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M. MYRZAKHMET[1], *Professor, Candidate of Physical and Mathematical Sciences, myrzakh@gmail.com*
Zh. MYRZAKHMET[2], *Associate Professor, PhD in Economics*
B. DUISEBAYEV[3], *Scientific Director, Doctor of Technical Sciences*

[1] *Almaty Management University, Almaty, Kazakhstan*
[2] *L. N. Gumilyov Eurasian National University, Astana, Kazakhstan*
[3] *Universal Design Technological Bureau LLP, Almaty, Kazakhstan*

WEBOMETRIC STUDY OF UNIVERSITY–BUSINESS–GOVERNMENT COLLABORATION POTENTIAL AT A REGIONAL SCALE: A CASE-STUDY OF THE MINING INDUSTRY IN THE ALMATY REGION IN THE REPUBLIC OF KAZAKHSTAN

This article studies activity and collaboration of universities, business and government in the Almaty Region of the Republic of Kazakhstan. The research is carried out by the webometric method. Large universities show more collaboration in the field of education, and small universities are focused on the local market are more active. In addition to the direct benefits due to increased flow of innovative content from universities in favor of industrial functioning, business can gain greatly from the creation of a special academic cultural environment at housing communities of miners. There is also a potential for the gradual transformation of the most prepared single-industry towns situated at mineral deposits into science cities with the help of regional universities. Actually, this means a certain confluence of a mining company and a university. The smart use of technologies coupled with more robust assessment can make a big difference in this environment. Even without major structural shifts, small modifications can lead to efficiency gains that bring large economic improvements. Eliminating bottlenecks inherent in individual mining companies within a territorial cluster with backing provided by a regional university can produce high marginal profits with relatively small additional investments. Integrating universities to mining activities and accompanying processes can significantly change the image and role of the mining industry. The expected economic effect from the closer collaboration between universities and mining companies can be illustrated by the performance of JSC Kazatomprom. Investments in the uranium science in the amount of 1% of revenue has provided the increase in the Company's in income by 3000% in 10 years. By assuming a rather conservative estimate of investment in university collaboration as 0.1% of the region's income, judged from the effectiveness of science and based on the above example, we get a growth of the gross regional product at least by 3% per year, even taking into account the fact that only every 10th project is successful.

Keywords: *structural shifts, university, mines, territorial cluster, region, webometric method, economic effect*
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Introduction

Literature describes models developed for the conceptualization of the university and business relationship, including the regional-scale innovation activities [1] and Freeman's national system of innovation [2].

The notion of the *triple helix government–university–business interaction model in the new knowledge generation and innovation promotion* was for the first time introduced in [3, 4]. The triple helix concept acquired critical significance in the last few decades in explaining an incipient economy of knowledge in the academic and political societies [5, 6]. The triple helix invoked rethinking of relevancy of universities and stimulated their involvement in economy, elevating the value of knowledge in the social development [7, 8]. The model provided a 'new stand of a university' as an equal participant together with government and business in creation and guidance of a society of knowledge, where the public–private partnership plays a predominant role in the national wealth improvement [9].

The importance of such collaboration between university and business for innovation and education is widely recognized [10] and grows in weight as many countries encounter an increasing competition on the global markets and enter the race for innovation and progress [11, 12]. The university–business collaboration is treated as transmission of knowledge between the university and the industrial enterprise and is considered as a top-priority field for the research and innovation policy development [13].

This study focuses on the performance and collaboration of university, business and government in the Almaty Region of Kazakhstan. The Almaty Region is situated in the southeast of the country. The administrative center of the region is Taldykorgan. The population of the Region is 2 059 200 (by the beginning of 2020). The chief university engaged in training of mining engineers is the Kazakh National Research Technical University—the Satbayev University.

Data and methods

The study uses the webometrics method [14] when the potential of an organization is assessed as the number of opened pages on web browser when searching by its name. For determining interaction of factors, the number of webpages containing the factors on the website (search line "factor_1 factor_2 site:[website]") is counted.

There exist three models of innovation processes: command-and-administration, market and triple helix [15]. The university's activities are categorized as education, science and business.

Here, we use a simplified variant when the key words are education (E), science (S) and business (B) [16].

The research subjects are the Satbayev University (satbayev.university), Almaty Region (site:kz, gov.kz/memleket/entities/jetysu) and the mining companies operating in the Almaty Region. All other objects are used for the purpose of comparison.

