Advancing Development in Kazakhstan: The Contribution of Research and Development

Dinmukhammed Shaikin and Richard J. Estes

Kazakhstan is a country in Central Asia with a population of more than 18.6 million people as of 2017. Indeed, it is the region's largest country and is fortunate in having an abundance of both natural and human capital resources. Until December 1991 Kazakhstan was a republic of the former Soviet Union and therefore all planning for its development was centralized outside of the country rather than in its own capital. With independence, the situation in Kazakhstan has changed dramatically. Under new popularly elected leadership, the country has committed itself to achieving a level of social, political, economic, and technological development comparable to that which exists in most mid-sized economically advanced Western countries. The major vehicle for bringing about this transformation is a series of carefully constructed scenarios whose implementation is based on extensive public-private investment and partnerships in research and development. This article will discuss two scenarios currently underway that have as their shared goal the advancement of Kazakhstan's socioeconomic development through an emphasis on human resource development and carefully focused programs of technological innovation.

Key words: *Central Asia, development, Kazakhstan, research and development scenarios*

The rapid advancement of all societies depends on strategic investments in research and development (R&D) for both scientific and technological development and advancement of the quality of life of their people (Miller & Morris, 1999). According to Pisano (2012), such investments may involve the application of already established technologies (secondary R&D) or the creation of entirely new technologies and areas of scientific inquiry (primary R&D). Although these

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innovations primarily involve "hard" or physical science (Anderson, 2000), they may also involve the social sector, such as new types of political, economic, or familial systems (Sherwin, 2016).

Most societies invest in both types of innovations, especially societies that are undergoing dramatic restructuring (Organisation for Economic Co-operation and Development [OECD], 2016). Such investments have proven to be especially essential to the newly independent countries of the former Soviet Union whose economies have shifted from being centrally planned to become more open and globally focused market systems (Investopedia, 2016). The goal in every case has been to advance the human technological capacity of these countries so that they can compete more successfully in highly competitive global markets. Economic diversity, involving multiple sectors of collective life, has proven especially effective in advancing the global competitiveness of developing post-Socialist societies (Graham & Werman, 2017; Lipovsky, 2016).

Kazakhstan, a former republic of the former Union of Soviet Socialist Republics, is one such developing post-Socialist nation and its approach to introducing R&D is the primary subject of this article (Hiro, 2009; Marvin, 2016; Wight, 2015; World Bank, 2016a). This article will begin by briefly introducing readers to the history of the Republic of Kazakhstan since regaining its independence in December 1991 (Golden, 2011; Lipovsky, 2016). Next, the most important natural and human capital resources available to Kazakhstan to promote its social, political, and economic development will be identified, and a special set of social and economic indicators that are essential for advancing R&D in this country will be introduced. The critical contributions made by R&D in accelerating the pace of Kazakhstani social and economic development will be identified, along with the pathways for accelerating the pace of Kazakhstan's development over the near term (Socor, Weitz, & Witt., 2016).

Modern Geographic and Ethnic Structure of Kazakhstan

The Republic of Kazakhstan is a fully independent nation-state located in Central Asia. A landlocked country, Kazakhstan shares borders with China, Kyrgyzstan, Russia, Turkmenistan, and Uzbekistan. Along with other Central Asian nations, Kazakhstan shares access to the Caspian Sea, the world's largest inland body of saltwater, consisting of more than 134,000 square miles of surface area (371,000 km^2).

As reflected in figure 1, the country's landmass is substantial (2,724,900 sq. km); Kazakhstan is the ninth largest country by landmass in the world. The country's population in 2017 numbered 18.6 million people, the most populous of Central Asian nations. As of 2009, Kazakhstan's ethnic mix consists of Kazakhs or Qazaqs (63.1%), Russians (23.7%), Uzbeks (2.9%), Ukrainians (2.1%), Uighurs (1.4%), Tatars (1.3%), Germans (1.1%) , and others (4.4%) (Central Intelligence Agency [CIA], 2017). Also as of 2009, the country's religious mix was diverse as well: Muslim (70.2%), Christian (mainly Russian Orthodox; 26.2%), atheist

Figure 1 Map of the Republic of Kazakhstan (CIA, 2016. Reprinted with permission.)

(2.8%), unspecified (0.5%), and other (0.2%). As of 2015, approximately 40.3 percent of Kazakhstan's population was younger than twenty-five years, a demographic pattern that characterizes most Central Asian post-Socialist countries and indeed most developing countries ("Youth population trends and sustainable development," 2015).

