The specifics of training for the industrial sector in the context of digitalization

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Abstract. The article provides an overview of the main trends in training for the industrial sector of the economy in the context of digitalization. The purpose of the article is to develop methodological tools for identifying areas of development of the knowledge economy in industrialized countries. Based on the methodology of cluster and correlation-regression analysis, the positioning of national economies in the theoretical space was carried out on the basis of indices - International Talent Index (GTI) and the Knowledge Economy Index. Based on the study, it is shown that, according to integral indicators, the position of the Russian economy in terms of the level of intellectualization and digitalization of the economy requires increasing financial, institutional and staffing to increase its competitiveness and adequacy to the trends of the global industrial system. The materials of the article can be used in the development of the main areas of training for the industrial complex of the national economy in the context of its digitalization.

1. Introduction

The most promising from the point of view of ensuring competitive advantages in the modern world is an innovation-oriented economy, in which the main contribution to the growth of gross domestic product is provided by the sphere of scientific and technological innovative production, and the intellectual resources of society become the main productive force. A system identified with the sixth technological order is often referred to as the knowledge-based economy, or as the knowledge economy.

A characteristic feature of this stage of economic and social development is integrated knowledge, which is embodied in systemically integrated clusters of innovative development of economic systems. At the same time, the necessary condition for transforming scientific knowledge into innovation is the quality of human capital - the corresponding susceptibility of human resources to new knowledge and their willingness to transform knowledge into economic benefits.

The essence of any economic category is always manifested through functions. The analysis of theoretical and methodological approaches allowed to systematize the basic functions of intellectual capital in the knowledge economy. These may include:

- reproduction function - increasing output volumes while increasing the quality and competitiveness of products;


• an incentive function - the possibility of appropriating innovative rents;
• economic function - achieving high labor productivity, ensuring innovative economic growth;
• social function - improving the quality of life of the population;
• synthesizing function - ensuring the interconnection of science and production in order to
develop the economy, consolidation of innovative potential into a single transforming resource;
• the function of ensuring technological safety.

The strategic objective of modern economic systems is the transition to a knowledge economy, which
is characterized primarily by the increasing profitability of social production: reduction of labor costs
and means of production per unit of value added; achieving high labor productivity in the real sector of
the economy. All economic development is significantly improving, the scientific and technical level
and quality of products are steadily increasing, and criteria for assessing the quality of life of the
population are changing. One of the trends in the knowledge economy is its digitalization, which
determines the relevance of the subject of this article.

2. Materials and methods
In the context of the transition to a digital economy, the national and regional community is most
urgently faced with the problem of training personnel endowed with the necessary professional
competencies to solve problems of an applied practice-oriented nature in various sectors of the economy.
According to the federal project “Personnel for the Digital Economy” of the national program “Digital
Economy of the Russian Federation” [1] the number of graduates of the vocational education system
with key competencies in the digital economy should increase 3.5 times from 2018 to 2024 - from 230
up to 800 thousand people; the number of specialists retrained in the competencies of the digital
economy as part of additional education - 5 times - from 200 to 1000 thousand people (figure 1).

![Figure 1. Personnel for the digital economy (thousand people, from Federal project "Personnel for the digital economy" of the national program "Digital Economy of the Russian Federation" https://files.data-economy.ru/Docs/Pass_EduHR.pdf).](image)

Within the framework of this program document, it is also expected to increase the share of the
population with digital literacy and key competencies of the digital economy from 26% in 2018 to 40%
in 2024 (figure 2).
In this regard, the development of new approaches to training for the digital economy is required. One of these areas is advanced training for various sectors of industry. The relevance of this issue is also confirmed by studies that allow us to conclude the impact of human resources on the increase in the number of highly productive jobs in the industrial sector of the economy: modeling innovation economy [1], research and technological capacity of Russia as an indicator of knowledge economy growth [2], digital entrepreneurship: toward a digital technology perspective of entrepreneurship [3], potential biases from quality change and new goods in an age of digital technologies [4], general education, vocational education, and labor-market outcomes over the lifecycle [5].

To comprehensively display the state of the potential of the national economic system in the development of a knowledge-based digital economy, you can use the International Talent Index (Global Talent Index http://www.weknowglobaltalent.com/gti/window/gti) and the Knowledge Economy Index (The Knowledge Economy Index http://www.worldbank.org/kam).

To analyze the level of development of the knowledge economy in the context of its digitalization in the context of the countries of the world, we propose to use the cluster analysis method, namely, the K-means method. Also in the article, discriminant and correlation analysis are used.

