The Effectiveness of Innovative Infrastructure: The Case of Kazakhstan

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ABSTRACT

Purpose: The development of an innovative economy is constrained by the problems of science funding, modernization of scientific institutions and innovative training of specialists. This article focuses on the problem of evaluating the effectiveness of the innovation infrastructure of the Republic of Kazakhstan using a systematized set of performance indicators.

Methodology/Approach: Approaches to assessing innovation infrastructure have been analysed. Based on the analysis, correlation and regression assessment model has been developed.

Findings: A forecast has been made for innovative infrastructure development based on the obtained performance indicators. This forecast is of high practical significance, as it allows predicting the outcomes of innovation.

Research Limitation/implication: In the light of globalization, it is extremely urgent to develop an innovative economy along with regional innovation systems. If combined, these systems can accelerate the innovation processes in the regions, ensure competitiveness and expedite the socio-economic development. The formation of an innovative economy should be in line with the productive forces and production relations.

Originality/Value of the paper: Through categorization, this study establishes a set of underlying indicators, which are used to measure the performance of the innovation infrastructure. A model of correlation and regression analysis is built, which allows evaluating the effectiveness of the innovation infrastructure of Kazakhstan.

Category: Research paper

Keywords: efficiency; forecast; infrastructure; innovation; national economy

1 INTRODUCTION

Currently, the effective use of innovative potential, which is the basis of an innovative economy, is becoming one of the prerequisites for achieving sustainability and quality of economic growth throughout the world. The main problem is to determine the factors, criteria and indicators of innovation infrastructure, build a mathematical model for evaluating effectiveness based on correlation and regression analysis and develop forecasts for innovation infrastructure development. The main difficulties in fulfilling the innovative potential are related to the lack of organizations' own funds, limited budget and extra-budgetary financing, including borrowed funds. At the same time, foreign direct investment in most cases brings innovations in the form of technology transfer, new approaches to management, etc. In this regard, when developing an innovative strategy, it is necessary to synchronize it with the investment policy. All this leads to the creation of an investment and innovation climate in the country where certain changes are necessary in the taxation system, distribution of investment preferences, protection of property rights and interests of all participants in the business process.

Scientific and technical developments do not always become innovative products, which are ready for production and effective implementation. The activation of innovative activity requires, on the one hand, coordination of actions of all public administration bodies and, on the other hand, the integration of all interested parties in the implementation of innovations, attracting investments, creating conditions conducive to the innovation process and introducing the achievements of science and technology to the country's economy.

The study aims to systematize performance indicators for the innovation infrastructure of Kazakhstan and to build a model for the assessment of its effectiveness.

In modern economic analysis, econometrics is one of the major directions that uses empirical methods to evaluate economic relationships (Aliyev and Shahverdiyeva, 2018). The Innovation Scoreboard divides European countries in four groups according to their innovation performance and captures 80 indicators, distinguishing between four categories of economic knowledge (Dogru, 2020).

Another assessment methodology focuses on comparable factors, which influence innovativeness. This methodology is based on the index method that includes the following indices: access to financing; innovation activity; best practices; internationalization; activity in the field of intellectual property (Simeonova-Ganeva et al., 2013). These indices allow the implementation of descriptive statistics, frequency allocations and rank criteria for the examination of correlations between factors. They also allow the creation of new models for multiple linear regressions to access the impact of factors involved in the innovation process (Kalaydzhieva, 2016).

Existing approaches use indicators characterizing the innovative potential of the country, the functional index allows evaluating the functional efficiency, while the resource and structural indices describe the state of the innovative infrastructure. However, no comparison was provided for the infrastructure efficiency and safety. Besides, methods using expert estimates deliver less accurate and reliable results (Kharitonova and Krivosheeva, 2012; Fomina et al., 2019).

In modern economic literature, the study and evaluation of the innovative potential of industrial enterprises receive increasing attention. Previous studies described a diverse methodology for assessing the innovative development of a region and a strategic management system (Kortelainen and Lättilä, 2013; Tafti, Jahani and Emami, 2012). A set of indicators, developed by Kazantsev (2012), do not fully improve the accuracy of quantitative measurements. Rauter et al. (2019) studied openness of firms' economic innovation measures (Stefan and Bengtsson, 2017) in the context sustainable development. Organizational culture affects openness in innovation (Brettel and Cleven, 2011; Wiener, Gattringer and Strehl, 2018), it also influences sustainability of innovative companies (Globocnik, Romana and Baumgartner, 2020). The company's strategy in terms of the influence of internal and external factors is fundamental to improving the effectiveness of innovation (Faems et al., 2010). Openness in innovation implies a loss of control, managerial and organizational complexity, and, consequently, increased costs (Manzini, Lazarotti and Pellegrini, 2017). Despite the existence of various forms of open innovation approaches (Hossain, 2010; Mustaquim and Nyström, 2014), there is a need to change the design of goods, services and processes in accordance with the sustainable development requirements of both customers and non-governmental organizations and the state (Ketata, Sofka and Grimpe, 2015; Tsai and Liao, 2017).