The innovation potential of the university is the product of the activity index A and collaboration index C. The activity index A is the overlapping area of the circles of education, science and business, calculated as the sum of the circles with deduction of their pairwise overlaps and addition of the triple overlapping. Thus, $A = E+S+B–ES–EB–SB+ESB$.

The collaboration index C is the optimization of the overlapping of the circles, when the optimal overlapping equals the half area of a circle as the other variants reduce collaboration. In this study, we use one of the most suitable functions for this—a cosine. In this manner, the collaboration index is a product of cosines, namely, cos(ES/E–0.5)·cos(ES/S–0.5)·cos(SB/S–0.5)·cos(SB/B–0.5)·cos(EB/E–0.5)·cos(EB/B–0.5).

The data are taken from the Internet using the Google Chrome search engine. Usually, E, S, B > ES, EB, SB > ESB. Such relations sometimes hold untrue because of how the search engine functions. In those cases, the number of opened webpages was reduced to match the highest expected value.

The potentials are calculated as the multiplication of activity, collaboration and the logarithmic ratio of a website volume to its least value in some power: $IP = A \times C \times LOG(N;N_{min})^7$. The power is selected so that the subject with a clearly high potential is never the weakest. In this study, we select the power of 7.

The list of mining companies (subsoil users) can be found on the website of the Electronic Government [17], and their financial performance is described in the database of the Ministry of Finance [18].

The computation and graphical plotting use the data analysis and visualization program R [19].

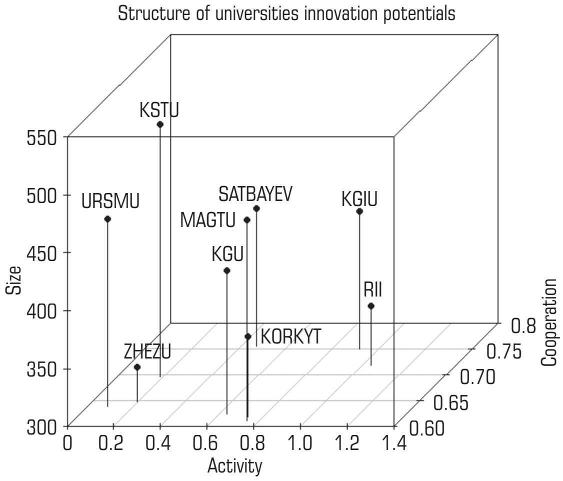

Fig. 1. Innovation potential of test universities

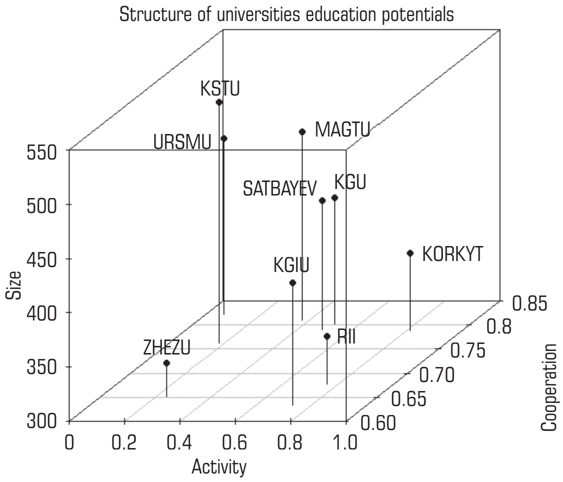

Fig. 2. Education potential of test universities

Results

Figure 1 presents these universities in the space of collaboration (y-axis), activity (x-axis) and size (z-axis). The size is determined as the log number of the opened webpages to the university's website. The vertical lines are intentionally drawn from the points xyz, standing for the test universities (names abbreviated nearby), down to the plane xy to help the readers to orient themselves in the three-dimensional space. The three-dimensional presentation fits the triple helix concept where the size, collaboration and activity mean the government, business and science, respectively. The larger universities are less innovative both in terms of activity and collaboration. The smaller universities, such as RII, are more active and cooperative. Accordingly, the smaller-size Karaganda and Rudny Industrial Universities (KGIU and RII) possess the highest innovation potentials.

Figure 2 depicts the similar trend—the larger universities are more cooperative but less active or even inert.

