

The Impact of Digital Transformation on the Competitiveness of Small and Medium Agro-Industrial Enterprises

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Abstract — The work studies the way to assess the effectiveness of the digital transformation of the economy and, as a result, its impact on the competitiveness of small and medium agro-industrial enterprises as they can't accomplish a large-scale digital transformation in a short time. The research shows that investments in ICT are more effective when they simultaneously aim both organisational and human assets. This is especially true in the case of agro-industrial enterprises as they don't have enough resources for simultaneous investments in three types of assets. In this work, we offer a mathematical model that describes the impact of digital transformation in small and medium agro-industrial enterprises on their competitiveness. The model accounts for numerous factors of the internal and external environment as well as current, complete, objective, reliable, and coherent data with the necessary speed and search simplicity that can be achieved only in the case of forming a universal informational Internet space of digital interaction within the country including educational and scientific resources. This environment is an implementation of A.I. Kitov and academician V.M. Glushkov's ideas aimed at developing a national automated system for country management.

Keywords — *competitiveness; mathematical model; digital platforms; effectiveness.*

I. INTRODUCTION

From the very beginning of information and communication technologies (ICT), economists considered the effectiveness of this new asset and looked after the ways for using it in all spheres of human activities. This became especially important in the age of transition to a digital economy.

One of the main studies in this direction was carried out based on the so-called complementarity theory [1]. The results showed that investments in ICT are more effective when the level of two other complementary assets, i.e. organisational and human, are high. That means that investments in ICT are related to high contributions to changing both organisational and human assets.

This theory showed that complementary assets have a particular degree of freedom that can vary, i.e. some of them are more changeable than others. In this case, a more changeable asset becomes the driver of changes. Moreover, its changes lead to changes in other assets through the chain of

fundamental complimentary links. Based on this theory, we can say that the history of enterprises consists of three periods [2].

1. Before industrial production, the effectiveness of enterprises and business competitiveness depended on the personal abilities of workers. At that point, human assets determined the development of enterprises. Thus, at that time human capital was the most changeable complementary asset.

2. With the advent of industrial production (the end of the XVIII century) a human asset gradually gives way to an organisational asset as the new ways of production created new forms of their organisation and management.

3. The computer assets are the most changeable. The mass adoption of ICT at the end of the XX century and the automation of some management functions resulted in the growth of a computer asset that became the most changeable.

Further research by Erik Brynjolfsson, Lorin Hitt, and Shinkyu Yang [3] in this sphere supported the presence of complementary relationships between these groups of assets. They determined that conditions in which ICT and an organisational asset combine rather play a bigger role in forming higher value rather than their independent changeability. Investments in computer assets greatly influence the price of enterprises. In comparison with other types of assets, one dollar invested in ICT gives 12 times increase in the market price of enterprises. This indicates that improved company management and performance of staff are prerequisites for the digital transformation of enterprises. We should also note that improvements in staff performance without using ICT give a 9 % increase in profits, while improvements with simultaneous adoption of ICT give 26 %. The introduction of ICT without staff improvements lowers profits by 11 %. Without the digital transformation of staff, the decline in profits reaches 24 % in comparison with advanced digital enterprises.

Based on the information above, let's consider the impact of digital transformation on the competitiveness of small and medium agro-industrial enterprises using the example of machines and equipment production as well as one of the consumers of these products – agro-industrial enterprises, as these spheres are the primal examples of all advantages and drawbacks in this area.

II. THE CHALLENGES IN ASSESSING THE COMPETITIVENESS OF SMALL AND MEDIUM ENTERPRISES IN DIGITAL TRANSFORMATION

According to Rosstat, 57 % of all small and medium enterprises turnover belongs to the sphere of trade. Processing enterprises account for 10.6 % Construction took 25 % of all non-trade small and medium enterprises. Food enterprises are leaders in the processing industry (more than 1 trillion roubles). Next is the production of finished metal products (675 billion roubles). The production of machines and equipment accounts only for 353.3 billion roubles and chemical industry – for 321.9 billion roubles. [4].