Framework Programs (FP) of European Commission finance research projects of consortia in the field of innovation, whose partners consist of representatives of firms (SMEs and large firms), universities, government research centers and government agencies from different countries (Barajas, Huergo and Moreno, 2012). Firstly, FP projects are funded through grants from the European Commission and own funds of the consortium partners. Direct financial assistance to R&D through grants stimulates socially significant projects. Secondly, FP encourage R&D collaboration between partners, through which revenue increases in such consortia (Nepelski, Van Roy and Pesole, 2019). FP influence the mission of creating new opportunities in the market and the further development of industries (Audretsch and Link, 2016; Leyden, 2016; Mazzucato, 2016). The problems of management of industrial enterprises in general and, in particular, the problems of management of their sustainable innovative development were investigated in the works (Amah, 2017; Sorokin and Novikov, 2019; Tuguskina, 2019; Usov et al., 2018; Ustinova and Sirazetdinov, 2017).

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The article aims to investigate the following:

- assessment methods of innovative potential;
- the formation of a strategy for company's innovative development;
- most effective methods of innovative infrastructure development.

2 METHODS

For the innovation infrastructure of Kazakhstan, performance indicators were systematized by categorizing activities that take place within the innovation infrastructure: financial, information provision & consulting, production & research, employment & salary payment (Table 1).

Table 1 – Indicators for Assessing Innovation Infrastructure in Terms of Effectiveness (Source: Developed by the Authors)

Financial Activity (F)	**Information Provision & Consulting (I)**	**Production & research (P)**	**Employment &salary payment (E)**
F1. Internal R&D costs	I1. Number of advanced technologies created	P1. Number of research organizations	E1. Number of researchers
F2. R&D work scope	I2. Total protection documents issued	P2. Fixed assets for R&D	E2. Average salary for a researcher
F3. Innovation spending	I3. Exports of innovative products	P3. Volume of brand new products	E3. Number of advanced researchers
	I4. Total protection requests issued	P4. Internal equipment-related costs	

Data from 2012-2019 reports of the Agency of the Republic of Kazakhstan on Statistics (hereinafter, the Statistics Agency) were processed to fit groups described earlier. A correlation and regression analysis was performed and the correlation coefficients, paired and general, were calculated. All calculations were carried out using the Microsoft Excel software (Table 2).

Table 2 – The Set of Indicators to Find Dependence between the Volume of Innovative Products and Factors of Innovation Infrastructure (Source: Author's Own Elaboration Adapted from Reports of the Statistics Agency)

Indicator, million tenge	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Total volume of innovative products	65,020.40	74,718.50	120,408.40	156,039.90	152,500.60	111,531.60	82,597.40	142,166.80
F1. Internal R&D costs	11,643.50	14,579.80	21,527.40	24,799.90	26,835.50	34,761.60	38,988.40	33,466.82

Indicator, million tenge	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
F2. R&D work scope	14,374.60	18,549.50	29,591.30	35,571.60	37,041.80	40,172.50	36,998.40	44,577.90
F3. Innovation spending	26,933.10	35,360.30	67,088.90	79,985.90	83,523.40	11,3460.10	61,050.90	235,501.70
I1. Number of advanced technologies created	533.00	599.00	787.00	920.00	702.00	823.00	487.00	1,037.00
I2. Total protection documents issued	3,211.00	2,870.00	4,034.00	4,097.00	3,071.00	5,382.00	5,707.00	6,358.00
I3. Exports of innovative products	43,944.80	48,076.00	65,686.10	81,149.90	82,841.60	60,655.70	34,259.50	73,393.50
I4. Total protection requests issued	5,782.00	6,045.00	5,168.00	6,118.00	6,175.00	6,237.00	0,5725.00	5,946.00
P1. Number of research organizations	273.00	295.00	390.00	437.00	438.00	421.00	414.00	424.00
P2. Fixed assets for R&D	9,037.30	12,396.60	14,584.20	19,247.70	18,782.00	19,176.70	22,003.27	22,810.90
P3. Volume of brand new products	9,538.90	21,384.70	44,133.10	88,416.50	107,585.80	89,650.30	71,591.50	12,4587.50
P4. Internal equipment-related costs	827.40	1,475.50	3,188.90	3,416.00	1,978.10	3,254.40	1,131.00	1,197.40
E1. Number of researchers	9,899.00	10,382.00	11,910.00	12,404.00	11,524.00	10,780.00	10,095.00	10,870.00
E2. Average salary for a researcher	29,348.00	34,946.00	41,512.00	51,400.00	64,108.00	81,810.00	90,325.00	103,571.00
E3. Number of advanced researchers	3,761.00	3,753.00	4,124.00	4,304.00	4,224.00	4,052.00	4,072.00	4,388.00

The strongest correlations with the volume of innovative products and the minimal correlations among themselves were established. By assessment, the most significant factors are the internal R&D costs (F1), the number of new technologies and solutions created (I1), the export of innovative products (I3), the internal equipment-related costs (P4), and the number advanced researchers (E3).

