

ON THE CONCEPTUAL MODEL OF OIL AND GAS BUSINESS TRANSFORMATION IN THE TRANSITIONAL CONDITIONS TO THE INDUSTRY 4.0

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Abstract: *Digital transformation of business centers in the transition period to the Industry 4.0 is becoming a key competitiveness growth factor for Russian oil and gas factories. It is characterized by a wide range of potential effects, which often do not show themselves fully in reality due to dominant fragmentary approach to the introduction of the Industry 4.0 innovation technologies; as well as the fact that companies' managers do not have an integral view on the business digital transformation. The aim of the research consists in developing a conceptual model of oil and gas business digital transformation, allowing to make more reasonable managerial decisions on the implementation of digital technologies at enterprises. The research used the method of information statistical analysis about the state of the oil and gas industry and the methodology of conceptual approach to ensuring the transition of these companies to the Industry 4.0. The authors made the conclusion that the developed conceptual model improves the coordination and planning of works implementing digital transformation of oil and gas business, defines strategic priorities of the company's digital development, promotes the development of corporate knowledge about business processes digitalization and formation of positive social and economic effect.*

Keywords: *Oil and Gas Business, Digital Transformation, Conceptual Model, Industry 4.0 Technologies, Potential Effects.*

JEL Classification: *M15, L71, O32*

Introduction

The new digital technologies dissemination in the conditions of implementing the Industry 4.0 principles leads to radical changes in business process in all economic sectors. Nowadays the development of technological infrastructure and big data use have led not only to the provision of mass access to the Internet, but also integrated a wide range of digital services, products and systems into one cyber physical system (Cagnin et al., 2013; Jeschke et al, 2017).

Digital business transformation in traditional sectors, including the oil and gas one, is the key direction of Russian economy digitalization, which successful implementation can significantly increase the country's economic role in global digital processes. To speed up the transition of traditional economic sectors to modern digital technologies and through digital processes one needs to develop a systematic policy in this sphere, taking into account specific features of separate branches digitalization. A united conceptual approach is also required to implement digital transformation in any given sector. Digital transformation needs a profound understanding of its priorities, opportunities and risk for a certain business; the problems it solves and the ways of achieving that (Rogers, 2017).

1 Statement of a problem

Today Russia does not have an official document reflecting the business digital transformation features in key economic sectors. The governmental program «The Russian Federation digital economy» (Legislation, 2017), accepted in 2017 and functioning to 2024, has a general character. It does not provide detailed plans on digitalizing oil and gas sector. «Russian energy strategy to 2030» (Ministry, 2015) gives a long term forecast of oil and gas industry development. But it does not show how digital technologies influence on achieving the forecast indicators. The measures, providing the energy strategy implementation, include only general directions of an increase in oil and gas business efficiency, such as «energy sector modernization» and «innovative technologies acquisition».

The absence of ISO international standards regulating the implementation of innovative digital technologies makes the situation, connected to the lack of a systematic conceptual approach to macroeconomic digital transformation of oil and gas industry, more complicated. So far the project of ISO standard «Information technology. Compatibility requirements and model for devices within IIoT systems» has been developed. Three more ISO standards «Artificial Intelligence» are also being worked out (Comnews, 2019). The new standards are suggested to come into force in 2020. Now companies mostly focus their digital solutions on current ISO standards of 9000-9004 series «Quality management system», 14000 series «Ecological management», and 21500 series «Project management». The digital business transformation is seen in this case not as an independent development strategy, but as a special process, focused on achieving the aims of the sphere regulated by a current ISO standard.

In the scientific aspect, the research prevail, which deal with studying separate areas of digital transformation. Especially, there are many works, describing the issues of digital fields use (Berezina, 2015; Dmitriev et al, 2016; Tcharo 2018), and summarizing the best practices of enterprises' digitalization (Tcharo et al, 2018). There are few publications where authors approach to digital processes as complex ones, connected to green economy demands (Perelet, 2018), current ISO standards (Levchenko, 2018), and company's strategic development (Bauer et al, 2018). At the moment there are no publications, containing a developed model of business digital transformation in relation to specific economic conditions of oil and gas business in Russia.

