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Key competences of industry professionals in the digital economy

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***Abstract*—The ongoing digital transformation of the economic and social life of society has led to a change in the models of competence development, which are based on systematic knowledge about the nature of digital technologies, cloud computing and cognitive technologies, Big Data technologies, Internet of Things and "SMM-promotion". In the course of the study, the list of key competencies was defined and systematized which are in demand in the context of economy digitalization; additional competencies for specialists with a managerial position were identified; the list of significant features of the digital economy in the agricultural sector was expanded. It is noted that the interrelation and interdependence of social and technical processes of agrarian production determine the formation of hybrid competencies associated with the ability to analyze the impact of technological trends on the business processes taking into account industry-specific features; develop and implement solutions for digital transformation of production taking into account environmental and social risks of digitalization. Evidence-based analysis of empirical data obtained during online testing confirmed the relevance of the proposed digital competencies and revealed the majority of respondents' incompetence (except for IT-specialists) in the field of digital technologies application. The obtained results confirm the need to update the content of higher education professional educational programs and professional development of teaching staff in accordance with the needs of digital economy and can become a starting point for the development of continuous training system of industry professionals for the digital economy.**

Keywords—competences, digitalization, economy, agriculture, training.

I. INTRODUCTION

IT development and globalization of society have led to a modification of economic activity, the development of global competition in business, an increase in the speed of information flows, electronic communications and documents. There are organizational changes in the structure of enterprises that become geographically distributed, spatially localized, network and virtual. The integration of enterprises takes place on the basis of horizontal communication between Russian and/or foreign partners. Business processes which take place at the enterprise are not conceivable without automatization and reengineering. The share of information component in the structure and cost of fixed assets (information technology, software, databases) is increasing. There are changes in the nature and structure of the workforce: the proportion of workers engaged in information activities, working remotely or as a freelancer. The speed of decision-making, mobility in communication with partners and customers, constant monitoring of market needs, relevance, reliability and timeliness of the analyzed information are becoming increasingly important for the effective management of the enterprise. The ongoing transformations cause the transition to digital information of all aspects of economic and social life, which is recognized as the driver of the current stage of world social development, ensuring the efficiency of the economy and improving the quality of life. The digital economy – this is a set of relationships that develop in the processes of production, distribution, exchange and consumption, based on online technologies and aimed at meeting the needs for life benefits [1], which, in turn, involves the formation of new ways and methods of management and requires effective tools of state regulation. The significance of this trend of economic development is confirmed by the development of the program "Digital economy of the Russian Federation" (Governmental Executive Order of the Russian Federation dated July 28, 2017 №1632-P), one of the aspects of which is "Digital agriculture" [2]. The background for industry digitalization are a large amount of information (intensive data flow); the need for innovative solutions that can be found on the basis of digital information and can lead to the optimization of business processes in the industry, reducing costs and the emergence of new sources of industry revenue [3]. Thus, according to the Director of the Department of Development and Management of Public Information Resources of Agro-Industrial Complex of the Ministry of Agriculture of Russian Federation I.S. Kozubenko, through the introduction of digital tools in crop production and livestock (precision farming, vegetation control, digital field, etc.), increase productivity and full use of modern digital platforms for management at macro- and local levels of production efficiency of agricultural production can increase at least three to four times in index terms [4]. It is noted that the integrated digitalization of agricultural production will reduce costs by 23%. Thus, the effect of the use of precision farming technologies is 11-14%, differentiated fertilizer application – 8-12%, the use of parallel driving systems – 8-13% [5]. According to experts, IoT solutions (Internet of Things) and digitalization in agriculture will bring a total economic effect of 4.8 trillion rubles per year or 5.6% of GDP growth in Russia [6]. At the same time, the volume of information technology consumption can grow by 22%, only due to the digitalization of one enterprise – agriculture. It is noted that the transition of agricultural organizations to digital systems will improve safety and improve working

conditions in enterprises (work with pesticides, toxic chemicals, fertilizers, etc.); improve the quality of agricultural products; creation of employment in related industries involved in the production of electronic components of equipment, software [7].