These indicators were applied in the subsequent regression analysis (Table 3) and substituted as coefficients in the following equation:

$$Y = 0.196x1 - 24.903x2 + 1.368x3 + 2.35x4 + 68.434x5 - 241745 \qquad (1)$$

Where: *Y* – the volume of innovative products, million tenge; *X1* – the internal R&D costs, million tenge; *X2* – the number of new technologies created; *X3* – the export of innovative products, million tenge; *X4* – the internal equipment-related costs, million tenge; *X5* – number advanced researchers.

Table 3 – Results of the Correlation-Regression and Variance Analysis of Performance Indicators (Source: Author's Own Elaboration)

Regression statistics		**Analysis of Variance**					
Multiple R	0. 999	**Source**	**DF**	**SS**	**MS**	**F**	**P**
R-squared	0. 998	*Regression*	5	8,992,310,933. 531	1,798,462,186. 706	180.980	0.006
Adjusted R-squared	0.992	*Residue*	2	19,874,681. 749	9,937,340. 874		
Standard error	3,152.355	*Total*	7	9012185615. 280			
	Coefficients	**Standard error**	**t-statistic**	**P-value**	**95% lower**	**95% upper**	
Y-intersection	-241,745.823	50,970. 147	-4.743	0.042	-461,052.664	-22,438. 981	
Ô1	0.195	0.244	0.800	0.508	-0.855	1.246	
È1	-24.903	11.510	-2.164	0.163	-74.428	24.622	
È3	1.368	0.172	7.942	0.015	0.627	2.109	
Ï4	2.350	1.435	1.638	0.243	-3.823	8.523	
Ê3	68.434	16.110	4.248	0.051	-0.880	137.748	

3 RESULTS

The results of regression analysis are presented in Table 3. As it turned out, only three factors have the strongest influence on the effectiveness of innovation infrastructure: the number of advanced researchers; the internal equipment-related costs; and the volume of innovative products. The more advanced researchers involved per a unit of output, the higher the mean volume of innovative products. One advanced researcher equals 68.43 million tenge. When internal costs of the equipment grow extra 1 million tenge, the innovative products generate additional 2.35 million tenge. If exports rise 1 million tenge, then the industry will produce additional 1.4 million tenge.

The effectiveness assessment model allows to predict the potential state of the innovation infrastructure. This requires knowledge about the behavior of the given factors.

To predict the buoyancy of indicators necessary, the following equations were applied:

- for F1:

$$Y = 10926X0.593, \tag{2}$$

with a coefficient of determination R2 = 0.954 that indicates high accuracy;

- for I1, a logarithmic function:

$$Y = 132.4\ln(x) + 560.4Y, \tag{3}$$

- for I3:

$$Y = 771.1x3 - 12168x2 + 57003x - 9908, \tag{4}$$

- for P4:

$$Y = -175.7x2 + 1577x - 557.1, \tag{5}$$

- for E3:

$$Y = 67.71x + 3780. \tag{6}$$

Based on these calculations, the values of performance indicators were forecasted. Afterwards, the regression equation (1) was applied to forecast the volume of innovative products (Table 4). As a result average annual growth rate of the volume of innovative products was 13.6%. The average annual growth rates for other indicators were as follows. The internal R&D costs are projected to grow 5.1%. The number of new technologies and solutions will increase by 1.08%. The exports of innovative products are expected to rise 16.2%. The internal equipment-related costs will become higher by 30.5% and the number of advanced researchers will grow 6.4%.

Table 4 – The Effect of Performance Indicators on the Volume of Innovative Products (Source: Author's Own Elaboration)

Year	Volume of Innovative Products – Forecast	F1	I1	I3	P4	E3
2007	66,692.51	11,643.50	533.00	43,944.80	827.40	3,761.00
2008	72,248.54	14,579.80	599.00	48,076.00	1,475.50	3,753.00
2009	122,427.70	21,527.50	787.00	65,686.10	3,188.90	4,124.00
2010	153,759.98	24,799.80	920.00	81,149.90	3,416.00	4,304.00
2011	153,046.26	26,835.50	702.00	82,841.60	1,978.10	4,224.00
2012	112,456.93	34,761.60	823.00	60,655.70	3,254.40	4,052.00
2013	81,917.25	38,988.40	487.00	34,259.50	1,131.00	4,072.00
2014	142,460.35	33,466.60	1,037.00	73,393.50	1,197.40	4,388.00
2015	149,610.47	40,209.35	851.31	79,642.90	422.88	4,307.37
2016	198,253.04	42,801.72	865.26	114,422.00	22.00	4,334.38
2017	277,505.59	45,290.49	877.88	171,131.10	-49.88	4,358.82
2018	394,015.54	47,688.72	889.40	254,396.80	330.96	4,381.13
2019	554,423.84	50,006.86	900.00	368,845.70	1,288.24	4,401.65

The effectiveness assessment model introduced in the study allows to predict the volume of innovative products. Such application justifies the practical significance of this model.