Kazakhstan's Natural and Human Capital Resource Base

The availability of natural and human capital resources is essential to a country's development. Kazakhstan is particularly advantaged in having a rich array of both (Witte, 2016; World Bank, 2016b). All of these resources are being used to accelerate the pace of the country's social and economic development as well as to build a strong network of economic partnerships with other nations in the Central Asian region and with other countries worldwide (Legvolf, 2003; World Bank, 2012).

Kazakhstan's Economy

Kazakhstan's economy totaled US$430 billion (purchasing power parity [PPP]) in 2016. The country's per capita income in 2016 averaged US$24,300 (PPP) and, like the global economy in general, is expanding at a modest rate of approximately 1.2 percent annually. However, the rate of economic expansion ranged from a high of 6.0 percent in 2013 to its current low of 3.5 to 4.1 percent for 2017 and the first quarter of 2018 ("Kazakhstan's annual GDP growth rate 1995–2018," 2018). Declining prices in the energy sector, the major driver of the country's economic expansion, are reflected in the lower economic growth rates between 2013

and 2016. Slow growth is also pushing the country's political and economic leaders to increase levels of investment in R&D in all sectors of the economy. Other major components of the country's economy are associated with its very rich natural resources, especially petroleum and petroleum-related by-products including natural gas (Witte, 2016). The country's major export trading partners in 2016 were Italy (20.3%), China (11.5%), Russia (9.5%), Netherlands (8.9%), Switzerland (7.3%), and France (4.9%). In total, the country's exports totaled an estimated US$44.1 billion in 2017 as opposed to an estimated US$37.3 billion in 2016 (CIA, 2017).

Kazakhstan's Natural Resources

Kazakhstan's natural resources are substantial and highly diversified. Along with its vast stores of petroleum and natural gas reserves, Kazakhstan's major industries include the production of manganese, chromites, lead, zinc, copper, titanium, bauxite, gold, silver, phosphates, sulfur, uranium, iron, and steel (Open Energy Information, 2016; Vigar, 2015), all of which add to the country's foreign exchange reserves of US$30,541 million as of October 2016 ("Kazakhstan's foreign exchange reserves 1993–2018," 2018). These sectors contribute substantially to the country's national economy and thus are the sectors receiving the highest levels of R&D investment. The expectation is that, along with Kazakhstan's energy economy, each of these sectors will continue to increase in importance as the country's five-year national development strategy unfolds (U.S. Department of State, 2013).

Kazakhstan's Human Capital Resources

The exact number of Kazakhstan's full-time researchers and technicians, including those engaged in R&D, is not known with any degree of precision. Their numbers are expected to be substantial, however, especially in the country's multifaceted energy and public enterprises. Many R&D specialists are also working in Kazakhstan's state-centered health industry as well as in its large network of primary and secondary schools and more than 150 state-supported universities and other types of institutions of higher education (Silk Project, 2009).Typically, however, R&D activities are just a part of the job responsibilities of most research scientists, a reality that makes the number of researchers engaged in R&D on a full-time basis even more difficult to measure.

Kazakhstan's General Human Resource R&D Profile

Readers are referred to data collected by the United Nations Educational, Scientific, and Cultural Organization (UNESCO; 2016), which reports R&D personnel data for most nations of the world. These data typically cover the period from 1996 to 2015 and offer a general picture of the R&D profile in Kazakhstan in comparison to other countries of the world.

National Estimates of Kazakhstani R&D Personnel

Official reports prepared by the Kazakhstani government offer more precise estimates of the number of R&D personnel working across the country's major economic sectors from 2013 to 2015. Table 1, for example, summarizes these data by percentage distribution between specialist/researcher and technical personnel. As reflected in these data, the number of Kazakhstani researchers in 2015 rose to 24,735, a 4.3-percent increase since 2013.This increase occurred in all categories of researchers: a 7.3-percent increase for the specialists/researchers (to 18,454) and a 3.0-percent increase (to 3,692) for technical personnel (R&D maintenance staff).The number of R&D workers per one hundred thousand people in 2015 was 141.0, an increase of at least 1.8 percent compared to 2013. The percentage of R&D workers had the same development tendency (Table 2). Thus, the percentage of specialists-researchers in 2015 was 74.6 percent, up 2.1 percent from 2013.

The number of the Kazakhstani researchers with scientific degrees in different sectors of economic activity also shows a positive development tendency (see Table 3). In 2015, the number of R&D workers with scientific degrees was 7,920, which represents an increase of 7.4 percent compared to 2013.

