

THE  
**IIOAB**  
JOURNAL

VOLUME 11 : NO 3 : DECEMBER 2020 : ISSN 0976-3104

**SUPPLEMENT ISSUE**

Institute of Integrative Omics and  
Applied Biotechnology Journal

Dear Esteemed Readers, Authors, and Colleagues,

I hope this letter finds you in good health and high spirits. It is my distinct pleasure to address you as the Editor-in-Chief of Integrative Omics and Applied Biotechnology (IIOAB) Journal, a multidisciplinary scientific journal that has always placed a profound emphasis on nurturing the involvement of young scientists and championing the significance of an interdisciplinary approach.

At Integrative Omics and Applied Biotechnology (IIOAB) Journal, we firmly believe in the transformative power of science and innovation, and we recognize that it is the vigor and enthusiasm of young minds that often drive the most groundbreaking discoveries. We actively encourage students, early-career researchers, and scientists to submit their work and engage in meaningful discourse within the pages of our journal. We take pride in providing a platform for these emerging researchers to share their novel ideas and findings with the broader scientific community.

In today's rapidly evolving scientific landscape, it is increasingly evident that the challenges we face require a collaborative and interdisciplinary approach. The most complex problems demand a diverse set of perspectives and expertise. Integrative Omics and Applied Biotechnology (IIOAB) Journal has consistently promoted and celebrated this multidisciplinary ethos. We believe that by crossing traditional disciplinary boundaries, we can unlock new avenues for discovery, innovation, and progress. This philosophy has been at the heart of our journal's mission, and we remain dedicated to publishing research that exemplifies the power of interdisciplinary collaboration.

Our journal continues to serve as a hub for knowledge exchange, providing a platform for researchers from various fields to come together and share their insights, experiences, and research outcomes. The collaborative spirit within our community is truly inspiring, and I am immensely proud of the role that IIOAB journal plays in fostering such partnerships.

As we move forward, I encourage each and every one of you to continue supporting our mission. Whether you are a seasoned researcher, a young scientist embarking on your career, or a reader with a thirst for knowledge, your involvement in our journal is invaluable. By working together and embracing interdisciplinary perspectives, we can address the most pressing challenges facing humanity, from climate change and public health to technological advancements and social issues.

I would like to extend my gratitude to our authors, reviewers, editorial board members, and readers for their unwavering support. Your dedication is what makes IIOAB Journal the thriving scientific community it is today. Together, we will continue to explore the frontiers of knowledge and pioneer new approaches to solving the world's most complex problems.

Thank you for being a part of our journey, and for your commitment to advancing science through the pages of IIOAB Journal.



Yours sincerely,

*Vasco Azevedo*

**Vasco Azevedo**, Editor-in-Chief  
Integrative Omics and Applied Biotechnology  
(IIOAB) Journal





**Prof. Vasco Azevedo**  
*Federal University of Minas Gerais*  
Brazil

## Editor-in-Chief

### *Integrative Omics and Applied Biotechnology (IIOAB) Journal Editorial Board:*



**Nina Yiannakopoulou**  
*Technological Educational Institute of Athens*  
Greece



**Jyoti Mandlik**  
*Bharati Vidyapeeth University*  
India



**Rajneesh K. Gaur**  
*Department of Biotechnology, Ministry of Science and Technology*  
India



**Swarnalatha P**  
*VIT University*  
India



**Vinay Aroskar**  
*Sterling Biotech Limited*  
Mumbai, India



**Sanjay Kumar Gupta**  
*Indian Institute of Technology*  
New Delhi, India



**Arun Kumar Sangaiah**  
*VIT University*  
Vellore, India



**Sumathi Suresh**  
*Indian Institute of Technology*  
Bombay, India



**Bui Huy Khoi**  
*Industrial University of Ho Chi Minh City*  
Vietnam



**Tetsuji Yamada**  
*Rutgers University*  
New Jersey, USA



**Moustafa Mohamed Sabry Bakry**  
*Plant Protection Research Institute*  
Giza, Egypt



**Rohan Rajapakse**  
*University of Ruhuna*  
Sri Lanka



**Atun RoyChoudhury**  
*Ramky Advanced Centre for Environmental Research*  
India



**N. Arun Kumar**  
*SASTRA University*  
Thanjavur, India



**Bui Phu Nam Anh**  
*Ho Chi Minh Open University*  
Vietnam



**Steven Fernandes**  
*Sahyadri College of Engineering & Management*  
India

## ARTICLE

# BLOCKCHAIN TECHNOLOGY: SUPPLY CHAIN MANAGEMENT

Nikolai V. Lyasnikov<sup>1</sup>, Elena Aleksandrovna Smirnova<sup>2</sup>, Galina Nikiporets-Takigawa<sup>3</sup>,  
Tatyana Vladimirovna Deeva<sup>1</sup>, Nataliya Vladimirovna Vysotskaya<sup>4</sup>

<sup>1</sup>Market Economy Institute of RAS (MEI RAS), Nakhimovsky Prospect, 47, Moscow, 117418, RUSSIA

<sup>2</sup>V.I. Vernadsky Crimean Federal University, Vernagского Prospect, 4, Simferopol, 119334, RUSSIA

<sup>3</sup>Russian State Social University, Wilhelm Pieck Street, 4, bld.1, Moscow, 129226, RUSSIA

<sup>4</sup>Moscow State University of Railway Engineering (MIIT), Obratsova Street, 9, bld. 9, Moscow, 127055, RUSSIA

## ABSTRACT

One of the tasks of the supply chain management in the digital economy is a harmonious combination of the digital and physical worlds, which, in particular, implies the efficient use of a wide range of digital technologies, the blockchain technology being one of them. The article is aimed at studying the essence of blockchain technology, determining its advantages and disadvantages and prospects for use in supply chain management. The following methods were used in the study: analysis of scientific literature on the use of blockchain technology in supply chain management, a case-based method for carrying out a comparative analysis of the experience of foreign companies in the implementation of blockchain technology in supply chain management, comparing transactions using a blockchain system to the traditional trading process, as well as conducting an expert survey to assess the reliability of the selected sources. The characteristic features of the blockchain technology and the specifics of the supply chain management based on it are identified in the article; the experience of foreign companies in introducing the blockchain technology in the supply chain management and implemented blockchain projects in the supply chain management are analyzed. The observance of the logistics principles in the application of the blockchain technology and smart contracts is substantiated based on the analyzed experience and the traditional trading process and transactions using the blockchain system are compared. It has been proven that due to the use of blockchain technology, innovative changes in the management of companies' supply chains will help to increase the transparency of information and the reliability of operations in production and trade chains based on a well-defined network of participants, the confidentiality of transactions, the availability of information, and reduction in the time of interaction between participants.

## INTRODUCTION

With the development of globalization and the subsequent internationalization of trade, the organizational and financial processes of the supply chain management are determined by a variety of issues related to the production and delivery of products: from the purchase stage to the sale to the end consumer. Accordingly, it becomes more difficult for stakeholders to track and control the supply of products. The current situation in the supply chain management is determined by some difficulties in ensuring security and monitoring various operations in the supply chain [1-3].

The issue of transparency of the product delivery operations is also relevant for customers of all levels, because it is impossible to trace all events in general [4-6]. In particular, there is insufficient information for most end consumers about the products they buy and use because the entire network of retailers, distributors, transporters, storage facilities, and other suppliers is beyond control [7-9]. The issue of ensuring the trust and transparency of the supply chain is also important for intermediate suppliers because monitoring of the transaction history will help the management of distribution centers be confident in the supply reliability and optimize the supply chain. As such, the use of the end-to-end monitoring of financial and information flows among all participants in the supply chain becomes an urgent challenge in the modern logistics. The capabilities of the blockchain technology in the supply chain management can solve the problem of transparency and security of the stock movement [10-12].

The issues of optimizing and improving the efficiency of the supply chain management are also relevant and in demand due to the increased competition in the market of logistics intermediaries, which implies the search for new innovative ways of working using digital technologies.

The capability of digital technologies to fundamentally change the established organizational and financial processes of the supply chain management is confirmed in [13-15], for example, where it is noted that the existing linear structure of the supply chains is being replaced by a network structure. The linear supply chains are already transforming into the dynamic interconnected open supply systems (digital supply networks), where information flows are continuous and simultaneously accessible to all the network stakeholders, which allows to avoid various problems and delays in operation inherent in the traditional supply chains [16]. The information flows in the digital supply networks are digital [17] and can occur as follows [18]:

- from the physical world to the digital one (data are recorded on the digital media corresponding to the real world);
- information circulation inside the digital world (data exchange, comprehensive data analysis, economic and mathematical modeling – in particular, using artificial intelligence); and

**KEY WORDS**  
supply chains; supply chain management; blockchain; logistics; smart contract; platform for online learning events

Received: 3 Nov 2020  
Accepted: 2 Dec 2020  
Published: 4 Dec 2020

\*Corresponding Author  
Email:  
elena-a-smirnova@list.ru

- from the digital world to the physical one (the results of analysis and data modeling influence the decisions implemented in the physical world).

The blockchain technology is one of such digital technologies today. It has gained popularity relatively recently due to the intensive development of cryptocurrencies in the global economy and was originally used to conceal information about transactions. The blockchain technology is gaining rapid popularity today: articles are written about it, it is discussed at forums and industry-specific conferences, and startups are introduced in various sectors of the economy on its basis.

The term “blockchain” literally means “chain of blocks”, where each block is associated with the previous one. A block is an information package that contains all the preliminary information and some of the new data. The whole chain is a database distributed among many participants and operating without centralized control. The data forming the chain of blocks may contain various information: about transactions, people, objects, transactions, serial numbers, issued loans, etc. Therefore, the scope of this tool may vary [19].

The blockchain technology is based on the complex encryption system, where each block has its unique key. This feature of blockchain databases makes hacking almost impossible because hackers need to simultaneously access a copy of the database on all computers on the network for this. Even if the original document or transaction is subsequently changed, the data will receive another digital signature as a result, which will indicate a discrepancy in the system [20]. This system is organized in such a way that each of its participants constantly verifies the incoming information. As a result, the integrity and reliability of the materials stored on the network are confirmed with any transaction. This guarantees the preservation and accuracy of the information [21-23].

According to researchers [24], the use of the blockchain technology changes the management paradigm from hierarchical “from top to bottom” to “horizontal”, where decisions are made in a decentralized manner, and the entire process is transparent to the participants in the supply chain. In this case, the parameters of the material flow are minimized (reduction of time required for the order execution due to the reduction of intermediaries); the parameters of information flow are optimized (transparency of all documentation in the public domain along with minimizing the time of its processing, verification, and provision, as well as minimizing the associated information flow – “one-click” cargo insurance); and the parameters of financial flow are minimized (reduction of transportation costs and related expenses, time for processing operations, and risks due to the absence of intermediaries and ensuring transparency of the supply chain).

The goal of the article is to explore the essence of the blockchain technology, determine its advantages, disadvantages, and prospects for its use in the supply chain management. The hypothesis of the study is that innovative changes in the supply chain management of companies, which are ensured by the use of the blockchain technology, will increase the transparency of information and the reliability of operations in production and trade chains based on a clearly defined network of participants, transaction confidentiality, information availability, and reduced interaction time among the participants.

According to the results of the study, it can be concluded that the goal set in the study has been achieved.

## MATERIALS AND METHODS

The following set of research methods was determined to achieve the goal set in the study:

- theoretical methods (analysis of scientific literature) to study the scientific literature regarding the state of the research problem; and
- empirical methods (case method) to carry out a comparative analysis of the experience of foreign companies in introducing the blockchain technology in the supply chain management and to compare the traditional trading process and transactions through the blockchain system.
- an expert survey to assess the reliability of the selected sources.

Analysis of scientific literature allowed collecting a variety of information on the use of blockchain technology in supply chain management. Taking into account the existing limitations in the application of the document analysis method (the quality of the selected sources, their completeness and the subjective positions of the authors), the authors of this article conducted an expert survey to assess the reliability of the selected sources. The study structurally consisted of a sequential analysis of the peculiarities of using blockchain technology in supply chain management, analysis of the experience of foreign companies in the implementation of blockchain technology in supply chain management, consideration of implemented blockchain projects in the field of supply chain management, determination of compliance with the basic principles of logistics when using blockchain technologies and smart contracts, comparison of the traditional trading process and the blockchain system.

At the first stage of the study, the selected information was grouped according to its type: scientific research on the characteristics of supply chain management, as well as research on blockchain technology (articles from peer-reviewed scientific journals indexed in Scopus and Web of Science over the past 10 years).

At the second stage of the study, the authors contacted 10 experts in the field of blockchain technology and supply chain management. The criterion for the selection of experts was the availability of at least three author's articles on the specified subjects published in journals indexed in Scopus or Web of Science. E-mail messages were sent to the experts with a request to assess the reliability of the selected material. For this purpose, Harrington's scale was used. The results of the experts' answers are summarized in the Table 1.

**Table 1:** The results of the experts' answers

No	Main characteristics	Results
1	The number of proposals sent to experts	10 pieces
2	The number of questionnaires received from experts	8 pieces
3	Average reliability results of research/ expert information	0.73 points

On average, the experts rated high the selected documents (according to Harrington's scale, "high" level started from 0.64-0.8). At the third stage of the study, the collected information was processed with the creation of cases and their analysis, the construction of tables and the interpretation of the results.

## RESULTS AND DISCUSSION

### Experience in using blockchain technology in supply chain management

The world experience of using the blockchain technology in the supply chain management indicates the efficiency of its use by the leading transport and logistics companies [Table 2].

**Table 2:** The experience of foreign companies in introducing the blockchain technology in the supply chain management

No	Company	Experience of introduction
1	Maersk	worldwide container tracking in order to increase transparency and secure exchange of information among trading partners
2	Walmart	automation and optimization of container logistics at the terminal; tracking food products from a supplier to supermarkets
3	AT&T	independent supply chain management platform provides control from the factory to the end user
4	Antwerp (port)	automation and optimization of the terminal operation
5	Marine Transport International (MTI)	blockchain supply chain, which ensured the optimization of communications among the participants in the process
6	Rotterdam (Blockchain logistics)	optimization and supply chain management, including the information regarding transactions among the participants
7	Blockfreight	tracking all the shipping information and fraud prevention in container shipping
8	Co-op Food	display of the entire supply chain
9	A2B	reducing costs for international transportation through the use of cryptocurrency

Some other corporations, such as Amazon, Alibaba, and Kestrel, were also interested in the capabilities of using the blockchain technology in the supply chain management.

The successful use of the blockchain technology for the logistics industry is confirmed by the following completed projects or startups [Table 3].

**Table 3:** Completed projects or startups in the supply chain management

No	Project	Experience of introduction
1	Hyperledger Fabric	allows to track millions of container shipments annually and to better integrate with the customs (IBM in collaboration with Maersk)
2	Container Streams	provides information among the supplier, shipper, loading points, and customs terminals in one blockchain register (MTI in collaboration with Agility Sciences)
3	Provenance	real-time data platform providing transparency and customer access to the complete supply chain information (including the source, environmental impact, etc.)
4	TBSx3	providing an innovative level of protection for global supply chains in intermodal transportation using road and sea vehicles
5	Yojee	online order tracking, billing, supply chain management

## Case study analysis of the experience of foreign companies and startups in the implementation of blockchain technology in supply chain management

Let us analyze some case studies of foreign companies and startups on the introduction of the blockchain technology in the supply chain management.

In particular, Maersk and IBM created a digital solution for global trading using the blockchain technology based on the Hyper ledger Fabric system. It allows simplifying the document flow for container transportation by transferring it to the Internet and provides the exchange of information and documents among all participants in the process in real time from the initial to the final stage of the supply chain. The new technology allows reducing costs and time required for paperwork between the shipper and the recipient, and the entire workflow will be reduced to blockchain-based smart contracts [25].

The container line customers within the Maersk group gained access to the Remote Container Management (RCM) system of refrigerated trucks in 2017. The RCM technology contains fairly simple GPS cognitive system elements, a modem, and a SIM card installed on each of Maersk's 270,000 refrigerated containers. The system allows monitoring the current location of the refrigerated container, the temperature and humidity inside the container, and the status of the connection to the power supply during the entire transportation process. The data are transmitted to customers and RCM support specialists via satellite transmitters on board each of Maersk's 400 owned and chartered vessels [26].

The Maersk's blockchain technology works as follows in the context of shipments [27]:

- Each participant can track a transaction in the blockchain;
- The supply chain ecosystem allows tracking the stock movement, customs status, billing, and deadlines;
- Events and documents of the supply chain are exchanged in real time;
- None of the parties can modify, delete, or add an entry without the consent of other participants in the supply chain; and
- The result is transparency, reduction of fraud and the transit time of the goods.

Another example is the experiment on the introduction of a blockchain-based logistics tool of the American retail network Walmart, which also uses the Hyper ledger Fabric system. The service helps track food products from suppliers to supermarkets. Such data as the warranty period for the supply of products and requirements for transportation conditions and storage temperature were used. Chinese pork became a test product due to the worsening reputation of suppliers from China. The Walmart management declares that the transition to the blockchain is required to let consumers understand who delivers products to their tables and where from [28].

It later became known that the British Co-op Food began to test a similar scheme. The used blockchain system allowed displaying the entire fish supply chain: from catch to supermarket shelves [29].

The US mobile giant AT&T launched its own supply chain management platform. Services such as IBM Blockchain and Microsoft Azure were used for its development. The AT&T supply chain management system ensures control from the plant to the end user. This service allows controlling the origin of materials and the quality of production at the production stage, track shipments from the company's warehouses to the end consumer, and retailers will be able to constantly monitor the availability of goods at their warehouses. The AT&T system is based on the blockchain, which also allows confirming the authenticity of the goods. All batch information is entered into blocks and cannot be modified or deleted. The recipient can obtain the required information at any time [12].

The London-based company Provenance strove to make the delivery of products to the end consumer more transparent using the blockchain by providing complete information about the company's activities and covering all operations, including environmental impacts and places of origin of goods and production. This decision was made because the top management of the company was concerned about the kind of data provided to consumers and formed the client policy focusing on the availability of the complete information and the way it was presented on the product or in the store. Using the Provenance blockchain in the format of a real-time data platform allows the end consumer to see every step that the product made on its way. For example, producers of organic or unique farm food can emphasize its authenticity by telling the food story using the blockchain. Building a chain of "reliable facts" provides an excellent customer experience and can theoretically enhance the retailer's image. Any claim that the product is organic can be verified by a demanding customer [30].

Joint programs for developing a blockchain-based platform are another confirmation of the successful use of the blockchain technology for the supply chain management. The blockchain platform developed by IBM allows to track the location and condition of trucks, and all authorized participants in the chain can see the required information during the transportation cycle. Traditionally, the supply chain transactions are performed manually, thus creating delays and increasing the likelihood of data duplication or false information. The use of RFID tags containing data about the vehicle, driver, and cargo allows the IoT



(Internet of Things) sensors to track the truck movement and information about the availability of free space, and then enter these data into the blockchain. Thus, a single database is created, and all authorized participants can access it, while the data in it can be modified only by agreement of all parties. Once the truck leaves the load point, an automatic notification is sent to the user informing them of the load, weight, and estimated arrival time. In addition, a database is created based on the tags that tracks all exchanges, stops, and transactions made by each vehicle and its cargo from the load point to the end customer [31].

**Comparison of the traditional trading process and the blockchain system**

The following basic principles of logistics were observed in all the examined cases: consistency, reliability, efficiency, safety, and cost-efficiency [Table 4].

**Table 4:** Compliance with the principles of logistics in the application of the blockchain technology and smart contracts

Principles of logistics	Advantages	Prospects
Consistency	Creating integrated management structures	All files are integrated into a single system.
	Information availability	All bills of lading, waybills, declarations, certificates, etc. may be publicly available, regardless of the owner and the respective positions.
	Documentation unification	The entire range of cargo and transport documentation is in the unified format. Clearer systemic planning of business processes.
Reliability	Improving the reliability of workflow	Creating a distributed ledger of all approved documents. Data security. Protecting document storage from hacking. Inability to modify the information in the course of transportation.
	Improving the quality of the logistics product	Recording environmental changes that are critical to a particular type of product.
Efficiency	Real-time data updates for all parts of the supply chain	Synchronizing the work of all counterparties and improving the accuracy of forecasting and planning, which will reduce the cost of goods.
	Reducing order processing time	Eliminating duplicated data records in the system. Integrating automatic triggers and using data from the IoT tags.
Safety	Reducing logistic risks	Impossibility of falsification or loss of documentation, absence of corruption risks and the influence of the human factor, prevention of incorrect labeling of goods, and turnover of smuggled and illegal goods.
Cost-efficiency	Reducing logistic costs	Reducing the number of intermediaries and procedures associated with analog interactions. Reducing the time spent on information processing. Reducing customs duties.