Although the digitalisation of the economy is quite common in the modern world, not all industries can use its advantages. Production enterprises are the most conservative in this respect. This is due to the need for replacing old equipment with new high-technology facilities and an insufficient level of staff skills. Besides, there is a lack of clear trends for digitalisation in some industries in a predicted period, mainly on the side of authorities. For example, even in Europe, about 41 % of enterprises don't use the huge potential of digital transformation at all while only 2 % use it to a full extent [5].

In Russia, the situation is even worse. Moreover, the supply of expensive, highly technological, and digital equipment for digitalising the manufacturing of machines in our country will have a delayed effect for all equipment manufacturers due to the high cost and large underutilisation of already-supplied equipment impacting the level of digitalisation in the agricultural industry. Thus, the first stage of digitalisation in machine manufacturing aims for 4 times increase in the utilisation of equipment within 10 next years. The strategy also supposes the exclusion of legacy equipment from usage and creation of processing centres for complex operations that are not possible or reasonable to perform on existing equipment. It is supposed that the bulk delivery of new digital machines will start only after this 10-year period [6].

To implement this strategy, the Ministry of Trade and Industrial Development forms a unified information environment to enable the exchange of data between enterprises and industrial equipment. The project involves several companies such as STAN enterprise that creates machining equipment, Kaspersky that provides cybersecurity, ITELMA (logistics and consulting), and Siemens for creating in Russia a digital platform according to the Industry 4.0 concept based on the MindSphere platform [7].

The peculiar feature of small and medium enterprises in this sphere is that they appear, grow, and disappear depending on the state of a large industry because in general, they provide outsource services for it. In this case, small and medium enterprises have to modernise their machine pools when big businesses replace their old equipment with a new one that needs increased precision in terms of parts. Thus, the competitiveness of outsources significantly depends on the quality of their products [8] and, to a lesser extent, on the price. Quality is one of the most important properties of their products. We suppose that in the agricultural industry the situation will be developing according to the same scenario.

Small and medium agro-industrial enterprises will become outsourced by big agricultural companies.

From the producer's point of view, competitiveness is its ability to maintain and expand target markets by concentrating on activities aimed at both qualitative characteristics of products and competitors. Increasing competitiveness is the main aim of all the decisions on entering new markets, reorganising the structure of an enterprise, modifying existing or creating new products, changing production volumes, replacing main production facilities, changing economical relationships, and marketing policies. Thus, market competitiveness is expressed in quality and price.

The process of competitiveness formation is a set of organisational and economic measures aimed at bringing the programmes of production characterised by some volume, range, and quality in accordance with actual production potential. Production potential is usually described as the Cobb–Douglas production function that establishes the dependency of some resulting indicator of a product on the amount and combination of used resources. In our case, these indicators are the quality and prime cost of products. The dependency is determined with a regression relationship using a significant set of statistical data. As a result, it is possible to find the sought parameters of a production function in the situation when requirements to input data are high. The found indicators represent some average characteristics that are the basis for their comparison. This is necessary to determine the place of small and medium enterprises among other companies. Some researchers [9] apply other methods of searching for a generalised indicator of competitiveness, e.g. In comparison with best practices.

III. THE MATHEMATICAL MODEL FOR ASSESSING THE COMPETITIVENESS OF SMALL AND MEDIUM ENTERPRISES IN DIGITAL TRANSFORMATION

Let's use general terms to write the indicators of quality and prime cost that influence the competitiveness of an enterprise as a functional dependency on a set of factors in the internal and external environments of its functioning.

$$y_{ijk} = F_{ijk}(x_{nj}), \quad (1)$$

where y_{ijk} is a value of j indicator of the competitiveness of i product of k enterprise, $j \in J$, $i \in I$, $n \in N$, $k \in K$, $j=1$ represents the quality of a product, $j=2$ represents the prime cost, x_{nj} is the characteristics of n factor that influences j indicator of k enterprise.

Depending on the aims of competitiveness study, there may be considered several factors of external environment: technical (the level of technological development), social and cultural (the type of consumer culture), economic (the level of support for small and medium enterprises, personal income, taxation, availability of financial resources). The factors of the internal environment are organisational, technical, economic, and social. Moreover, these factors include a range of other indicators with different degrees of detail.