The literature review showed that currently there is no unified notion of «Digital business transformation». Different authors interpret it differently trying to link it to the Industry 4.0 principles (Berman, 2012; Garifullin, 2018; Gray & Rumpe, 2017; Mat et al, 2015; Nylén & Holmström, 2015). Besides, international organizations, focused on doing research in the digital economy sphere, greatly contribute to studying this issue (World Bank, 2016; UNO, 2018; OECD, 2017; EEC, 2017). In our opinion, the definition, given by OECD, suits oil and gas business most of all: «Digital business transformation is a process integrating digital technologies in all aspects of business activity, and requiring the transformation of business operation models, managerial paradigms, economic relations and social practices» (OECD, 2017).

As far as Russian digital business transformation practice is concerned, in most cases enterprises introduce only separate digital projects, without developing the

digitalization strategy for all business lines. At the same time, the leading oil companies have generated some experience in the sphere of complex digital business transformation. For example, the oil company «Transneft» actively introduces digital solutions on pipelines. The oil company «Gazprom Neft» started the first Russian open digital platform EvOil and began the construction of the first digital refinery. The «LUKOIL» group of companies is implementing the technologies of integrated production modeling and planning. The companies «Gazprom Neft», «Tatneft», «Rosneft», and «LUKOIL» are the leaders in the number of digital oil fields. But even the leaders need to bolster their efforts to achieve a better integration of digital solutions with a general strategy of the company's development.

The given problems are extremely actual for Russian oil and gas companies, whose share in the country's GDP reaches about 70%, in the export structure about 50%, and the in federal budget formation up to 40% (VYGON consulting, 2018). Their scientifically based solution could speed up the digital transformation process of the oil and gas industry, as well as Russian national economy in general. So far Russia has taken the 42nd place out of 63 countries in the IMD digital competitiveness rating (VYGON consulting, 2018).

The above listed issues determine the aim and tasks of the research. The research purpose is to develop a conceptual model of Russian oil and gas sector transformation in the transition to the Industry 4.0. To achieve the aim, the following tasks had to be solved:

- To formulate strategic challengers for Russian oil and gas industry, which predetermine the necessity of oil and gas business digital transformation;
- To structure the conceptual model of oil and gas business digital transformation in the transitional conditions to the Industry 4.0.
- To determine the conditions of the developed model's successful implementation into managerial practice as well as its influence on oil and gas company's activity indicators.

2 Methods

The research used the methodology of conceptual approach to stating and solving a scientific problem, as well as the statistics analysis method of the information on oil and gas companies' activity.

Table 1 (Tab. 1) presents the statistic indicators, characterizing the efficiency of Russian oil and gaz companies development. The sample includes data from 2013, when the first information collection started to make an annual public rating of Russian oil and gas companies' ecological responsibility. Before 2013, Russian official statistics did not single out oil and gas industry as a separate one in extracting industries of the economy; and these companies did not provide nonfinancial accounts on their ecological activity. The data demonstrate a number of negative trends in their activity, such as low growth rates of labour efficiency indicators; the increase in fixed assets depretiation; the decrease in returns on assets accompanied by the rise in capital-labour ratio; a low share of highly technological working places.

Tab. 1: Russian oil and gas industry efficiency development indicators

Indicators	2013	2014	2015	2016	2017
1. Oil conversion ratio, %	71,6	72,4	74,3	79,0	81,0
2. Labour productivity index	100,8	102,8	98,3	100,3	100,4
3. Capital-labour ratio change index	103,7	106,6	106,4	104,7	104,5
4. Returns on assets change index	91,1	96,6	94,9	94,5	93,45
5. Fixed assets depreciation, %	53,2	55,8	55,4	57,5	57,7
6. A share of highly technological working places, %	5,0	4,7	5,1	5,3	5,8
7. Specific emissions of pollutants into the atmosphere kg/ tfoe	3,82	3,16	2,09	1,92	2,48
8. Specific gross greenhouse emissions kg/ tfoe	No data	No data	41,18	71,81	87,68
9. The ratio of polluted land area at the end of the year to the beginning of the year ha/ ha	0,39	0,18	0,17	0,19	0,31
10. The level of oil associated gas utilization, %	78,22	84,88	85,90	88,21	86,7

*Note: accountability on greenhouse gases emission was introduced only in 2015

Source: made based on data (FSSS, 2018; WWF.2018)

Changes that are even more negative can be seen in the dynamics of oil and gas companies' impact on the environment. For example, for the period from 2015 to 2017 specific emissions of pollutants into the atmosphere increased by 18%; specific gross greenhouse emissions rose more than twice; the land pollution index grew by 1.8 times. This situation can be partly explained by the introduction of sectoral sanctions in 2014 – 2015, as the result, oil and gas industry forfeited the benefits of buying foreign innovative technologies in the required quantity. The decrease in environmental pollution level should be considered one of the priorities of Russian oil and gas sector digital transformation.