Note: compiled by the authors

Transparency and security are seen as the key to a successful business in today's competitive world. Sharing information among all parties in the supply chain can improve relations among them and make them more efficient. The main factors of using the components of the blockchain system can be useful for improvement in the logistics industry for the following reasons:

- access to information on activities within the supply chain is opened;
- customers can rate the product, service, suppliers, and carriers before making a purchasing decision;
- customers are provided with the information they need about the origin of the goods and the freight route;
- risk of fraud or fake goods is reduced; and
- exchange of goods and payment systems is simplified.

Differences between the traditional trading process and operations using the blockchain system can be seen in [Table 5].

**Table 5:** Comparison of the traditional trading process and the blockchain system

Parameters	Traditional process	Blockchain, smart contracts
Transparency of processes	Delays in fulfilling obligations, violation of contract terms, shipment monitoring is difficult.	All network partners supply real-time data to the unified system; data accuracy.
Cost effectiveness	Use of physical media, which requires expenses for maintenance and disposal.	Absence of physical documents or transportation. No risk of the information duplication or loss.
Customized settings	Customized needs of all parties to	Smart contracts, consideration for the

	the supply are often ignored, operations are routine.	needs of participants, adaptation to the specifics of the partner.
Convenience of processes	There may be delays in the data exchange, a significant proportion of operations are offline.	Unified database shared by all participants, digital data, online access to all data.
Safety of processes	Information is not synchronized among participants, data may be concealed from participants, fraud.	Information is verified and supplemented, but is not modified. The risk of fraud is minimal.
Speed of processes	There may be delays in the contracts execution due to difficulties in information exchange.	Simple and quick access to information due to data encryption, cloud technology.

Note: compiled by the authors

Given the comparison provided in [Table 5], the advantages of the blockchain are undeniable. The blockchain is a technological solution to the current issues in various sectors. As a result, many companies implement it to gain a competitive advantage due to transparency in their activities. However, the introduction of such a system can cause significant difficulties because it is fairly difficult to modify and adapt the supply chain. Companies spend years on reorganizing the supply chains, thus, the difficulty of integrating new technology cannot be underestimated.

Lack of trained personnel – specialists with experience in the cryptocurrency space and understanding of crypto assets – is one of the main barriers to the blockchain introduction. Accordingly, a company that plans to introduce innovations in its operation should learn more about the specifics of working with the blockchain and analyze the business to assess potential advantages and disadvantages. Along with this, the technological imperfection of the system, namely the problems of equipment failure, must be noted. It must be understood that the adoption of the blockchain as an innovative technology of the supply chain management is quite slow today due to certain risks and skepticism of individual companies, but it is very likely that it will soon gain trust, and its use will significantly increase the efficiency of the supply chain management.

## CONCLUSION

The study of the specifics of the blockchain technology and analysis of the experience of using this tool in the supply chain management allow identifying the following main advantages of its introduction. First, it is compliance and transparency, which are ensured by a clearly defined network of participants, where membership and access rights are allowed for all contacts in the specific business network. The access to confidential information by third parties and fraud are excluded under such conditions. Second, it is transaction confidentiality which manifests itself in the fact that the companies are provided with the flexibility and security of transactions, which are only visible to its participants when using the correct encryption key. Third, it is access to information: it can be simply and quickly determined how all information is synchronized among the participants; instant access to data in the digital system is also allowed; respectively, there is a reduction in the interaction time among the participants, which reduces delays in transactions. Fourth, it is increasing customer confidence because the blockchain allows companies to provide reliable information about the product at all stages of its life cycle, and customers can find all the necessary information about the products, methods of transportation, and packaging. The companies may have a real-time feedback from consumers because customers can answer questions about products they bought or received in real time. This can help various participants in the supply chain analyze their operation and avoid mistakes. Fifth, it is the possibility of using cloud technologies and transferring information from physical media. As such, the hypothesis of the study has been confirmed, namely, that innovative changes in the supply chain management of companies, which are implied by the use of the blockchain technology, will increase the information transparency and reliability of operations in the production and trade chains based on a clearly defined network of participants, transaction confidentiality, information availability, and reducing the time of interaction among the participants.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] Purohit Frolova EE, Polyakova TA, Dudin MN, Rusakova EP, Kucherenko PA. [2018] Information Security of Russia in the Digital Economy: The Economic and Legal Aspects. *Journal of Advanced Research in Law and Economics*, 9(1):89-95.
- [2] Litvinova TM, Glazkova IU, Levagina SA, Shalyapina EN, Sheina AG. [2020] Supply chain of the imported ginseng medicinal plant materials for the pharmaceutical industry of the Russian federation. *Supply Chain Management*, 8:225–230.
- [3] Bykov VA, Kolesov RV, Sirotkin SA, Tarasova AYU, Fedulin AA. [2020] Improving external state financial control at the

- regional and municipal level. *Revista Inclusiones*, 7(SI):178-187.
- [4] Altynbekkyzy A, Zhumabaeva GA. [2019] Constitutional Guarantees of Freedom of Speech and the Right to Access Information on the Internet. *Journal of Advanced Research in Law and Economics*, 10(1):13-19.
- [5] Dzhanelidze OM, Azhibayev MG. [2019] Problems of Countering Criminal Offenses in Information and Communication Networks. *Journal of Advanced Research in Law and Economics*, 10(1):134-143.
- [6] Pisenko KA, Botvinnik SL. [2020] Protection against imposing unfavorable contract terms by the dominant party in the Russian legislation: issues of ensuring the balance of convenience. *JURÍDICAS CUC*, 16(1):251-268.
- [7] Fedorova IYu, Urunov AA, Rodina IB, Ostapenko VA. [2020] Financing and quality of housing construction: introduction of information systems as a regulatory tool. *Revista Inclusiones*, 7(SI):328-339.
- [8] Chernysheva AM, Gusakov NP, Trofimova AA, Bulatenko MA. [2019] Diversification of Transit Risks of Oil Supplies Bypassing Ukraine as the Basis of Energy Security in Europe. *International Journal of Energy Economics and Policy*, 9(6):461-468.
- [9] Nikolskaya EYu, Lepeshkin VA, Kulgachev IP, Matveev AA, Lebedeva OYe. [2020] Perfection of Quality Management of Hotel Services. *Journal of Environmental Management and Tourism*, 11(2):417-421.
- [10] Kim HM, Laskowski M. [2018] Toward an ontology-driven blockchain design for supply chain provenance. *Intelligent Systems in Accounting, Finance and Management*, 25(1):18-27.
- [11] Nakasumi, M. [2017] Information sharing for supply chain management based on block chain technology. In: *IEEE 19th Conference on Business Informatics (CBI 2017)*, Thessaloniki, Greece, 24-27:140-149, IEEE.
- [12] Kshetri N. [2018] Blockchain's roles in meeting key supply chain management objectives. *The International Journal of Information Management*, 39:80-89.
- [13] Zaheer N, Trkman P. [2017] An information sharing theory perspective on willingness to share information in supply chains. *International Journal of Logistics Management*, 28(2):417-443.
- [14] Shi Q, Ding X, Zuo J, Zillante G. [2016] Mobile Internet based construction supply chain management: A critical review. *Automation in Construction*, 72:143-154.
- [15] Strelkova IA, Antropov VV, Zubenko VV, Tolmachev PI. [2020] The role of e-commerce in global scm practice. *Revista Inclusiones*, 7(SI):414-423.
- [16] Chang PY, Hwang MS, Yang CC. [2018] A blockchain-based traceable certification system. *Advances in Intelligent Systems and Computing*, 733:363-369.
- [17] Hofmann E, Strewé UM, Bosia N. [2018] Introduction - Why to Pay Attention on Blockchain-Driven Supply Chain Finance? In: *Supply Chain Finance and Blockchain Technology*. SpringerBriefs in Finance, Cham: Springer. DOI: 10.1007/978-3-319-62371-9\_1.
- [18] Beck R, Avital M, Rossi M, Thatcher JB. [2017] Blockchain Technology in Business and Information Systems Research. *Business & Information Systems Engineering*, 59(6):381-384.
- [19] Chen Y. [2018] Blockchain tokens and the potential democratization of entrepreneurship and innovation. *Business Horizons*, 61:567-575.
- [20] Underwood S. [2016] Blockchain beyond bitcoin. *Communications of the ACM*, 59:15-17.
- [21] Cole R, Stevenson M, Aitken J. [2019] Blockchain Technology: Implications for operations and supply chain management. *International Journal of Supply Chain Management*, 24(4):469-483.
- [22] Abeyratne SA, Monfared RP. [2016] Blockchain Ready Manufacturing Supply Chain Using Distributed Ledger. *International Journal of Research in Engineering and Technology*, 5:1-10.
- [23] Iansiti M, Lakhani KR. [2017] The truth about blockchain. *Harvard Business Review*, 95(1):118-127.
- [24] Tapscott D, Tapscott A. [2017] How blockchain will change organizations. *MIT Sloan Management Review*, 58(2):10-13.
- [25] Jović M, Filipović M, Tijan E, Jardas M. [2019] A Review of Blockchain Technology Implementation in Shipping Industry. *Scientific Journal of Maritime Research*, 33:40-148.
- [26] Allam Z. [2019] On Smart Contracts and Organisational Performance: A Review of Smart Contracts through the Blockchain Technology. *Review of Economic and Business Studies*, 11(2):137-156.
- [27] Helo P, Hao Y. [2019] Block chains in operations and supply chains: A model and reference implementation. *Computers & Industrial Engineering*, 136:242-251.
- [28] Kamilaris A, Fonts A, Prenafeta-Boldu FX. [2019] The rise of blockchain technology in agriculture and food supply chains. *Trends in Food Science & Technology*, 91:640-652.
- [29] Tse D, Zhang B, Yang Y, Cheng C, Mu H. [2017] Blockchain application in food supply information security. In: *2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, Singapore, December 10-13:1357-1361, IEEE.
- [30] Lu Q, Xu X. [2017] Adaptable Blockchain-Based Systems: A Case Study for Product Traceability. *IEEE Software*, 34(6):21-27.
- [31] Christidis K, Devetsikiotis M. [2016] Blockchains and Smart Contracts for the Internet of Things. *IEEE Access*, 4:2292-2303.

*\*English translation of the references are presented*

## ARTICLE

# CURRENT TRENDS AND DIRECTIONS OF DEVELOPMENT OF THE INTERNATIONAL ECONOMIC ENVIRONMENT

Olga Vladimirovna Glinkina<sup>1\*</sup>, Svetlana Aleksandrovna Ganina<sup>1</sup>, Marina Viktorovna Soloveva<sup>2</sup>,  
Alexei Nikolaevich Litvinov<sup>2</sup>, Irina Leonidovna Smirnova<sup>2</sup>

<sup>1</sup>Russian New University, 22 Radio Street, Moscow, 105005, RUSSIA

<sup>2</sup>Financial University under the Government of the Russian Federation, Leningradsky Prospekt, 49, Moscow, 125993, RUSSIA

## ABSTRACT

The role and importance of international economic organizations in the formation of a new multipolar world order with centers of power and decision making on different continents are reviewed in the article. It is revealed in the study how the global economic problems of mankind are gradually multiplying in the unipolar world led by the US. The problems and prospects of development of the modern global and regional organizations, which are also influenced by the complex process of forming a multipolar world, its crises, contradictions, and confrontation between the great powers, are analyzed and forecasted. As a result of the study, measures are identified that will contribute to the productive improvement of the modern system of international economic organizations of all kinds and types, because the taken measures will have an almost immediate effect on each organization in the context of globalization.

## INTRODUCTION

The developing states – first of all, the BRICS member states – regularly express their dissatisfaction with the activities of the modern international economic organizations at various political and diplomatic platforms, which, in their opinion, are focused primarily on protecting the interests of the US and Western European states. The developing countries are gradually creating new formats for financial and economic cooperation on the world stage and establishing their own institutions, which causes the need for deep reforming of the existing international economic organizations. International economic organizations appear to be an important instrument for cooperation and regulation of multilateral interstate relations in the field of trade and economy. They have agreed goals, their permanent bodies, as well as organizational norms, including the charter, protocol and procedure for making decisions [1, 2]. When participating in international lawmaking, international economic organizations in their decisions increasingly touch upon economic issues that have been traditionally regulated at the domestic level. An important aspect of the analysis is identifying active role of transnational corporations (TNCs) in the global economy, since states concede to TNCs in the competition for power in international relations and management of global processes in the world [3, 4]. In world politics and economics, TNCs and their network system of activity have their own power dispersed in different countries, which takes them out of the control of the nation-states. The political strategy of TNCs is to bypass the existing political institutions and ensure influence on the process of making foreign policy decisions by nation states in various areas of public life, primarily in politics and economics [5]. In order to solve global problems, humanity has sufficient scientific, technical and material achievements, appropriately developed mechanisms, which are used by various international institutions.

The authors consider that the stability and security of the entire system of international economic relations depend on how the current differences between the most developed and developing states within the framework of international economic organizations are overcome. The issues related to the development of trends in the international economic environment are reviewed in various works [1-6]. An analysis of the current situation and the need to find options for adapting the international economic organizations to the modern realities determine the relevance of the study

## METHODS

System approach, statistical, financial and economic analysis, methods of quantitative and structural analysis, as well as statistical and economic methods were used in the study. The study comprised two stages. At the first stage, an empirical analysis of the activities of modern economic organizations in the context of the main problems of global development was carried out by comparing data on the efficiency of international specialized economic organizations (WB, IMF, OECD, WTO), as well as the regional international economic organizations (EU, EAEU, APEC, ASEAN, CARICOM). At the second stage, based on the data obtained, the most realistic directions for the development of international economic organizations were determined: 1) political and economic aspects of the recent advances in formation of the multipolar world order; 2) possible transformation of the role and significance of international economic organizations in the context of the emergence of new centers of power in the world arena. The study has resulted in the following conclusions. It has been shown in this study how in the conditions of a unipolar world led by the United States, the global economic problems of mankind are gradually increasing. A paradoxical situation is

### KEY WORDS

international economic organizations, world economy, BRICS member states, UN, IMF, WTO, EU, multipolar world

Received: 1 Nov 2020  
Accepted: 3 Dec 2020  
Published: 4 Dec 2020

\*Corresponding Author

Email:  
ovmail@bk.ru

emerging when international financial and economic institutions should take measures to bring the national economies of countries in need of assistance out of the crisis but in reality, the loans and trade preferences provided by them only lead to an aggravation of the situation.

## RESULTS AND DISCUSSION

### Analysis of the efficiency of international specialized economic organizations (WB, IMF, OECD, WTO)

The international economic and financial organizations provide structure and financing for many unilateral and multilateral development projects. Such organizations handle the basic economic and political problems faced by both local society and the international community. Their activities contribute to the sustainable development of the private and public sectors mainly through financing the projects of the private sector located in the developing countries, helping private companies in the developing countries mobilize financing in the international financial markets, and providing advice and technical assistance to enterprises and governments.

The international economic organizations are an important tool for cooperation and regulation of multilateral interstate relations in trade and economy [1]. International organizations of any kind are designed to solve various global problems in their fields of activity and the world community as a whole. More than 1,000 international conferences are held annually to solve economic and other problems, which are convened to develop and adopt international treaties, conclude acts, and establish principles of cooperation in the specific area of international relations.

According to the general opinion of the world community, the United Nations (UN), International Monetary Fund (IMF), World Trade Organization (WTO), as well as regional and industry-specific organizations with extensive experience in coordinating international efforts, using resources, and regulating international economic relations should all play their role in regulating these processes and solving global problems. Mankind has sufficient scientific, technical, and financial achievements, as well as appropriately developed mechanisms to solve global problems [3].

At the same time, the complexity of solving global economic problems of our time does not mean that the world community is not aware of their harmful effects and ignores them. The international organizations are now trying to develop a comprehensive interstate approach to solving them. The situation is complicated by the increasing role of TNCs in the global economy, because their policies can hardly be influenced due to the transnational nature of their activities [2]. A TNC is a company with production facilities in several countries, and its percentage of assets in foreign branches is more than 25 – 30 %. States lose to the TNCs in the competition for power in international relations and the management of global processes in the world.

The influence of the TNCs on making foreign policy decisions by states and international economic organizations is likely to significantly decrease after the new multipolar world order is formally established. In this case, many sovereign states claiming the status of new centers of power (for example, China and Russia) will strengthen their positions in the international stage.

The development of global (economic, political, financial, trade) processes in the modern world is far ahead of the possibilities to manage them. In fact, the situation in the world is developing in such a way that the existing specialized economic organizations such as the World Bank, IMF, Organisation for Economic Co-operation and Development (OECD), and WTO fail to cope with their functions and to effectively solve the tasks they face.

The BRICS member states constantly indicate the need for serious reform of the IMF and the World Bank at various international platforms, primarily as part of the G20. The international financial and economic crisis and the peculiarities of eliminating its consequences have forced the BRICS member states to unite in their consolidated demand in the G20 to redistribute quotas and voting rights in favor of the developing countries, as well as to grant them access to managerial posts of the World Bank, IMF, and WTO [7].

It must be noted that the coordinated actions of the BRICS member states on the world stage have already brought some results. The agreements reached at the G20 Summit in Pittsburgh on the redistribution of national quotas and voting rights as part of the reform of the World Bank's representation system took effect in April 2010. At the time, the share of votes of the developing countries increased by 3.13 % due to the developed countries (their share had been previously increased by 1.46 % in 2008) [2]. As a result, China moved from the sixth to the third position in the list of countries with a large share of votes in the World Bank, and the shares of Brazil, India, Turkey, and Mexico increased, while the shares of the largest shareholders of the World Bank (Japan, Great Britain, France, and Germany) decreased.

The same year, the IMF also carried out a reform with an increase in quotas, which implied an unprecedented 100 % increase in aggregate quotas and a significant change in the balance of quota shares in favor of the dynamically developing states with emerging markets by 6 %. The IMF decision package under consideration increased the total quota of the BRICS member states in the IMF to 14.91 %, and these states with a consolidated position obtained a group right of veto over the most important IMF decisions, which was adopted by a qualified majority of 85 % of quotas.

The reforms also increased the representation of the developing countries in the Executive Council due to two seats that had previously been assigned to the European countries. However, the IMF reforms in its structure and management system did not solve all the pressing problems of this international organization [1]. They were a band-aid solution and failed to satisfy all the requirements of the BRICS member states. In particular, a new formula for calculating quotas is required today, adjusted in accordance with the real ranking of some states in the global economy. It is also important to revise the principles of providing assistance to countries in crisis and to continue improving the IMF management system.

The BRICS member states insist on a formula for calculating quotas based on the GDP by purchasing power parity (PPP) or the volume of international reserves [4]. However, the BRICS member states have not yet developed any agreed proposals on the specific components of the new formula that could be presented to the world community at the next G20 summit, for example. The experts predict the continuing pressure of the developing countries on the IMF in the foreseeable future in order to level the leading role of the US and Western Europe in the organization, because even after the reforms have already been implemented, the US quota exceeds 15 %, which allows Washington to use the veto right in the IMF when making important decisions.

With regard to the management system in the World Bank and IMF, the BRICS member states also have many questions to the OECD and WTO. In particular, the WTO provides preferences for the least developed and developing countries, but in practice, mainly the developed countries of the West benefit from them [8]. Antidumping measures can now be noted among the most urgent and complex problems of the WTO, which block the way for inexpensive foreign goods to the domestic markets of the developed countries. The US expert economists have identified another problem in the current activities of the WTO: it is associated with the high standards of the organization, which cause the reluctance of individual countries to join the union.

The legal regulation of the trade relations with the participation of the developing and least developed countries in the WTO currently faces many problems. In fact, the developed countries that have influence on the WTO approve such rules and provide for such procedures in this international organization which can be conveniently used in their favor in practice to gain access to the markets of the newly joined states, while creating obstacles for them in the competitive trade on their territories.

The OECD includes 34 developed countries with 55 % of world GDP and 60 % of international trade [5]. The organization is designed to promote the sustainable economic growth of the member states and the world community as a whole. Its activities cover almost all sectors of the modern economy. The priority of the OECD is to form the innovative coordination of the global economic policy. However, the OECD provides a list of recommendations for bringing the internal structure of states in line with its requirements, which is why the developing countries have to wait years to join it, modernize the economy, and pay the contributions. As a result, the most developed countries gain economic benefits from this process again and allocate the funds received by the OECD primarily to the development of their own national economies.

As such, it becomes obvious that the activities of the international specialized economic organizations (World Bank, IMF, OECD, and WTO) in the modern emerging multipolar world are not efficient. They do not satisfy the interests of the new developing centers of power – on the contrary, the policies of these organizations are aimed at strengthening the unipolar world led by the US and Western European countries, which causes an increasing discontent among the BRICS member states and other influential states on the world stage every year.

