Development of methodologies of innovation management for digital agricultural enterprises

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Abstract. Digital transformation is gaining its momentum in all industries. On the one hand, agriculture is usually considered as an outsider industry in terms of digitalization. On the other hand, during the last decade several countries have managed to improve the quality of agricultural industry and solve many of its problems with the use of modern information and digital technologies. In Russian Federation the Ministry of Agriculture announced the national project “Digital agriculture”, however the Projects is hard to release due to the lack of employees with decent soft and digital skills which are essential to the process of digital transformation. There are several models and frameworks of digital competences management, but none of them considers the specifics of agricultural sector. Thus, authors in this pre-research article justify the necessity to develop adaptable methodology for innovation management via various types competencies (hard, soft, digital ones) based on preliminary investigation of problem and solutions used in other countries.

1 Introduction

The economy digitalization is now spreading across countries. According to the McKinsey forecast, by 2020 digitalization will provide from 19 up to 34% of Russia's GDP growth, and the share of the digital economy will be around 8-10% of the country's total GDP [1]. Businesses in most industries are trying to go digital as quickly as possible - partly due to the high speed of development of "disruptive" information technologies as well as the necessity to be closer to the consumer. For such a change in the organization, there is a term: "digital transformation" – a fundamental transformation of companies’ products and services, as well as their business models using information technology.

Traditionally, agriculture does not belong to digital spheres [2] and ranks last among the industries in terms of innovativeness [3]. Over the past decades, it was common for agricultural companies to automate production and management processes (via implementation of information systems [4]). Automation in agriculture affects both

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production processes (drainage and irrigation of soils, sowing and fertilizing, harvesting and sorting of crops, milking and shearing of livestock, etc.), and managerial ones (enterprise resource management, accounting etc.). As a result, such automation has allowed [5]:

- to increase the speed of processing information and cut time on for repetitive tasks,
- to increase the transparency of managerial processes,
- to store, process and control large amounts of information,
- to automate manual monotonous work,
- to reduce production costs,
- to reduce the number of errors in processes,
- to increase the speed of decision-making by quickly obtaining the necessary information.

During the season, a regular farmer has to make more than 40 different decisions: what crops to plant, when to plant, how to process them, how to treat a diseased plant, how to cope with harsh weather conditions and climatic situations [6]. The lack of information for decision-making can lead to potential 40 % loss the harvest during planting, growing, care for crops. Other 40% can be lost during harvesting, storage and transportation.

At the same time, it is claimed that apart from uncontrolled weather conditions up to 2/3 of the loss factors can be controlled via information management systems [7]. However, due to the lack of a single digital space and smart connection between the automated control systems, farmers cannot be provided with decent analytical support and the ability to manage loss factors.

It is important to emphasize that digital transformation considers not only investments in innovative technologies and process automation, but also a complex comprehensive transformation of the company's development strategy, its products and services, business processes, organization structure and corporate culture.

2 Materials and methods

As research methods, authors have used a systematic analysis of models based on scientific information retrieval, after that the models have been evaluated by comparative analysis using a set of criteria.

During the active growth of technological start-ups in the agriculture (2013-2016), Israel, Canada, and China have become leaders in agro-digitalization. The positive results of digitalization on the example of several agricultural processes are given in Table 1 [8, 9].

Table 1. Benefits of digital transformation on the example of various agricultural processes in the leading agricultural countries (on the example of Israel).

Country	Process	Innovation technology	Benefit
Israel	Milking and keeping of cattle	Robotic milking system based on artificial intelligence	- Increased milk production per cow; - Reducing payroll costs
Israel	Irrigation and maintenance of soil temperature	The system of water-filled pipes in soil based on the Internet of things	Increasing crop yields
Israel	Irrigation of territories	Precision irrigation system based on machine learning algorithms	Saving water resources by 30-70% (depending on the cultivated crop and region)
Israel	Harvesting (for example, almonds and dates)	Machine learning algorithms for calculating the amplitude of tree shake, taking into account the parameters of a particular	- Reducing the duration of processing one tree from several tens of minutes (in manual mode) to 30-60

		plant	seconds (by a combine) - Strengthening the root system due to the correctly selected shake amplitude
Israel	Sorting and packing of crops	Robotic sorting system based on 3D models of each fruit and their clustering by size, weight, etc.	Reduction of scrap in products supplied to the end consumer
Israel	Full cycle of growing various agricultural crops	Smart greenhouse using the Internet of Things and climate control system using artificial intelligence	The ability to grow any crop in extreme conditions (in cold and hot conditions, when external irrigation and soil warming are inaccessible)

In Russia, the process of digitalization of agriculture is only gaining momentum. Successful pilot projects in individual regions include [10-11]:

- the use of elements of a "smart farm", including robotic milking and feeding technologies, energy-saving ventilation systems, automatic lighting and climate control in advanced farms in the Moscow region,
- the no-till farming (Lipetsk, Belgorod, Rostov regions),
- "digitization of fields" for systematization according to the agrochemical state of soils, crops, producers (Belgorod region),
- the use of cluster approach to gather several companies as a part of eco and agricultural touristic complex in Ural region,
- the use of auto piloting aerial vehicles to gain information about fields with weeds and pests, to identify the readiness of a field for sowing and harvesting, to monitor the state of crops and the quality of work performed in the fields, land inventory (Sverdlovsk region).