Tab. 2: The profitability indicators of the oil and gas industry leaders for 2013-2017

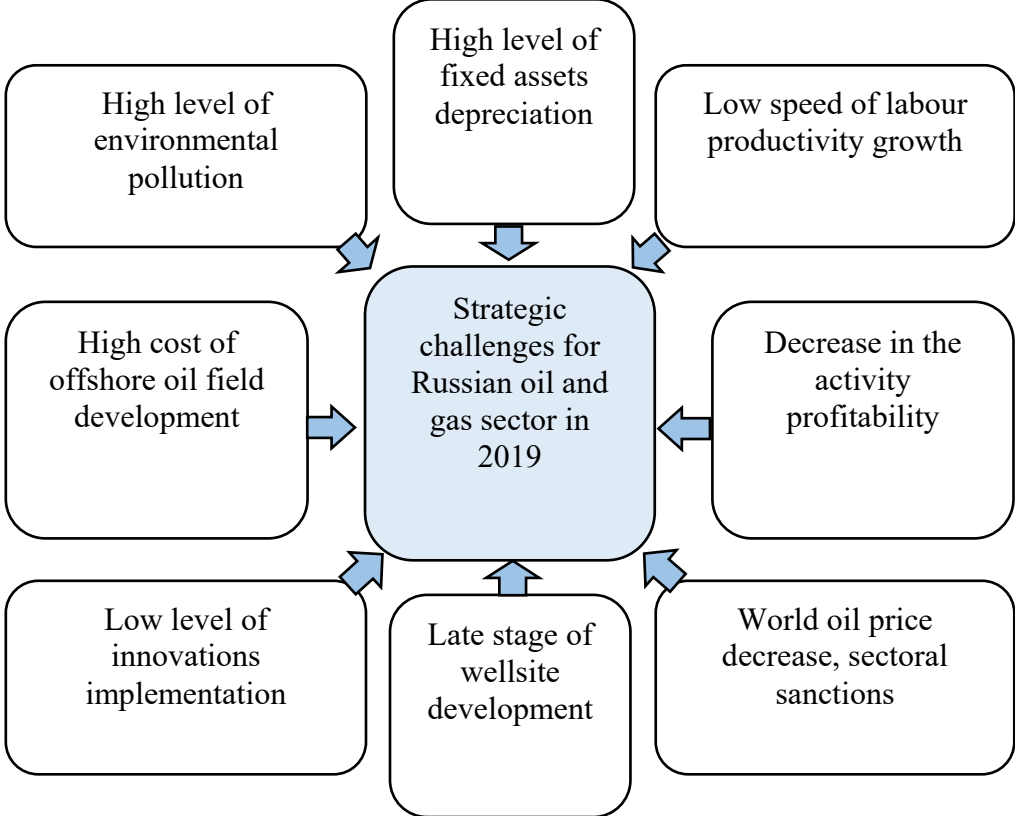
Indicators	2013	2014	2015	2016	2017
Sales profitability, %					
• LUKOIL	82,987	83,540	82,165	85,548	70,605
• Rosneft	5,880	3,626	3,049	9,782	7,357
• Gazprom	24,459	23,061	18,733	8,455	8,706
Assets profitability, %					
• LUKOIL	16,828	24,371	16,000	9,197	9,197
• Rosneft	5,628	7,855	2,778	1,023	1,321
• Gazprom	6,017	1,636	3,199	3,066	0,710
The average, %					
• Sales profitability	37,77	36,742	34,649	34,595	28,889
• Assets profitability	9,491	11,287	7,326	4,429	3,743

Source: made based on data (LUKOIL, 2018; Rosneft, 2018; Gazprom, 2018)

The problem of decreasing operating costs has become actual for oil and gas companies in the conditions of world oil price decrease. The data in the table 2 (Tab.2) allow to conclude that the profitability of sales and assets of Russian oil and gas companies is constantly falling. One more problem of Russian oil and gas

industry development consists in the growth of costs for current land wellsites repair and reconstruction, as well as high capital costs for offshore oil field development, mainly in Arctic.

Fig. 1: Strategic challenges for Russian oil and gas sector



Source: made by the authors

The cost of offshore works can exceed hundreds millions dollars. The question inevitably arises about the purposefulness of investments in such expensive projects, because such «expensive oil» cannot compete with traditional cheap oil (VYGON consulting, 2018). The use of digital technologies can reduce operating costs; extend the brown fields’ lifecycle; reduce risks and cost of offshore drilling considerably; increase the depth of oil extraction of the volume of oil production.