Future R&D Personnel Enrolled in Kazakhstani Universities

Kazakhstan recognizes the importance of continuous investments in educating future generations of R&D personnel. Indeed, the nation allocates a substantial share of its total resources to more than one hundred universities and institutions of high education. Consistent with the nation's strategic goals and the scenarios

Table 1 Types and distribution of Kazakhstani R&D workers, 2013–2015 (Aydapkelov, 2016)

Base year	Population of Kazakhstan (000)	No. of R&D workers	No. of R&D workers by specialty: Specialists/ researchers	Technical personnel (maintenance staff)	Others	No. of R&D workers per 100,000 people
2013	17,035.40	23,712	17,195	3,586	2,931	139.2
2014	17,289.25	25,793	18,930	3,882	2,981	149.2
2015	17,544.15	24,735	18,454	3,692	2,589	141.0

Table 2 Job classifications of R&D workers in Kazakhstan, 2013–2015 (Aydapkelov, 2016)

	Percentage of R&D workers by job classification: Specialists/ researchers	Technical personnel (maintenance staff)	Others
2013	72.5	15.1	12.4
2014	73.4	15.1	11.6
2015	74.6	14.9	10.5

Table 3 Distribution of Kazakhstani University students by area of specialization, 2013–2015

	Number of R&D workers with scientific degrees by economic sector				
Year	Public	Business	Higher education	Noncommercial	Total (all sectors)
2013	1,484	674	4,847	366	7,371
2014	2,185	852	4,813	430	8,280
2015	1,903	766	4,701	550	7.920

Sources: Aydapkelov, 2016; "Kazakhstan—Number of technicians in R&D," 2013.

summarized in this article, a very large percentage of these students have declared majors in physics, chemistry, mathematics, and other specializations that contribute directly to R&D research staffing (Silk Project, 2009). Such a larger number of potential workers in the R&D sector adds further strength to the country's efforts to enhance the overall level of socioeconomic development and global competitiveness.

Kazakhstan's R&D Investments

The R&D data for Kazakhstan's private sector throughout the article should be regarded as estimates only until more rigorous accounting systems are developed for both the public and private sectors over the near term ("Kazakhstan's annual GDP growth rate 1995–2018," 2018; UNESCO, 2016). The data presented in Table 4 pertain to selected aspects of public and private expenditures on R&D in 2015. Mostly likely, these figures underestimate actual expenditures on R&D, but they are nonetheless suggestive of the general pattern of investment in inventions and technological innovations (UNESCO, 2016). Additional data confirming Kazakhstan's educational and training investments in R&D are reported in detail in the annual statistical reports prepared by UNESCO (2016).

Table 4 R&D expenditures by sector of performance and source of funds in Kazakhstan, 2015

R&D expenditures			Sources of funds	
Amount (million tenge)	Share (%)	Sector	Amount (million tenge)	Share (%)
20,325.8	29.3	Government	42,572.7	61.4
7,701.3	11.1	Private nonprofit	1,817.8	2.6
13,485.0	19.5	Higher education	887.0	1.3
27,790.9	40.1	Business enterprise	20,798.3	30.0
-	-	Foreign investments	1,254.7	1.8
-	-	Other	1,972.6	2.9
69,303.0	100.0	Total	69,303.0	100.0

Kazakhstan's R&D Outcomes Since Achieving Independence

In the main, Kazakhstan has been an adopter of technological innovations developed outside the country. Since regaining its independence, however, Kazakhstan has developed its own emerging R&D culture. Today, Kazakhstan ranks third among the Commonwealth of Independent States (CIS) in inventions ("Kazakhstan is third in CIS by inventions," 2011):

> The Institute (NIIP) received 32,857 applications between 1992 and 2010. 28,000 applications were made by Kazakhstan residents. Other applications were registered by foreign companies to patent their products at the territory of Kazakhstan. 26,370 inventions have been patented between 1993 and 2010.
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> Most of the inventions are associated with satisfying human life necessities. Agriculture, medicine, veterinary science, [and] food are . . . [at the top] of the list. Chemical and metallurgical industry are . . . [in] second place by the number of issued patents. For example, many countries use environment friendly technology in processing of concentrated lead-zinc products invented in Kazakhstan. Various technological processes are at the third place. Construction and mining engineering, mechanical science, lighting and heating systems, physics, [and] electricity inventions follow them.
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> Inventions associated with ways of cooking of different national food products include kurt (a dried roll from curd and salt), kumys (mare's milk), shubat (camel's milk), tary (millet cooked with molten butter), zhent (sweetened millet) and so on are being actively patented now. Earlier Kazakhs prepared kumys by hand. At present inventors suggest power-operated devices to mix kumys. These devices make the process easier and cut production time. The way of cooking of a dry shubat has also been patented. In the process of recombination yellow and white powder with sour taste preserves its natural nutrition properties.