The penetration of new technologies into the production process is always associated with the demand for new competencies. At the same time, it is noted (L.V. Lapidus) that the mass character of transformations and inertia of the education system lead to "staff shortage" in the labor market, which is the main inhibiting factor in the launch of reforms. Currently, there is a growing demand in all sectors of the economy for experts on working with cloud systems, Big Data, Agile, artificial intelligence, machine learning. Thus, according to the analytical center of the Ministry of Agriculture of Russian Federation, the lack of IT-specialists in the agricultural sector is at least 90 thousand people; there is a lack of industry specialists able to work with computer programs and their applications [4]. Therefore, the problem of the formation and expansion of the digital economy competencies is actualized.

II. Literature Review

To determine the methodological basis for the design of digital competence models, we consider the essence of the key concepts of "digitalization" and "digital economy". The analysis of scientific literature revealed ambiguity of interpretations of the definition of "digitalization" by representatives of scientific and professional communities: the result of the introduction and further development of information and communication; the era of big data and technologies based on them; as a new paradigm of thought, communication, interaction with each other and society; a new stage of society development, based on the digital form and leading to an increase in the efficiency of the economy and the population life quality; a special approach to the use of digital resources to improve business processes, the working environment, interaction with partners and other employees of a distributed enterprise; a comprehensive solution of infrastructure, management, behavioral and cultural nature [3, 8-11].

In terms of economic activity, the term "digital economy" (alternative options: Internet-economy, Web-economy) is widely used. Doctor of Technical Sciences, Professor of RAS R.V. Meshcheryakov distinguishes two approaches to the definition of this concept: the first focuses on the economy based on information technologies (for example, online learning); the second – on digital technologies used in economic production [12]. Doctor of Economics, Professor L.V. Lapidus focuses on new relationships emerging in the processes of production, distribution, exchange and consumption, based on online technologies and aimed at satisfying the requirements the essential demand [1]. The authoring team headed by A.V. Keshelava makes an attempt to combine these points of view and defines the "digital economy" (which he considers to be correctly called electronic) as an economy existing in the conditions of the merger of the real and virtual worlds, with the possibility to perform all "vital" actions in the real world through the virtual one. Researchers refer to the main tools of this "hybrid world": online trading, bank transactions, messengers, forums and chat rooms, social networks, online games, augmented reality. They predict the strongest impact on society and the "digital economy" of cognitive and cloud technologies, on "Internet of Things" and "Big Data" technologies [13]. In the works of the Doctor of Economic Sciences, Processor S.A. Dyatlov the "digital economy" is called "neural network", which emphasizes the importance of neural networks for the development of digitalization; it is noted the emergence of a new class of neural network effects the effective management decision making in the context of large-scale digitization and transition of management structures into global network [14]. At the moment official and accepted at the government level in Russian Federation is the definition of the digital economy as an economic activity, a key factor in the production of which are data in digital form.

The analysis of the presented views on the essence of the "digital economy" concept and the materials describing this phenomenon allows us to identify a number of conditions under which the conventional economy can become a digital one: developed IT-infrastructure that provides high-speed multi-channel Internet; commitment of business processes to the use of modern cloud technologies; transformation of documentation into digital form and creation of global databases even without knowledge of enterprise bases; providing employees with the necessary knowledge and work skills with digital and cloud technologies.

According to scientists (L.V. Lapidus) the "digital economy" has already passed the period of formation (1990-2005), characterized by the development of e-business and commerce; the period of explosive growth of digital products and e-services (2005-2010); the period of maturity and penetration of digital technologies in traditional business. The current stage of digital economy evolution – the "digital fever" is characterized by chaotic restructuring of business processes and transformation of business models, which is confirmed by increased attention to this phenomenon in media, science, production and education spheres. According to 2015 data, the share of the "digital" segment in the Russian economy is 3.9% of GDP, the list of industries that have embarked on digitalization (education, oil and gas industry, etc.) is expanding [15]. Establishment of the program "Digital economy of the Russian Federation" indicates the onset of a new stage in the development of the digital economy (2020-2030) – the stage of system transformation focused on qualitative system shifts, the search for new mechanisms and tools for the participation of the state, business and every citizen in the development of the digital economy, what, according to experts, will lead to a staff shortage who possess the competencies of the digital economy [1].