The strategic challenges for Russian oil and gas sector are presented in the figure 1 (Fig. 1).

The given data prove the necessity of systematic modernization for Russian oil and gas sector based on new Industry 4.0 digital technologies, which allow to solve business development problems quicker, more economical, with less risks and better results. It is forecasted that due to the implementation of the Industry 4.0 technologies the potential oil deposit extraction will reach 6.8 bln tonns to 2035; the oil production volume will reach 607 mln tonns; the depth of oil extraction will increase to 90%; the operating costs will decrease by 2.2 tln. roubles; the production cost of oil and gas extraction and refining will decrease by 15% (VYGON consulting, 2018). This will allow Russian oil and gas companies compensate for fall in income due to the constant decrease in world oil prices.

3 Problem solving

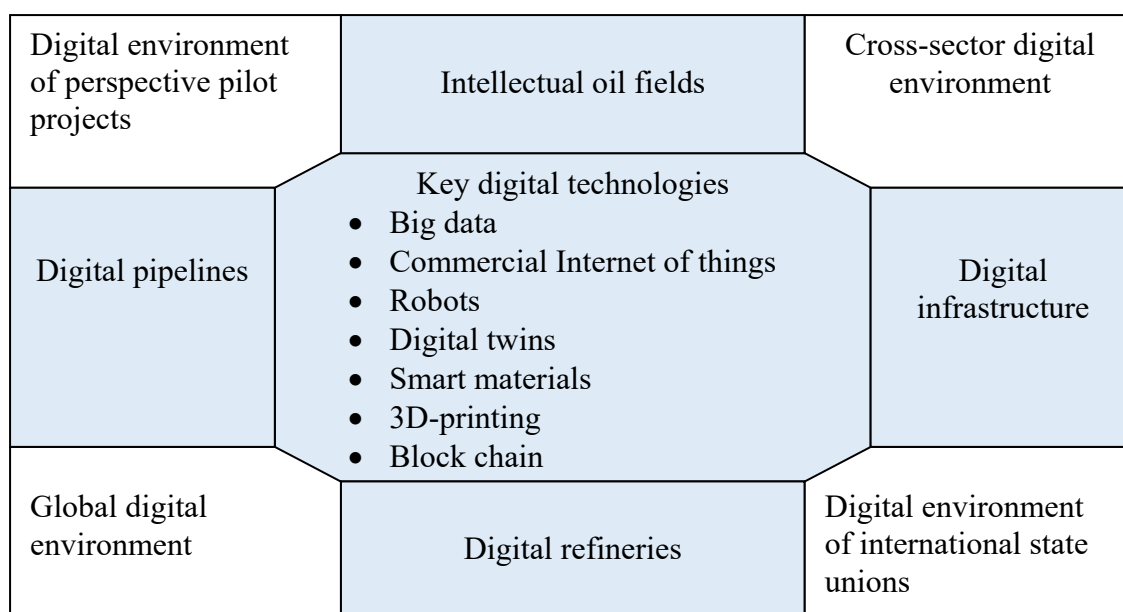
The development process of Russian oil and gas industry is regulated by different legislative documents, which lack the concept of the sector's digital transformation. An objective reason for that constitutes in the complexity and variety of business processes in oil and gas industry, which leads to a more labour intensive process to develop a strategic vision of digital modernization of oil and gas companies' activity.

The authors believe, that the specific features determining the necessity of conceptual approach to oil and gas business digital transformation include the following ones:

- The technological process is complex and resource intensive, which functions in a close connection with the development of energy saving programs, the development of energy efficiency, the use of low waste and wasteless as well as resource efficient technologies.
- The oil and gas business is based on fragmented combination of different spheres. That is why different digital directions of the 4.0 Industry are often united here in one technological solution. For example, a digital wellsite includes the elements of the commercial Internet of things, big data, robotics and others.
- Ecological requirements to the oil and gas business activities in the implementation of green economy concept (CSD, 2018) predetermine the priority focus of digital transformation process in oil and gas business on implementing tasks that are connected to providing industrial security and environmental protection.
- The leading oil and gas companies aim at achieving the leadership position in the sphere of oil and gas extraction and refining. They include such oil business giants as Petroleum, Conoco Philips, Exxon Mobil, Royal Dutch Shell, Total, Gazpromneft, LUKOIL and other big corporations (Perfiljev & Solomatov, 2016). Moreover, exporting companies get involved into the processes of forming intercountries' digital space (EU, EAEU, BRICS and others), and participate in global digital processes.
- The biggest oil and gas companies are characterized by the trend to diversification of their activities. One should also note a quite complex product supply chain and a large number of business partners from other industries. In these conditions, the intensive development of digital processes in oil and gas sector contributes to a more efficient cross-sector digital transformation.