In the field of education, the large universities demonstrate the stronger collaboration so that we can state that a university is more aligned to its preferences and at the governmental requirements (government issues educational grants) when preparing and implementing educational programs rather than at the market or employers' desires. Therefore, the smaller universities oriented at the local market are naturally more active. The Satbayev University has the highest index of collaboration and the median activity.

Mining and metallurgy

By the data on the website of the Electronic Government of Kazakhstan, more than 50 companies possess the right to carry out geological exploration and extraction of minerals in the territory of the Almaty Region of Kazakhstan.

We filtered out all companies which are listed on the website of the Region but have no financial reports in the database of the Ministry of Finance. As a result, we have 11 big-league companies in the Region. The innovation potential determination uses the key words of innovation, project and mine.

The procedure for determining the innovation potential of mines differs from the procedures for the universities and the region (below) since mining companies have weak and flawed websites (or have none at all) and their names are rarely encountered on the websites of universities and of the Region. For example, JETYSUGEOMINING company concentrates more on collaboration while Tau-Ken Samruk focuses on activity. Most companies have weak performance in both areas.

Which obvious and hidden benefits can mining companies have from active collaboration with universities? Complimentary to a tangible benefit from the increased innovative content fed by universities to the good of industrial performance, mining companies can greatly gain from the academic cultural environment created in the housing communities of miners. These are, as a rule, small settlements, or neighborhood centers at best (an exception is some singular large metallurgical plants at the regional centers such as Oskemen, Pavlodar, Aktobe or Kokshetau), or even shift camps meant for the temporary residence of miners in house trailers. Naturally, it is yet impossible to make such locations university towns. However, it is feasible to turn stage by stage the most prepared monotowns situated at mineral deposits into science cities with assistance of regional universities. This matter is anticipated to be an issue of survival of both towns and mining industry in the near term, connected with conversion of the currently gigantic outflow of people from such towns to an inflow of labor, especially young people. Such towns with high potential to become science cities are, for instance, Stepnogorsk in the Akmola Region, Zhitikara in the Kostanai Region, Shieli in the Kyzylorda Region, Kentau in the Turkestan Region, or Temirtau and Zhezkazgan in the Karaganda Region. To this effect, mines, universities and local authorities should pool their laborious efforts using the approaches discussed in this article. Actually, this is a point of splicing of a mine and a university. Being successful in this respect, Navoi Mining and Metallurgical Integrated Works wholly finances the Navoi State Technical University, and the Company's CEO acts as a rector of the University. Or, for instance, in the Soviet period, Zhezkazgan Copper Plant (formerly Zhezkazgantsvetmet) integrated both the mining and metallurgical works and a sectorial research and design institute. Such experience should certainly be used in our new conditions toward innovative advancement of the country.

Region

The regional innovation potential assessment used the key words of local government, project and services. Collaboration is best developed in the Almaty, Kostanai and Kyzylorda Regions, while the Karaganda Region demonstrates the highest activity (**Fig. 3).** Russian regions feature low collaboration and median activity. We emphasize that our calculations are not for any ranking purposes. The regions of Russia are taken for the comparison, as industrial areas in the northern neighborhood of Kazakhstan.

The calculation of the resource potential of regions included the key words of technology, capital and labor. The Kostanai and Akmola Region show the higher collaboration and activity (**Fig. 4**).

In the competitive environment of the free market, economy underlays any choice—either in mineral exploration, in mine planning, design and operation, or in mineral finance and marketing. The mining sector is an interdisciplinary industry and it dictates any operation to obey certain guidance or requirements as any industry with cross-coupled disciplines.

Mineral mining gets to increasingly deeper levels, it becomes more difficult to strike and extract minerals, while labor efficiency grows. It is critical to preserve the available resources and to focus on processing of secondary metals and using unconventional, especially renewable sources of energy. Since 1950 and for 30 years, metal production has overrun metal reserves available in 1950. Still, by 1980 metal resources exceeded even more the startup reserves. Even today, under conditions of higher productivity and more rigorous definition of what a reserve is, the current reserves of iron are expected to last for 26 years while other mineral reserves – even longer [20]. In terms of the most raw material products, the volume of resources increases both generally and by years of production.

Accordingly, for those engaged in engineering and economic evaluation in the mining industry, the present day offers many opportunities to undertake sophisticated and very interesting research and advance regarding the whole range of minerals.