### **Analysis of the performance of regional international economic organizations (EU, EAEU, APEC, CARICOM)**

During and after the 2008 global financial crisis, the regional international economic organizations faced a significant challenge to economic sustainability and stability [9, 10]. The problems were particularly significant in the EU, because Western countries were actually tied to the US economy, which was the epicenter of the economic collapse. What is happening in the EU (European Union) clearly demonstrates that the mechanisms of economic integration and state support in force there leave much to be desired. The EU currently includes 28 member states. The EU economy is the second largest in the world in nominal terms and by PPP. However, the GDP growth rates of the EU member states are not equal. The unevenness of the economic development is one of the main problems of the integration processes in this regional organization and the cause of the crisis phenomena [4].

The Asia-Pacific Economic Cooperation (APEC) is also described by insufficiently high efficiency of its activities today. The monetary policy of this association is primarily focused on the regulation of financial instruments rather than on the real economic sector. At the same time, there is a heterogeneity in the political preferences of the member states in the APEC political and economic coalition, which means that high rates of integration are impossible. Moreover, the economic stability of the Eurozone is important for the APEC member states, because the emergence of problems in it automatically influences the countries in the Asia-Pacific region (Vietnam, Indonesia, China, Malaysia, New Zealand, Japan, etc.).

Numerous disintegration factors are observed in the Caribbean Community (CARICOM, the trade and economic union of the countries in Central and northeast South America). In particular, the organization lacks domestic sales markets for products, which leads to a decrease in the export potential of countries

and the development of noneconomic forms of cooperation and functional cooperation, where greater success is possible than in the trade sector. The CARICOM is described by a high degree of the import dependence due to the need to support domestic production and satisfy consumer demand. Imports significantly exceed exports in most countries [6]. The member states of this regional organization are very limited in domestic financial resources, and therefore, they are too dependent on export revenues and world market conditions.

It is important for the community to ensure the synchronization of decision-making processes, but the experience of the EU is being copied in CARICOM without its mandatory adaptation to the local regional realities. At the same time, its member states constantly experience financial and economic pressure from the US because Washington has subsidiaries in the main sectors of the economy in the Caribbean countries, which also impedes the acceleration and expansion of regional economic integration.

As such, it can be stated that all regional international economic organizations currently feel the problems of creating a new multipolar world and the US desire to maintain its dominance in the world. At the same time, the ongoing policy of economic sanctions, restrictions, and pressure from Washington is narrowing down the possibilities of attracting investment capital to the developing countries, which is why the latter strive to reform the largest international organizations or to establish new institutions that would take their interests into account and contribute to real development.

The formation of a multipolar world is currently described by increased competition among the main centers of the world economy: China, the US, the Eurasian Economic Union (EAEU) and the EU, each having its own economic and military potential, in order to expand its influence on the development of integration processes, both in its own and other regions. The main problems of the world order in the course of transition from unipolarity to multipolarity include the specifics of interaction among these centers of power and development.

China, the US, the EU and the EAEU differ in their areas of behavior: consultation, consensus, equal partnership, and coalition, respectively. The joint existence of several centers of economic development suggests that a period of strong rivalry begins. The EU, the US, China, and the EAEU, being the most influential centres, have their impact on other developing countries and force them to join forces to protect national interests in the context of globalization.

The perception of the US omnipotence in the modern world conflicts with its limited capabilities, including economic and political. At the same time, the existing contradictions in the US economic and social development do not influence the country's position in the world, and it remains significant. The trends observed in politics and economics indicate a slow decline in the US influence on the world economy, a consistent decrease in the value of the dollar as a reserve currency, and a decrease in the US economic growth.

The US experience indicates that it is advisable for countries to identify their own differences and advantages in an innovative way. This approach will also be efficient for Russia.

Integration processes in the post-Soviet space are ongoing. The EAEU is also currently experiencing difficulties in its development, caused primarily by the introduction of anti-Russian sanctions in 2014. The EAEU is a project of cooperation of the states providing for a single humanitarian, economic, cultural, and customs space. In the future, the Union can transform into a completely new center of the international development without such former shortcomings as dogmatism and objectively meeting the real requirements of national traditions. Despite the denial of a merger, such a union can become the basis of a strategic alliance and mutual understanding at the level of traditions. The economy acquires the key importance in the union, because the principle of preserving traditions and culture is implemented through economic interaction.

### **Promising directions for the development of international economic organizations in the conditions of multipolar world formation**

According to the forecasts of the experts, the total volume of economies of the BRICS member states (Brazil, Russia, India, China, and South Africa) will significantly increase and occupy a significant share in the global economy at present and in the coming decades. The BRICS institutional capacity, the development of human capital, the stable macroeconomic model, and the high level of management quality will ensure the necessary conditions for the economic growth. Research institutes make very optimistic forecasts for the BRICS member states regarding the dynamics of their GDP growth rates in the foreseeable future in comparison with the developed countries. Regionalization is a reinforcing stage in the individual and collective positions of the developing states, because it promotes equal participation in the globalization process.

Improving the efficiency of the modern international economic organizations in the emerging multipolar world largely depends on the political will of the current leading states to seriously reform these organizations.

Some proposals have been formulated based on the results of the study, which can help in solving the identified problems:

- the ongoing real reform of the international economic institutions should be ensured, primarily of the World Bank, the IMF and the WTO. It is important to ensure equal quotas and votes for the developed and developing member states of these organizations during the reform. The US must abandon its hegemony in these organizations for this purpose. On the one hand, this decision will significantly limit the Washington's ability to develop the national economy, but on the other hand, if this is not done now, the consequences for the US and the world will be much more serious, because it will cause an open economic war between the developed countries and the developing and least developed countries. It will inevitably lead to the collapse of the international economic system, and all the institutions will have to be created from scratch;
- the governing bodies of the international economic organizations should change the procedure for appointing representatives of different countries to high posts in such a way that the developed and developing countries are represented there on an equal footing (in the same number and according to the most transparent system); and
- the legal regime for trade preferences for the least developed and developing countries within the WTO should also be improved in such a way that the developed countries cannot restrict their access to their markets.

## CONCLUSION

It is difficult to overestimate the role of the international economic organizations in the system of the world economic and financial relations today. They contribute to the development of the integration processes, intensify economic growth and the commodity circulation in the states, help raise foreign investment and loans to the national economies, deal with the global economic problems of mankind, etc. The authors have analysed the problems and prospects of development of the modern global and regional organizations in this study. Based on the results, they have come to the general conclusion that the hegemony of the US and Western countries directly influences the specifics of their functioning in the existing unipolar world. The imperfection of the international economic organizations is primarily associated with the fact that the positions of the new centers of power and decision-making strengthen every year in the world. The role and importance of the international economic organizations are being transformed as a result of the emergence of the new centers of power on the world stage. This leads to the loss of the leadership positions by the World Bank, IMF, OECD, G7, and other formats of financial and economic cooperation of the states, while the new international organizations such as the BRICS and the financial institutions created by them are gradually taking the initiative.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES #

- [1] Ganina SA, Glinkina OV, Soloveva MV. [2018] Effective business models. In: Role of scientific crises in the development of the modern society. Modern medicine. Theory and practice: proceedings of the International Research-to-Practice Conference, St Petersburg, Russia.
- [2] Ganina SA, Glinkina OV, Soloveva MV, Solostina TA. [2019] Organizations in the modern space: Configurations of aspects. In: Economics and Management: in search of a new model of innovation-driven growth. Collective monograph. GYu Gulyaev (Ed.).
- [3] Bodrunov SD, Novikova MN. [2018] Future: the fourth technological revolution necessitates profound changes in the economic and social life. *Economic Revival of Russia*, 2(56):5–13.
- [4] Glinkina OV. [2019] The era of the digital economy: digital technology. *Modern research and development*, 4(33): 89–92.
- [5] Shpilkina TA, Zhidkova MA, Rybakova OI. [2018] Role of digital technologies in the country's development strategy – 2024. In: *Modern Information Technologies in Education, Science, and Industry: X International Conference*, Moscow, Russia, 25-26. Moscow: Publishing house "Sputnik+".
- [6] Sokolova EN, Maslennikova AV, Kubrak IA, Panina OV. [2017] Social policy of Russian business as a way of forming the social capital of territories. *Financial Economics*, 2: 15–23.
- [7] Regent TM. [2019] On the possibilities for the development of the digital economy in Russia. In: *Modern trends in the development of the digital economy: realities, problems, and impact on finances: collective monograph*. Politkovskaya IV et al (Eds.).
- [8] Maslennikova AV. [2016] Dynamic model of the interregional development of the Russian Federation for the study of strategies for managing socioeconomic regional processes. In: *Knowledge Civilization: Russian realities: proceedings of the Seventeenth International Scientific Conference*, Moscow, Russia, 22–23, Moscow: RosNOU.
- [9] Maslennikova AV, Sokolova EN. [2017] Improving the competitiveness of territories as a priority direction of the state regional policy. *Economics and Entrepreneurship*, 6:244–248.
- [10] Shpilkina TA, Zhidkova MA, et al. [2018] Digital economy: development tools and their impact on the country's financial system. In: *Modern Information Technologies in Education, Science, and Industry: XI International Conference*, Moscow, Russia, Moscow: Publishing house "Sputnik+".

#English translations of the references are used.



## ARTICLE

# TESTING THE METHOD FOR EVALUATING THE EFFICIENCY OF THE COMPLEX ECONOMIC SYSTEM DEVELOPMENT IN ACCORDANCE WITH THE INDUSTRY 4.0 CONCEPT

Vladislav Genrihovich Frolov<sup>\*</sup>, Oleg Vladimirovich Trofimov, Vladimir Yakovlevich Zakharov, Angelina Alexandrovna Pavlova

Lobachevsky State University of Nizhny Novgorod, Gagarin Avenue, 23, Nizhny Novgorod, 603950, RUSSIA

## ABSTRACT

The study is aimed at solving the issue of evaluating the efficiency of measures and projects implemented during digitalization, which is relevant for enterprises of various industries during digital transformation. The digital transformation is currently considered to be an important and even crucial criterion for the competitiveness of enterprises. Creating a method for evaluating the efficiency of the complex economic system development should form an understanding of the successful development of enterprises in the new reality – the digital economy. By applying an economic model with specific factors of enterprise development defined in the earlier works of the authors under the conditions of digitalization, the authors have managed to analyze an example of the automobile industry enterprise and draw a conclusion about its development efficiency in the context of the digital transformation. The obtained results can be used by the management to adjust or supplement the development strategy or to compile statistics for a group of industrial enterprises to calculate standard and other values in the new conditions of the digital transformation of the industry.

## INTRODUCTION

New concepts in production and logistics through digitalization promise to change the manufacturing sector (as part of the Industry 4.0 concept – abbreviated I4.0), which is secured by new information and communication technologies. These changes are relevant for most enterprises of various industries around the world.

As was noted earlier, the digital revolution offers enormous opportunities for building the capacity of national economies [1]. Wireless networks with connected devices gradually become automated, self-optimizing, and self-recovering; they increase productivity, reduce losses, and encourage economic growth, increasing, at the same time, the security risks (costs) associated with the rapid growth of interconnectedness and complexity of the systems. Costs and profits are distributed in the complex economic systems differently due to their digital transformation [2].

The objectives of the study are as follows:

- Testing the previously proposed method for evaluating the efficiency of the complex economic system development in accordance with the I4.0 concept;
- Estimating the desired indicator of the A\_CESmodel [2];
- Making an analytical conclusion on the complex economic system development;
- Identifying weaknesses in the previously proposed method and formulating a hypothesis about the need to adjust the previously proposed evaluation model; and
- Making proposals about the research prospects.

The authors evaluate the efficiency of the complex economic system development in the context of digitalization at the levels of both specific enterprises and the country's economy. For example, at the level of the country, Goryacheva identifies a system of indicators that describe the efficiency of implementing the industrial policy at all levels: state, regional, and enterprise ones. The authors note the need to use indicators available in statistical and accounting reports as an important condition for the selection of the efficiency indicators [3]. Satunina notes the importance of a comprehensive evaluation and drawing up criteria for the functioning of the industrial sector of the economy. The authors propose to make a criterion analysis multilevel: first to evaluate the development and efficiency of each individual industry, then of the intersectoral interaction, and then the combined efficiency of the country's industrial sector. It is proposed to evaluate efficiency using standards. The authors propose to evaluate the investment and innovation potential using the following indicators: the level of innovation activities, the share of costs for innovation activities, efficiency of the costs for innovation activities, and the share of innovative products in the total volume of products shipped [4].

Some authors note the need to identify new factors and indicators that evaluate the development efficiency in the context of digitalization at the enterprise level [5, 6]. The efficiency indicators become systemically focused or multidimensional, expressing the ability of various social groups to adapt to changes and influence them. The key strategic characteristics of successful companies in Industry 4.0 are the flexibility, the ability to make changes in real time, and the acceleration of decision-making and adaptation processes [7]. The existing methods for evaluating the innovation-driven growth are based on

**KEY WORDS**  
complex economic systems, efficiency of development, digitalization, industry, Industry 4.0

Received: 2 Nov 2020  
Accepted: 4 Dec 2020  
Published: 6 Dec 2020

**\*Corresponding Author**  
Email:  
vg-frolov@bk.ru

the following methods: point rating, functional, integral, and combined. In this case, the combined technique is the most progressive as it combines the best aspects of the considered methods on the basis of multivariate or criteria analysis [8]. The method proposed by Muravyova [9] is an interesting methodology for evaluating the efficiency of the innovation-driven growth and innovation potential. This methodology is based on the integral evaluation, which provides an evaluation of factors (areas of activity) of the innovation-driven growth based on the analysis of various groups of indicators (potentials) describing this particular factor (area of activity). The integral indicator of the innovation-driven growth is found as the sum of points obtained according to the following components: the potential for expanding the current business activities and the innovation potential of the organization.

## MATERIALS AND METHODS

### Model for assessing the effectiveness of complex economic systems

The previously proposed model (hereinafter referred to as the Model) for evaluating the efficiency of complex economic systems ( $A_{CES}$ ) from the standpoint of the intensity and efficiency of the selected indicators, which is an adiabat of eight functions, is presented below [2]:

$$A_{CES} = Int\_Fin() + Eff\_Fin() + Int\_Imp() + Eff\_Imp() + Int\_Bis() + Eff\_Bis() + Int\_Dev() + Eff\_Dev()$$

#### Refinement of the developed model

The main independent variables are presented in [Table 1]. The authors specified the indicators to form a more informative analysis of the results of evaluating the complex economic system efficiency. The testing was carried out at an automobile industry enterprise. The obtained  $A_{CES}$  coefficient should be taken for comparison between the enterprises in the complex economic system for the subsequent comparison of this indicator in benchmarking: either with enterprises within the economic system or with competitive systems. Another application is to introduce its standard value to maintain the complex economic system at a competitive level, the value of which is determined separately for each such system (depending on the industry).

**Table 1:** Updated independent variables for the  $A_{CES}$  model

Function	Details of the selected indicator
Function of intensity of the financial and economic condition $Int\_Fin()$	Turnover ratio (x1) Ratio of the turnover duration (x2) Capital productivity of fixed assets (x3)
Function of efficiency of the financial and economic condition $Eff\_Fin()$	Volume of production and sales (y1) Amount of consumption or cost of resources on production, i.e. cost price of production/service package (y2) Volume of added value of products/services (y3)
Function of intensity of improvement $Int\_Imp()$	Percentage of improved processes in the total number of processes (k1) Percentage of feedback received from customers on the improved processes in the total number of customers served (k2) Percentage of workforce engaged in improvement in the total workforce (k3)
Function of efficiency of improvement $Eff\_Imp()$	Percentage of ROI in improvement (z1) Percentage of increase in total revenue (z2) Increase in the cost of shipped products/service package per employee (z3)
Function of intensity of business development $Int\_Bis()$	Inventory turnover rate (m1) Percentage of intellectual services sold in the overall structure of industrial services (m2)
Function of efficiency of business development $Eff\_Bis()$	Cycle time (weighted average for all products by individual stages of production) (n1) Share of production using the I4.0 principles in the total production (n2) Share of digitalization costs in the total output (n3) Digital maturity index of the enterprise (n4)
Function of intensity of employee development $Int\_Dev()$	Percentage of personnel trained in customer requirements (p1) PPM ratio (parts per million) (p2) Percentage of personnel in constant rotation among the enterprises in the complex economic system (p3)
Function of efficiency of employee development $Eff\_Dev()$	Percentage of stops per shift (due to the operator's fault) (e1) Labor-output ratio (e2) Internal reject rate (e3)

Let us refine the  $A_{CES}$  model for testing purposes. The resulting model is as follows [Table 2]:

**Table 2:** Detailing of partial summary indicators for the  $A_{CRS}$  model

Function name	Function
Function of intensity of the financial and economic condition $Int_{Fin}()$	$Int_{Fin} = \sqrt[3]{x1 + x2 + x3}$
Function of efficiency of the financial and economic condition $Eff_{Fin}()$	$Eff_{Fin} = \sqrt[4]{y1 + y2 + y3 + y4}$
Function of intensity of improvement $Int_{Imp}()$	$Int_{Imp} = \sqrt[3]{k1 + k2 + k3}$
Function of efficiency of improvement $Eff_{Imp}()$	$Eff_{Imp} = \sqrt[3]{z1 + z2 + z3}$
Function of intensity of business development $Int_{Bis}()$	$Int_{Bis} = \sqrt[3]{m1 + m2}$
Function of efficiency of business development $Eff_{Bis}()$	$Eff_{Bis} = \sqrt[4]{n1 + n2 + n3 + n4}$
Function of intensity of employee development $Int_{Dev}()$	$Int_{Dev} = \sqrt[3]{p1 + p2 + p3}$
Function of efficiency of employee development $Eff_{Dev}()$	$Eff_{Dev} = \sqrt[3]{e1 + e2 + e3}$

The resulting data are to be processed by reduction methods to obtain unambiguous results. The authors made it a rule for the purposes of the study that the factors were equally significant due to the lack of statistical studies on the distribution of the weight of the aggregate indicator factors in the adiabatic function.

### RESULTS

Based on the obtained data about the enterprise performance, financial statements, a survey conducted within the automobile industry in Russia, as well as a survey of the enterprise customers, the above indicators are calculated [Table 3]:

**Table 3:** Detailing of partial summary indicators for the  $A_{CRS}$  model

Functions	2016	2017	2018
Function of intensity of the financial and economic condition	28.09	29.99	33.92
Function of efficiency of the financial and economic condition	16,380,001	9,869,887	104,264,117
Function of intensity of improvement	10.8	21.91	38.94
Function of efficiency of improvement	1.32	2.69	3.61
Function of intensity of business development	0.61	0.73	0.8
Function of efficiency of business development	0	0.07	0.11
Function of intensity of employee development	0.07	0.15	0.14
Function of efficiency of employee development	0.00135	0.0017	0.0013268

The model is a system of partial indicators, where objectives, subjects, objects, principles, methods, tools, and resources are considered separately. Economic and financial indicators of the efficiency and intensity of the manufacturing enterprise development are based on the study of the work of Russian and foreign authors, who distinguish them as the most informative. The authors use various methods for finding the weight values of individual coefficients to increase their reliability. Digitalization is a relatively new phenomenon for the Russian industry, and therefore, the weights of the indicators included in the groups are defined as single. Another research is needed to determine their exact weighted coefficients.

### Data standardization

Two-stage standardization methods consisting of the reference indicators are used for the research purposes. It must be noted that the observed values are distributed uniformly without the statistically significant limitations. The positive ratio of aggregation to all components must also be noted. The unified data for each of them must be applied for this purpose. The data can be standardized and convenient to use if the variables are measured in scales and their orders, which is observed in this particular case. Given the condition that the indicators are zero for each factor, they do not reduce the generality.

The reduction is described below in accordance with the calculation formulas for discrete values:

$$x_j^* = \frac{x_j - x_{min}}{x_{max} - x_{min}},$$

Where

$x_j^s$  is the unified value of the variable for the j-th observation;  
 $x_j$  is the value of the variable for the j-th observation;  
 $x_{min}$  is the minimum value of the variable; and  
 $x_{max}$  is the maximum value of the variable.

It follows from the above standardization approach that if the model is equal to zero (0), then at least one of the three indicators was the worst for the enterprise over the observed period. If the aggregate indicator grows, it follows that the systemic effect of localization and digitalization grows as well, provided the ongoing overall development of the complex economic system.