The figure 2 (Fig. 2) demonstrates the digital environment of Russian oil and gas sector, modeled taking into account all given above specific functioning features of oil and gas companies.

Fig. 2. The model of digital environment in oil and gas business



Source: made by the authors

The methodological approach, developed by the research group of the World Bank and Eurasian Economic Commission (EEC, 2017) constituted the basis to form a conceptual model of oil and gas business digital transformation. This methodology recommends a complex approach to digitalization process, taking into account possibilities and risks of the Industry 4.0 technologies, qualitative and quantitative aspects of digitalization, measures to provide business digital transformation. In the research process it was specified relating to peculiarities of oil and gas companies development.

The authors' model is presented in figure 3 (Fig. 3). It includes 6 blocks, each having its own structure and performing a certain function:

- Block 1 «Priority purposes». It performs the goal setting functions.
- Block 2 «Target indicators». It gives details of priority purposes in the form of quantity indicators, which can be measured and estimated.
- Block 3 «Digital transformation directions». It reflects the key trends of using digital technologies in oil and gas business.
- Block 4 «Possible effects». It reflects potential benefits from implementing digital transformation in oil and gas business.
- Block 5 «Possible risks». It informs about potential risks, connected to ignoring digital transformation of business.
- Block 6 «Implementation mechanisms». It describes the necessary measures to regulate the digital transformation process in oil and gas business.

Fig.3 The conceptual model of Russian oil and gas business digital transformation

Priority purposes	<ul style="list-style-type: none"> • A sustainable development of oil and gas business in Industry 4.0 • Digital environment formation in oil and gas sector • Environmental protection and restoration 			
Target indicators	<ul style="list-style-type: none"> • Increase in oil extraction coefficient • Decrease in operating and capital costs • Decrease in pollutants emission • Increase in highly technological work places • Increase in the energy efficiency of production 			
Directions	Digital twins creation	Labour automation	Providing the staff with digital devices	Creation of digital ecosystem
Possible effects	Increase in efficiency of oil and gas extraction and refining	Optimization of the number of staff, development of digital labour	Improvement of working conditions, the increase in production safety rate	Increase in transactions speed, improvement of collaboration with third parties
	<ul style="list-style-type: none"> • Increase in quality and speed of decision making • Increase in labour productivity and quality • Optimization and cutting of costs 			
Possible risks	<ul style="list-style-type: none"> • Missed profit risk • Risk of digital technologies late implementation • Risk of decrease in competitive ability • Risk of increase in digital space control from leading market players • The risk of resistance to digital innovations 			
Implementation mechanisms	<ul style="list-style-type: none"> • Support of digital initiatives and pilot projects • Working out of new generation standards • Stimulating investments in digital technologies • Creating sectorial centers of competence and techno parks • Promoting best practices of digital business transformation 			

Source: made by the authors

The main research results can be used by oil and gas companies to organize the digital business transformation process; by scientific-research and expert organizations to work out digital programs and projects; by sectorial ministries to work out strategies of industry development; and by governmental bodies to develop state innovation policy for both country and regions.

4 Discussion

In 2018 the conceptual model of digital oil and gas business transformation, developed by the authors, was tested in the management practice of OOO «LUKOIL Perm» in the part concerning the measures of planning digital technologies implementation in the spheres of industrial security and environmental protection. The company conducts these activities based on ISO standard 14001. The model approbation results are presented in Table 3 (Tab. 3).

The presence of general concept of oil and gas business transformation in the conditions of 14001 ISO standard allowed of OOO «LUKOIL Perm» to implement a complex approach to developing and introducing digital solutions for providing industrial security and environmental protection. The actions taken have led to positive effects, for example, in 2018 OOO «LUKOIL Perm» decreased the water intake from surface watercourses by 7%, atmosphere pollution dropped by 14%, the number of new wellsites rose by 30%, operating costs fell by 10%, and energy consumption by 15%.