Positive Outcomes Associated with R&D

Since regaining its independence in 1991, Kazakhstan's pace of national development has been rapid and has affected virtually all aspects of the country's collective life. Important reforms, for example, resulted in Kazakhstan's emergence as a democratic society with a strong and diversified open market economic system. Kazakhstan also joined the United Nations as a fully autonomous member and is among the leadership countries of the CIS and other regional associations. Additionally, Kazakhstan is a contributor member of the community of nations that is helping poorer nations of Central Asia, as well as Afghanistan and the Caucasus, to speed up the pace of their development (Golden, 2011). Kazakhstan is a major provider of international technical assistance and has steadily increased its purchase of goods and services from less affluent members of the CIS. These activities are considered essential to attaining Kazakhstan's strategic goals as laid out by the nation's parliament (Orazgaliyeva, 2014).

Much of Kazakhstan's rapid development is associated with its adoption of new technologies that support its highly competitive energy system. Major national investments in health care, educational reforms, arts and culture, human services, and the country's newly emerging not for profit sector are also helping to stabilize the country's rapid development into a fully modern nation state. These important societal achievements are being realized while Kazakhstan is adhering to its highly diverse and traditional multiethnic values and norms (Aitken, 2012).

Investments in at least moderate levels of R&D are major drivers of Kazakhstan's increasing development and are intended to enhance the country's comprehensive growth and global competitiveness, including its sparsely populated rural areas. Increasingly, the country is expected to shift from its historic role as an adopter of technological innovations developed by others to a nation that is providing leadership in the creation of innovations that work to its own benefit and that of other nations in Central Asia (Graham & Werman, 2017; Hiro, 2009; Lipovsky, 2016). Given the development priorities identified by the country's national leadership, every reason exists to believe that this level of technological leadership will continue to prevail in Kazakhstan (Witt, 2012; World Bank, 2016b).

Pathways for Accelerating Kazakhstani Development over the Near Term

Although it is developing rapidly across a wide range of sectors, Kazakhstan is still at an early stage of R&D investment (World Bank, 2016c). Many of the resources allocated for this purpose are dedicated to the discovery and processing of its energy reserves; comparatively lower but still substantial investments are being made in other market sectors (Rashkin, 2007). However, turbulence in global energy markets makes it clear that investing in a single industry is not sufficient to sustain the country's comprehensive economic growth over the long term (Mahroum & al-Saleh, 2016). It is expected that the dramatic uncertainties and market fluctuations in the value of energy will continue at least over the near term ("Crude oil price forecast," 2017); thus, Kazakhstani economic growth levels are expected to rise and fall in response to broader market forces. As a result, more diversified R&D approaches to a wider range of economic and technological sectors will be needed to offset the current and inevitable future declines in the energy sector. Several approaches for dealing with these new challenges are suggested below (Legvolf, 2003).

A more robust strategic approach to planning and national development is needed at this point in the country's history. At a minimum, public strategic planning for both the short and long term involves the following elements:

- Identifying strategic priorities and goals
- Allocating sufficient human and capital resources to the pursuit of these priorities and goals
- Initiating specific programs and other activities that support each of the country's identified priorities and goals

- Developing continuous monitoring mechanisms to ensure that the designated activities have been implemented efficiently and effectively
- Modifying all aspects of the continuous monitoring mechanisms as necessary to ensure that the designated strategic goals and objectives are being achieved consistent with the plan

As Kazakhstan continues to move forward, there is a broad range of strategic pathways that it can follow. For purposes of this article, these pathways will be referred to as *scenarios*, defined as postulated sequences or series of events that are to be achieved during discrete time periods. Three scenarios have been selected as most practical for the short term:

1. Scenario 1: Staying the Course (2017–2025)
2. Scenario 2: Accelerating the Pace of National Development (2026–2040)
3. Scenario 3: Dramatically Accelerating the Pace of National Development (2041–2060)

Strategic Scenario Frameworks

The discussion that follows details two scenarios, Scenario 1 (2017–2025) and Scenario 2 (2026–2040), whose central purposes are to strengthen the R&D goals of Kazakhstan. As in the past, both scenarios depend on financing from oil revenues received and budgeted by the country's government across a broad range of sectors.