Based on the theory of complementarity in our research we will concentrate on the factors of an external environment, in

particular the volume of market demand, normative regulations, and recent requirements of third parties, the availability of general-purpose ICT. We also consider internal environment factors such as the volume of production, the level of enterprise digitalisation, the quality of human assets, physical, technical, and financial resources.

Let's pay attention to such a factor as normative regulations and recent requirements of third parties. With the development of Internet technologies, this factor starts to gain a significant influence on products in many world industries. This is especially obvious in the pharmaceutical industry as health is a factor of high attention in the world. In other industries, this effect is not so obvious and lags. That's why we decided to show the manifestations of this factor based on the example of the pharmaceutical industry. However, nowadays the quality of agricultural products also becomes the target for increased requirements. The market requires the medical community to identify diseases more precisely and create solutions for population health protection. This needs a transition from so-called dimensionless drugs to targeted therapeutic solutions.

On the other side, global normative and regulative trends in the sphere of pharmaceutical products are oriented towards global harmonisation of requirements to produce medicinal products throughout the whole life cycle starting from the development to obtaining a therapeutic effect.

Thus, we can note two possible directions:

- an increase in the social responsibility of producers imposed by the government and society;
- the attention to ensuring the quality of products by means of management decisions at all stages starting from the development to selling finished products.

As for third parties, there is a concept that has recently become popular when every buyer can use on-line services to check the information about the quality, safety, and legality of products. At the same time, within this concept regulators can access the full data on this product. In the agricultural industry, this concept became known as the traceability of products. Thus, we can conclude that companies that couldn't react to market requirements or the demands of authorities of third parties will face a decrease in the attractiveness of their business. To avoid this, all companies must invest in new digital technologies that can become drivers for their survival in the market [10].

Such an integral factor as the level of production digitalisation depends on many factors, mainly on the level of enterprise management system development, the level of automating the relationships with clients, the degree of technological processes digitalisation, the level of cloud computing usage, and the level of integration and typification of information systems. As we already noted, the ratio of these factors is determined by sectoral differences.

Based on these thoughts, we can specify the expression (1) as

$$y_{ijk} = F_{ijk}(W_i, y_i^H, z_{ko}, V_{ik}, z_{kc}, L_k, M_k, \Phi_k), \quad (2)$$

where W_i is the demand on i product in the market; y_i^H is normative regulations and requirements of third parties to the quality of i product; z_{ko} is expenditures on general-purpose ICT of k product, V_{ik} is the production volume of i product of k enterprise; z_{kc} is the total expenditures for k enterprise digitalisation; L_k is the quality of human assets at k enterprise M_k is physical and technical resources; Φ_k is the number of financial resources for the digitalisation of k enterprise.

Let's use y_{ik} to identify the j indicator of competitiveness

for k enterprise $y_{ik} = \sum_{i=1}^I \alpha_i y_{ijk}$ where $\sum_{i=1}^I \alpha_i = 1, 0 \leq \alpha_i$. Then, let's call y_k an integral indicator of competitiveness for k enterprise

$$y_k = \beta_1 y_{1k} + \beta_2 y_{2k}, \quad \beta_1 + \beta_2 = 1, 0 \leq \beta_1, 0 \leq \beta_2. \quad (3)$$

In this situation, we can formulate the task of increasing the integral indicator of the competitiveness of k enterprise

$$y_k = \max(\beta_1 y_{1k} + \beta_2 y_{2k}), \quad (4)$$

where c_{ik} is the price of i product of k enterprise at the market with restrictions: $y_i^H \leq y_{1ik}$ (Requirements for the quality of i product); $\sum_{k=1}^K V_{ik} \leq W_i$ (the total amount of products can't be higher than the demand on i product in the market); $f_{ik}(y_{i2k}) \leq c_{ik}$, where c_{ik} is the price of i product of k enterprise in the market (the price of a product shouldn't be lower its prime cost, expressed through a corresponding indicator of competitiveness); $z_{ko} + z_{kc} \leq \Phi_k$ (financial limitations).