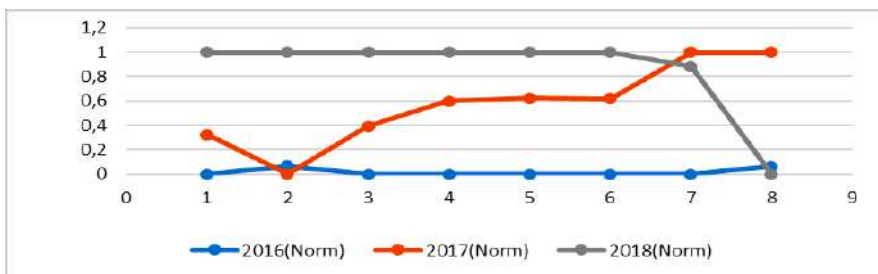
As such, the following values of the reduced indicators are obtained [Table 4].

**Table 4:** Obtaining the coefficients for the *A<sub>CES</sub>* model

Sl No	Function	MIN value	MAX value	2016(Norm)	2017(Norm)	2018(Norm)
1	Function of intensity of the financial and economic condition	28.09197	33.92206152	0	0.325921176	1
2	Function of efficiency of the financial and economic condition	9,869,887	104,264,116.6	0.068967287	0	1
3	Function of intensity of improvement	10.80123	38.94440482	0	0.394684312	1
4	Function of efficiency of improvement	1.316561	3.614784456	0	0.599001913	1
5	Function of intensity of business development	0.614576	0.801265073	0	0.625223136	1
6	Function of efficiency of business development	0	0.105594765	0	0.620211302	1
7	Function of intensity of employee development	0.070711	0.151974961	0	1	0.883375603
8	Function of efficiency of employee development	0.001327	0.001699735	0.063003496	1	0

**Analysis of company development indicators**

Let us visualize the obtained values of the indicators [Fig 1]. A significantly low level of development of the selected indicators was observed in 2016. The company also began working on the application of the digitalization methods at the enterprise in various areas of its activities in 2016. The period of 2017 looked very reasonable, it could be described as transitional, because the efficiency from the specific digitalization methods could not be achieved in one calendar year. The values of 2018 had a positive trend compared to 2016. The least efficiency was achieved in the personnel development due to the lack of proper retraining and advanced training for the factory personnel.



**Fig. 1:** Visualization of the obtained values for the *A<sub>CES</sub>* model indicators

The obtained values allow to calculate the desired *A<sub>CES</sub>* model. Let us calculate it with a simultaneous reduction to more convenient values for further analysis in the format from 0 to 1 [Table 5].

**Table 5:** The *A<sub>CES</sub>* model calculus by year

A_CES_2016_norm	0.02
A_CES_2017_norm	0.57
A_CES_2018_norm	0.86

In accordance with the model values obtained above, the following conclusions should be made about the measures taken by the company to increase the efficiency of the complex economic system in the context of digitalization:

- The conducted analysis allows asserting that, in accordance with the evaluation, the company is developing in a positive way. However, the attention should be paid to the indicators of the employee development, because the low value of this indicator will lead to an imbalance in the development of the company's internal systems, and as a result, the growth will be restrained.
- Uniquely high results of specific directions can be distinguished due to the proposed model. A strong growth of such indicators as the improvement efficiency and business development intensity is observed in many respects due to the accented business development strategy, namely, the work done to increase the efficiency of internal business and production processes using the digitalization capabilities.
- The results can be interpreted as follows: despite the general deterioration in the production and economic indicators of the enterprise, the work on the comprehensive improvement continued in the complex economic system, which included increasing additional resources aimed at improvements.

The personnel development indicators have lagging values in the aggregate indicator after reduction. A fairly common practice is that the enterprises in the complex economic system lose attributes of the balanced development. In this regard, the personnel are not developed as a labor resource, which should be taken into account in the context of the complex development in digitalization. According to Russian and foreign researchers, the need for the personnel retraining is the first challenge to digitalization – in this regard, this direction should be given priority.

## DISCUSSION

It must be noted that the evaluation of the efficiency of enterprises in the context of digitalization is a poorly studied topic in the domestic and foreign science. To date, an exhaustive number of indicators have not been compiled to evaluate the effects of digitalization as comprehensively as possible. The existing scientific works on the evaluation of the efficiency of the complex economic systems contain the following differences from the method proposed by the authors. For example, Savin [10] uses an indicator of the efficiency of the chosen option for the development of the organizational structure to show whether the transformation of the organizational structure ensures the full achievement of the main goals of the organization operation, as well as the development and implementation of innovative projects at a fairly low cost of adaptation of the organizational structure. However, the authors believe that the evaluation of the efficiency within the digitalization phenomenon cannot be limited only to the results of the transformation of the organizational structure.

The authors agree with the approach proposed by Yashin and Schekoturova [11] to assign weight coefficients when calculating the integral indicator of the innovation-driven growth and selecting the expert method. The array of available information is not sufficient for economic conclusions about the weights of the coefficients in the context of digital transformation, with the availability of a relatively small array of data on the companies that have begun to apply the digitalization principles, and also taking into account the fact that digitalization has been actively used in the last two to five years. The authors also support the conclusions made by Konovalenko and Trofimov [8] that such methods require a careful classification of the development factors for a unified approach to linking the quality indicators of innovation to these factors. The factors can be added to the proposed methods in compliance with the criteria of adequacy and balance of the number of such factors. Strengths and weaknesses of the proposed method following the results of its testing are provided in [Table 6].

**Table 6:** Analysis of strengths and weaknesses of the method for evaluating the efficiency of the complex economic system development in accordance with the Industry 4.0 concept

Strengths	Weaknesses
1. Coverage of most areas of activity of the industrial enterprise in which digitalization methods and techniques can be used to date.	1. Lack of the exact weighting values of the coefficients.
2. Capabilities of calculating the basic indicator, as well as indicators for benchmarking in the enterprises of the same industry.	2. The calculation overload may occur when the method is used in the organization's ongoing operations.
3. Lack of complex auxiliary calculations.	3. Difficulty of calculating the selected model.
4. The method allows to develop and improve the efficiency of the final result.	4. Need for the preparatory stage of collecting information in the accounting system.

## CONCLUSION

Evaluation of the development efficiency of complex economic systems within the framework of I4.0 projects is an urgent and little-studied issue in economic science. The complicity and complexity of this issue lie in the fact that I4.0 projects affect not only well-known indicators, such as production and

operational ones, but also have impact on all areas of the company. The main difficulty in assessing the effect of the management system implementation is the need to compare similar indicators of the financial and economic activities of the organization before and after the digital systems introduction, as well as ensure the possibility of accounting in the economic activities of the organization of the direct contribution from the digital systems implementation [12]. Evaluation of the possible profitability or loss-making of a particular investment in the I4.0 projects is a relevant and poorly studied issue in economic science. The complexity of this issue is associated with the fact that the I4.0 projects influence not only such well-known indicators as production and operation, but also all other areas of the company: customers and partners, employees and their functionality, safety and compliance in companies, infrastructure, and other aspects. The main difficulty in evaluating the effect of introducing a management system is the need to compare similar indicators of the financial and economic activities of the organization before and after the introduction of digital systems, as well as to provide the ability to account for the direct contribution from the introduction of digital systems in the economic activities of the organization [12]. An in-depth study of the effects and ROI of digitalization is aimed at supplementing the economic feasibility of investments with a budget deficit aimed at innovating in companies. The effects of digitalization arise as a result of events in various operational and strategic aspects of the company operation, while not all the advantages that can be achieved are associated with technologies; it is often assumed in the evaluation that business models remain unchanged. The aggregate quantitative indicators of the digitalization efficiency, such as productivity, performance, value added, jobs, production volume, and cost reduction, are most often used at the national level, as well as qualitative measurements describing competitiveness, confidence in business, and sustainable development. The impact of digital technologies is highly dependent on the country, industry, a set of technologies used, and their degree of maturity; the observed impact is usually lower than expected [13]. The authors conclude that different methods for measuring the efficiency of the digital transformation of production have a common basis; they do not contradict but complement each other, reflecting the specifics (levels of development) of countries, industries, and technologies used, and bring substantially similar results. As digital technologies are deployed and experience is gained in assessing their impact on business development in Russia, the existing methodological approaches to evaluating the efficiency of the complex economic system development will be synthesized in the nearest future.

#### CONFLICT OF INTEREST

There is no conflict of interest.

#### ACKNOWLEDGEMENTS

The reported study was funded by the RFBR according to research project No. 18-010-00781.

#### FINANCIAL DISCLOSURE

None.

#### REFERENCES#

- [1] Frolov VG, et al. [2019] Opportunities and risks from cooperation among companies within the production sphere and the sphere of services in Russia in the context of industry 4.0. *Amazonia Investiga*, 8(20):596–608.
- [2] Zakharov VYa, et al. [2018] Evaluation and monitoring of the efficiency of the complex economic system development in accordance with the Industry 4.0 concept]. *Financial Economics*, 7:1200–1212.
- [3] Goryacheva TV. [2012] Criteria and a system of indicators for evaluating the efficiency of the industrial policy implementation. *Heteromagnetic microelectronics*, 12:123–129.
- [4] Satunina TA. [2009] Methodological approaches to the development of criteria for the industrial policy efficiency in Russia. *Bulletin of the Kazan State Agrarian University*, 1(11):47–49.
- [5] Walasek W, Barszcz A. [2017] Analysis of the Adoption Rate of Building Information Modeling [BIM] and its Return on Investment [ROI]. *Procedia Engineering*, 172:1227–1234.
- [6] Essakly A, Wichmann M, Thomas S. [2019] A reference framework for the holistic evaluation of Industry 4.0 solutions for small and medium-sized enterprises. *IFAC PapersOnLine*, 52(13):427–432.
- [7] Shu G, Anderl R, Gauzemeyer Y, ten Hompel M, Walster V. [2017] *The index of riparian industry 4.0 – Management of digital transformation of companies* (acatech research). Munich: Herbert Utz Verlag.
- [8] Konovalenko SA, Trofimov MN. [2019] On the issue of applying methods for evaluating the efficiency of the innovation-driven growth of an enterprise. *Colloquium-journal*, 6–11(30):115–125.
- [9] Muravyova NN. [2016] Method for evaluating the investment potential of commercial organizations: an integrated approach]. *International Accounting*, 6:28–40.
- [10] Savin YuV. [2015] Method for evaluating the efficiency of the development option for the organizational structure of an innovatively active industrial enterprise. *Scientific proceedings of the Russian Academy of Entrepreneurship*, 43:126–130.
- [11] Yashin SN, Schekoturova SD. [2016] Application of the method for evaluating the efficiency of the innovation-driven growth of an enterprise by the example of PJSC Ruspolimet. *Finance and Credit*, 47(719):27–46.
- [12] Kurganova MV, Sevastyanova SA. [2019] Evaluation of the payback period for digital management systems. *21st Century Science: Current Trends*, 2-2:102–108.
- [13] Institute for Manufacturing (IfM), University of Cambridge. [September, 2018] *The Practical Impact of Digital Manufacturing: Results From Recent International Experience*. Final Report. [https://www.ifm.eng.cam.ac.uk/uploads/Content/Images/PL\\_U\\_report\\_for\\_IUK\\_web.pdf](https://www.ifm.eng.cam.ac.uk/uploads/Content/Images/PL_U_report_for_IUK_web.pdf)

#English translations of the references are presented.

## ARTICLE

# PERCEPTION OF INTERNATIONAL BRANDS BY CHINESE AND RUSSIAN CONSUMERS

Irina Matveevna Romanova<sup>\*</sup>, Elena Viktorovna Noskova, Anna Vladimirovna Loksha, Irina Arkadevna Mokhireva

School of Economics and Management, Far Eastern Federal University, Suhanova Street, 8, Vladivostok, 690091, RUSSIA

## ABSTRACT

A brand is of great importance for people when they choose a product or a service. Representatives of different cultures perceive brands in a special way and determine the most significant, necessary, and important one for them, depending on their cultural specifics. An attempt has been made to explain the specifics of brand perception in products and services through the prism of cultural values of Russian and Chinese consumers in this study. Rokeach's value survey construct (terminal and instrumental values) and Keller's brand performance construct, adapted to the goals of this study, have been used to achieve the purpose of the study. The results of the empirical study of brand perception by Russian and Chinese consumers have allowed determining the gaps in the brand construct evaluation and their causes. The hypotheses of the study that brands of products and services are perceived differently by representatives of different cultures and that brand perception depends on the brand belonging to the product category and the specifics of geographic markets have been confirmed. Further directions of empirical research can be aimed at evaluating the factors that influence the choice of brands of products and services by representatives of different cultures.

## INTRODUCTION

**KEY WORDS**  
brand, perception,  
consumer behavior,  
globalization, cross-  
culture

A brand is of great importance for people when they choose a product or service. This fact has been repeatedly proven in the course of various studies by companies trying to identify a direct connection between the brand and its role in consumer buying decisions. It can be said that there is a competition not so much among products or services as among brands for their place in the minds of consumers. Globalization opens up new opportunities for companies but encourages them to make decisions about a marketing strategy aimed at adapting brands to a new sociocultural environment, including their names, slogans, visual identifiers, and advertising messages with due consideration of the cross-cultural specifics of the country, while maintaining their emotional and rational characteristics. This problem cannot be solved without knowledge of foreign consumers, their perception, buying habits, consumption culture, language specifics, and legal and political aspects; therefore, cross-cultural studies are relevant [1-3]. However, companies face some questions regarding the choice of the most efficient research method, tools, brand evaluation indicators, as well as the very strategies of brand development abroad.

Cross-cultural studies, during which, according to D. Matsumoto [4], the specific behavior of two or more cultures is compared, are the main tool that allows companies and their brands to successfully adapt to a new sociocultural environment. Such methods of studying cultural specifics as "Value Orientations" by Rokeach [5], "Personal Preference Schedule" by Edwards [6], the scale of values by Schwartz [7], and morphological test of life values by Sopov [8] are widely known. Cross-cultural studies indicate that the behavior of people from various cultures often differs significantly. The cross-cultural studies allow revealing common features and underlying factors that explain the reasons for these similarities and differences. Such studies include a study by K. Keller et al [9-10] with the aim of studying consumer brand perception in the USA and China in order to clarify measurement scales and evaluate brand performance. Authors have indicated that consumer response to marketing incentives can be evaluated by several indicators that can range from a fairly low level of brand awareness or familiarity with it to a high level of engagement and brand loyalty based on emotional, cognitive, and behavioral attitudes.

According to Aaker [11] and Melewar et al. [12], a brand is a certain idea carried by a product, a service or a value, which occupies a certain place in the mind of the consumer. Indeed, consumers who prefer a particular brand are loyal to it not only because of its excellent external attributes and functions – they want to become a part of the brand as it becomes a part of their life. When choosing a strategy for penetrating a new geographic market, it is important to answer the following question: how will a certain brand be perceived by foreign consumers? Domnin [13], Carpenter et al. [14], and Schmitt et al. [15] believe that the image of the manufacturer's country plays an important role in the perception of the brand by foreign buyers. For example, some countries with high economic potential exert minimal influence on the consciousness of the mass consumer through their brands, which does not contribute to strengthening the positive image of the manufacturer's country in their minds. Such countries include China, the country that maintains a leading position in the world economy in terms of growth rates, production volumes, and economic potential, but despite this, it has a modest and sometimes negative position in the perception of the mass Russian consumer in terms of their emotional component. The formation of a successful brand is based on the knowledge about the consumers, their psychographic and socio demographic characteristics, and the specifics of their perception, which indicates the relevance of the research topic.

<sup>\*</sup>Corresponding Author  
Email:  
romanova.im@dvfu.ru

Received: 1 Nov 2020  
Accepted: 3 Dec 2020  
Published: 6 Dec 2020

## METHODS

The purpose of this study is to develop a methodological approach to measuring the influence of cultural specifics of Russian and Chinese consumers on the perception of brands of products and services. The following tasks are set in accordance with the purpose of this research project:

- I. To develop a theoretical model for studying the influence of consumers' cultural specifics on their perception of brands of products and services [Fig. 1].

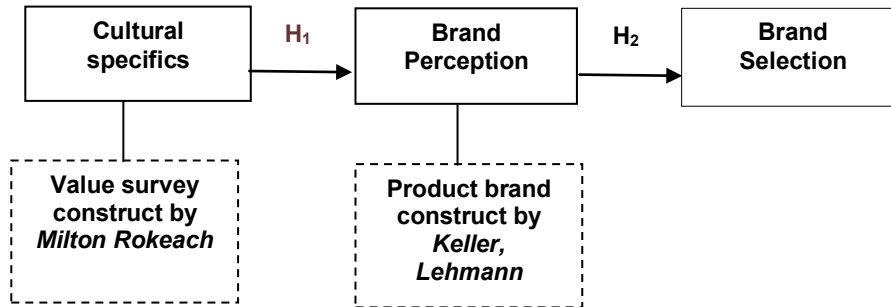


Fig. 1: Theoretical research model

H1: the brands of products and services are perceived differently by representatives of different cultures; and  
 H2: the brand perception depends on the brand belonging to the product category and the specifics of geographic markets.

- II. To choose constructs for measuring the cultural values of consumers and perception of product brands. We developed a questionnaire to test the hypotheses put forward, which included constructs (a set of variables united by a common research subject) adapted from the works of such authors as Rokeach [5], Keller et al. [10].

The construct of "cultural values" covers 18 terminal and 18 instrumental values: active life, life wisdom, health, interesting job, beauty of nature and art, love, financially secure life, good and faithful friends, public recognition, cognition, productive life, development, entertainment, freedom, happy family life, happiness of others, creativity, self-confidence, diligence, good manners, high demands, cheerfulness, duty performance, independence, intransigence to shortcomings in oneself and others, education, responsibility, rationalism, self-control, courage in defending opinions and views, strong will, tolerance, open-mindedness, honesty, efficiency in business, and sensitivity.

The product brand perception construct includes 27 positions: presence, awareness, knowledge, relevance, level of distinction, degree of respect, effectiveness, advantage, affection, heritage, trust, innovation, care, nostalgia, prestige, acceptance, recommendation, quality, environment, service, commitment, intention, value for money, overall attitude, expansion potential, consistency, and activity. According to this classification, the consumer brand perception can vary from a standard level of brand awareness or familiarity with it to a high level of engagement and brand loyalty based on emotional, cognitive, and behavioral attitudes. All variables in the construct were measured using the Likert scale, where one was "strongly disagree" and five was "absolutely agree".

- III. To quantify:

- the cultural values of consumers; and
- the perception of brands of products/services.

The opinions of the Russian and Chinese respondents were studied using an online survey. The purpose of the questionnaire survey was to obtain quantitative estimates for establishing connections among the constructs of the research model. The results of the questionnaire survey were processed using the SPSS software package. The sample included 764 respondents: 397 people (52%) from Russia and 367 people (48%) from China. In general, the sample included a proportional number of women and men, including 24% of women from Russia and 26% from China, and 28% and 22% of men, respectively. The sample included representatives of different age groups.

- IV. To select brands that will be used as an example to estimate the impact of cultural values on the perception of brands of products. The following brands were selected for research:

- information services (Google, Microsoft, Facebook);



- catering services (KFC, McDonald's);
- FMCG (Nestle, Coca-Cola, Pepsi); and
- electronics (Apple, Samsung).

The sample included brand leaders; they were grouped into categories depending on the market and the type of products and services sold for convenience.

Our contribution consists in the development of a method for studying the influence of consumer cultural values on the perception of brands of products and their choice.

## RESULTS

Values underlie the concept of marketing communications designed for a specific brand of a product or service, because a brand acquires emotional value for consumers over time, being the sum of associations, images, and impressions.

Values help a person and society define good and bad, beautiful and ugly, essential and secondary. The priority of certain values reflects the degree of a person's spirituality. A five-point Likert scale was taken as a basis to more accurately evaluate the respondents' opinions on certain cultural values. According to the results of the study, out of 36 cultural values, 11 were excluded that had the least significance for the respondents (beauty of nature and art, public recognition, entertainment, happiness of others, creativity, diligence, duty performance, education, self-control, strong will, and tolerance) [Table 1].