After the previous period of expansion, the mining industry has now entered the phase of efficiency and cost optimizations. There are plenty of opportunities out there. The feasibility of adding a higher economic value appears already at the start of projects and at the moment when some foundational changes take place in mines, particularly, changes that facilitate re-capitalization after modification of the proprietary rights or of a mineral mining method. A reasonable use of technologies in combination with more reliable estimation procedures can produce higher benefit in such environment.

Operating mines also have many opportunities to introduce modifications and have a high profit. Even without serious structural shifts, moderate reformations can stimulate effectiveness and bring larger economic improvement. New mines begin operating with a limited knowledge on many factors such as the composition of an orebody, mining and processing constraints and the market demands. All details become known better in the course of operation. Revision of the mine performance aspects for the purpose of operation regulation (often this means elimination of bottlenecks) can produce high marginal profit at the comparatively low additional investment. Participation of universities

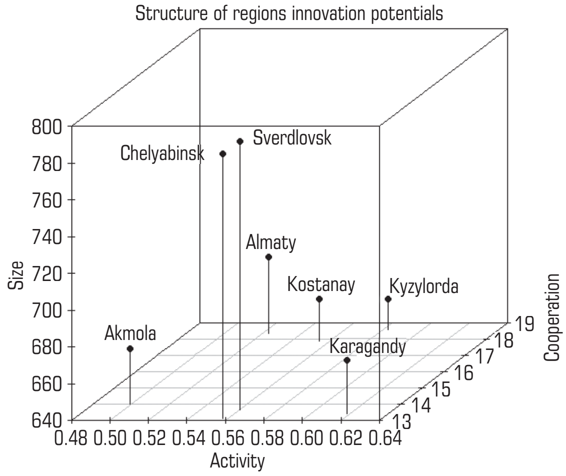

Fig. 3. Structure of innovation potential of regions

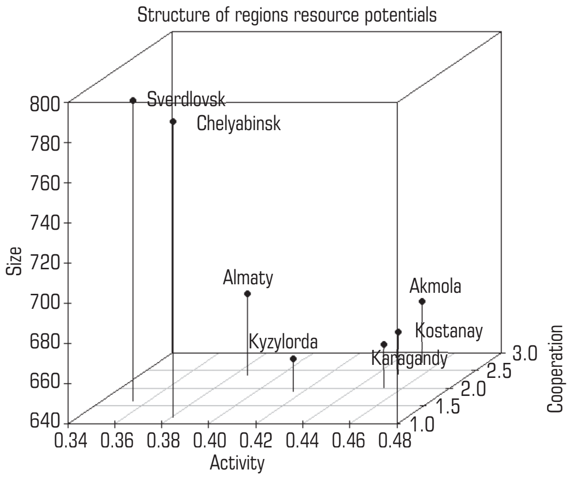

Fig. 4. Structure of resource potential of regions

in mineral mining and in the by-processes can change considerably the image and role of the mining industry for better.

Kazatomprom performance is a bright illustration of the economic effect of the close university and industry collaboration. The Company's investment in the uranium science in the amount of 1% of the revenue has resulted in the growth of income by 3000% in 10 years. By assuming a conservative estimate of investment in university collaboration as 0.1% of a region's income and on the basis of effectiveness of science, it follows from the above-given example that the gross regional product increases by not less than 3% every year even if only each 10th project is fruitful.

Conclusions

For more active participation in regional development by universities, they need to act as either a research or interactive university. So, we can only speak about lean. Universities having developed websites trend more to collaboration and are inert in terms of activity. On the other hand, smaller universities are more active. Weaker collaboration or activity in the field of education means that a university orients itself more at its own preferences and at the government demands (as government issues educational grants) when preparing and implementing educational programs rather than at the market and at the wishes of employers. For this reason, the smaller universities oriented at the local market are naturally more active. The regional scale universities should enhance their structural flexibility (intra-collaboration of factors) and arrange broad collaboration with regional mines.

Mining companies may gain much from creation of a special academic cultural environment at residential communities. Furthermore, such communities as monotowns situated at mineral deposits have a high potential to turn stage by stage into science cities with the help of the regional universities. The mines, universities and local authorities should mass their coordinated and diligent efforts to this effect using the approaches we have discussed in this article. This virtually means splicing of a mine and a university. Engagement of universities in the mineral mining and by-processes can drastically improve the image and role of the mining industry.

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