Of course, this illustrates just a general view on the assessment of the impact of digital transformation in small and medium enterprises on their competitiveness in the market, which depends on the effectiveness of information systems. Moreover, at the current stage of digital economy development, it's not possible to solve the problem of information systems effectiveness because of insignificant statistical data about the assessment of information system effectiveness. This is still a fundamental problem that is being solved by many specialists. Although digitalisation costs become a significant part of expenses, such investments are usually made blindly without considering the results. There are many sources of effectiveness, the main of which are [11]:

- the source of the first kind is defined by saving the production costs (retrenchments, the decrease in the downtime and expenditures on storing physical resources, etc.);
- the source of the second kind is related to an increase in production discipline and labour quality;
- the effect of the third kind is related to the possibility of using ICT to enhance the mental abilities of users by accumulating knowledge in the form of information products: software, databases, electronic libraries, etc.

The first and second kinds of effects can be evaluated, while third kind effects cannot.

The effectiveness is usually assessed by using separate approaches that evaluate the manifestations of its different sources. For example, it is possible to assess productivity (number of processed documents, time spent on solving tasks, etc), availability and reliability of services (possibility to work in several time zones, the possibility of losses during downtime); comparison of profits and expenses in terms of particular information services.

Let's consider the two most appropriate approaches [11]. The first is based on using static assessments. The main criterion of this method is TCO. This criterion accounts only for direct and indirect project expenditures which, together with the standardisation mentioned above, almost turned this method into an industrial standard on assessing the TCO of information systems. It includes six main characteristics of expenditures grouped into main or operational, direct or indirect, permanent or temporary expenditures. The main characteristics include expenditures for equipment, software, staff, deployment, transfer of inter-enterprise transactions, and accounting of financing for information systems.

The second criterion in the methodology of statistical assessment is the return of investments and the return on capital. It reflects the return of the capital invested in a project: $ROI = (P + I_1 + I_0) / I_0$, where I_0 is investment capital, I_1 is the price of a project at the end of the period, P is a profit. It is also called the return on capital. This criterion determines the effectiveness of a project and the payback period of a project.

The third criterion of this method is Economic Value Added (EVA). This criterion reflects the difference between a pure operational profit of a company and all expenses: $EVA = NOPAT - WACC * I_0$, where $NOPAT$ is a pure operational profit (profit minus taxes), $WACC$ is a weighted average cost of a capital, I_0 defined above. If we define ROI as $ROI = NOPAT / I_0$, we will get EVA in the form of $EVA = ROI * I_0 - WACC * I_0$. Thus, we see that investments create added value only in the case when the difference between profitability and taxes is higher than a weighted average cost of capital.

If it's not possible to assess a predicted profit clearly, it is calculated by reducing the labour intensity or excluding some operations when implementing the information system. The corresponding values are multiplied by an average salary and increase by the magnitude of tax contributions and the cost of a necessary workplace for using information systems. To evaluate the cost of money in different projects that take a considerable time we can apply different methods of discounted cash flows. Here the main criterion of the Net Present Value (NPV) methodology is the following:

$$NPV = I_0 + \sum_{k=1}^N F_k / (1+r)^k, \tag{5}$$

where NPV is a net present value, r is a rate of discount, F_k is a total cash flow in k period, N is a number of periods.

Another criterion of the methodology is the Internal Rates of Return (IRR). IRR determines the rate at which the criterion is equal to zero.

To calculate NPV and IRR it is necessary to assess the values of r .

Another applied criterion is a Weighted Average Cost of Capital (WACC)

$$WACC = \sum_{i=1}^M K_i \alpha_i (1-t_i) / \sum_{i=1}^M K_i, \tag{6}$$

where K_i is the price of i source, α_i is the rate of i source, t_i is the tax rate for i source, M is the number of sources.

For better reliability of assessing the effectiveness of investment projects, the criteria described above are assessed together as generalised methods, including some of their weighted values. The generalised assessment methodology can be supplemented by the methods of analogues based on the actual data on successful projects that are close to the activities of these enterprises. To account for decreased investment risks in ICT, it is possible to complement the generalised methodology with expert evaluation methods.

The national programme called 'Digital Economy of the Russian Federation' states that to increase the effectiveness of digitalisation in small and medium enterprises it will use a platform approach. Given a large number of small and medium enterprises, the development of methods for assessing the economic effects of their digitalisation should go after the development of digital platforms for this process.

