Aktobe	4	10	17	23	24	18	16	27	37
Almaty	4	10	15	20	16	14	10	7	28
Atyrau	-	1	3	22	11	9	8	9	14
East-Kazakhstan	16	20	37	63	55	41	47	60	70
Zhambyl	5	9	19	23	32	23	14	31	41
West-Kazahstan	6	5	7	7	12	13	12	9	26
Karaganda	16	30	42	57	60	64	56	67	71
Kostanay	14	5	8	11	16	13	9	17	31
Kyzylorda	-	3	3	6	6	8	4	17	22
Mangistau	5	8	10	13	12	10	6	5	5
Pavlodar	10	23	16	39	44	19	19	26	28
North-Kazahstan	4	5	8	8	9	10	10	11	11
South-Kazakhstan	9	8	16	17	19	17	15	25	51
Astana city	-	1	11	20	22	15	15	18	29
Almaty city	52	45	132	164	176	166	151	133	143

Table A.8 Activeness level in Innovations, %

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Republic of Kazakhstan	**2.1**	**2.3**	**3.4**	**4.8**	**4.8**	**4**	**4**	**4.3**	**5.7**
Akmola	0.6	0.2	1.5	2.2	2.1	1.2	1.2	0.7	1
Aktobe	7.4	3.2	4.6	6	5.6	4.1	4	6.1	8.5
Almaty	4.9	1.7	2.2	2.9	2.1	1.9	1.4	0.9	4.6
Atyrau	-	0.5	1	7.8	3.7	2.7	2.9	3.7	6.6
East-Kazakhstan	1.5	2.8	4.1	6.8	5.6	4.3	5.9	6.4	8.1
Zhambyl	5.4	2.7	5.7	6.6	8.8	6	4.4	7.8	10.2
West-Kazahstan	2.9	2	2.2	2.1	4.9	4.9	4.5	4.6	12.7
Karaganda	1.6	4.2	4.5	6.4	6.1	6.5	6.2	7	7.2
Kostanay	6.3	1.2	1.4	1.9	2.5	2	1.5	2.6	4.8
Kyzylorda	-	1.3	1.2	2.4	2.4	3	1.5	6.1	8
Mangistau	2.2	4.5	2.5	3.2	2.3	1.9	1.4	1.1	1.1
Pavlodar	2.3	3.4	2.8	7.2	8.1	3.6	3.8	5.1	5.4
North-Kazahstan	1.7	1.4	1.9	2.1	2.2	2.5	2.6	2.4	2.4
South-Kazakhstan	0.7	1.4	2.3	2.5	2.8	2.4	2.2	3.4	7
Astana city	-	0.4	1.5	2.8	3	1.8	2.1	2.6	4.1
Almaty city	3.8	2.6	5.5	6.3	7.2	6.4	6.7	5.4	5.7

APPENDIX 2

LIST of INTERVIEWEES

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APPENDIX 3

LIST of ABBREVIATIONS

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
CASEF	Central Asia Small Enterprise Fund
CETT	Centre for Engineering and Technology Transfer
CICA	Conference on Interaction and Confidence-Building Measures in Asia
CIS	Commonwealth of Independent States
COMCEC	Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation
CPS	Country Partnership Strategy
DAMU	Entrepreneurship Development Fund
DBK	Development Bank of Kazakhstan
DCI	Development Cooperation Instrument
DKU	Kazakh-German University
EAPATIS	Eurasian Patent Information System
EBRD	European Bank of Reconstruction and Development
EBRD	European Bank for Reconstruction and Development
ECTS	European Credit Transfer System
EDI	The Education For All Development Index
EKSTU	East Kazakhstan State Technical University
EU	European Union
FDI	Foreign Direct Investment
FTTH	Fibre-To-The-Home
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GIZ, formerly GTZ	German Society for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit)
GRP	Gross Regional Product
HSTC	The Higher Scientific and Technical Committee (under the Government of The Republic of Kazakhstan)
IBRD	International Bank for Reconstruction and Development
ICAO	International Civil Aviation Organization
ICSTI	International Centre for Scientific and Technical Information
ICT	Information and Communication Technologies
IDB	Islamic Development Bank
IFAS	International Fund for Saving Aral Sea
IIC	International Innovative Club
INCO-NET EECA	International Cooperation Network for Eastern European and Central Asian Countries
IPR	Intellectual Property Rights
IPSTDC	The Interdisciplinary Plan of Scientific and Technological Development Of The Country
IDB	The Islamic Development Bank

ISESCO	Islamic Educational, Scientific and Cultural Organization
ISTC	International Science and Technology Centre
JICA	Japan International Cooperation Agency
JICA	Japanese International Cooperation Agency
JSC	Joint-Stock Company
KAZNU	Kazakh National University
KBTU	Kazakh-British Technical University
KIMEP	Kazakhstan Institute of Management, Economics and Strategic Research
KNTU	Kazakh National Technical University
KZT	Kazakh Tenge
MES	Ministry of Education And Science
MINT	Ministry of Industry And New Technologies
MoU	Memorandum of Understanding
NC-STI	National Centre for Scientific and Technical Information
NATD	National Agency for Technological Development (former National Innovation Fund (NIF))
NIS	National Innovation System
NREL	National Laboratory of Renewed Energy Sources
NU	Nazarbayev University
OECD	Organization for Economic Cooperation and Development
OIC	Organization of Islamic Cooperation
OSCE	Organization for Security and Cooperation in Europe
PCA	Partnership and Cooperation Agreement
PPP	Public Private Partnership
PPP	Purchasing Power Parity
RES	Renewable Energy Sources
RTTN	Russian Technology Transfer Network
SEC	Social-Entrepreneurial Cooperation
SESRIC	Statistical, Economic, Social Research and Training Centre for Islamic Countries
SEZ	Special Economic Zone
SPAIID	State Program of Accelerated Industrial-Innovation Development
STI	Science Technology and Innovation
STP	Science and Technology Parks
TCP	The Technology Commercializing Project
TEMPUS	Trans-European Mobility Programme for University Studies
TVET-UK	Technical Vocation Education and Training
UES	Unified Electrical System
UNECE	United Nationals Economic Commission for Europe
UNT	Unified National Test
WE-WC	Western-Europe-Western China
WIF	World Innovation Foundation
WTO	World Trade Organization

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