Scenario 1. Staying the Course (2017–2025)

Research and development activities in Kazakhstan have been financed primarily by state-funded economic sectors, especially those associated with the petrochemical sector and related activities. These and other investments have been directed at accelerating the pace of the country's overall development during a period of declining petrodollars. Among the strategic goals of conducting rigorous scientific and technical policy, the primary goal has been the pursuit of innovative leadership that is directly linked to the entry of Kazakhstan into the top thirty countries in the world's R&D industry. The development of young scientists and a large pool of technicians to support their activities is a central feature of this policy that is designed to advance the country's objective and subjective level of living.

Strategic goals

The goals of the first strategic plan are those articulated by President Nursultan Nazarbayev. Strategic investments in the R&D sector are central to the plan, with a target of 3.0 percent of GDP expenditures by 2050 (compared to Kazakhstan's current very low expenditure level of approximately 0.17% on R&D). The plan identifies various milestones for realizing the ultimate commit-

ment and at the same time identifies a broad range of supportive activities needed to make efficient use of the eventual target expenditure level.

Strategic initiatives

The government's program of R&D development during Scenario 1 (2017–2025) emphasizes the implementation of considerable innovative activity in the sciences that, in turn, is expected to stimulate the development of more aggressive investment patterns in the country's extensive network of private businesses and industries. A central goal in this commitment is to reduce the gap in level of adaptability and innovation vis-à-vis the technologically rich and high-income countries of the OECD. These supportive outcomes include (a) encouraging technology transfer and localization of high-tech industries in priority sectors, (b) providing substantially increased financial incentives to increase the demand for innovation, and (c) improving the technological and managerial skills of the country's largest and most complex industrial enterprises. If successful, as an outcome of Scenario 1, increased expenditures are expected to achieve the following results:

- To increase the share of R&D investments in 20 percent of Kazakhstan's most innovative enterprises (in accordance with the OECD methodology [OECD, 2015])
- To increase the share of innovative products to 2.5 percent of the total gross domestic product (GDP)
- To improve the country's standard of life and well-being
- To substantially increase the share of intramural R&D expenditures as a percentage of the GDP

Investments in the human capital resource base

Substantial increases in the scientific and technical human capital resource base of Kazakhstan's scientists working in R&D settings are also a major commitment for the country. National investments in the work of young and emerging scientists engaged in R&D will be particularly emphasized. Public expenditures in human capital development during Scenario 1 will focus on (a) the most promising sectors of the national economy, (b) education of increasingly larger numbers of R&D workers employed by companies in targeted sectors, and (c) strategic investments in the types of research that will receive direct subsidies from the central government. Fiscally, public investments in R&D will decrease steadily from 20.4 billion tenge in 2015 to 18 billion tenge by 2019. (In 2017, 1,000 tenge was equal to US$3.15; 1,000,000 tenge was equal to US$3,150.) State-sponsored R&D expenditure levels will be very likely to increase to even higher levels should major shifts occur in the revenues collected by the country's national treasury.

Although public monetary allocations for R&D will decrease, there will be deficits in terms of human resources:

- Lack of staff with technical and engineering skills and specialties obtained through technical and professional education
- Lack of scientific personnel for technical, engineering, and innovation management
- Lack of compatibility between professional standards and educational standards
- Lack of English language proficiency in engineering and technical personnel

These issues will be targeted for improvement in Scenario 1.

Monitoring progress

During the implementation of the State Program of Industrial-Innovative Development of Kazakhstan for 2015–2019, funding covered a wide range of industries, which led to a shortage of funds and underfinancing of sectored support measures and parts of some projects. However, insufficient funding was largely due to the undeveloped domestic market financial infrastructure where secure resources would be formed, attracting long-term investments.

In the absence of adequate financing from commercial financial institutions, this niche market of Kazakhstan had to rely on a system of national holdings and development institutions. This system was expanded and adjusted to meet the needs of industrial and innovative development. Various instruments of support for industrial development were tested, including interest rate subsidies, reimbursement of expenses, grants for innovation and technology implementation, and loan guarantees.

The key barriers to development in Kazakhstan continue to be the high loan burden on existing manufacturing enterprises and the absence of available liquid assets for debt financing, resulting in (1) lack of access to financial resources for the formation of share capital, (2) lack of access to long-term loans, and (3) the high cost of credit.