To formalise the feasibility of digital platform development for digitalising small and medium enterprises, we will use the following designations: $S = \{S_m\}$ is a set of information systems, where $S_m = \{S_{mp}\}$; $r = \overline{1, R}$; $m = \overline{1, M}$; $p \in P$; $S_{mp} - r$ is a subsystem of m information system for a small or medium enterprise p . $P = \{P_{oj}\}$, where o is an index that designates a sector, j is an index reflecting organisational, economic, technological, and environmental features of a production process $j = \overline{1, J}$.

Let's designate $I_{sm}(i, UK_l)_{l \in L_i}$ as a project of m information system at a particular i stage of design l , K_l is a set of information about data structures, where $K_l \subset K$; $l = \overline{1, L}$; $i = \overline{1, I}$.

In this case, we will depict the design procedure in the following way

$$I_{sm}(i, UK_l)_{l \in L_i} \xrightarrow{\Pi(i, i+1)} I_{sm}(i+1, UK_l)_{l \in L_{i+1}}, \tag{7}$$

where $\Pi(i, i+1)$ is a design method that forms the project of an information system. $F(\Pi, P, K, S, J)$ is a criterion for assessing the effectiveness of the design procedure that must take an optimal value.

In the case of determining projects $I_{sm}(i, UK_l)_{l \in L_i}$, $I_{sm}(i+1, UK_l)_{l \in L_{i+1}}$ in the form of information arrays, and if design methods can be used only for a single enterprise $p = p_0$, the design becomes individual. If design methods can be used for a group of enterprises $P_1 \subset P$, the design is considered

standardised. If design methods are independent on particular p and are represented in the form of instrumental means, they are called automated.

In real life the choice of design methods depends on the available resources R_{II} ; design tools C_{II} ; information system structure G_{sm} , e.g. planned reengineering of control structure; system resources R_{sm} , e.g. hardware; system characteristics B_{sm} (time, cost, etc.). In this case, to create digital platforms for sectors with many small and medium enterprises we need to solve the following task: choose design instruments C_{II} and methods and achieve the desired set of system characteristics $D_{sm} \subset D_o$. For example, the mathematical model for clustering digital platforms is given in [12]. Then, based on created digital platforms, the model for assessing the impact of digital transformation on the competitiveness of small and medium enterprises will take the following form.

Let's introduce designations: $f_{jo} - j$ is a management function of o type of an enterprise, $j \in J_o$, $J_o \subset J$, $s_k - s$ is a subsystem of an information system, $s_k \in S$, E_{jo} is an indicator of the digitalisation effectiveness of j control function of o type of enterprise.

Then, the total effectiveness of digitalisation of o type of enterprise is written in the form of $E_o = \sum_j E_{jo}$.

Based on this we can plan a gradual optimal digital transformation of small and medium enterprises while defining the local and general effectiveness of this process. For example, we can calculate the impact of r_s on lowering the losses in the total production of an enterprise $w = \sum_{n,m} \Delta y_{n,m}(r_1, \dots, r_i, \dots)$, n is a type of technology, $n = [1, N]$, m – a type of technological operation, $m = [1, M]$. After calculating the value of $k_s = -\partial W / \partial r_s$ we will get the ratio of k_s influence on lowering the losses in the total production of an enterprise.

Let's use the calculations for some types of technologies used in small and medium enterprises as an example.

The size of additional earnings U_1 due to a decrease in time needed for performing technological operations as a result of digitalisation looks as

$$U_1 = \sum_{i=1}^M c_i s_i (Q_i^2 - Q_i^1), \quad (8)$$

where M is a number of product types, c_i is the prime cost of production, s_i is the scale of production for i products, Q_i^1 , Q_i^2 is a volume of i product manufactured before and after digitalisation.

The decrease in expenses due to lowering the downtime of equipment U_2 is determined according to formula

$$U_2 = [(r_1 - r_2)/H] * p,$$

where r_1 , r_2 is a yearly downtime before and after equipment digitalisation, H is the uptime of one standard machine measured in hours per year, p is a cost of one standard machine.