The analysis of scientific works [1, 13] allowed to emphasize the most significant competences for any specialist of the digital economy and to group them in the following way:

- intellectual competences: knowledge of analytical skills, ability to critical and flexible thinking, ability to intellectual interaction with specialists from different fields (transdisciplinarity);
- activity competences: multitasking and complex problem solving skills, ability to work creatively, ability to work together in international teams, heterogeneous in professional profile, gender, value orientations (multi-team);
- digital literacy competencies: skills in working with cloud and web-technologies, the ability to effective

online communication, skills in working with digital platforms, the ability to apply knowledge about the opportunities and risks of digital technologies in various spheres of life;

- technological competences: possession of working skills with Big Data technologies, the ability to SMM-promotion of the professional activity products, possession of programming skills.

For specialists with a managerial position, researchers identify additional competencies: the ability to organize teamwork and achieve a synergetic effect through the potential of the collective intelligence; the ability to build an ecosystem of activities taking into account the risk of cyber security, duplication and synchronization of "Big Data", interoperable information systems.

Based on long-term personal experience in the implementation of professional educational programs in the following fields of study: "Applied Informatics in Economics", "Organization Management", "Enterprise Economics, Finance and Credit", "State and Municipal Management" in the field of mathematical disciplines and science, we consider it necessary to expand the list of competencies: possession of skills of schematic thinking, the ability to model business processes and systems for industry purposes, the ability to perform joint professional activities in the global network, the ability to apply in professional activities the technology of Internet of Things.

It is obvious that the allocated competencies of the digital economy are basic for specialists in all sectors of the economy, including agriculture. At the same time, to minimize the risks of digitalization of the economy and possible negative consequences, in our opinion, it is necessary to take into account the regional characteristics and specifics of certain industries. Thus, in the agricultural sector, which has a high potential for digitalization, the rapid transition to mass transformations should be justified by investment decisions, and not "the pursuit of indices", to which some experts are trying to link the assessment of the level of digitalization of enterprises and regions, while ignoring the social (unemployment growth in regions with city-forming production systems, migration outflow of rural residents, etc.) and environmental factors (preservation of the landscape, water resources, biological diversity, prevention of soil erosion, etc.). Thus, the significant features of the digital economy (collaboration: "man-man", "man-machine", "machine-machine") in the agricultural sector are complemented by a new collaborative process "machine-man-nature". The relationship and interdependence of social and technical processes of agricultural production lead to the formation of hybrid skills (technical+economic+industrial) which are connected with the ability to analyze the impact of technological trends on business projects with regard to field specific character; to develop and implement solutions for digital transformation of production taking into account environmental and social risks. Note that, in terms of technological progress, the problem of reproduction of personnel for the agro-industrial complex grows from economic and political to social phenomenon with the dominance of human-centered orientation.

III. Research Methodology

As a part of study methods of theoretical analysis and synthesis of scientific literature, empirical methods (overt observation, questionnaire), qualitative and quantitative methods of scientific information processing were used.

IV. The practical significance, the suggestions and the implementations' results, the experimental studies' results

To establish the truthful overview of the digital economy competencies' formation in modern specialists and identify the most important of them, an online survey was conducted. The questionnaire contained three main questions: "About what digital technologies do you know?"; "What competencies should be formed in modern specialists for the development of the digital economy?"; "Which of the proposed competencies do you own?" 230 people participated in the survey, representatives of various fields: education and science (48.2%), management and event-management (10.4%), accounting and auditing (14%), IT-management and SOFTWARE development (18.6%), oil industry (2.3%), digital (3.4%), agricultural production (3.1%). Almost half of the respondents are involved in vocational education (48.2%), a little more than a half – to the economic sphere (51.8%), of which 22% – representatives of the IT. An average experience in these fields is – 11 years (education – 16.5; audit and accounting – 12.5; management – 11; IT – 5; oil industry – 2, agricultural production – 20). The female part of the respondents was 55%, which indicates the gender balance of the setting; 90% of respondents are under the age of 45 years and a third of them are under the age of 30 years, i.e. respondents represent the main layer of specialists, which will account for the planned period of systemic transformation of the economy (2020-2030).