**Table 1:** Comparative evaluation of the cultural values of Russian and Chinese consumers, points

Cultural values	Russia	China	Gap value
Active life (fullness and emotional richness of life)	3.86	2.80	1.06
Life wisdom (maturity of judgment and common sense that are achieved by life experience)	4.03	3.70	0.33
Health	<b>4.46</b>	3.10	1.36
Interesting job	4.29	3.55	0.74
Love (spiritual and physical closeness with a loved one)	4.26	2.85	1.41
Financially secure life (no financial difficulties)	4.00	<b>4.65</b>	0.65
Good and faithful friends	4.14	3.10	1.04
Cognition (possibility to expand education, horizons, general culture, and intellectual development)	3.69	3.60	0.09
Productive life (the fullest use of capabilities, strengths, and abilities)	3.74	3.80	0.06
Development (self-improvement, constant physical and spiritual improvement)	3.83	3.60	0.23
Freedom (independence in judgments and actions)	3.66	3.40	0.26
Happy family life	4.06	2.95	1.11
Self-confidence (inner harmony, freedom from internal contradictions and doubts)	4.09	3.50	0.59
Good manners	3.74	2.90	0.84
High demands (high demands to life and high aspirations)	2.14	3.75	1.61
Cheerfulness (sense of humor)	3.83	2.70	1.13
Independence (ability to act independently and decisively)	3.43	2.95	0.48
Intransigence to shortcomings in oneself and others	2.40	3.30	0.90
Responsibility (sense of duty, ability to keep the word)	3.71	2.95	0.76
Rationalism (ability to think soundly and logically, make deliberate and rational decisions)	3.30	3.60	0.30
Courage in defending opinions and views	3.40	3.26	0.14
Open-mindedness (ability to understand someone else's point of view and respect others' tastes, customs, and habits)	3.43	3.35	0.08
Honesty (truthfulness and sincerity)	3.71	3.50	0.21
Efficiency in business (hard work, performance at work)	3.31	3.60	0.29
Sensitivity (caring)	3.43	3.10	0.33

According to the results of the comparative analysis, it can be seen that different values prevail among the Russian and Chinese respondents. For example, health is absolutely important for the Russian respondents, while financial security is absolutely important for the Chinese ones. The largest gaps between the evaluation of Chinese and Russian consumers are noted for high demands for life and aspirations (1.61 points), where the demands are higher for Chinese consumers, which correlates with their high demands for a financially secure life. The gap between the evaluation of Chinese and Russian consumers is slightly smaller for love (spiritual and physical closeness with a loved one) (1.41 points). This value is important for Russian consumers, which correlates with their high evaluation of such cultural value as happy family life (4.06 points). The third-largest gap between the evaluation of Russian and

Chinese consumers is in health (1.36 points), which may be explained by the growing popularity of a healthy lifestyle among the Russians.

The respondents were offered ten service brands and ten product brands to evaluate brand perception, each of which had to be evaluated using a number of constructs developed by Keller and Lehmann. Twenty-one constructs were selected for the study, which were modified in accordance with the objectives of this study and the specifics of the target audience for the survey. Each construct included several parameters, with the total number of parameters being 45. The parameters were evaluated using a five-point Likert scale. The Likert scale was used due to the need to evaluate the attitudes and opinions of the respondents in order to determine a pronounced positive or negative attitude towards the brand. The answer options in the range from one maxim to another were expressed in words (from “absolutely disagree” to “absolutely agree”), the unipolarity was preserved, and the odd number of answer options were provided for subsequently obtaining average values. As a result, the average value of the ratings obtained for each brand was calculated within each of the 45 parameters, then the average value of the ratings of all the parameters that form the construct was calculated.

The respondents were asked to evaluate the service brands first. Among them, the brands of the companies providing information and catering services were analyzed [Table 2].

**Table 2:** Average ratings of the Russian and Chinese respondents regarding brand perception in the category of information and catering services, points

No.	Construct	KFC			McDonald's			Google			Microsoft			Facebook		
		Russia	China	Gap	Russia	China	Gap	Russia	China	Gap	Russia	China	Gap	Russia	China	Gap
1	Presence	3.57	3.82	0.25	2.85	3.79	0.94	4.65	4.02	0.63	4.57	3.76	0.81	3.69	3.27	0.42
2	Awareness	3.90	3.85	0.05	4.20	3.63	0.57	4.79	3.85	0.94	4.84	3.63	1.21	4.07	3.33	0.74
3	Knowledge	3.57	3.72	0.15	3.83	3.72	0.11	4.72	3.75	0.97	4.81	3.49	1.32	3.74	3.27	0.47
4	Respect	2.86	3.34	0.48	2.95	3.33	0.38	4.45	3.82	0.63	4.44	3.78	0.66	3.28	3.48	0.20
5	Relevance	2.74	3.39	0.65	2.90	3.48	0.58	4.45	3.75	0.70	4.36	3.41	0.95	2.63	3.22	0.59
6	Distinction	2.57	3.62	1.05	3.27	3.36	0.09	3.63	3.72	0.09	3.78	3.47	0.31	2.54	3.30	0.76
7	Proximity	2.61	3.66	1.05	2.88	3.39	0.51	4.12	3.68	0.44	3.89	3.42	0.47	2.56	3.21	0.65
8	Effectiveness	2.93	3.57	0.64	3.24	3.51	0.27	4.53	3.82	0.71	4.46	3.54	0.92	3.00	3.17	0.17
9	Affection	2.33	3.47	1.14	2.58	3.43	0.85	3.68	3.63	0.05	3.64	3.46	0.18	2.22	3.13	0.91
10	Nostalgia	2.94	3.28	0.34	3.69	3.28	0.41	4.55	3.63	0.92	4.69	3.42	1.27	3.14	3.46	0.32
11	Innovation	3.74	3.67	0.07	3.39	3.50	0.11	2.90	3.41	0.51	2.94	3.54	0.6	2.52	3.49	0.97
12	Care	3.08	3.40	0.32	3.24	3.58	0.34	4.02	3.52	0.50	3.96	3.44	0.52	3.10	3.26	0.16
13	Quality	3.13	3.50	0.37	3.34	3.39	0.05	4.36	3.50	0.86	4.38	3.35	1.03	2.91	3.04	0.13
14	Prestige	2.90	3.42	0.52	3.29	3.42	0.13	3.90	3.66	0.24	3.80	3.46	0.34	3.22	3.16	0.06
15	Value for money	3.07	3.43	0.36	3.36	3.27	0.09	3.44	3.63	0.19	3.77	3.50	0.27	2.92	3.11	0.19
16	Readiness	1.67	3.42	1.75	1.97	3.30	1.33	2.12	3.64	1.52	2.59	3.36	0.77	1.78	3.04	1.26
17	Intention	2.31	3.65	1.34	2.45	3.35	0.9	3.05	3.59	0.54	3.21	3.39	0.18	2.16	3.19	1.03
18	Atmosphere	2.74	3.38	0.64	3.41	3.32	0.09	4.38	3.77	0.61	4.37	3.69	0.68	2.67	3.27	0.60
19	Recommendations	3.44	3.50	0.06	3.90	3.52	0.38	4.24	3.65	0.59	4.30	3.46	0.84	3.31	3.28	0.03
20	Activity	1.72	3.46	1.74	2.01	3.36	1.35	2.47	3.52	1.05	2.62	3.56	0.94	1.88	3.07	1.19
21	Overall attitude	3.00	3.62	0.62	3.65	3.44	0.21	3.84	3.72	0.12	4.10	3.50	0.60	2.47	3.12	0.65

According to the results of the study, it was found that brand perception through the prism of the construct by Russian and Chinese consumers differed. Significant gaps were recorded for some elements of the construct. For example, the largest gaps for the KFC, McDonald's, Google, and Facebook brands were observed in such elements as “readiness” and “activity”. The respondents were asked to rate the following statements for the construct elements according to the degree of agreement/disagreement:

- readiness: “I am ready to pay more for this brand” and “I can spend a lot of time looking for this brand in my city” (the gap values were 1.75 points for KFC, 1.33 points for McDonald's, 1.52 points for Google, and 1.26 points for Facebook); and
- activity: “I discuss this brand with my friends” and “I search for and read additional information about this brand” (the gap values were 1.74 points for KFC, 1.35 points for McDonald's, 1.05 points for Google, and 1.19 points for Facebook). The specifics of the perception of the Microsoft brand by Russian and Chinese consumers must be noted. The gap in the "activity" element of the construct is quite large (0.94 points), but the maximum gap in relation to the perception of this brand is noted in the "knowledge" element of the construct: "I understand well how this brand works"; "I have experience using this brand"; and "I know a lot about this brand" (1.32 points).

According to the results of the evaluation, a pronounced degree of cross-cultural differences for the analyzed brands was revealed. Despite their adherence to certain brands, Russian consumers are not always ready to spend more money and a lot of time searching for a particular service in their city – unlike Chinese consumers, who are ready to devote more resources to finding and buying apps from Google and meeting the need for food and communication through their visits to KFC and McDonald's. With regard to the “activity” construct element, Chinese consumers are more proactive in discussing brands and searching for additional information about them.

The brands of products were evaluated next, including FMCG (Nestle, Coca-Cola, Pepsi) and electronics (Apple, Samsung) [Table 3].

**Table 3:** Average ratings of the Russian and Chinese respondents regarding brand perception in the categories of FMCG, electronics, points

No.	Construct	Nestle			Coca-Cola			Pepsi			Apple			Samsung		
		Russia	China	[Gap]	Russia	China	[Gap]	Russia	China	[Gap]	Russia	China	[Gap]	Russia	China	[Gap]
1	Presence	4.43	3.33	1.1	4.58	4.70	0.12	3.65	3.00	0.65	4.38	4.65	0.27	4.56	3.57	0.99
2	Awareness	4.47	3.29	1.18	4.57	4.65	0.08	3.83	2.95	0.88	4.52	4.64	0.12	4.54	4.47	0.07
3	Knowledge	4.06	3.31	0.75	4.20	4.44	0.24	3.33	2.99	0.34	4.23	4.66	0.43	4.19	3.39	0.8
4	Respect	4.16	3.28	0.88	3.91	3.72	0.19	3.34	2.97	0.37	3.97	3.44	0.53	3.85	3.42	0.43
5	Relevance	3.94	3.45	0.49	3.39	4.23	0.84	3.21	3.03	0.18	4.12	4.49	0.37	4.02	3.23	0.79
6	Distinction	3.04	3.27	0.23	2.57	3.36	0.79	2.53	2.94	0.41	4.10	3.58	0.52	2.99	3.43	0.44
7	Proximity	3.74	3.23	0.51	3.32	3.66	0.34	2.81	2.85	0.04	3.92	3.34	0.58	3.29	3.25	0.04
8	Effectiveness	3.77	3.31	0.46	3.40	3.81	0.41	3.30	2.99	0.31	4.01	3.47	0.54	3.81	3.37	0.44
9	Affection	3.33	3.19	0.14	2.45	3.15	0.7	2.50	2.91	0.41	3.57	3.52	0.05	3.05	3.41	0.36
10	Nostalgia	3.65	3.19	0.46	3.12	4.35	1.23	3.37	2.98	0.39	2.05	2.35	0.3	3.42	3.19	0.23
11	Innovation	4.14	3.34	0.80	3.62	4.22	0.6	3.76	2.90	0.86	4.40	4.50	0.1	4.20	3.66	0.54
12	Care	3.82	3.26	0.56	3.04	3.58	0.54	3.34	2.86	0.48	4.04	3.36	0.68	3.56	3.38	0.18
13	Quality	4.02	3.36	0.66	3.48	3.91	0.43	3.78	2.92	0.86	4.36	3.49	0.87	4.18	3.51	0.67
14	Prestige	3.26	3.24	0.02	3.10	3.60	0.50	3.26	2.86	0.4	4.58	3.60	0.98	3.62	3.56	0.06
15	Value for money	3.78	3.48	0.30	3.72	3.77	0.05	3.38	3.11	0.27	2.78	3.40	0.62	3.69	3.75	0.06
16	Readiness	1.89	3.12	1.23	1.88	1.87	0.01	1.73	2.93	1.2	3.05	3.30	0.25	3.46	3.17	0.29
17	Intention	2.89	3.29	0.40	2.32	2.89	0.57	2.29	2.89	0.6	4.06	4.49	0.43	3.82	3.48	0.34
18	Atmosphere	3.70	3.39	0.31	3.05	3.46	0.41	3.10	2.86	0.24	4.18	3.48	0.70	3.36	3.32	0.04
19	Recommendations	3.76	3.24	0.52	2.90	3.17	0.27	3.55	2.89	0.66	4.25	3.46	0.79	3.65	3.36	0.29
20	Activity	2.06	3.42	1.36	1.82	2.47	0.65	1.76	2.87	1.11	2.70	3.48	0.78	3.95	3.61	0.34
21	Overall attitude	3.74	3.48	0.26	3.06	3.84	0.78	3.28	3.02	0.26	3.76	3.62	0.14	3.68	3.54	0.14

Following the analysis of brand perception in the FMCG and electronics categories, it must be noted that the scope of brand ownership influences their evaluation. The smallest gaps in the perception of brands by Russian and Chinese consumers are noted in the field of electronics. For example, the minimum gaps are observed for the Apple brand, and all the elements of the brand construct were evaluated by consumers at a high level, which indirectly testified to competent brand management. The degree of cross-cultural differences is pronounced for such constructs as "prestige" (0.98 points), "quality" (0.87 points), "recommendations" (0.79 points), and "activity" (0.78 points). Russian consumers consider the Apple brand to be of higher quality and more prestigious, and they are also more willing to recommend the brand's products to others. However, low indicators were recorded for "value for money" due to the high price, as well as for "readiness" from both cultures, i.e., a relatively small number of the respondents agreed that they were willing to pay more money for the brand and spend a lot of time searching for Apple products. It must be noted that Apple strives to maximize access to its products through a variety of distribution channels to facilitate the shopping process. Both Russian and Chinese consumers agree that Apple is an innovative brand. According to Russian consumers, the company cares about its customers, and they feel comfortable and pleasant with this brand. The mean values are almost identical for the "general attitude" construct; both cultures agree rather than disagree that they have positive images, thoughts, and associations with the brand. Following the analysis of the perception results, the Apple brand can be assigned the status of a leader in the Russian and Chinese markets. The degree of cross-cultural differences in the Samsung brand is clearly expressed for such constructs as "presence", "knowledge," and "relevance" in favor of the Russian market. In general, it can be noted that the brand received an above-average rating due to its acceptable value-for-money ratio. There are maximum gaps in the "readiness" and "activity" elements of the construct in the FMCG category, which repeats the situation with the elements of the brand construct in the category of communication technologies and catering enterprises.

The hypotheses put forward in the study that brands of products and services are perceived differently by representatives of different cultures and that brand perception depends on the brand belonging to the product category and the specifics of geographic markets were confirmed.

## DISCUSSION

Two constructs were used to achieve the research objectives: Rokeach's value scale and K. Keller's brand performance construct. It has been found in the course of the analysis of scientific literature on this topic that many methods of measuring cultural values are now used [4-7]. However, problems arise in the choice and application of a particular method when conducting empirical marketing research. This problem is related to the specifics of the subject area of research and the specifics of geographic markets, determined by cross-cultural differences of consumers. The study has confirmed the possibility of using Rokeach's value survey construct [5] to measure the characteristics of brand perception through the prism of the values of consumers from Russia and China.

The ability to use Keller's brand performance construct [10] is fraught with difficulties, which are due to the discrepancy in the answers of the respondents from different cultures in the analyzed markets of information services (Google, Microsoft, Facebook), catering services (KFC, McDonald's), FMCG (Nestle, Coca-Cola, Pepsi), and electronics (Apple, Samsung), caused by different interpretations of the elements of the brand construct. In the course of this study, K. Keller's brand construct was adapted to the goals of the study, which allowed us to obtain comparable results for evaluation.

The conducted research prompted us to believe that the brand construct directly depended on the industry specifics of the brand and the geography of the study. In this regard, the testing of the brand construct in

different product markets and geographic segments is a promising research vector, which will ultimately allow forming a universal construct for future research.

## CONCLUSION

The following results have been obtained in the course of this study:

1. A theoretical model of research has been developed, and constructs have been proposed:
  - for measuring the cultural values of Russian and Chinese consumers; and
  - for measuring the performance of brands of products and services (the K. Keller's brand performance construct has been adapted for the goals of this study).
2. Cultural values of Russian and Chinese consumers have been evaluated; gaps and their causes have been identified. According to the results of the evaluation, we have recorded that health is absolutely important for the Russians, while financial security is absolutely important for the Chinese.
3. The specifics of the brand perception of products and services have been established in the course of the survey of Russian and Chinese consumers. Significant gaps have been recorded for individual elements of the construct. For example, the largest gaps have been observed in the "readiness" and "activity" elements for the KFC, McDonald's, Google, and Facebook brands. The smallest gaps in brand perception by Russian and Chinese consumers have been noted in the field of electronics. For example, the minimum gaps have been observed for the Apple brand, and all the elements of the brand construct have been evaluated by consumers at a high level, which indirectly testifies to competent brand management. Future research may focus on detecting differences in factors that influence brand choice among different cultures.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES<sup>#</sup>

- [1] Agarwal J, Malhotra N, Bolton RA. [2010] Cross-National and Cross-Cultural Approach to Global Market Segmentation: An Application Using Consumers' Perceived Service Quality. *Journal of International Marketing*, 18(3):18–40.
- [2] Cheung FM, Van de Vijver FJR, Leong FTL. [2011] Towards a new approach to the assessment of personality in culture. *American Psychologist*, 66(7):593–603.
- [3] Davvetas V, Sichtmann C, Diamantopoulos A. [2015] The impact of perceived brand globalness on consumers' willingness to pay. *International Journal of Research in Marketing*, 32(4):431–434.
- [4] Matsumoto D. [2003] *Culture and Psychology*. St. Petersburg: Publishing house "Peter", RU.
- [5] Rokeach M. [2000] *Understanding Human Values*. Free Press, NY.
- [6] Edwards A. [1976] *Edwards Personal Preference Schedule*. Manual. New York: Psychological Corporation.
- [7] Schwartz S, Sagiv L. [1995] Identifying culture specifics in the content and structure of values. *Journal of Cross-Cultural Psychology*, 26:92–116.
- [8] Sopov V, Karpushina L. [2001] Morphological test of life values. *Applied psychology*, 4:9–30.
- [9] Keller KL. [2015] Designing and implementing brand architecture strategies. *Journal of Brand Management*, 21(9):702–715.
- [10] Keller KL, Lehmann DR, Farley JU. [2008] The Structure of Survey-Based Brand Metrics. *Journal of International Marketing*, 16(4): 29–56.
- [11] Aaker D. [1996] *Building Strong Brands*. Free Press, NY
- [12] Melewar TC, Nguyen B. [2015] Five areas to advance branding theory and practice. *Journal of Brand Management*, 21(9):758–769.
- [13] Dominin VN. [2009] Method for measuring the area of maximum consumer preferences and building maps of the emotional-value attitude of consumers to brands. *Brand management*, 6:330-344.
- [14] Carpenter GS, Glazer R, Nakamoto K. [1994] Meaningful brands from meaningless differentiation: the dependence on irrelevant Attributes. *Journal of Marketing Research*, 8:339–350.
- [15] Schmitt BH, Brakus J, Zarantonello L. [2015] The current state and future of brand experience. *Journal of Brand Management*, 21(9):727–733.

<sup>#</sup>English translations of the references are presented..

ARTICLE

# SOCIO-ECONOMIC CONSEQUENCES OF THE COVID-19 PANDEMIC FOR UNIVERSITIES

Nadezhda Victorovna Filinova\*, Vladimir Petrovich Filinov, Elena Vladimirovna Luneva, Olga Nicolaevna Pogodina

Russian State Social University, Volokolamsk Highway, 20/1, Klin, Moscow Region, 141607, RUSSIA

## ABSTRACT

The coronavirus crisis has huge impact on higher education, as well as on the economy and the lives of millions of people around the world. The immediate consequences and inconveniences will intensify as the coronavirus has spread to nearly every country and affects more and more people. The research aims at analyzing the socio-economic consequences of the COVID-19 pandemic for universities. In order to analyze the socio-economic consequences of the COVID-19 pandemic for universities, an analysis of scientific literature, analytical reports of international organizations in the field of higher education (European Students' Union (ESU), national academic exchange services), consulting companies, and opinions of experts in the field of higher education has been carried out. The article analyzes the opinions of scientists on the impact of the COVID-19 pandemic on the global and national higher education systems. Based on an expert survey, the impact of the COVID-19 viral spreading on the activities of higher education institutions is analyzed, and the consequences of the pandemic for universities, as well as changes in higher education, are predicted. It is shown that the COVID-19 pandemic will cause restructuring of the structure of students' mobility and will be a serious problem for society, individuals and higher education. It is proved that, on the one hand, COVID-19 has triggered a global crisis, which, on the other hand, can become an impetus for the transformation of educational systems and science, as well as contribute to the development of new strategies and mechanisms.

## INTRODUCTION

News about the outbreak of new coronavirus infection in China has gradually spread around the world, seizing with anxiety more and more regions and areas of people's activities. Education and science being the most stable and globalized sectors of economic activity have experienced significant impact and expect extraordinary results of unprecedented restrictions for the entire history of mankind.