IV. THE FORMATION OF A SINGLE INFORMATIONAL INTERNET ENVIRONMENT FOR THE INTERACTION OF AGRO-INDUSTRIAL ENTERPRISES

The result of calculating the mathematical model for clustering digital platforms [13] of small and medium agro-industrial enterprises is a single informational Internet environment for their digital interaction. The described digital platform is formed based on cloud integration of prime records databases and technological databases of small and medium enterprises based on unified standards. This cloud also stores unified registers of all physical, intellectual, and human resources. This approach to the digitalisation of small and medium enterprises gives an opportunity to develop standard information systems for their management with typical websites of all organisations involved in this digital interaction. This will enormously lower the expenses of digitalisation and greatly increase the impact of digitalisation in small and medium enterprises on their competitiveness in the market.

This concept is gradually implemented all over the world. For example, some of its features are implemented in the German textile and consumer goods industries. In Saxony, for instance, a single information platform unifies 800 enterprises with data stored in a shared database. There is also a website www.textil-server.de that is integrated with a virtual technological centre of Saxony. It holds the data about 73 enterprises and 213 products as well as the information about exhibitions, research, etc. In Russia, an electronic information system for subcontracting was created in St. Petersburg. It uses a cloud database to store the data on the production capabilities of enterprises. The database formulates the demand of enterprises for subcontractor services by transferring formalised data.

These approaches are based on the ideas of production and logistics networks that are actively developed in the world [14]. Nowadays, the concept of these networks is the highest point in the evolution of logistics activities integration. The main idea of the production and logistics network concept lies in the formation of organisational, technological, and informational environment by temporarily combining the resources of different autonomous economic agents to increase the effectiveness of their activities and competitiveness. Within this type of network, the information environment is used as a basis for integrated planning and management of projects in the network. The core of the production and logistics network consists of 1) a system for operational control related to a production and economic system and 2) a shared cloud database that stores current data on logistics processes, classifiers, master data common for all participants in logistic activities and the information about all members of the network.

Let's consider a mathematical model for optimising the logistic activities of participants that use digital platforms of small and medium agro-industrial enterprises in the form of an electronic trade platform based on typical websites. The implementation of a trade platform in such a way could facilitate the accomplishment of the strategy for developing small and medium businesses in Russia until 2030 that was adopted on June 9, 2016, by D.A. Medvedev. The strategy aims at enormously increasing the competitiveness of small

and medium enterprises in the market, in particular, on the international scene. Based on the documents, the export share of small and medium enterprises Russia will significantly increase to 12 % in 2030 from 6.5 % in 2015. However, this indicator is still too small in comparison with, for example, South Korea (40 %) and China (more than 50 %) [14].

According to the concept of a single informational Internet platform, a typical site of an electronic trade platform should contain the following sections: announcement date, product (service) name, product (service) characteristics, the number of products, the cost of a product (service), container description, additional shipping conditions. Let's give a mathematical description:

- v_{ik} is a demand of i user for k product, $i \in I; k \in K$;
- w_{jk} is a quantity of k product in stock that j supplier has $j \in J$;
- p_{jk} is the cost of k product of j supplier;
- m_{ijr} is the cost of logistics from j supplier to i consumer by r type of transport;
- $v_{ijk}^1 = v_{ik}$, if $v_{ik} \leq w_{jk}$, and $v_{ijk}^1 = w_{jk}$ else;
- $c_{ijrk}^1 = v_{ijk}^1 * m_{ijr}$ is the cost of transporting k product from j supplier to i consumer by r type of transport;
- $c_{ijrk}^2 = v_{ijk}^1 * p_{jk}$ is the cost of a k product purchased by i consumer from j supplier;
- $c_{ijrk} = c_{ijrk}^1 + c_{ijrk}^2$ is the total cost of k product, purchased by i consumer from j supplier by r type of transport. The search algorithm is the following: stage 1: let's define the multitude $J^* \subset J, J^* = 0$; stage 2: let's find the solution $c_{ijrk} = \rightarrow \min$ in respect of variables r and j

under conditions $v_{ik} \leq \sum_j w_{jk}, j \in J^*$. The obtained value j^* is included into J^* ; stage 3: completing stage 2 until finding all suppliers, meeting the requirements of stage 2. In this case, we will find suppliers that can satisfy the demand of an indicated consumer. These suppliers are arranged in ascending order of the total cost of a k product.