Tab. 3: The approbation results of oil and gas business digital transformation model at OOO «LUKOIL Perm»

Conditions necessary for model implementation	Measures taken by OOO «LUKOIL Perm»	Measures efficiency prof ^{ec}
Orientation on digital standards demand regulating the development of «smart» production, when they are absent, the choice of business priorities, which aims will make a basis for model functioning.	The model is focused on maintaining a high level of production security and environmental protection in compliance with 14001 ISO standard.	Economic efficiency: <ul style="list-style-type: none"> • Decrease of operating costs by 10% • Drop of energy consumption by 15% • Increase in the number of new wellsites by 30%
Top priority introduction of Industry 4.0 innovation technologies into production business processes, which provide a decisive contribution into forming positive effects of digitalization.	Introduction and gradual development of three intellectual oil fields. A preparatory work of mastering digital technologies of off-shore oil drilling.	Ecological efficiency: <ul style="list-style-type: none"> • Decrease of fresh water intake from watercourses by 7% • Fall in atmosphere pollution by 14%
Use of automated management methods in making strategic and tactical decisions.	Using methods of preventive diagnosis of wellsites states; monitoring of productivity loses; oil extraction indicators analysis in real time.	Social efficiency: <ul style="list-style-type: none"> • Development of the workers' digital thinking • Increasing staff's adaptability to digital technologies introduction
The use of model in the company's strategic planning.	The model is used at the initial stage of strategic planning as a set of key guidelines for developing programs, plans and projects.	

Creating managerial departments to coordinate different business processes.	Three Centers of integrated operations are created within the company's management.	Public efficiency: The visit of «Ernst & Young» experts to study the digitalization experience at OOO «LUKOIL Perm».
The development of staff's digital competencies, necessary for comprehension and implementation of the model; providing the implementation of developed measures.	Working out further training programs in the digital sphere; introducing personal responsibility of workers for fulfillment of the company's digitalization plan.	

* Note: the indicators are calculated as the ratio of 2018 data to 2017 ones.

Source: created by the authors

However, some difficulties were observed alongside with the positive effects from implementing this model. They were connected to the fact, that the digital business transformation procedure has become more complex, varied and labour intensive. Managerial and production staff needed a higher qualification level and rediness to work in new conditions. A specialized training in digital technologies was organized at OOO «LUKOIL Perm» to solve the problem of knowledge deficiency and unstable performance discipline. The company also introduced personal responsibility of workers for compliance with the requirements of 14001 ISO standard and performance of plan actions connected to development and implementation of digital solutions in the sphere of industrial security and environmental protection.

Conclusions

The conducted research allows to make the following conclusions:

- The worked out conceptual model contributes to the development of corporate knowledge about managing digital processes and technologies. It forms a holistic vision of oil and gas business digital transformation perspectives in the transition to Industry 4.0, increases the level of coordination between departments and services of managerial apparatus in digitalization processes;
- Methodological approach, used at model working out, develops the methodology of making the digitalization concept of the World Bank and Eurasian Economic Commission as it takes into account industrial peculiarities of business digital transformation using the example of Russian oil and gas companies;
- The developed conceptual model of oil and gas business digital transformation satisfies managerial demands in justification the choice of companies' strategic development options. Compliance with parameters, embedded in separate blocks of the model, can serve as a datum mark for including corporate measures and projects in strategic programs and development plans of oil and gas companies;
- To implement the developed model into managerial practice it is necessary to comply with conditions, which guarantee a successful integration of an innovation into oil and gas companies' activities. Positive effects are noticed as the result of model approbation at OOO «LUKOIL Perm». They prove a positive influence of this approach on the oil and gas business digital transformation process and an increase in the company's efficiency;

- The use of conceptual approach to business digital transformation does not only contributes to improving productive and managerial activity of an oil and gas company, but also creates problems, connected to using new knowledge and skills. Companies' managers must quickly identify these problems and provide measures to develop staff's competence and performance discipline.

The conducted research contributes to the theory of modern industry-based management. If this model is applied, it will allow to formalize the process of making managerial decisions in the sphere of business digital transformation; it will help to determine the features of digital technologies implementation for separate oil and gas companies more reasonably. The use of this model will also contribute to the growth of positive influence of oil and gas sector on achieving target indicators of the governmental program «The digital economy of the Russian Federation», which will provide a factor and a more successful transition of the country's economy to the Industry 4.0.

The authors see further research direction in working out the adoption strategy of Russian oil and gas companies to the principles of the Industry 4.0.

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