4 DISCUSSION

Supporting small innovative organizations is one of many ways to boost innovation activity and innovative susceptibility of the regions. Unlike developed countries, small innovative businesses in Kazakhstan do not drive the innovative growth and do not receive significant inflows of investment. At the present stage of economic development, various countries tend to provide various kinds of support, from innovation, to legal, organizational and financial. Kazakhstan is no exception here. The Government of the Republic of Kazakhstan established an effective innovation policy, which embraces issues related to the creation and implementation of innovations, promotion of innovations in foreign markets, and international cooperation in the field of innovation. Diverse indicators for R&D, e.g., the R&D personnel ratio, have positive effects on product and process innovations, while process innovations affect R&D intensity (Song and Oh, 2015). Business investment (Sosnowski, 2014) is defined as the primary indicator for measuring innovation activity and recognition of innovation corporations. R&D expenditures result in new knowledge and ties between various organizations, research institutes or universities (Cavdar and Aydin, 2015). Innovations such as those incorporated to improve production mediate the impact of R&D on further advances (Raymond and Saint-Pierre, 2010). Overall, high investment in innovation enhances innovation effectiveness (De Fuentes et al., 2015).

Innovative development requires an application of systematic approach, as it is not considered in terms of unilateral cause-and-effect relationships leading from R&D to innovation (Doskaliyeva and Orynbassarova, 2016). It presents interaction and feedback within the set of economic, social, organizational, financial and other factors that determine both the development of science-intensive industries and the commercialization of innovative activities (Manaenko, 2013). To promote investment and technological innovation activities, it is advisable to apply mechanisms and regulatory instruments, including models based on public-private partnership in the field of investment (Sun, Mitra and Simone, 2013). In particular, many well-known researchers made significant contribution to the theoretical foundations of innovation and investment processes (Bleda and Del Rio, 2013; Blind, 2016; Bloch and Bugge, 2013; Geels, 2013).

Industrial production occupies a significant place in the structure of GRP of the region – 41%. Figure 1 shows the GRP of East Kazakhstan region in 2016-2018.

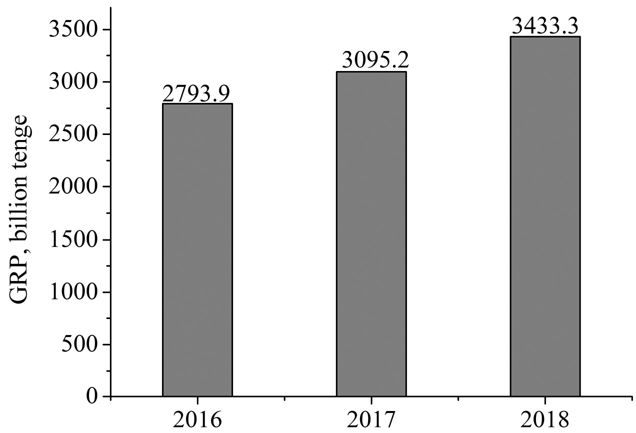

Figure 1 – The GRP of the East Kazakhstan Region in 2016-2018, billion tenge

In the region, there are car, bus and tractor assembly plants located, where, starting from the nodes and assemblies to the last screw, there is an urgent need to create production of the manufacturing of components for these assembly plants.

About 1.6 million hectares or 5.6% of the region territory is covered with high-trunk forests, which are represented by such species as fir, larch, spruce, cedar, aspen and birch, and where about 70% of the business wood of Kazakhstan is concentrated. At the same time, the woodworking industry, which was quite developed in the past, currently has a significant decline and needs to be restored. In order to develop small and medium-sized businesses using the resource potential of the forestry of the region, it is planned to implement two investment projects for processing low-speed, small-scale timber within the framework of the state program of industrial and innovative development. In 2018, the project "Reconstruction and development of woodworking and plywood-producing enterprises" was put into operation.

Agriculture is also a fairly developed sector of the economy today. In order to increase the productivity of animals, it is important to increase the efficiency of pastures in this direction. The volume of gross agricultural output compared to the corresponding period last year increased by 15.1% and amounted to 45.1 billion tenge. According to the index of physical volume of gross agricultural output, the region is on the 4th place in the Republic of Kazakhstan. The dynamics of agricultural development in terms of gross output in 2016-2018 is shown in Figure 2.