In the early days of the crisis, concerns focused primarily on the problems of serious disruptions that the pandemic caused in the destinations, structure, and volume of students' flows from China, as well as the economic impact on the higher education systems of all partner countries. Efforts to prevent the spread of the virus have ranged from extending, delaying, or postponing academic deadlines to banning students from enrolling in educational and research programs [2]. The British consulting company Quacquarelli Symonds has published the report "The impact of coronavirus on global higher education" [1] based on the results of a survey of about 11,000 international students worldwide, which was conducted from the second half of February to the end of March 2020. The main issues in this survey were the following ones: How did students respond to the coronavirus crisis? How did institutions respond to this global health emergency? As a result, it was revealed that 46% of respondents stated that the coronavirus had affected their training plans, and 25% were still undecided. Almost half of the potential international students intended to postpone their studies because of the pandemic, while only one in ten noted they no longer wanted to study abroad. Regarding distance learning, although 58% of potential international students expressed some interest in online learning, 42% said they had no desire to study over the Internet [3].

The report noted that universities were responding to the expected reduction in the number of international students by adapting the provisions on the English language proficiency testing, postponing the start dates of admission, and changing the application deadlines. Most of them offered to conduct digital events (75%), digital marketing (73%), and online meetings (70%). As for the admission campaign, 50% of universities noted that the pandemic would have a detrimental effect on the number of students' applications; 26% noted that the numbers would remain the same, and about a third (34%) of them noted they were seeking to diversify their source countries for recruitment.

Numerous publications and studies are devoted to the problem of the impact of COVID-19 on the global and national higher education systems, and the internationalization of education [Table 1].

**Table 1:** Analysis of opinions on the impact of the COVID-19 pandemic on the global and national higher education systems

No	Reference	Opinion
1	Basset RM [2]	Higher education around the world has experienced impact not seen since World War II
2	Holmes K [3]	The first aspect of higher education affected by COVID-19 is internationalization, in particular, students' mobility
3	Kamarianos et al. [4]	The COVID-19 pandemic is slowing down higher education. The pandemic is a serious problem for higher education, but eventually, the crisis will pass and, at least in the areas of internationalization of higher education, the status quo will largely prevail

### KEY WORDS

distance learning, higher education, international mobility, social distancing, information and communication technologies

Received: 2 Nov 2020  
Accepted: 4 Dec 2020  
Published: 7 Dec 2020

\*Corresponding Author  
Email:  
FilinovaNV@rgsu.net

4	Bilecen B. [5]	The continuation of the COVID-19 pandemic is causing significant concern in the higher education sector, with devastating consequences, particularly, for students' exchanges. COVID-19 has sharpened the need to teach and learn about innovation, and it is also forcing the international educational community to rethink how conferences and professional development should be conducted. When the pandemic passes, hybrid or remote participation by presenters, instructors, and audience members is likely to become the new norm. COVID-19 can also be seen as a test of the ability of universities and their associations to adapt and accelerate the rate of changes. However, the long-term outlook is not promising: after the crisis, universities are likely to take retrenchment measures, starting with limiting travel funding and professional development.
5	Watermeyer et al. [6]	Mobility is a key component of internationalization, which bears the main burden of the COVID-19 crisis. Students' mobility as well as visiting missions and delegations were one of the international educational areas most affected by the COVID-19 crisis.
6	Toquero [7]	The COVID-19 pandemic indicates that strengthening online education contributes to improving public safety and health. In this regard, governments should encourage making them more accessible and invest in developing the capacity of universities to protect the higher education sector in the face of social uncertainty and emergencies in the world.

Malkawi [8] summarized the significant challenges and consequences that the COVID-19 pandemic had caused in the global higher education community in 20 countries, by analyzing secondary information using university and government sources. It was revealed that the range of responses of education professionals ranged from lack of responses through various strategies of social isolation on campus to rapid conversion of educational programs to full-fledged learning materials available on the Internet. An attempt has been made to assess the response of higher education in preparing for the pandemic and to learn best practices of the pedagogical developments of other universities in order to strengthen the collective response to COVID-19 now and in the future.

Research by J. Crawford et al. [9] is devoted to the problem of the quality of providing distance learning in the context of pandemic when the university staff is not ready for emergencies. In such cases, cooperation with governments, businesses, and nongovernmental organizations is vital. However, as noted by Marinoni and van Land [10], unequal access to information and communication technologies is obvious. In some countries, such as Brazil, access to the Internet for students is so limited that some universities in the country have decided to completely interrupt education.

Some researchers [11, 12] are skeptical about distance learning and transferring courses to the Internet. In their opinion, effective online training is possible but it requires time and support. Making these changes quickly will definitely result in poor quality. In contrast, based on the study of the experience of adapting the higher education system to the effects of COVID-19, Favale et al. [13] conclude that the transition from on-campus learning to online teaching has been surprisingly smooth due to huge investments in learning management systems and the digitalization of administrative services conducted in recent years. Obviously, one should agree with the opinion [14] that COVID-19 has both negative and positive impact on higher education.

The purpose of the present article is to analyze the socio-economic consequences of the COVID-19 pandemic for universities. The present research aims at considering the impact of the COVID-19 pandemic on the activities of higher education institutions; predicting the impact of the pandemic on universities; analyzing the changes in higher education. Research hypothesis is as follows: on the one hand, COVID-19 has triggered a global crisis, which, on the other hand, can become an impetus to transform educational systems and science, as well as to develop new strategies and mechanisms.

## METHODS

The research was carried out from August 5 to September 21, 2020. To analyze the socio-economic consequences of the COVID-19 pandemic for universities, the authors analyzed scientific literature [2-22], analytical reports of international organizations in the higher education (ESU [33], as well as national academic exchange services), consulting companies, and opinions of experts engaged in higher education.

At the first stage of the research, the available analytical data and scientific works in the concerned topic were studied. At the second stage of the research, based on data analysis, the impact of the COVID-19 pandemic on the activities of higher education institutions was considered, as well as the consequences of the pandemic for universities and changes in the field of higher education were predicted. The research results were summarized at the third stage of the research.

Analysis of scientific and analytical materials allowed collecting a variety of information on the socio-economic impact of the COVID-19 pandemic on universities. In order to assess the quality of the selected sources, the authors conducted an expert survey to assess their reliability.

At the first stage of the research, the selected information was presented to a group of 13 higher education experts to assess its quality. The criterion for the selection of experts was the availability of at

least three author's articles indexed in Scopus or Web of Science. E-mail messages were sent to the experts with a request to assess the reliability of the selected material for this research according to the Harrington's scale. Summarized data with the results of assessment of the selected documents reliability by the experts are presented in the Table 2.

**Table 2:** Summary of results of assessment of the selected documents reliability by the experts

No	Main characteristics	Result
1	The number of proposals sent to experts	13 pieces
2	The number of questionnaires received from experts	11 pieces
3	Average reliability results of research/ expert information	0.69 points

On average, the experts rated high the selected documents (over 0.64).

At the second stage of the research, based on data analysis, the impact of the spread of the COVID-19 virus on the activities of higher education institutions and a forecast of the consequences of the pandemic for universities were determined, as well as changes in the field of higher education were revealed.

At the third stage of the research, the results were summed up with the construction of tables and the interpretation of the results.

## RESULTS

### Impact of the COVID-19 pandemic on higher education

According to researchers [15], the COVID-19 pandemic has revealed huge impact on higher education, as well as on the economy and lives of millions of people around the world [Table 3].

**Table 3:** Impact of the COVID-19 pandemic on higher education

No	Impact of the COVID-19 pandemic
1	The universities are closed, and the teaching is cancelled or carried out in online mode via the Internet
2	The conferences are not held or are held in remote mode over the Internet
3	Prospective students can't take exams, and international students cannot get to their campuses or come back home
4	Education programs abroad are cancelled
5	University teachers are advised not to travel to affected countries, or completely avoid trips abroad

### Consequences of the COVID-19 pandemic in higher education

Experts in the higher education Altbach and de Wit [16] from the Center for International Higher Education (CIHE), Boston College (USA), outlined the likely consequences of the COVID-19 pandemic that would require special consideration [Table 4].

**Table 4:** The consequences of the COVID-19 pandemic in higher education

No	Consequences of the pandemic	Expert opinion
1	The strongest will survive	Research and leading world universities will be the first to recover. At the other end of the spectrum are those universities that are most at risk, i.e. private institutions that are poorly funded and completely dependent on tuition fees. This reality is particularly true in low-income countries, where higher education is increasingly dominated by the low-quality private sector. Much of the massification of higher education, as well as international students' mobility, have been driven by the emergence of the middle class – these groups are likely to be most affected by changes in higher education after the pandemic.
2	Financial crisis	During the COVID-19 pandemic, universities – both public and private – have immediately faced financial problems from the moment of closing for quarantine. Many universities have already stopped hiring new employees. For prestigious private universities, mainly in the USA, endowment funds have lost value with the fall of the stock market. Most of them will recover, but in the medium term, the impact of the crisis will be noticeable. Due to large expenditures aimed at stabilizing the economy during the crisis, future state allocations for higher education will be reduced.
3	Rising inequality	Higher education around the world and in individual countries is characterized by inequality of all types. The COVID-19 pandemic is likely to exacerbate these inequalities.

4	Distance education versus an intramural form of study	All over the world, universities were forced to switch to hundred-per-cent distance learning. Access to relevant technologies and the speed of the Internet have become significant challenges. While experience is being learned, educator skills are being improved (mainly through practice), as well as learning platforms and online curricula available on the Internet. Experts doubt whether the current situation will result in a deep and lasting technological revolution in higher education. However, the COVID-19 pandemic will significantly expand the use of distance education, and from now on teachers will use the opportunities offered by hybrid learning models. Nevertheless, for many reasons, students and teachers will continue to prefer full-time higher education. The traditional method of teaching can become a privilege for wealthier students studying at top universities.
5	International students' mobility	The education market will become a buyer's market, where universities will hunt for scarce international students in the coming years. The infrastructure of higher education that has developed in recent decades – agents, training programs, and staffing companies – will be drastically reduced, and new models will need to be adapted. Completing study programs abroad may experience even greater challenges since students now take into account the possible risks and challenges when getting training.

According to researchers [18, 31, 32], the immediate consequences and inconveniences will intensify as COVID-19 has spread to almost all countries and affects more and more people. However, the mid- and long-term consequences of the pandemic will not be so multiple. Some experts see the inadvertent positive impact of the pandemic on higher education revealed, in particular, in increased teaching and learning on the Internet and the associated reduction of the carbon footprint, as well as in more diverse international students' recruitment policies with reduction of their dependence on one or two major countries, especially on China.

### Changes in higher education

According to some European experts [17], the implications for higher education will be significant and mostly negative, reinforcing the gaps and inequality among students, institutions, and countries [18- 20]. Significant changes will occur worldwide [21- 24]. Experts generally agree in their opinions with the previous works in this area; however, due to the development of global problems, such as COVID-19, believe that most likely the universities in the poorest parts of the world will suffer more seriously [Table 5].

**Table 5:** Changes in higher education

No	Changes	Expert opinion
1	Diversifying supplies from China	Universities around the world, especially those that rely heavily on international students – Australia, Canada, New Zealand, and the USA – no longer can expect the same number of Chinese students they have admitted for decades. The decline in the number of students from China has already affected the economies of Australia, New Zealand, and Canada.
2	Expanding distance learning	Most universities around the world have suspended or discontinued face-to-face education and replaced it with online teaching. The need to expand online learning options and massive open online courses (MOOC) can no longer be denied. The university authorities will have to reconsider which part of the training courses will be offered face-to-face and which part will be offered remotely.
3	Applying the methods of students' admission through the Internet	The practice of admission of students to study will change. Currently, entrance exams are postponed across Asia, which will eventually affect the fall admission of first-year students. To attract applicants in the future, deans and recruiters will use the Internet. Flexible application deadlines and review of qualification data require reassessment of current recruitment and students' admission practices.
4	Increasing the role of teleconferencing	Most universities have banned all non-essential travel for employees. Long-distance trips will be replaced by teleconferencing.
5	More and more students will be studying closer to home	Specific groups of students will decide to study closer to home, and they will increasingly turn to intraregional universities for higher education.

## DISCUSSION

According to researchers [25 - 27], the consequences and inconveniences will increase as COVID-19 has reached almost all countries and affected an increasing number of people. But the medium- to long-term impact of the pandemic will not be too dramatic. Some experts see the unintended positive impact of the pandemic on higher education, in particular, in the increase in online teaching and learning and the associated reduction in the carbon footprint, as well as in a more diverse international students' recruitment policy, reducing its dependence on one or two major countries, especially on China.

The reality and trends that are observed in international higher education are likely to remain, and higher education will quickly return to the normal organization; however, it will possibly be characterized by less



financial stability than currently existing in many countries and institutions. There is no doubt that global mobility will decrease for a year or so, especially for students who come to other countries of the world.

After the end of the pandemic, the mobility structure may change. Time shows constant changes in the patterns and flows of international students. One of the main sending countries at one time was Iran, and now its influence is almost invisible. The flow of students from Brazil and Saudi Arabia has declined, while from Vietnam and to some extent from India, it has increased. The number of students from Africa, mainly from Nigeria and Kenya, is expected to grow in the future [28]. Some host countries, especially Australia and the UK, as well as some universities in the USA, have become financially dependent on international students' tuition costs. After all, international education is valued at USD 300 billion worldwide. The pandemic shows that this dependence raises many questions: institutions that depend on this income will likely face significant problems [29].

Today, the impact of technology on mobility is increasing. Now many universities teach their students remotely, but the quality of online education is still insufficient, and students are not always satisfied. Most teachers, according to researchers [30], do not learn to conduct distance courses, do not have the perfect technology necessary for high-quality teaching and learning, and have not adapted their curricula to the features of the Internet. There are many aspects and ways to consider: asynchronous or synchronous learning, effective management of group discussions on the Internet, organization of tasks, and exams using the Internet. At the same time, according to experts [31], there will be structural changes in the university research and teaching staff. A fairly large cohort of universities in the world proclaims a reduction in lecturing positions. In this regard, young educators entering the labor market will face the need to be tested, in particular, their professional competence in the organization of distance teaching.

Due to the increase in social distancing and reduction of geographical movements, the possibility of the personal acquaintance of applicants with university campuses has been reduced. Respectively, video acquaintance with educational institutions and their infrastructure is becoming more relevant. Virtual acquaintance is becoming the main way to get to know the university. And those institutions that have not invested in the development of virtual presence will lose a significant number of potential students [32]. Consequently, the value of the university website is growing drastically.

## CONCLUSION

It is evident that in general, Russia and its education system have also been negatively affected by the COVID-19 pandemic and its consequences revealing vulnerabilities in organizational, managerial, and institutional support. However, it should be noted that the digitalization of higher education will certainly help to overcome today's challenges and gradually transform the higher education system, as well as implement new management mechanisms. Thus, the research results have confirmed the hypothesis that, on the one hand, COVID-19 has triggered a global crisis, which, on the other hand, can become an impetus to transform educational systems and science, and develop new strategies and mechanisms. However, it is necessary to keep in mind the requirements and expectations of society to ensure not only students' access to knowledge but also the provision of high-quality competitive education. The transition to receiving educational services based on online platforms expands the opportunities for higher education and international academic mobility, which in the future requires for scientific understanding of possible options for the development of the higher education digitalization process and its results to manage this process. Therefore, now the development of an innovative model of state management of the processes of higher education internationalization in the context of modern challenges should be considered as the urgent task of scientific research. In general, the authors believe that the modern model of public administration of the higher education internationalization should take into account both the requirements of external users of educational services regarding their volume and quality, as well as internal factors and the ability and readiness of domestic universities not only to switch to the latest technologies but also to provide competitive educational services.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] The impact of the Coronavirus on global higher education. Report of Quacquarelli Symonds. [2020]. Retrieved from <https://www.qs.com/portfolio-items/the-impact-of-the-coronavirus-on-global-higher-education/>
- [2] Basset RM. [2020]. Sustaining the values of tertiary education during the COVID-19 crisis. *International Higher Education*. 102: 5-7.
- [3] Holmes K. [2020]. Sustaining learning communities through and beyond COVID-19. UNESCO. Futures of Education Ideas LAB. <https://en.unesco.org/futuresofeducation/holmes->

- sustaining-learning-communities-COVID-19 (Accessed April 27, 2020)
- [4] Kamarianos I, et al. [2020]. Towards an understanding of university students' response in times of pandemic crisis (COVID-19). *European Journal of Education Studies*. 7(7): 20-40.
- [5] Bilecen B. [2020] Commentary: COVID-19 pandemic and higher education: International mobility and students' social protection. *International Migration*. 58(4): 263-266.
- [6] Watermeyer R, et al. [2020] COVID-19 and digital disruption in UK universities: Afflictions and affordances of emergency online migration. *Higher Education*. DOI:10.1007/s10734-020-00561-y
- [7] Toquero CM. [2020]. Challenges and opportunities for higher education amid the COVID-19 pandemic: The Philippine context. *Pedagogical Research* 5(4): em0063.
- [8] Malkawi BH. [2020]. COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*. 3(1): 1-20.
- [9] Crawford J, et al. [2020]. COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning and Teaching*. 3(1): 9-28.
- [10] Marinoni G, van Land H. [2020] The impact of COVID-19 on global higher education. *International Higher Education*. 102: 7-9.
- [11] Cao W, et al. [2020] The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Research*. 287: 1-5.
- [12] Espino-Díaz L, et al. [2020] Analyzing the Impact of COVID-19 on Education Professionals. Toward a Paradigm Shift: ICT and Neuroeducation as a Binomial of Action. *Sustainability*, 12: 5646.
- [13] Favale T, et al. [2020] Campus traffic and e-Learning during COVID-19 pandemic. *Computer Networks*. 176: 107-290.
- [14] Nicola M, et al. [2020]. The socio-economic implications of the coronavirus and COVID-19 pandemic: a review. *International Journal of Surgery*. 78: 185-193.
- [15] Macgilchrist F, Allert H, Bruch A. [2020]. Students and society in the 2020s. Three future 'histories' of education and technology. *Learning, Media, and Technology*. 45(1): 76-89.
- [16] Altbach PG, de Wit H. [2020]. COVID-19: The internationalization. The revolution that isn't. *International Higher Education*. 102: 16-18.
- [17] Di Pietro G, Biagi F, Costa P, Karpiński Z, Mazza J. [2020] The likely impact of COVID-19 on education: Reflections based on the existing literature and international datasets. Luxembourg: Publications Office of the European Union.
- [18] Filinova NV, et al. [2015] The socio-economic foundations of the development of contemporary economic innovations. *Asian Social Science*. 11(6): 150-160.
- [19] Rozhnova OV, et al. [2018] The role of trade in the socio-economic development of Crimea. *International Journal of Civil Engineering and Technology*. 9(12): 48-54.
- [20] Bobinkin SA, et al. [2015] The influence of individual psychological abilities on managerial activities of line managers. *Asian Social Science*. 11(7): 208-214.
- [21] Luneva EV. [2015]. Key performance indicators (KPI) system in education. *Asian Social Science*. 11(8): 194-200.
- [22] Mayorova A, et al. [2019] State and development of retail chains in the Russian regions. *Proceedings of the 33rd International Business Information Management Association Conference, IBIMA 2019: Education Excellence and Innovation Management through Vision 2020*.
- [23] Filinova NV, et al. [2015] The influence of individual psychological abilities on managerial activities of line managers. *Asian Social Science*. 11(7): 208-214.
- [24] Samylina YN, et al. [2020] Key indicators of the economic activity of educational institutions: Modeling and prospects. *Revista Inclusiones*. 7: 1-14.
- [25] Blankenberger B, Williams AM. [2020]. COVID and the impact on higher education: The essential role of integrity and accountability. *Administrative Theory and Praxis*. 42(3): 404-423.
- [26] Viktorov VY, et al. [2020] Economic and social processes in education: Development of universities in the context of international trends. *Revista Inclusiones*. 7: 72-84.
- [27] Matveeva S, et al. [2020] Digitalization of higher education and professional development of educators: Technologies and new opportunities. 9(29): 77-86.
- [28] Aucejo EM, et al. [2020] The impact of COVID-19 on student experiences and expectations: Evidence from a survey. *Journal of Public Economics*, 191: 104-271.
- [29] Bedford J, et al. [2020] COVID-19: Towards controlling of a pandemic. *The Lancet*. 395: 1015-1018.
- [30] Cecilio-Fernandes D, et al. [2020]. The COVID-19 pandemic and the challenge of using technology for medical education in low and middle-income countries. *MedEdPublish*. 9(1): 1-7.
- [31] Affouneh S, Salha SN, Khlaif Z. [2020]. Designing quality e-learning environments for emergency remote teaching in coronavirus crisis. *Interdisciplinary Journal of Virtual Learning in Medical Sciences*. 11(2): 1-3.
- [32] Dhawan S. [2020]. Online learning: A panacea in the time of the COVID-19 crisis. *Journal of Educational Technology Systems*. 49(1): 5-22.
- [33] European Students' Union. Retrieved from <https://www.esu-online.org/>

## ARTICLE

# RISK MANAGEMENT AT THE FINAL STAGE OF GAS FIELD DEVELOPMENT

Valeria A. Cheymetova\*, Yuriy V. Vaganov

Tyumen Industrial University, Volodarskogo Street, 38, Tyumen, 625000, RUSSIA

## ABSTRACT

The article introduces the problems of managing the risks of stimulating gas influx at the final stage of gas field development. The extraction of hydrocarbons, including gas, is carried out from numerous fields throughout the Russian Federation. The deposits differ in their properties and characteristics, which influence the indicators of the efficiency of extraction of hydrocarbon reserves, and are also distinguished by the extent of reserves depletion. In modern conditions of economic development at the macro- and micro levels, it is becoming increasingly important to extract gas reserves at the final stage of gas field development. This article is aimed at identifying the main risks and methods of their managing at the final stage of gas field development. The main problems at the final stage of gas field development are outlined. Risks in the gas field development with hard-to-recover gas reserves are highlighted and characterized. Actions to reduce the risks when carrying out mining works at the final stage of gas field development are presented. It is shown that the application of risk management methods at the final stage of gas field development includes, first of all, forecasting, as well as the introduction of a system of measures to reduce, prevent situations leading to damage and losses; herewith, risk management has to be implemented in stages. The effect of measures to manage risk reduction in the development of gas fields and the operation of field facilities will be shown through a reduction in the likelihood of risk. Nevertheless, it is currently not possible to completely eliminate the occurrence of risky cases, since this requires large investments (material, human, economic) to obtain additional information and conduct analytical and scientific research. This is also affected by the fact that it is fundamentally impossible to reliably predict the future state of the gas field and the environment.