Because of the reforms after the implementation of the State Program of Accelerated Industrial-Innovative Development, the share of innovation-friendly enterprises increased from 4.0 to 7.6 percent, a threefold increase in business expenditure on technological innovation (from 113.5 to 326 billion tenge). Similarly, there was a threefold increase in the volume of innovative products (from 111.5 to 379 billion tenge). For the innovation factor of the Global Competitiveness Index of the World Economic Forum in 2017, Kazakhstan improved its ranking by eighteen positions, moving into eighty-fourth place; for the technological readiness factor, it improved its ranking by twenty-five positions, moving into fifty-seventh place.

There continue to be six key barriers to innovation in Kazakhstan:

1. Insufficient stimulation of advanced technology transfer
2. Ineffectiveness of mechanisms to prioritize and solve technological problems of enterprises and businesses

3. Low level of business response to technological innovation
4. Lack of technical and managerial skills
5. Lack of development of innovative technologies in the educational system
6. Inadequate systems for monitoring the implementation of innovative projects

All these challenges to Kazakhstan's development must be resolved if the country's strategic national plans are to move forward. The following sections discuss each of these roadblocks to development more fully, especially as they relate to innovations associated with increased R&D.

Organizational issues

One organizational issue is that the R&D enterprises in Kazakhstan must follow European OECD standards for implementation of policies in the scientific sphere (OECD, 2015). It is very important that R&D enterprises and controlling authorities adhere to the essence and definition of the term *R&D* in the Frascati manual, not only for internal and external R&D expenditures, but also in the development of public policies in other sectors that impact private and public investments in R&D. The problem here lies mainly in the separation of any scientific activity from R&D in accordance with the Frascati guidelines. Thus, the issue is scientific novelty: innovations and new knowledge obtained because of R&D. In foreign countries, this issue is considered by the research/scientific fund or agency, attracting scientists in relevant fields as juries and experts.

R&D actors

A broad range of economic actors will be involved in the implementation of the strategic scenarios discussed below: government, businesses, not for profit organizations, international development assistance organizations, and consumers (individuals, families, and extended kinship systems). The plans are organized to benefit from the experiences of other countries and economic associations of countries in promoting their own R&D activities. The contributions of scholars and distinguished scientists are also expected to figure prominently in the framing of these plans.

Business and Nonprofit Sector. Each year, the state statistics bodies organize seminars for businesses engaged in the implementation of R&D. During these seminars, issues related to record keeping are explained. We believe that these seminars should include experts in the relevant branches of science who will clarify the differences between R&D research activities in accordance with OECD standards. Without proper control (from the Scientific/Research Fund) of organizations conducting R&D, the amount of intramural R&D expenditure and its share of GDP expenditures may be incorrect and distorted.

In several countries that are leaders in innovation, business tax benefits in the form of additional deductions are considered in calculating the corporate income

tax. The tax legislation of the Republic of Kazakhstan has similar measures. These measures were adopted in 2015 and are currently being tested. At the same time, there are many controversial issues that are contrary to practices in OECD countries. One is a tax deduction certificate that is received when research results are implemented in production. Often positive research results cannot be obtained initially and therefore the business cannot qualify for a tax credit for the implementation of R&D (although the expenditures have already been made). This may have a negative effect on the growth of the number of companies that would be interested in pursuing R&D. Therefore, the second issue in the refocusing goals is the development of indirect measures that would contribute to a positive R&D environment in Kazakhstan.

Again, there are some methodological issues:

- Research and development expenditures need to be allocated consistent with OECD standards
- Research and development expenditures must be made in a manner that reflects both OECD standards and international accounting methods

The introduction of internationally agreed upon standards for assessing R&D allocations is expected to contribute to the growth of R&D entities, as well as the workers they employ, and to achieve positive growth in the level of intramural R&D expenditures relative to the GDP.

Higher Education (Including Universities, Academies, and Research Institutes). Every three years the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan announces grants for funding R&D projects in the following areas: (1) rational use of natural resources, processing of raw materials, and products; (2) energy and engineering; (3) information and communication technologies; (4) life sciences; and (5) increasing the country's intellectual potential. The national research councils were established to examine and approve submitted applications.

Introduction of these research approaches may raise a number of methodological questions. One regards the novelty of the result (its correspondence to OECD standards). The solution of this problem must begin with the study and implementation of OECD standards among all sectors of performance (OECD, 2015). Today in Kazakhstan young scientists must learn these norms to be competitive in the future.