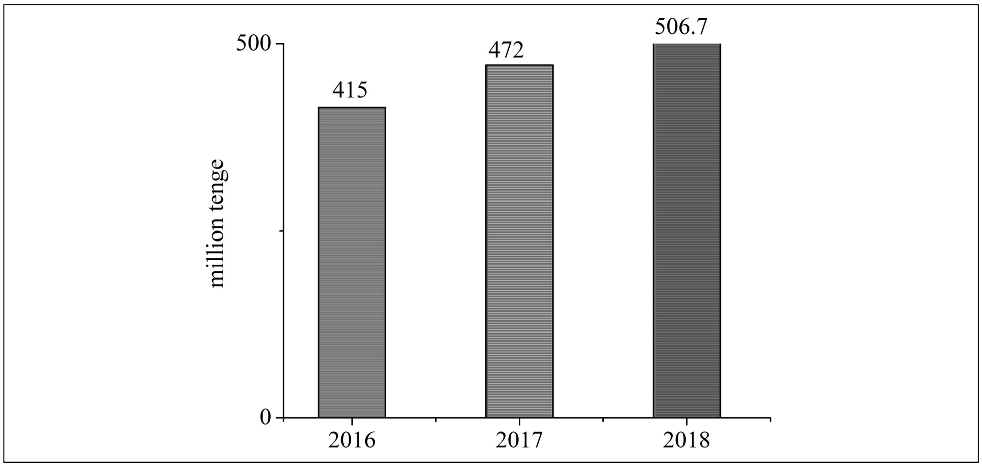

Figure 2 – The Gross Output of Agriculture 2016-2018 years, million tenge

However, due to the low water content, many pastures are not used effectively. In this regard, it is required to provide them with cattle drinking water through the drilling of deep water wells.

The agriculture of the region is mainly represented by animal husbandry, and there are rural regions that are exclusively engaged in animal husbandry. At the same time, enterprises for deep processing of livestock products are not developed in these regions.

The existing enterprises for processing of agricultural products also do not meet the existing requirements on the level of technological equipment and technology and require reconstruction and modernization.

The region has an inexhaustible potential of energy opportunities. In the annual (about 8 billion kWh) volume of electricity generation, about 70% is accounted for by hydroelectric power plants, and the rest by thermal power plants.

Small business is the most important component of the economy of the region and one of its main reserves (14% of the total number of Kazakhstan). The quantitative indicators are shown in Table 5.

Table 5 – Number of Existing Small and Medium-Sized Businesses in the Regions

Name of cities and areas	**Number of operating SMEs, units**		
	2016	2017	2018
Total	87,041	79,966	87,678
Ust-Kamenogorsk	27,204	26,424	28,466
Semey	21,343	18,047	20,880
Ridder	2,907	2,615	2,758
Kurchatov	555	468	486
Abay district	970	888	960
Ayagoz district	3,576	3,391	3,677
Beskaragai district	964	892	908
Borodulikha district	1,420	1,312	1,379
Glubokovsky district	2,398	2,273	2,354
Zharma district	1,822	1,566	1,715
Zaysan district	2,379	2,450	2,751
Katon-Karagaysky district	2,255	2,121	2,189
Kokpektinsky district	1,633	1,621	1,794
Kurchumsky district	1,684	1,633	1,715
Tarbagatai district	2,823	2,829	3,176
Ulan district	2,001	1,890	2,066
Urjar district	4,339	4,039	4,433
Shemonaiha district	2,586	2,341	2,508

The number of registered small and medium-sized enterprises (SMEs) is 111.0 thousand units or 99.9% by 2017. The number of active entities in the SME sector amounted to 87.7 thousand units or 109.6% by 2017. In 2018, the volume of output by SMEs amounted to 995.6 billion tenge, with an increase of 95.4 billion tenge or 110.6% to the corresponding period of 2017 (900.2 billion tenge). The index of physical volume (IFO) of output by SMEs – 104.6%.

Describing the effectiveness of the use of budget funds for research and development in Kazakhstan, it should be noted that at present, the total cost of research and development is practically not paid back by the cost of the amount of scientific and technical work performed. The Law of the Republic of Kazakhstan "On innovation" regulates relations in the field of innovation and defines the fundamental principles, directions and forms of implementation of state innovation policy. At the same time, special attention is paid to rapidly developing areas, in particular information and telecommunication technologies and electronics.

The system of indices, sub-indices and indicators used to measure technopole's performance has a hierarchical structure (Aliyev and Shahverdiyeva 2017; Shahverdiyeva, 2017). The first category of indicators consists, in fact, of only one index – the composite technopole index. The second category includes 10 indices, the third category – 106 sub-indices, and the fourth category – 320 macro/micro indicators, which embrace official statistics and other external and internal factors. The fourth-category of indicators plays a fundamental role in the expert measurement of the third- and second-category sub-indices, mostly. In this case, absolute indicators and their specific values are used. The approach varies depending on the context. A composite technopole index is made up of weight ratios given by the experts and specific indices that were examined in (Aliyev and Shahverdiyeva 2017; Bhattacharya and Saha, 2015). To measure technopole performance, the potential socio-economic indicators of technopole development are used alongside a correlation-regression analysis. As an investigated indicator, total innovative product or service production volume in the technopole has been accepted. Based on the initial values of performance indicators, the econometric model of technopole performance was established. To identify contributive factors, a pair correlation matrix has been implemented (Gusarova and Kuzmenkov, 2016; Shahverdiyeva 2017).

The ranking method used to evaluate complex performance is built around two categories of resources, production and innovation. For instance, decision on whether to initiate a technopole depends on the value of five indicators in the category of production resources (HER-X1, MTR-X2, SCP-X3, FFI-X4, SAF-X5). Indicators displaying the innovation background (INV-X6, SRE-X7, ECO-X8, SPD-X9, IRRX10) play an important role in the service-based technopole. The performance of some technopoles depends on the institutional environment (BTE-X11, INV-X12, HEA-X13). These factors, which were included in the regression models, were statistically significant and contributive to the total volume of products/services. Additional characteristics of the regression model allow to predict the performance of technopoles and calculate the volume of innovative products/services (Aliyev and Shahverdiyeva, 2018).