3. Results and discussion

Based on the goals of research on the innovation and modernization development of economic systems, using the integral values of the talent index and the knowledge economy index based on matrix positioning using cluster analysis, the position of 30 economies of the world in the theoretical space of RTI, KEI was determined.

At the first stage of the analysis, the partial correlation coefficients were calculated for the studied indicators, which showed a rather high and statistically significant relationship - the correlation coefficient was 0.75 at a 5% significance level. This means that, collectively, these indices reflect a generalized characteristic of the development of a knowledge-based economy, where the talent index is the potential of the system that can accumulate the necessary intellectual capital, and the knowledge economy index is the result of using intellectual potential.

At the second stage of the analysis, we conducted a dynamic matrix positioning of national economies by integral indices using the K-means method in 2007 and 2017.

In accordance with the values of the talent index and the knowledge economy index, in 2007 the cluster of countries leading innovation development was represented by the United States, Canada, the Netherlands, and the United Kingdom. This group of countries has the best characteristics of intellectual capital and a knowledge-based economy. They are characterized by: high quality education, labor market flexibility, high investment and intellectual attractiveness, the development of the ICT sector, and an effective institutional structure.
In 2017, compared with 2007, the relative position of national economies in the theoretical space of $R^{GTL, KEI}$ as a whole did not undergo significant changes.

The clustering of national economies in dynamics has shown the stable position of countries in terms of the talent index and knowledge economy index, which allows us to talk about maintaining a stable and long-term nature of innovative development. In addition to the leading countries, the economies of India and China have formed into a separate cluster, which can be described as a “cluster of breakthrough innovative development,” thanks to the highest value of the talent index among the countries under consideration. The economies of Saudi Arabia have improved their position by moving from a cluster of outsiders for the development of a knowledge economy to a cluster of “slaves” and Mexico from “slaves” to the middle group for innovative development. According to the results of 2017, Russia is included in the group of countries with an average level of development of the knowledge economy along with Poland, Italy, South Korea and others.

To assess the adequacy of the selected classification method, we conducted a discriminant analysis of integral indicators. In this case, Wilks lambda was used as a statistic for the criterion of significance of correlation. The differences between the averages of the six selected clusters were significant. The largest contributor to discrimination is the knowledge economy index (table 1).

**Table 1. The Equality criterion of group means.**

| Index                | Lambda Wilkes | F statistics | Significance |
|----------------------|---------------|--------------|--------------|
| International Talent Index | 0.134562      | 41.6         | 0.000        |
| Knowledge Economy Index            | 0.046713      | 11.4         | 0.000        |

It should also be noted that the a priori classification by the method of identifying a typical cluster using K-means for the integrated indicators of the talent index and the knowledge economy index was confirmed by classification using discriminant analysis. Discrepancy i.e. the assignment of the country to another cluster in the border areas occurred in only two cases out of 30, which allows us to talk about the reliability of the clustering.

**4. Conclusions**

Thus, training for industry in the context of the digitalization of the economy can be based on the following provisions.

1. Network and cluster initiatives in technology areas. They suggest the introduction of an open innovation model for the region, including a transfer of world-class developments; Triple Helix and RIS models - networkization of science, education, production. The Triple Helix model of innovative development includes three main elements: science, business, and the state. RIS - “Research and Innovation Strategies for Smart Specialization.”

2. Creation of industry engineering centers. It suggests the implementation of the following areas: harmonization of existing industries in the region with the challenges of technological development of the global economy and the Russian economy; introduction of the University 3.0 model. "University 3.0", which includes the number of university missions: University 1.0 - only an educational institution; University 2.0 aims at teaching and research; at university 3.0, the commercialization of knowledge is added to the last two missions.

3. Project-oriented training programs for the real sector of the economy. The key objectives of this strategic initiative are: educational support for the life cycle of innovative projects of new technological structures in the format of preparing multidisciplinary project teams; lifelong education and educational services for the population of the region, increasing the human (intellectual) capital of the region; dual training in technology entrepreneurship.

4. Youth technological entrepreneurship. This direction involves the implementation of an innovative elevator / career mechanism for technostarters. Technostarters - students or teachers who have established their own research or technology companies.
We suppose that the indicated measures will allow us to form a reserve for raising the level of education of workers and the potential personnel of the industrial complex, taking into account new trends in the digitalization of the economy. Strengthening the integration of science, business, the state and education will increase the synergistic effect of digitalization in accordance with the requirements of the new economic reality.

Acknowledgments
The reported study was funded by RFBR, project number 20-010-00655.

The research was carried out within the framework of the grant of the President of the Russian Federation for state support of leading scientific schools of the Russian Federation, project number NSh-2600.2020.6.

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