Based on the analysis of the collected empirical material, the following results were obtained. Among digital technologies (cloud, cognitive, Big Data, Internet of Things, SMM-promotion) the surveyed audience identified "cloud" technologies as the most well-known and used in activities (65% – own, the rest – understand the essence and purpose). The least known to respondents are cognitive technologies (73% have heard nothing or heard something about them) and SMM-promotion (58% have heard nothing or heard something about them). Big Data and the Internet of Things hold a middle position: half of the respondents know well about these technologies, while 31% and 15% of the respondents use in their professional activity such technologies as Big Data and Internet of Things respectively. It should be noted that the greatest contribution to the knowledge and use of these technologies is made by IT-professionals, due to their professional affiliation.

All respondents have the opinion that it is necessary to form most of the proposed digital competencies, what, in our opinion, is associated with the awareness of the competitive advantages of such specialists. The distribution of competencies by the number of respondents who chose them allowed to form groups of competencies (see table 1).

Thus, the respondents confirmed the need of formation of the declared competencies, with the exception of one "formation of programming skills". The opinion of respondents partly coincided with ours. We proceed from the fact that modern programming is a complex, multi-stage process of developing information systems (analytics, design, coding, testing), in which a team of IT-professionals takes place. Most likely, the researchers, highlighting this type of

competence, had in mind a certain cultural level of understanding of this process essence.

TABLE I. THE RESULTS OF THE SURVEY ABOUT MODERN SPECIALISTS' NEED OF DIGITAL COMPETENCIES FORMATION

Group	Number of respondents who noted competence	Competences
The vast majority	from 90% to 100%	Analytical skills, the ability to interact intelligently with experts from different fields, the ability to work with cloud and web-technologies, ability to work with Big Data technology, the ability to communicate online, the ability to apply knowledge about the opportunities and risks of digital technologies in their activities, the ability to model business processes and systems for various purposes, the ability to perform joint professional activities in the global network
The vast majority	from 80% to 89%	Ability to critical thinking, multitasking and integrated problem solving skills, ability to work together in international teams, schematic thinking skills, ability to perform professional activities with the help of Internet of Things technology
Most of them	from 60 to 79%	Ability to creative activity, ability to SMM-promotion of professional activity products
Half	from 50% to 59%	Programming skills

The question about the availability of such competencies among the respondents showed that the respondents possess the least: the ability to SMM-promotion of professional activity products (19%); the ability to work with Big Data technology (27%), the ability to perform professional activities with the help of Internet of Things technology (34%). Mainly representatives of IT and digital spheres possess the above competences. According to the self-assessment of respondents, most of them lack: the ability to apply knowledge about the opportunities and risks of digital technologies in their activities; ability to model business processes and systems for various purposes; ability to work together in international teams. Other competencies, according to respondents, to a variable degree have been formed. Thus, reaffirming the need for digital competences' obtaining, most respondents do not possess them. The main reasons for this situation may be: the "youth" of the technologies themselves; the complexity of their independent development; the objective assertion of training. The latter is confirmed by the results of the analysis of respondents' answers related to education: 65% of them own "cloud" technologies; Big Data, Internet of Things technologies – less than 10%; cognitive technologies and SMM–promotion – less than 5%. It is obvious that in order to provide the digital economy with competent personnel, it is necessary to change the content of training programs, improve the skills of the teaching staff in the field of digital technologies.

SUMMARY

The analysis of scientific literature revealed that the ongoing digital transformation of economic and social life of society has led to a change in the models of competence development, which are based on systematic knowledge about the nature of digital technologies, ownership of cloud and cognitive technologies, Big Data technologies, Internet of Things and SMM-promotion. In the course of study, a list of key competencies in demand in the context of digitalization of the economy in general and agricultural sector in particular is defined and systematized; the list of significant features of the digital economy in the agricultural sector was expanded by the introduction of the new "man-machine-nature" process. For the effective development of the digital agriculture is necessary the formation of the hybrid competencies associated with the ability to analyze the impact of technological trends on business processes taking into account industry-specific features; to develop and implement solutions for the digital transformation of the industry taking into account environmental and social risks of digitalization. The analysis of empirical data obtained during on-line testing confirmed the need to form the majority of the proposed digital competencies and revealed the incompetence of the majority of respondents (with the exception of IT-specialists) in the field of digital technologies' use. The results confirm the need to update the content of professional educational programs of higher education and professional development of teaching staff, in accordance with the needs of the digital economy. The results can be a starting point (target component) for the development of a system of continuous training of industry professionals for the digital economy.

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