When comparing the present assessment model with the existing ones, the study established the common goal of the employment of mathematical methods in the innovative economy. Techniques used to ensure sustainable economic development and innovative production growth in technology parks are aimed at accelerating the formation of a knowledge-based economy.

The novelty of this study is that it identified factors, which, alongside the production-related costs, have the strongest impact on the performance of the innovation infrastructure. These factors are the exports of innovative products, the number of advanced researchers, and innovation spending.

5 CONCLUSIONS

Under conditions of globalization, regions will not be able to step on the path of socio-economic development without innovation strategies. Currently the development of innovative economy is constrained by problems in the field of science financing, laboratory modernization activities that are currently in action; specialist training issues; poor support of education; the lack of innovative susceptibility of business and low financial opportunities; and by an insufficient innovation infrastructure in the regions. In this regard, the formation of spatially localized innovative subsystems with strong bonds that are connecting science, education, and production is objectively necessary.

Through categorization, this study established a set of underlying indicators used to measure the performance of the innovation infrastructure. The set consists of indicators evaluating:

- financial activity: the internal R&D costs; the R&D work scope; and the innovation spending;
- information provision and consulting: the number of advanced technologies created; total protection documents issued; the exports of innovative products; total protection requests issued;
- production and research: the number of research organizations' fixed assets for R&D; the volume of brand new products; internal equipment-related costs;
- employment and salary payment: the number of researchers; average salary for a researchers; the number of advanced researchers.

A model of correlation and regression analysis was built, which allowed to evaluate the effectiveness of the innovation infrastructure of Kazakhstan. The analysis revealed that only three factors have the strongest influence on the effectiveness of innovation infrastructure: the number advanced researchers; the internal equipment-related costs; and the volume of innovative products.

An innovation infrastructure development forecast was made based on the behaviour of given performance indicators. The volume of innovative products was projected to increase 2.72-fold over the coming five years, reaching 39,318.59 million tenge in 2025.

REFERENCES

Agency of the Republic of Kazakhstan, 2019. *Growth rate of sectors of the national economy (Volume index, %)*. [online] Ministry of National Economy of the Republic of Kazakhstan. Available through: Statistics committee <http://www.stat.gov.kz> [Accessed 03 November 2019].

Aliyev, A.G. and Shahverdiyeva, R.O., 2017. Scientific-methodological bases of development of the composite indicators system of comparative evaluation of technopoles' activity. *Problems of Information Society,* 1, pp.61-74.

Aliyev, A.G. and Shahverdiyeva, R.O., 2018. Application of mathematical methods and models in product-service manufacturing processes in scientific innovative technopoles. *International Journal of Mathematical Sciences and Computing,* [e-journal] 4(3), pp.1-12. DOI: 10.5815/ijmsc.2018.03.01.

Amah, E., 2017. Pro-activeness and survival of small and medium scale enterprises in Nigeria. *Journal of Small Business and Entrepreneurship Development,* [e-journal] 5(2), pp.67-72. DOI: 10.15640/jsbed.v5n2a7.

Audretsch, D.B. and Link, A.N., 2016. *Essays in public sector entrepreneurship*. Cham: Springer. DOI: 10.1007/978-3-319-26677-0.

Barajas, A., Huergo, E. and Moreno, L., 2012. Measuring the economic impact of research joint ventures supported by the EU framework programme. *The Journal of Technology Transfer,* [e-journal] 37(6), pp.917-942. DOI: 10.1007/s10961-011-9222-y.

Bhattacharya, B. and Saha, B., 2015. Analysis of signaling time of community model. *International Journal of Mathematical Sciences and Computing,* [e-journal] 2(2), pp.8-21. DOI: 10.5815/ijmsc.2015.02.02.

Bleda, M. and Del Rio, P., 2013. The market failure and the systemic failure rationales in technological innovation systems. *Research Policy,* [e-journal] 42(5), pp.1039-1052. DOI: 10.1016/j.respol.2013.02.008.

Blind, K., 2016. The impact of regulation on innovation. In: J. Edler, P. Cunningham and A. Gök, eds. 2016. *Handbook of innovation policy impact*. Cheltenham, UK: Edward Elgar Publishing. pp. 450-482.

Bloch, C. and Bugge, M., 2013. Public sector innovation – From theory to measurement. *Structural Change and Economic Dynamics,* [e-journal] 27(C), pp.133-145. DOI: 10.1016/j.strueco.2013.06.008.

Brettel, M. and Cleven, N.J., 2011. Innovation culture, collaboration with external partners and NPD performance. *Creativity and Innovation Management,* [e-journal] 20(4), pp.253-272. DOI: 10.1111/j.1467-8691.2011.00617.x.