Refocusing Goals. The refocusing goals in R&D at this stage should include implementation of measures promoting and contributing to innovative activity. There should be a national plan for R&D (conception) until at least 2025, expressing the concrete steps needed to achieve innovative leadership in Kazakhstan and containing a list of the responsible state bodies. During the fulfillment process, all these bodies should monitor the plan and make modifications for improvement.

To successfully implement Scenario 1, several refocusing goals are needed. First, it is necessary to study and implement European R&D standards (OECD, 2015). The first priority should be to train future Kazakhstan scientists in accordance with these norms and regulations to ensure that they understand the meaning and essence of innovations and modern world novelty with reference to an R&D project. Second, in-house R&D departments should be formed within comparable public and private research enterprises that, among other goals, aim to train employees with the help of international R&D experts. Third, a system of direct and indirect incentives for R&D businesses should be developed to stimulate investments in R&D projects.

One of the basic conditions that affects the funding of R&D projects is the potential commercialization of the research results. For several years, when the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (http://sc.edu.gov.kz/ru) offered scientific grant funding, many projects were conducted in the five areas outlined in the previous section. These results should now be presented to the market. The corresponding Law on the Commercialization of the Results of Scientific and (or) Scientific-Technical Activity (http://adilet.zan.kz/rus/docs/Z1500000381) has created new opportunities for the higher education sector to present R&D products to the market. One of the main problems here is to verify the novelty of R&D results. Therefore, the fourth refocusing goal is to continue considering and implementing European R&D standards (OECD, 2015). In conjunction with this goal, the authors note that new developments in various fields of science are presented in journal articles published by leading publishing houses such as Elsevier, Springer, Wiley-Blackwell, and Taylor and Francis.

Currently, Kazakhstan has free access to some journals published by Springer and Elsevier publishing houses. Limited access to these articles and lack of access to journals published by Wiley-Blackwell, Taylor and Francis, and others reduces exposure to new scientific knowledge and slows the growth of scientific-research potential in the Republic of Kazakhstan.

Today, most research of world importance is published in English. Therefore, knowledge of the English language is essential to scientists working on R&D in Kazakhstan. Scenario 2 is aimed at further diversification of R&D projects. This diversification will be characterized by further creation of innovative solutions in various industries.

Scenario 2: Accelerating the Pace of National Development

A second substantially more accelerated scenario for the promotion of R&D will follow the conclusion of Scenario 1. Scenario 2 will build directly on Scenario 1 and will lay the foundation for Scenario 3, which will be the subject of a separate article. All three scenarios build on the ambitious goals for the country's development formulated by President Nursultan Nazarbayev and, taken together, will advance Kazakhstan's scientific and technological development through the year 2050 and beyond.

Strategic goals

In subsequent years, we will continue to improve the innovation environment, developing sectors of performance that will focus on innovation. These are the sectors of the so-called new economy, which will be largely determined by R&D results. This economy will include mobile and multimedia technologies, nanotechnology and space technologies, robotics, genetic engineering, and research and discovery of future energy resources. The expectation is that the successful achievement of the goals of all three scenarios will advance Kazakhstan's R&D position to among the top thirty nations in the world.

The main strategic goal for Kazakhstan is to increase intramural R&D expenditures to at least 1.1 to 1.2 percent of the GDP by 2030. At the same time, the business share of intramural R&D expenditures should be no less than 8 to 10 percent. The current situation is the basis for formulating and refocusing the goals for Kazakhstan for the next ten years.

Strategic initiatives

The government's programs of R&D development during Scenario 2 (2026–2040) should emphasize the development of branches of science in which R&D products will meet the needs of domestic and foreign clients and thus will be in demand in local and CIS markets. One example is a food industry in which Kazakhstan will certainly possess a leading position. The government and business will continue to encourage technology transfer and localization of high-tech food industries, providing various financial incentive schemes to increase the demand for innovation. As an outcome of Scenario 2, the authors prognosticate (a) a 10-percent increase in the number of enterprises engaged in food R&D (in accordance with OECD methodology [OECD, 2015]), (b) an increase in the share of innovative food products to 1.0 percent of the total GDP, and (c) a substantial increase in food-product-related intramural R&D expenditures to 2.0 percent of the GDP by 2040.

All sectors of R&D performance

In higher education, a leader in the development of new innovative sectors and the creation of knowledge-based industries will be an autonomous organization of education (AOE), the Nazarbayev University. The role of this institution will be the development of fundamental, applied, and technological R&D in energy efficiency and conservation, renewable energy and environmental protection, advanced materials and energy sources, and translational and personalized medicine as the foundations of the biomedical industry in the Republic of Kazakhstan.