However, without aggregation of information flows into a single digital space, these “pilots” can remain examples of the process automation, and not digital transformation. To further support of the digitalization in agriculture in 2019 the Russian Federation Ministry of Agriculture completed the preparation of a departmental Project "Digital Agriculture" as a part of the national program "Digital Economy". The project is designed for 6 years, its main goal is to create a powerful digital infrastructure in agricultural areas with the subsequent implementation of a digital platform solution [12]. One of the main elements of digital transformation is clearly outlined in the Project – the creation of a united digital space (information platform), which will allow to collect, store, process, visualize and analyse the heterogeneous data of various business processes of agricultural production (Fig. 1).

Many stoppers in the Russian agricultural complex slow down the implementation of the Program and increase the technological gap with countries with developed agriculture. These stoppers are:

- the level of penetration of 3G Internet technologies on the agricultural territories of the Russian Federation is only 20% (in the leading countries this rate reaches 70-80%) [13],
- the sown area accounts for about 80 million hectares, but digital technologies are used for no more than 5-10% of these areas [7],
- the use of IT in agriculture is mainly limited to the use of computers and software for financial management and tracking commercial transactions [7].

In such a way, the crucial problem arises – the necessity to implement digital technologies as a part of national programme “Digital Agriculture” on the one hand, and low level of digital maturity at the majority of agricultural enterprises in Russia on the other hand.

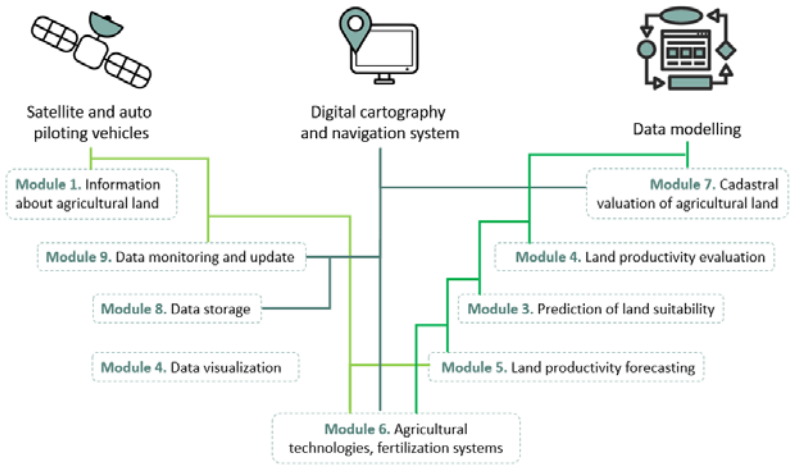

Fig. 1. Functional modules of an information platform solution of the Project «Digital Agriculture».

Obviously, it is almost impossible to supply such a volume of IT specialists within a short period of time, hence rises the alternative of developing IT competencies and increasing the level of digital technologies proficiency directly among the employees of the agricultural companies.

Digital transformation includes a radical change in the current business models of the agricultural companies, what dictates new requirements for the skills and competencies of workers. Apart of professional skills of an agricultural nature (hard skills) increases the importance of both over-professional skills (soft skills) and a new type of skills – digital ones.

The modern education system, which is based on the Federal State Educational Standards, allows maintaining a unified educational space and regulate educational activities within one framework. However, such fixation of educational standards and competencies leads to the fact that at the end of the educational program the graduate's skills are no longer relevant to the market. The development and updating of standards takes years, the long duration of the process of their verification and approval increases the "gap" between the competencies of the university graduate and the real needs of the market. The scale of the "competence gap" is also affected by the high rate of technological development: at least once every 1-1,5 years a new technology enters the IT market or the existing one is significantly updated.

In such conditions, the educational standards do not have time to take into account the market needs, which future employee will meet in a digital environment. The forms of postgraduate education in the form of workshops, trainings, master classes are gaining more and more popularity. This is largely facilitated by the educational methods with information technologies, and the interaction of education establishments with the market via competencies models.

According to the European Centre for the Development of Vocational Training, the importance of soft skills in modern organizations is increasing [15]; participants of the World Economic Forum also note that in the context of technological progress, the importance of soft skills increases [16].

The relevance of digital skills is also increasing: the European Commission, in its definition of digital competence, prepared under the Digital Education Action Plan, emphasizes the importance of the sustainable and responsible use of digital technologies in learning, work and in public life [17].