Cavdar, S.C. and Aydin, A.D., 2015. An empirical analysis about technological development and innovation indicators. *Procedia – Social and Behavioral Sciences,* [e-journal] 195, pp.1486-1495. DOI: 10.1016/j.sbspro.2015.06.449.

De Fuentes, C., Dutrenit, G., Santiago, F. and Gras, N., 2015. Determinants of innovation and productivity in the service sector in Mexico. *Emerging Markets Finance and Trade,* [e-journal] 51(3), pp.578-592. DOI: 10.1080/1540496X.2015.1026693.

Dogru, C., 2020. Gaining Strategic Advantage through Social and Technological Innovation: Evidence from European Countries. In: E. Akdevel, D. Akella, D. Bingol, J. Crawford, C.M. Montaudon-Tomas, M. Pejic-Bach and R. Walden, 2020. *Leadership Styles, Innovation, and Social Entrepreneurship in the Era of Digitalization*. IGI Global. pp.25-43. DOI: 10.4018/978-1-7998-1108-4.ch002.

Doskaliyeva, B.B. and Orynbassarova, Y.D., 2016. Development of the system of investment support of projects in the industrial-innovative development of Kazakhstan. *International Journal of Environmental and Science Education*, 11(12), pp.5109-5127.

Faems, D., De Visser, M., Andries, P. and Van Looy, B., 2010. Technology alliance portfolios and financial performance: value-enhancing and cost-increasing effects of open innovation. *Journal of Product Innovation Management,* [e-journal] 27(6), pp.785-796. DOI: 10.1111/j.1540-5885.2010.00752.x.

Fomina, S., Sizikova, V., Shimanovskaya, Y., Kozlovskaya, S. and Karpunina, A., 2019. The effect of teaching and supply chain management on employees' skills in small and medium sized enterprises of Russia. *International Journal of Supply Chain Management*, 8(4), pp.930-938.

Geels, F.W., 2013. The impact of the financial–economic crisis on sustainability transitions: Financial investment, governance and public discourse. *Environmental Innovation and Societal Transitions,* [e-journal] 6, pp.67-95. DOI: 10.1016/j.eist.2012.11.004.

Globocnik, D., Romana, R. and Baumgartner, R.J., 2020. Synergy or conflict? The relationships among organisational culture, sustainability-related innovation performance, and economic innovation performance. *International Journal of Innovation Management,* [e-journal] 24(1), pp.2050004. DOI: 10.1142/S1363919620500048.

Gusarova, O.M. and Kuzmenkova, V.D., 2016. Modeling and analysis of the trends of development of regional economy. *Fundamental Research,* 3, pp.354-359.

Hossain, M., 2010. Open innovation: So far and a way forward. *World Journal of Science Technology and Sustainable Development,* [e-journal] 10(1), pp.30-41. DOI: 10.1108/20425941311313083.

Kalaydzhieva, V., 2016. The influence of innovation on increasing the competitiveness of industrial enterprises. *Journal of Varna University of Economics,* 60(3), pp.336-349.

Kazantsev, S.V., 2012. The assessment of resources and scale of innovative activity in the entities of the Russian Federation. *Innovations,* 8, pp.36-45.

Ketata, I., Sofka, W. and Grimpe, C., 2015. The role of internal capabilities and firms' environment for sustainable innovation: evidence for Germany. *R&d Management,* [e-journal] 45(1), pp.60-75. DOI: 10.1111/radm.12052.

Kharitonova, T.V. and Krivosheeva, T.M., 2012. Methodology for assessing the level of development and the effectiveness of the functioning of the innovation infrastructure of the region. *Bulletin of the Russian State University of Tourism and Service*, 2, pp.100-106.

Kortelainen, S. and Lättilä, L., 2013. Hybrid modeling approach to competitiveness through fast strategy. *International Journal of Innovation and Technology Management,* [e-journal] 10(5), pp.1-27. DOI: 10.1142/S0219877013400166.

Leyden, D., 2016. Public-sector entrepreneurship and the creation of a sustainable innovative economy. *Small Business Economics,* [e-journal] 46(4), pp.553-564. DOI: 10.1007/s11187-016-9706-0.

Manaenko, J.H., 2013. Investment maintenance of innovative development of electric power industry enterprises: Theoretical and methodological aspect. *Scientific-Methodical Journal of New Economy,* 2(62), pp.343-349.

Manzini, R., Lazzarotti, V. and Pellegrini, L., 2017. How to remain as closed as possible in the open innovation era: the case of Lindt & Sprüngli. *Long Range Planning,* [e-journal] 50(2), pp.260-281. DOI: 10.1016/j.lrp.2015.12.011.

Mazzucato, M., 2016. From market fixing to market-creating: A new framework for innovation policy. *Industry and Innovation,* [e-journal] 23(2), pp.140-156. DOI: 10.1080/13662716.2016.1146124.