## INTRODUCTION

**KEY WORDS**  
hard-to-recover gas reserves, issues of gas extraction, cost of gas extraction, raw hydrocarbon reserves, risk management,

Gas in Russia is extracted from numerous deposits and fields located throughout the country. The deposits are characterized by different geological and physical properties which exert strong influence on extraction efficiency of the reserves, on efficiency of deposit development, as well as by different depletion of reserves and fields. Under modern economic situation of the industry development, extraction of gas at final stage becomes increasingly important. Herewith, the mentioned properties of deposits vary in significant ranges, which predetermine different expenses for gas extraction at each single well. The largest and most unique gas deposits in the world are located in the Arctic and extreme northern regions of West Siberia, such as Urengoy, Yamburg, Bovanenkovo gas fields. According to predictions, total area of these deposits exceeds 769,250 km<sup>2</sup> [1]. In the ranges of the considered territory, oil and gas reserves were detected from Paleozoic deposits to Upper Cretaceous combined into five largest regional oil and gas complexes with overwhelming majority of deposits (up to 98%) in Aptian-Cenomanian, Neocomian, and Jurassic sediments. Herewith, more than 85% of explored gas reserves are embedded in exclusively gas fields confined to Aptian-Cenomanian gas bearing complex of northern regions [2]. The available studies of Russian companies as well as the experience of development of gas deposits demonstrate that final stage of raw hydrocarbon production is sufficiently complicated problem due to the following reasons:

- decrease in seam pressure;
- decrease in total gas extraction at deposits;
- complicated and more expensive operation of flooded wells.

Received: 29 Oct 2020  
Accepted: 2 Dec 2020  
Published: 7 Dec 2020

Under such conditions of deposit development, the expenses for gas extraction sharply increase, this demonstrates that the project is complicated and requires for unique approach to further development of gas field and subsequent use of the extracted gas [3- 5].

Development of gas deposit design is a multipurpose complex system of single life cycle with high risks and uncertainties. For project of such type it is highly important, though difficult, to estimate risks. Therefore, it is necessary to develop and apply measures for their decrease and elimination for each project stage, that is, to manage risks. Herewith, the main task it to minimize risks of a project at each stage of its execution.

At final stage of deposit development, the project is aimed at:

- increase in gas extraction from field, available technically and economically;
- provision of long-term social guaranties and living conditions for inhabitants and employees of gas production company since they reside in single-industry cities in gas producing regions or in the vicinity of large deposits.

\*Corresponding Author  
Email:  
cheymetovava@tyuiu.ru

## METHODS

Hard-to-recover gas reserves are characterized by significant difficulties of their extraction both in terms of technology and economy. This results in increased expenses, especially at initial stages, when innovation technologies of extraction are commissioned.

In order to initiate active production, it is required to develop and to approve appropriate regulatory decisions at top level. For instance, it could be proposed that in the case of implementation of complicated and large-scale projects of gas extraction, the mineral extraction taxes are reduced to 0% of standard rates. In the case of medium-scale projects, this reduction can equal to 60%, and in the simpler cases – to 40% [1, 6]. This preference concerning tax rate depending on the complexity of gas deposit development and subsequent production will be granted for ten, seven, and five years, respectively. If such innovations by top-level management are allowed and applied in the areas of extraction for a long time, then the mining industry will have real opportunities to continue secure gas extraction. This is related with the fact that gas extraction is accompanied by deep scientific studies and the need to purchase and to implement the innovative equipment and technology. All these results show increased expenses of deposit development.

Under such conditions, it is required to apply individual approach to each specific project. Only with such decision it is possible to expect compliance with all geological and engineering conditions for a specific deposit. It should be mentioned that key industries should be involved in development. At the same times, at present qualified experts in this sphere are nearly unavailable and it is necessary to train them, which requires for time and money [7, 8].

In addition, extraction of hard-to-recover hydrocarbons is accompanied by high risks. This is stipulated by the fact that at initial stage of scientific studies and implementation of new machinery and technology, they are not unified but experimental, suitable only for a certain deposit.

Some risks could be highlighted peculiar for the initial stage:

- uncertainty of energy policy at meso- and macro-level;
- growth containment of expenses as the main trend at companies of the industry;
- climate changes and environmental issues;
- unsteady prices and dependence on global markets;
- deficiency of qualified experts in the industry and scientific sphere;
- possible violations in deliveries due to vast territories;
- new difficulties of operational nature, including operation under unknown conditions (new risk);
- outdated infrastructure of companies of the industry;
- competition of new technologies, including alternative fuels.

Let us analyze the most important risks and their influence on extraction of hard-to-recover gas reserves. Geological risk is a consequence of occurring geological uncertainty since, at present, it is impossible to develop geological model of certain gas deposit, its effective seam, and surrounding water bearing basin with the required accuracy and details [7].

In order to develop geological model for large and unique gas deposits with the surface area of several thousand square kilometers, 30–50 exploration wells are drilled; however, geological cross sections are poorly correlated (especially when the structure of productive layer is complex) [9–11].

Preliminary seismic exploration is aimed at detection of structural forms of deposit seams; however, this does not allow to determine physical properties required for development of geological model: porosity, permeability, water saturation and gas saturation. These properties are determined by obtained cores from exploration wells. The consequences of the existing geological risks are technological risks. Therefore, it is required to estimate risks upon forecasting of production well capacities, this is especially important at final stage of deposit development.

It should be taken into account that during design of gas deposit estimation of risk of average well capacity is interrelated with:

- limited number of analyzed exploration wells;
- high scatter in well capacities.

Estimation of risks upon bulk watering of wells with seam and condensation waters takes place at final stage of deposit life cycle. Peculiar difficulty upon estimation of all risks is related with economic risks since it is very difficult to reveal and to analyze material and financial demands which appear at all stages of deposit lifecycle, especially at final stage [12–14].

During development of large gas deposit at final stage, it is required to take into account high consumption of material and financial resources. Therefore, several alternative projects are developed and then the most reasonable one is selected according to specific targeted criteria based on previously determined target.

As mentioned above, achievement of the formulated target requires for high consumptions of material, financial, human, information, and other resources. The leading aim of a project is provision of preset gas extraction regarding years of development. Nevertheless, it should be based on minimum consumption of resources: only in this case maximum profit can be received (which is another major purpose) [15, 16]. Application of risk management upon implementation of gas deposit project at final stage involves forecasting and implementation of a set of measures to decrease and to eliminate situations leading to damages and losses. The risk management is carried out in stages.

The first stage: detection of possible risks at all stages of development of gas deposit project, that is, identification of risks. The second stage: quantitative estimation of possible losses or damages in case of each risk event (development of gas deposit project is based on gas dynamic models for estimation of possible process variables in productive layer and economic mathematical models for prediction of possible material damage). The third stage: formation and development of measures to reduce and to prevent possible risk among the detected risks. The fourth stage: cost estimation of implementation of the developed measures and comparison with the cost of damages in each case of risk event.

Then the experts make final conclusions about application of these or those measures to reduce risks.

## RESULTS AND DISCUSSION

### Risk reduction actions at the final stage of gas deposit development

All actions to reduce risks always require for supplemental expenses. Therefore, a company faces the problem to detect the level of expenses for risk reduction, however, it should be taken into account that business activity of the company and its departments should remain efficient and profitable.

The risks during development of gas deposits as well as operation of all production facilities should be reduced as follows:

- provision of reliable operation of equipment at the deposit;
- development and improvement of control methods and tools for all production processes;
- development and implementation of CAD and management systems for development of gas deposits.

Application of modern machinery and technologies used for extraction of hard-to-recover gas reserves is unreasonable and, in some cases, impossible.

### Stages of work in the development of deposits with hard-to-recover gas reserves

Therefore, development of deposits with hard-to-recover gas reserves requires for two stages. The first stage is comprised of arrangement of test sites for R&D activity:

- analysis of geology of cross section, core, fluids;
- test extraction of gas;
- verification of processing of raw materials extracted by these new technologies.

The second stage is comprised of:

- scaling up of the performed studies and activities;
- improvement of the technologies according to demands and unique essence of each gas deposit.

Each new project will require for supplemental financial investments for performing R&D studies, arranging pilot sites for preliminary developments as well as testing trial gas extraction.

It should be mentioned that upon further development of gas deposit, the risks related with implementation of innovative technologies are stipulated by difficulties of capacity forecasts and continuous watering of wells, which influences significantly the economic constituent.

### Activities for rationalizing costs when developing fields with hard-to-recover gas reserves

Thus, in order to rationalize costs, at present it is necessary to perform a number of actions in a certain sequence:

- pilot tests using hydrodynamic simulator with consideration for various spatial disposition of wells and profiles of gas extraction in accordance with economic efficiency performances;
- additional 3D studies with development of 3D models at the area of at least 700 square kilometers [17, 15].

All activities should be performed in two years, thus eliminating numerous uncertainties, first of all, regarding geology. Herewith, the properties of deposits vary in significant ranges, which predetermines different expenses for gas extraction at each specific well.

## Determination of Hard-To-Recover Hydrocarbon Reserves

At present, the regulatory base of the Russian Federation does not define the notion of hard-to-recover hydrocarbon reserves. However, it should be mentioned that the existing scientific terminology clearly separates:

- reserves and resources;
- geological reserves and extractable reserves.

The Russian classification of reserves is based on the properties of hydrocarbon reserves used upon formation of United Nations Framework Classification:

- cost efficiency of field development;
- the degree of commercial development of the field;
- the degree of geological exploration of the deposit.

For the first time, the Russian classification of hydrocarbon reserves is supplemented by such notion as cost efficiency of deposit. Herewith, the criteria for groups of hydrocarbon reserves define not only commercial significance of the deposit but also the net present value determined by predicted indices of deposit development at fixed coefficients of discounting.

Thus, it is required to consider for the influence of various risks and uncertainty upon solution of weakly structured issues, including project development of any large has deposit, especially at final stage. This should be considered in management of various risks upon project development of gas deposit [7].

Therefore, hydrocarbon reserves can be considered as extractable, including hard-to-recover reserves, only when they are cost efficient upon extraction in competitive environment. Moreover, modern technical means and technologies of gas extraction should be used reasonably, complying with the requirements of protection of mineral resources and environment. The notion of hard-to-recover reserves is referred to deposits or developed sites characterized by unfavorable for gas extraction geological conditions and/or physical properties [18, 19].

Development of Cenomanian gas deposits in the north of West Siberia was based on step-wise commissioning of its individual sites determined by geological structure of deposit and asynchronous commissioning of facilities of integrated gas preparation. This circumstance stipulated heterogeneous lifting of gas water contact and heterogeneous distribution of seam pressure across deposits [20].

Herewith, the development of giant Cenomanian gas deposits in the north of West Siberia at present reaches its final stage, where the main negative factor influencing the coefficient of gas extraction is:

- watering of wells due to lifting of gas water contact;
- lateral penetration of marginal seam waters.

Increased watering of well products leads to formation of sand liquid plug at the bottom hole, hydrate formation, abrasive impact of sand on pipelines of casing connection and process equipment, which leads to unreasonable losses of formation energy. However, the main negative factor of penetration of formation water into the seam is pinching (formation of water barriers) of gas reserves. Only at Vyangurovo deposit, the pinched reserves, according to simulations, equal to 7.8 bln m<sup>3</sup> or 2% of initial reserves (Cenomanian deposit). After completion of deposit development using conventional methods of increase in gas recovery factor, the deposits will contain at least 1.5 tln m<sup>3</sup> of gas, and more than 500 bln m<sup>3</sup> of them will be low pressure gas in free state. This leads to decrease in final gas recovery, increase in development time, and, finally, to high material expenses for gas extraction. This factor stipulates deep analysis of motion of bottom waters, peculiarities and regulations of seam and well watering, mutual influx of liquids to bottom hole and studying of natural factors, promoting increase in waterless period of operation and improvement of technological conditions of deposit development aiming at the highest gas extraction [2].

## CONCLUSION

The most preferable project of deposit development at the final stage should be based on predictions by criteria of economic efficiency both for the company and its single departments. However, the results of these predictions due to economic uncertainties at macro- and micro levels are characterized by high risks and can exert negative impact on selection of project alternatives. The effect of measures to decrease in risks upon development of gas deposits and operation of production facilities can be expressed by decrease in risk probability on the basis of:

- provision of reliability of facility operation (in particular, backing up of number of wells and field devices);
- implementation of methods and tools of control of production processes upon development of gas field at final stage;
- development and implementation of CAD and control systems of gas deposits.

It is impossible to eliminate completely occurrence of risks, since it requires for high resource investments (material, human, economic) for acquisition of additional information and execution of analytical studies. Additional influence is caused by impossibility to forecast reliably future state of deposit and ambient environment (for instance, long-term economic situation in the world, probability of new sanctions).

Therefore, the analysis of issues of development of hard-to-recover gas reserves under conditions of market economy and provision of respective substantiated concept based on generalization of Russian and foreign experience are important and promising.

#### CONFLICT OF INTEREST

There is no conflict of interest.

#### ACKNOWLEDGEMENTS

None.

#### FINANCIAL DISCLOSURE

None.

### REFERENCES #

- [1] Vasil'ev YuN, Dubina NI. [2011] System approach and methods of system analysis upon design and development of gas deposits. Nedra, Moscow.
- [2] Abdulin RS, et al. [2015] Technogenic risks upon production and transportation of hydrocarbons in Russian Polar Regions. Problemy sbora, podgotovki i transporta nefi i nefteproduktov. 1(99): 84-93.
- [3] Vaganov YuV, Kustyshev AV. [2016] Estimation of economic efficiency of complicated maintenance of gas wells under varying operation conditions. Problemy ekonomiki i upravleniya neftegazovym kompleksom. 1: 13-16
- [4] Vaganov YuV, et al. [2010] Improvement of maintenance in oil and gas wells of West Siberia. Stroitel'stvo neftyanykh i gazovyykh skvazhin na sushe i na more. 8: 19-21.
- [5] Vaganov YuV, et al. [2009] Estimation of construction quality of development wells in East Siberia. Tyumen: Oil and gas of West Siberia. Proceedings, International Conference devoted to 50-year anniversary of TyumII., TyumGNGU: 7-10.
- [6] Ermilov OM et al. [2004] Features of geological structure and development of unique gas deposit at Far North of West Siberia. Russian Academy of Sciences, Siberian Branch, Novosibirsk.
- [7] Vasil'ev YuN, et al. [2013] Uncertainties and risks upon design and management of gas deposit development. Vesti gazovoi nauki: Collection of works: Gazprom VNIIGAZ. 4(20): 16-29
- [8] Kossov VV, Livshits VN, Shakhnazarov AG. (Eds.) [2000] Recommendations for efficiency estimation of investment projects. – 2-nd edition. Ministry of economy of the Russian Federation, National Committee for construction, architecture, and housing policy. Ekonomika, Moscow.
- [9] Peaceman DW. [1978] Interpretation of Well block Pressures in Numerical Reservoir Simulation. SPEJ; Trans. AIME.
- [10] Peaceman DW. [1983] Interpretation of Well block Pressures in Numerical Reservoir Simulation With Non square Grid blocks and Anisotropic Permeability, SPEJ, 23 (03): 531–543.
- [11] Peaceman DW. Interpretation of Wellblock Pressures in Numerical Reservoir Simulation - Part 3: Some Additional Well Geometries. paper SPE 16976 presented at the 1987 SPE Annual Technical Conference and Exhibition, Dallas, 27-30.
- [12] Ertekin T, Adewumi MA. [1995] Reservoir Simulation, Video Library for E&P Specialists, Intl. Human Resources Development Corp., Boston, Massachusetts, USA
- [13] Vaganov YuV, et al. [2017] Geological Aspects of Producing Reserves from Complex Gas Deposits. International Journal of Applied Engineering Research. 12(24): 16077-16082
- [14] Phillips JL. [1984] Reservoir Simulation Technology-Results of a Survey, Proc., Boeing Computer Services Spring 1984 Colloquium for the Geosciences, Houston, USA.
- [15] Kustyshev AV, et al. [2014] Estimation of environmental risks upon major overhaul and retrofitting of oil and gas wells]. Zashchita okruzhayushchei sredy v neftegazovom komplekse. 5:25-29.
- [16] Emmanuel AS, Ranney JC. [1981] Studies of Offshore Reservoir With an Interfaced Reservoir/Piping Network Simulator. J Pet Technol 33 (03): 399–406.
- [17] Kustyshev AV, et al. [2013] Estimation of risks upon maintenance of oil and gas wells. Bezopasnost' truda v promyshlennosti. 9:76-82.
- [18] Nezhdanov AA, Turenkov NA. [2005] Modern geological and geophysical models of giant deposits of north regions of West Siberia. Gornye vedomosti. 3: 58-68.
- [19] Oyewole A, Kelkar M, Pereyra E. [2018] Well performance modeling in unconventional oil and gas wells. SPE Annual Technical Conference and Exhibition 2018. Dallas, Texas, USA.
- [20] Barbe JA. [1983] Reservoir Management at Dunlin. J Pet Technol 35 (01): 227–233.

*#English translations of the references are presented.*

## ARTICLE

# MANAGING CROSS-CULTURAL COMMUNICATION IN THE CONTEXT OF DIGITALIZATION

Elena Viktorovna Moshnyaga<sup>1\*</sup>, Liudmila Sergeevna Kryukova<sup>2</sup>, Ilona Vitalievna Chernaya<sup>3</sup>,  
Elena Yurievna Orlova<sup>3</sup>, Maksim Georgievich Chardymskiy<sup>4</sup>

<sup>1</sup>Higher School of Economics, 20, Myasnitskaya Street, Moscow, 101000, RUSSIA

<sup>2</sup>Military University, 14, Bolshaya Sadovaya Street, Moscow, 125047, RUSSIA

<sup>3</sup>Moscow Polytechnic University, 38, Bolshaya Semenovskaya Street, Moscow, 107023, RUSSIA

<sup>4</sup>Russian State Social University, 4, Vilhelm Pieck Street, Moscow, 129226, RUSSIA

## ABSTRACT

The article deals with the formation of approaches to managing cross-cultural communication in the context of digitalization. It is established that cultural digitalization means a crisis of institutions and a loss of their own space in the social sphere. It is proved that cultural identity destroys the processes that are interconnected with digitalization in the cultural sector since the cultural identity of a person belonging to a certain community is implemented primarily through the formation of norms, ideas, values, and behavior patterns that form this identity. It is revealed that the ecological crisis, digital and demographic explosions, unprecedented social and financial turmoil around the world lead to an increase in uncertainty and unsustainability, and change a person's idea of the purpose and meaning of his/her existence. It is determined that one of the features of cross-cultural communication in the context of digitalization is the appeal to the knowledge of self-organization mechanisms of complex evolutionary and super complex systems.