To develop an effective national scientific training system, the joint programs will be developed and implemented with foreign partners for the preparation of master of science and PhD candidates and the organization of scientific training. For the development of competencies and skills of the staff involved in the organization and implementation of scientific projects and programs (e.g., engineering and technical personnel, services personnel, and administrative and technical support and maintenance personnel), it will be necessary to conduct regular

courses of qualification improvement and advanced training in accordance with the basic and perspective directions of Nazarbayev University.

Formation of Nazarbayev University as a world-class research university by developing its research base and a system of research and innovation support is closely linked to the development of national scientific personnel, successfully combining teaching and scientific innovations, as well as creating favorable conditions for attracting the best domestic and foreign scientists and research experts.

Particular attention will be paid to the implementation of fundamental and applied scientific research in the following current and future directions: space equipment and technologies, renewable energy and smart network technology, solar energy, power systems simulation, information and communication technology, computing studies, robotics, economics of natural resources and environmental protection, electrical engineering (materials for optoelectronic devices), regenerative medicine, and organic chemistry and chemical technology. Research will focus on the development of new biological products as well as biosensors for the detection of tuberculosis, infectious agents and cancer biology, protein expression, and models and mechanisms of osteo-articular diseases.

Human and capital resource base

During further development of the R&D sphere in Kazakhstan, the share of state participation should decrease to 30 to 35 percent of the total funding for scientific research. The state will primarily fund fundamental and applied research. To keep pace with global competition, more qualified scientific personnel will be needed to carry out R&D projects characterized by originality and novelty in accordance with international OECD standards. A key goal is the creation of new products that are in demand on the market.

The government will support businesses engaged in R&D in implementing various programs. For R&D projects that are to be developed and modified in accordance with OECD standards and principles, special attention should be paid to qualifying criteria, such as novelty, creativity, inventiveness, systematic activity, and transference and reproduction capability. For different types of business (small, intermediate, and large) we would establish four key evaluation criteria for grants: differentiation, business model feasibility, potential market opportunity, and a management team with the skills necessary to both oversee and give direction to R&D activities consistent with OECD standards.

Depending on market conditions, the share of the state and business participation will be determined separately for each R&D project. For example, 70 percent of funding might be provided by the state and 30 percent by business, with different caps established according to the size of the business.

Monitoring progress

One of the main goals is systematic state control and monitoring of the level of innovation development within the Republic of Kazakhstan. Growth is expressed mainly by the level of intramural R&D expenditures as a percentage of the GDP;

the target for expenditures is 1.1 to 1.2 percent of the GDP by 2030. An important aspect of monitoring involves inviting international experts to provide consulting services in the R&D sphere.

Refocusing goals

At the completion of Scenario 2, the refocusing goals will be centered on the development of final targets for 2026 to 2040, when Kazakhstan is expected to achieve leadership in R&D as one of the thirty top countries in this sector. The primary refocusing goal here will be furthering growth of innovative activity through increased business investment in R&D and an increased level of intramural R&D expenditures equivalent to at least 3 percent of the GDP by 2050.

Discussion with a Focus on Next Steps

Kazakhstan is on its way to achieving a more enlightened and technologically advanced path to reform its economy toward becoming one of the major global actors. This advancement is reflected especially by the country's steadily increasing R&D activities as well as its growing numbers of university-educated R&D researchers, scientists, and technicians. Kazakhstan has been joined in this effort by other members of the former Soviet Union as well as major R&D centers located in Europe and South and Southeast Asia. Kazakhstan's rapidly expanding numbers of R&D scientists illustrate its new commitment to knowledge development through research, as does the percentage of its national economy currently committed to R&D activities. These important gains are contributing to increases in the standard of living of the country's highly diverse population.

The country's next steps in advancing its R&D profile will be realized through the more complete implementation of its presidentially driven national plans of action for 2020, 2030, and 2050. This process will also involve meaningful partnerships with the country's profit and not-for-profit sectors and, to a lesser extent, with the country's families, who have made multifaced contributions toward strengthening local community capacity for scientific and technological innovation.

Meaningful contributions to economic development by these critical actors will bring about the dramatic scientific and technological changes needed to modernize Kazakhstan. We believe that the country is successfully moving forward toward achieving these goals; its prospects for the future remain positive and forward looking.

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