Mustaquim, M.M. and Nyström, T., 2014. Designing information systems for sustainability–the role of universal design and open innovation. In: M.C. Tremblay, D. et al., eds., *International Conference on Design Science Research in Information Systems, Advancing the Impact of Design Science: Moving from Theory to Practice.* Miami, USA, 22-24 May 2014. Cham, Springer. pp.1-16. DOI: 10.1007/978-3-319-06701-8_1.

Nepelski, D., Van Roy, V. and Pesole, A., 2019. The organisational and geographic diversity and innovation potential of EU-funded research networks. *The Journal of Technology Transfer,* [e-journal] 44(2), pp.359-380. DOI: 10.1007/s10961-018-9692-2.

Rauter, R., Globocnik, D., Perl-Vorbach, E. and Baumgartner, R.J., 2019. Open innovation and its effects on economic and sustainability innovation performance. *Journal of Innovation & Knowledge,* [e-journal] 4(4), pp.226-233. DOI: 10.1016/j.jik.2018.03.004.

Raymond, L. and Saint-Pierre, J., 2010. R&D as a determinant of innovation in manufacturing SMEs: an attempt at empirical clarification. *Technovation,* [e-journal] 30(1), pp.48-56. DOI: 10.1016/j.technovation.2009.05.005.

Shahverdiyeva, R.O., 2017. Development of an econometric model of innovative products or services in technology parks. In: Institute Economy of Azerbaijan National Academy of Sciences (ANAS), *International scientific-practical conference on "Strategic economic reforms: Preventive Tax Policy".* Baku, Serbia, 12 October 2017. Baku: Institute Economy of ANAS. pp.587-594.

Simeonova-Ganeva, R., Vladimirov, Z., Ganev, K., Panayotova, N., Dimitrova, T., Davidkova, T. and Ivanova Yordanova, D., 2013. *A study of entrepreneurship and the prospects for innovations development in SMEs (2012-2013).* [online] Bulgarian version. Available at SSRN: <https://ssrn.com/abstract=2290685>. DOI: 10.2139/ssrn.2290685. [Accessed 03 November 2019].

Song, C. and Oh, W., 2015. Determinants of innovation in energy intensive industry and implications for energy policy. *Energy Policy*, [e-journal] 81, pp.122-130. DOI: 10.1016/j.enpol.2015.02.022.

Sorokin, A.E. and Novikov, S.V., 2019. Formation of the national economy of Russia in the context of state support of innovation actions. *Espacios,* 40(38), pp.4-8.

Sosnowski, J., 2014. Precipitating innovations by academia and industry feedback. *Procedia – Social and Behavioral Sciences,* [e-journal] 109, pp.113-119. DOI: 10.1016/j.sbspro.2013.12.429.

Stefan, I. and Bengtsson, L., 2017. Unravelling appropriability mechanisms and openness depth effects on firm performance across stages in the innovation process. *Technological Forecasting & Social Change,* [e-journal] 120, pp.252-260. DOI: 10.1016/j.techfore.2017.03.014.

Sun, M.Y., Mitra, M.P. and Simone, M.A., 2013. *The driving force behind the boom and bust in construction in Europe.* [Working paper No. 13-181]. Washington, USA: International Monetary Fund. Available at: <https://www.imf.org/external/pubs/ft/wp/2013/wp13181.pdf> [Accessed 03 November 2019].

Tafti, S.F., Jahani, M. and Emami, S.A., 2012. Explaining evolutionary trend of strategic planning from traditional economy to innovation economy. *Procedia – Social and Behavioral Sciences,* [e-journal] 58, pp.56-65. DOI: 10.1016/j.sbspro.2012.09.978.

Tsai, K.H. and Liao, Y.C., 2017. Sustainability strategy and eco-innovation: A moderation model. *Business Strategy and the Environment,* [e-journal] 26(4), pp.426-437. DOI: 10.1002/bse.1926.

Tuguskina, G.N., 2019. Regional features of innovative potential. *Creative Economy,* [e-journal] 13(2), pp.239-248. DOI: 10.18334/ce.13.2.39918.

Usov, N.V., Trofimov, O.V., Frolov, V.G., Makusheva, Y.A. and Kovylkin, D.Y., 2018. Assessment of innovative potential of priority industries of Nizhny Novgorod region. *Russian Entrepreneurship,* [e-journal] 19(10), pp.2921-2930. DOI: 10.18334/rp.19.10.39487.

Ustinova, L.N. and Sirazetdinov, R.M., 2017. Innovation potential of an enterprise: essence, structure, evaluation. *Russian Journal of Entrepreneurship,* 18(23), pp.3751-3764.

Wiener, M., Gattringer, R. and Strehl, F., 2018. Participation in inter-organisational collaborative open foresight A matter of culture. *Technology Analysis & Strategic Management,* [e-journal] 30(6), pp.684-700. DOI: 10.1080/09537325.2017.1376045.

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B.B. and A.N. – conceptualization; B.B., M.T. and T.K. – validation; A.N. – methodology, investigation, writing-review and editing; E.T. – software, funding acquisition; L.P. – formal analysis; M.T. – resources, supervision, project administration; B.B. – data, writing original draft preparation; T.K. – visualization.

CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.