In the modern world, the competitiveness of most enterprises is significantly influenced by the opportunity to obtain current, complete, objective, reliable, and coherent data with the necessary speed and search simplicity. In this respect, Jac Fitz-enz has formulated very important principles of people and information interdependence [15].

1. People and information are the basis of the informational economy, and human is the main resource in this combination. That's why the development of people and management should have the same speed as the development of technologies.
2. In this respect, management needs reliable data that allows performing control. Those who have better information win in the competition.
3. The information about workers, namely, expenses, time consumption, and other factors defining a human asset, create a basis for effective solutions.

This is the basis for a digital platform of a single informational environment of educational and scientific resources represented in [13]. The platform is provided with corresponding means for automating the design of information and computation systems [16]. Figure 1 depicts the functional structure of this platform with a list of different service sub-projects, the number of which will grow with the accumulation of information.

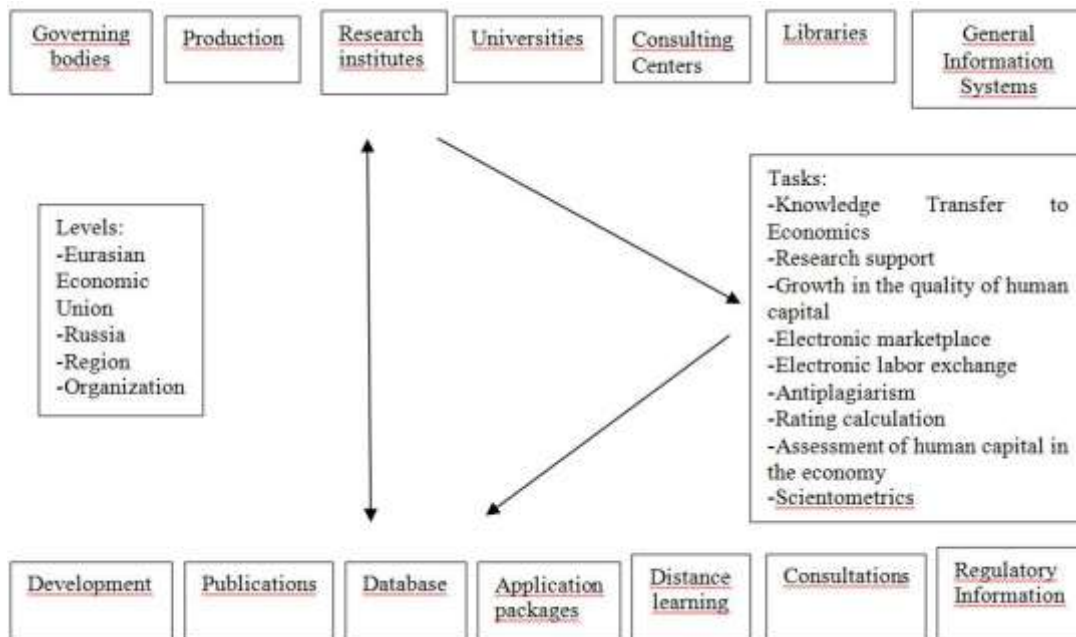


Fig. 1. The functional structure of a digital platform of a single informational environment of educational and scientific resources

V. CONCLUSION

The digital platform formed this way represents a cloud integration of educational and scientific resources and plays three roles: support scientific research, raise the level of education (sometimes by means of retraining) for all levels of the population, transport knowledge to economy effectively by means of unrestricted access to this knowledge not only for scientists, students, and teachers, but school graduates, employers, state authorities, producers, business, management, and other categories of the population. This environment should eliminate the contradictions between the volumes of accumulated information and their effective use. It should also become an instrument for increasing the quality of human resources and its assessment. It should influence the social well-being in the country as the previous system of innovation distribution in the form of articles, abstracts, and other paper media was destroyed and a new ICT-based system hasn't formed yet.

The project of a digital platform of a single informational environment of educational and scientific resources is the implementation of A.I. Kitov and V.M. Glushkov's ideas that were aimed at creating a national automatized system for science and education in the 60s [17]. The improved capabilities and the development level of both scientific components of the system and Internet instruments allow implementing these ideas on a full scale.