3 Results

As it was set in previous chapter, in order to meet the requirements of future market it is vital to develop adaptable methodology for innovation management via digital competencies (hard, soft and digital ones). As a result, in this study several major competencies frameworks and models have been analysed and compared in order to choose the basis for development of a new complex competencies model.

Over the years, a number of successful models and frameworks of traditional (hard and soft skills) and digital competencies (digital skills) have been formed.

The first group includes the EU Competency Framework [18], the US Department of Labour Competency Model Clearinghouse [19], the ATD competency model [20] and others. These models do not always include digital competencies in an explicit form, which does not meet the needs of companies on the path of digital transformation.

Among the most common models of digital competencies are the EU Digital Competence Framework for Educators [21], the CML Media Literacy Kit [22], the Digital skills standard [22], IC3 Digital Literacy Certification [22]. The comparative analysis of these models is given in table 2.

Table 2. Comparative analysis of digital competencies models and frameworks.

Model/ Framework name	Author organization	Year	Applicability field	Granularity level of digital skills maturity	Model/ Framework elements
Digital Competence Framework for Educators	The European Commission's science and knowledge service	2017	Educational organizations	1 – Newcomer 2 – Explorer 3 – Integrator 4 – Expert 5 – Leader 6 - Pioneer	- Self-assessment tool; - Detailed description of maturity levels; - No “how-to” guide to improve maturity level.
CML Media Literacy Kit	Centre for Media Literacy (California, USA)	2012	Educational organizations	No maturity levels are given	- Core concepts; - Description of data processing skills; - Description of data organization process; - Tools; - “How-to” strategies.
National standards for essential digital skills	Department for Education (UK)	2019	Universal	1 – Entry 2 - Mature	- List of skills, devices and processes for dealing with data and information - Description of maturity levels - “How-to” between two levels
IC3 Digital Literacy Certification	Certiport, a business of NCS Pearson, Inc. (Utah, USA)	Since 2012	Universal	Level 1 Level 2 Level 3	- Level description - Courses for preparation for each level certification

As it can be seen from the comparative analysis, digital competencies models and frameworks lack the “how-to” techniques and tools for improvement of maturity either level or lack these very levels at all. Moreover, mentioned models apply only in educational

field or, on the contrary, are presented as universal what means they do not take into account the industrial specifics of industries, in particular agriculture.

The mentioned models describe the competencies themselves, their essence and content, but not aspects of their management. Among publications on competency management models, articles about the principles and approaches to building such models ([23], [24], [25]), cases for specific industries ([26], [27]) or enterprises ([28], [29]). However, work about competencies (hard, soft, digital) management for agricultural companies in Russia can be hardly found. Overall, it indicates that the issue has not been sufficiently studied.

4 Conclusion and discussion

Preliminary research in this study has shown several points:

- the benefits from total agricultural digitalization in leading countries highlighted the necessity not only to automate agricultural processes, but to rethink and rebuild company's business model, products and services as well as to prepare digital infrastructure in agricultural companies of Russian Federation;
- the process of digital transformation can only be supported by educated employees which have necessary hard, soft and digital skills. It is obvious that there is a gap between current amount of such employees and requirements of agricultural sector of Russian Federation;
- current educational system does not allow to adapt educational programs in short periods of time;
- a new comprehensive model for competencies (hard, soft, digital) is required in order to support the process of digital transformation in agricultural companies of Russian Federation.

The object of further study (the enterprises of the digital agro-industrial complex) as well as its subject (the management of competencies at the enterprises of the digital agricultural industry) have been formulated.

The aim of the further work is outlined as to study the possibilities of managing IT innovations at agricultural enterprises in Russia through their employees' competence. To achieve this goal, the following tasks have been identified:

1) Exploring the theoretical aspects of digital transformation based on IT innovations in agriculture.

2) Research and development of a competency management model for employees of a digital agro-industrial complex.

3) Formation of a methodology for managing the skills of digital agro-industrial complex employees based on the model from clause 2,

4) Approbation of the developed model.

Finally, the methods for use in further study have been outlined. They include both theoretical and practical ones - at the initial stage it is planned to use methods such as analysis and comparison to identify the features of digitalization in agriculture, these methods are also applied at the second stage to find a competence management model for an employee of a digital agricultural enterprise. To modify the model for the specifics of research and development of a skill management methodology, it is planned to use the synthesis method; at the third stage of the work, it is supposed to use the method of empirical research - an experiment of implementation of the developed methodology at one of the Russian enterprises. The scientific novelty of this work lies in development of a method for managing IT innovations through the employees' competence management on the digital agricultural enterprises. The practical significance of further study lies in the fact that the developed model can be used at enterprises to train personnel for the process of

digital transformation of agricultural enterprises within the framework of the Digital Agriculture Project and their further functioning in the digital agricultural environment.

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