References

- [1] P. Milgrom, J. Roberts, "The economics of modern manufacturing: Technology, strategy, and organization", *The American Economic Review*, 1990, pp. 511–528.
- [2] A.A. Akaev, A.I. Rudskoi, "Convergent ICT as a key factor of technological progress in the coming decades and their impact on world economic development", *Int. J. of Open Inform. Technol.*, vol. 5, no. 1, pp. 1–18, 2017.
- [3] Erik Brynjolfsson, Lorin Hitt, Shinkyu Yang, "Intangible Assets: Computers and Organizational Capital", *Brookings Papers on Econ. Activity*, vol. 2, no. 1, 2002.
- [4] B. Titov, Small and medium enterprises in Russia and world. Retrieved from: <http://stolypin.institute/wp-content/uploads/2018/07/issledovanie-ier-msp-27.07.18.pdf> (date of the address 22.02.2019).
- [5] I. Guseva, "The economic stimuli for increasing the effectiveness of production using digital economy tools", *Econ. and life*, no. 11, 2018.
- [6] The economic effect of digitalisation and the application of IoT in Russian machine manufacturing sector. Retrieved from: http://json.tv/ict_telecom_analytics_view/ekonomicheskie-effekty-ot-tsifrovizatsii-i-vnedreniya-iot-v-mashinostroenii-v-rossii-20180817013305 (date of the address 22.02.2019).
- [7] S. Nedoroslev, The digitalisation of the industry is our near future. Retrieved from: <https://deloros.ru/cifrovizaciya-promyshlennosti-nashe-blizhajshee-budushhee.html> (date of the address 22.10.2019).
- [8] A. Alekseev, Small business doesn't exist by itself. Retrieved from: <https://unecon.ru/sites/default/files/1-1-3.pdf> (date of the address 11.10.2019).
- [9] The competitiveness of products and services. Retrieved from: <http://www.grandars.ru/college/ekonomika-firmy/konkurentosposobnost-tovara.html> (date of the address 11.10.2019).
- [10] V.M. Kolishkin, E.V. Makovskiy, S.A. Bogatikov, S.N. Marchenkov, V.D. Mizyuk, "The practical experience in forming the enterprise knowledge base according the requirements of ISO 9000 standards", *Biotechnol.*, no. 1, pp. 79–89, 2016.
- [11] V.I. Medennikov, L.G. Muratova, S.G. Salnikov, A.A. Lichman, The theoretical basis and the methodology for assessing the effectiveness of using information resources in the agricultural economy. Moscow: Analytic, 2015.
- [12] F.I. Ereshko, V.V. Kulba, V.I. Medennikov, "Digital platforms clustering model", 2019 [12th Int. Conf. Manag. of Large-Scale Syst. Development (MLSD)]. Moscow. DOI: 10.1109/MLSD.2019.8911012.
- [13] F.I. Ereshko, V.I. Medennikov, L.G. Muratova, "Modeling of a digital platform in agriculture. IEEE Xplore Digital Library", 2018 [11th Int. Conf. Manag. of Large-Scale Syst. Development (MLSD)]. Moscow. DOI: 10.1109/MLSD.2018.8551894
- [14] V.N. Bayda, K.A. Gaidash, F.I. Ereshko, V.I. Medennikov, "Digital platforms in logistics", pp. 110–113, 2018 [Proc. of XIII Int. Sci. Conf. HTCS-2018]. Stary Oskol: STI NITU MISIS.
- [15] Jac Fitzenz, The ROI of human capital: measuring the economic value of employee performance, Transl. from engl. by M.S. Menshikova, Yu.P. Leonova, ed. by V.I. Yarnikh. Moscow: Vershina, 2006.
- [16] A.A. Zatsarinnyy, V.A. Kondrashev, A.A. Sorokin, "Approaches to the organization of the computing process of a hybrid high-performance computing cluster in the digital platform environment", *CEUR Workshop Proc.*, vol. 2426, pp. 12–16, 2019.
- [17] P. Benjamin. How Not to Network a Nation: The Uneasy History of the Soviet Internet. USA MIT Press, 2016.