## INTRODUCTION

The relevance of the study of cross-cultural communication is due to its exceptional importance in the development of human civilization as a guarantor of the existence of the cultures as they are. As such, cross-cultural communication is scientific ethics attempting to develop scientific methods to improve mutual understanding and intercultural exchange. One of the reasons for the interest in cross-cultural communication is the development of human civilization, internationalization, globalization, and digitalization. Besides, cross-cultural communication involves communication among representatives of different cultures and peoples and is aimed at expanding cultural contacts in the context of digitalization. As a social phenomenon, it is characterized by many qualities and dynamism, and therefore culture is considered as a generic concept, while cultural contacts take various forms, which are expressed in complementarity and dialogue. At the same time, cross-cultural communication is an indicator of the development of culture in the society: on the one hand, it reveals its ability to perceive foreign cultural elements and generate new forms for this socio-cultural organism on this basis; while on the other hand, it reveals its ability to translate its own values into other cultures.

The study of cross-cultural communication development issues is reflected in the works of Baimurzayeva [1], Belyakova [2], Vinokurova [3], Drach [4], Tarasyuk [5], Vorontsova [6], and others. The conducted research shows that scientists have made a significant contribution to the formation and development of cross-cultural communication. However, the implementation of a strategy for managing cross-cultural communication in the context of digitalization requires further meaningful study.

## METHODS

The theoretical and methodological basis of the research includes an abstract-logical method, methods of induction, deduction, analysis, synthesis, and systematization, used to justify the approach to the study of cross-cultural communication, as well as the graphic method employed to explore the level and trends in the parameters reflecting the development of cross-cultural communication in the context of digitalization.

The information base of the article includes statistical data of state bodies, legislative and regulatory documents governing the management of cross-cultural communication in the context of digitalization, approaches to regulating the system of interaction among the main participants of cross-cultural communication, as well as the results of scientific research [7- 9].

In the course of the research, it is planned to consider cross-cultural communication managing options in the context of digitalization, to justify the development paths of the cross-cultural communication system in order to confirm their development parameters in present-day conditions.

\*Corresponding Author  
Email:  
emoshnyaga@gmail.com

Received: 2 Nov 2020  
Accepted: 4 Dec 2020  
Published: 7 Dec 2020



## RESULTS

### The influence of digital culture on the functioning of social mechanisms

The practice has shown that cultural globalization is a process in which all countries and civilizations are involved not only as subjects but as objects. Initially, the cultural digitalization processes lead to the fact that public macro social relations of people go beyond the nation-state communities and acquire a transnational character. At that, digital culture involves customer-centricity, data-driven decision-making, collaboration, open communication, and digital thinking [Fig. 1].

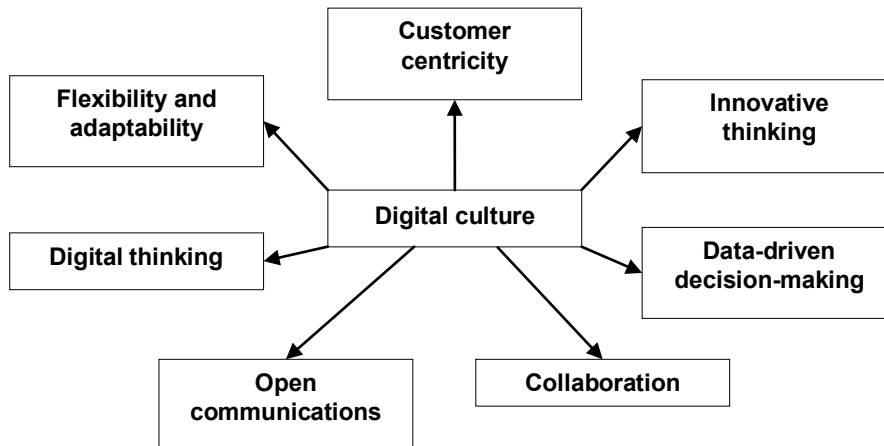


Fig. 1: Main aspects of digital culture in present-day conditions

Besides, digital culture weakens identification; along with digitalization, the structure of the basic principles on which states and societies were based, representing territorial fenced-off unities, is destroyed; new power and competitive relations are created, new conflicts and contradictions appear between nation-state unities and factors, on the one hand, and transnational factors, identities, social spaces, situations, and processes develop, on the other hand.

At the same time, digit-based culture means a crisis of institutions and the loss of their own space in the social sphere: personal life displaces public life and absorbs it (one of the manifestations of the process of individualization). As a result, the uncertainty and ambivalence of people's consciousness and social identity increase. Under these circumstances, cultural identity destroys the processes that are interconnected with digitalization in the cultural sector since the cultural identity of a person belonging to a certain community is implemented primarily through the formation of norms, ideas, values, and behavior patterns that form this identity.

At that, national minorities involved in the cultural globalization process, both elite and mass (for example, migrants) become carriers of not one, but two, or even more cultures. In this case, we acknowledge the formation of a new global cultural identity, or even a global spirit, referring to the standards of culture that are rapidly spreading throughout the world, and partial mixing of cultures makes it possible to form cultural families, which indicates a transition to wider cultural areas.

However, the imperative of contemporary digitalization is the interaction of cultures and civilizations. In this context, cross-cultural communication is developing as a complex social phenomenon that generates more and more contradictions. In this case, cross-cultural communication is one of the conditions for exchanging spiritual values among people, and in each new generation, a human becomes a personality only as a result of mastering the entire cultural wealth of humanity.

A number of outstanding scientists participated in the development of the concept of cross-cultural communication. A characteristic feature of this process is the growing role of cross-cultural communication as an objective factor, which has objectively led to an increase in scientific and practical interest in the study of problems of cross-cultural communication which is developing in the context of digitalization and puts forward the task of deploying scientific research on this issue.

This pattern has acquired signs of a priority trend of cultural digitalization in the context of the comprehensive development of ethnic groups, the growth of national identity and the role of the national idea, as well as the search for ways to optimize ethnic identity in the context of new trends in a multicultural society. Against this background, the study of cross-cultural communication problems in the context of digitalization, overcoming conflicting ethnicity, new problems of a multicultural society, migration, and immigration processes, strengthening the role of a nation-state, shows that cross-cultural communication is one of the determining factors. The development of modern science actualizes the study of cross-cultural existence among the cultural realities of digitization, understanding the deep conflicts,

contradictions, and problems in the ethno national sphere, the search for optimal models of society modernization and development. Preservation of self-identity and identity of ethnic groups and national minorities and the implementation of creativity and self-determination of the social subject in the context of digitalization take place in the framework of cross-cultural communication which is an important factor that gives personality rootedness in the life of a nation, or ethnic group, defining cross-cultural communication as the main trend in the contemporary development of mankind.

**The concept and approaches of cross-cultural communication**

In this regard, the need for the social analysis of cross-cultural communication as an important factor in the development of an individual is significantly actualized, and therefore, social analysis appears as a powerful factor in the consolidation of national existence and can find optimal forms of overcoming conflict-causing factors due to cross-cultural communication between peoples and civilizations.

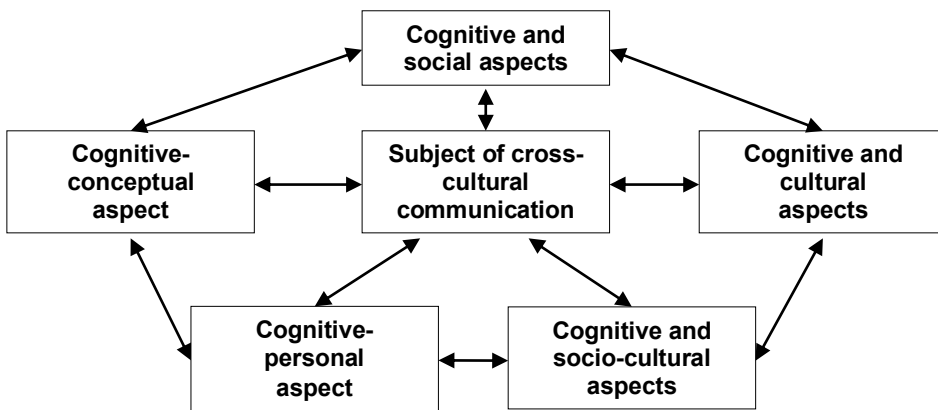
An attempt to generalize the interpretation of cross-cultural communication among the realities of cultural globalization leads to the conclusion that they are diverse and contradictory. Trying to cope with the inexhaustible complexity of cross-cultural communication in the context of globalization, society is faced with an urgent necessity to understand the essence of new digital trends, determine the place and role of the cross-communication factor, and find out the causes of new ideological problems that have arisen in a multicultural society.

Contemporary studies of cross-cultural communication adhere to Western scientific traditions in their approaches to this complex and contradictory phenomenon. They reflect the following research interests: 1) sociological (social, ethnic, and other factors of cross-cultural communication); 2) linguistic (language styles, language personality, the effectiveness of cross-cultural communication); 3) psychological (psychological and emotional components of cross-cultural communication, value orientations and motivations).

The research made it possible to introduce the concept of "integral field of culture", which allows reducing all facets of the axiological aspect of human social activity to a single whole. An informational and semiotic approach to cross-cultural communication is also being developed. At the same time, digital analysis of cultural processes has allowed us to consider cultural phenomena as signs that carry certain meaning and information, and to build information models of cultural processes.

At that, cross-cultural communication gives rise to a new problem of cultural adaptation in the context of digitization, involves the cultural adaptation process of personality to the specific conditions of the cultural environment that defines certain characteristics of culture existence, the inner desire of the individual for improvement; active interaction with the cultural environment that determines human behavior; effective interaction of a human with the ethno cultural environment; as well as the result of the interaction in the system of "human - cultural environment".

Research within the framework of cross-cultural communication focuses on the problems of cross-cultural differences in the context of digitalization, analysis of the relationship between them, and the characteristic behavior of culture bearers. As such, the problems of culture and personality, the emergence of the so-called competence model of the cross-cultural communication subject serve the basis for cross-cultural research [Fig. 2].



**Fig. 2:** Competence-based model of the subject of cross-cultural communication

Studies exploring cross-cultural differences usually include three approaches to the analysis of cross-cultural communication: 1) the first approach is based on the classical positivist methodology of subject-object relations, represented by the concept of structural functionalism, the system-based method, and the concept of digital society; 2) the second approach is based on the methodological framework which is built upon the cognitive model of subject-object relations, in which the communications sphere is

distinguished as a special ontological object; 3) the third approach reduces the nature of the social aspect to subjective-objective relations, that is, to the principle of inter subjectivity and excludes objectivity.

In the framework of the present study, society is considered as a network of communications that create an opportunity for self-description of society and its self-reproduction, and appear as an active self-organized environment. Such an analysis of communication brings it to the scientific level and gives it a digital role. One of the reasons for the interest in cross-cultural communication is the development of human civilization, internationalization, and digitalization.

Practice has shown that the ongoing geopolitical changes will experience a balance among the nation, territory, and state, a balance that is recognized and ensured mainly by national systems. At that, the scientific hypothesis includes the presence of structural and functional links and interdependencies between culture and civilization, culture and communication, communication and interaction; and allows us to consider cross-cultural communication as a social phenomenon in the context of digitalization. Besides, cross-cultural communication provides interaction between subsystems of culture within the society, individuals within the same culture, or at the level of cross-cultural communication, as well as between different and time transgressive cultures. In the course of cross-cultural communication, the cross-cultural experience is transmitted, as well as interacting subjects change, and new personal qualities are formed.

As the community develops globally, cross-cultural communication is also developing, which is reflected in the growing importance of common achievements in digitalization for humanity. Cross-cultural communication appears as a dialectical-synergetic process in which various vectors (integration-differentiation-universalization-particularization-conflicts-cooperation) do not exclude but complement each other.

The cross-cultural communication dynamics is considered as a process of continuous development, improvement of the cross-cultural interaction quality, growth of relationships in various spheres of social life and at different levels (the civilizational, national, intergroup, and interpersonal ones). In each case, putting forward the goal of achieving and expanding mutual understanding, the possibility of inversion, that is, the degradation of relations, is also taken into account. It is not excluded that with the emergence of new factors and impulses for interaction and communication, mutual understanding is still deepening.

At the same time, contemporary conditions of digitalization give rise to many problems of cross-cultural communication in contemporary society, caused by the contradictions between the global and the local, the universal and the individual. The digital system is getting tighter based on the integration of economic, political, technological, and information systems. Increasing digitalization leads to an increase in cultural identity. This process forms a conglomerate of interacting cultural social media, different in their history, traditions, language, and religion.

### Cultural adaptation in the context of cross-cultural communication

The reliability of the presented approaches is confirmed by the fact that cultural characteristics are less amenable to change than political and economic ones. It is ever more obvious that cross-cultural communication is becoming an important factor in regulating both: one's internal life and relations between peoples who need dialogue in the context of digitalization and globalization [10- 12].

At that, cultural adaptation in the context of cross-cultural communication involves cultural and psychological mechanisms that form stereotypes of cultural behavior and perception of a certain type of cultural communication, belonging to a certain ethno cultural group, and using the capabilities of a certain society in which digitalization processes take place.

Cultural adaptation is related to adjustment mechanisms, such as communication, values, norms, identification, traditions, folklore, education, religion, family, and kinship. The essence of cultural adaptation is manifested in ensuring the protection of the individual in the situation of the information space, in the influence of the socio-cultural environment on the individual in a constantly changing digital society.

Therefore, the digital model provides support for the ethnic identity by restoring ethnic culture, which is a symbol of this ethnic group; ensuring the integration of the ethnic group into the new socio-cultural, socio-political, and economic conditions; developing the necessary cultural customs, taking into account the specifics of the development of a particular ethnic group. At the same time, cultural adaptation is based on the principle of similarity of attitudes and behavioral patterns that arise in the course of digital development.

Cultural adaptation occurs in the context of a particular ethnic group, which is a type of cultural community determined by the historical and symbolic-cultural attributes of the ethnic identity. As such, the synergetic methodology for analyzing the management of social processes in the context of digitalization is reduced to rational explaining the laws and principles of organizing social life and joint life of people in the contemporary society; achieving stability in the society which is characterized by constantly occurring crises, transformations or reforms that shake the society in a vortex of permanent social changes.

## CONCLUSION

Summing up, it can be noted that the analysis of social management as a complex social whole involves the use of the conceptual construct and methodological tools of synergetic as a scientific research paradigm. At that, the environmental crisis, digital and demographic explosions, unprecedented social and financial turmoil around the world, the intense transformation of public institutions, and the entire socio-cultural environment lead to an increase in uncertainty and unsustainability, as well as change a person's idea of the purpose and meaning of their existence in the context of digitization.

Therefore, one of the features of cross-cultural communication in the context of digitalization is to address the knowledge of the mechanisms of self-organization of complex evolutionary and super complex systems which are in a condition far from equilibrium, when their sensitivity to minor fluctuations at the micro level increases, leading to changes in the behavior of the entire macro system. In this case, the destruction of the dynamic balance of cross-cultural communication structures and subsystems, the entry into a phase of the crisis in which unstable structures are subject to rapid disintegration, lead to a change in the scenario of digitalization processes.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES<sup>#</sup>

- [1] Baymurzayeva NZ. [2019] Cross-cultural communications: Issues of mainstreaming and development in the contemporary world. Transactions of the Kuban State Technical University. 2: 391-404.
- [2] Belyakova IG. [2019] Components of global cross cultural competence in the context of modern cross-cultural communication. Culture and Civilization. 9(4-1): 138-147.
- [3] Vinokurova MA, Vasilyeva NP. [2019] The role of cross-cultural communication in higher education. World of Science: Sociology, Philology, Cultural Studies. 10(4): 41.
- [4] Drach GV, Semina GV. [2019] Transformations of ethnic cultures in the globalized world: Main aspects of the problem. Bulletin of the Northern (Arctic) Federal University. Series: Humanities and Social Sciences. 1: 92-101.
- [5] Tarasyuk NA, Razdorskaya OV. [2019] Specifics of the contemporary language functioning in the context of globalization. Bulletin of the Southwest State University. Series: Linguistics and Pedagogy. 9(1(30)): 117-121.
- [6] Gil Martinez MA, Vorontsova YuV. [2020] Influence of cross-cultural communications on increasing business profitability in the context of using digital technologies. E-Management. 3(1): 27-35.
- [7] Golovetsky NYa, et al. [2019] Improvement of methodological approaches to financial analysis of fixed assets of the enterprise. Espacios. 40(34): 2.
- [8] Novolodskaya GI, et al. [2018] Public-private partnership as innovative form of attraction of financial resources in sphere of tourism. Journal of Environmental Management and Tourism. 9(4 (28)): 714-720.
- [9] Ogloblina EV, et al. [2020] Socio-economic consequences of digital development of the economy. Revista Inclusiones. 7: 421-430.
- [10] Agamirova E, et al. [2017] Methodology of estimation of quality of tourist product. Quality - Access to Success. 18(157): 82-84.
- [11] Lukiyanchuk IN, et al. [2020] Development of online retailing logistics flows in a globalized digital economy. Revista Inclusiones. 7(S2-1): 407-416.
- [12] Zavalko NA, et al. [2017] Methodical approaches to rating the quality of financial control at the enterprise. Quality - Access to Success. 18(161): 69-72.

<sup>#</sup>English translations of the references are presented.

## ARTICLE

# MANAGERIAL DECISION PROCESS CONCERNING DEVELOPMENT OF ENERGY-SAVING PROGRAMMES AT OIL AND GAS COMPANIES

Miroslava Gennadyevna Salko\*, Vera Vladimirovna Plenkina, Alexander Andreevich Zubarev, Olga Gennadyevna Yakunina

*Industrial University of Tyumen, Volodarsky's Street, 38, Tyumen, 625000, RUSSIA*

## ABSTRACT

The problems of energy saving at enterprises of the oil and gas complex require an effective managerial decision process concerning the efficient use of energy. High energy intensity levels in the oil and gas sector bring about the priority of optimising the use of fuel and energy for improved economic performance and competitiveness of the end product in the market. The paper substantiates the relevance of energy saving for industrial production in Russia, providing target references for bringing down energy intensity levels in the GDP and outlining the aspects of the state policy of energy efficiency until 2035. The authors propose a methodological approach for decision-making involved in the development of an enterprise-level energy-saving programme (ESP). The paper proposes to use management by objectives for optimising the content and performance of the ESP. Additional criteria for selecting efficiency proposals are recommended to help improve the energy efficiency of production. The proposed algorithm of development of the ESP based on management by objectives reflects the structural logical sequence of decision-making in the enterprise system of energy management. The authors confirm the significance of the scholarly definition by the conducted practical study of an enterprise of the oil and gas sector. The analysed fragment of an ESP and estimated calculations of its potential performance confirm the applicability of the proposed methods. The alignment of target references of oil and gas enterprises with their strategic objectives helps to identify the most promising solutions to energy efficiency problems in the sector as a whole.

## INTRODUCTION

**KEY WORDS**  
energy efficiency,  
managerial decisions,  
management by  
objectives, oil and gas  
enterprise.

The energy intensity of GDP in Russia is several times higher than the respective global average and the figures of other countries. The high energy intensity of the Russian economy weakens Russia's energy security and slows down economic growth [1]. The adoption of standards of well-being in Russia as in developed industrial economies amid the intensifying competition and depletion of material resources requires higher efficiency in the use of energy of all types [2]. The priorities of modernization and technological development of the Russian economy are energy efficiency and energy saving.

A key step toward a comprehensive solution of the energy efficiency problem was the adoption of several legislative acts and bylaws, as well as amendments and resolutions by the Government of the Russian Federation. The federal program of measures to raise energy efficiency was adopted, envisaging a reduction of energy intensity levels of the national GDP by 46% by 2035 under the best-case scenario [Fig. 1].

The Ministry of Economic Development of Russia developed four forward-looking scenarios of energy efficiency trends in the Russian economy depending on the robustness of the government's energy-saving and energy efficiency policies [3]:

- Scenario 1 – "conservation" of energy efficiency levels (as in 2016–2018);
- Scenario 2 – extrapolation of technology factor impact;
- Scenario 3 – modernisation of technological capabilities in the economy (progress in energy efficiency levels driven by the world's most advanced technologies by 2035);
- Scenario 4 – advanced modernisation (progress in energy efficiency levels driven by the world's most advanced technologies by 2035).

The Russian "Energy Industry Development" programme until 2024 charts reliable, quality and economically sound approaches to the provision of energy and material needs of the domestic market governed by the principles of energy saving and energy efficiency and honoring overseas contracts. Funding from the federal budget is systemically assigned for energy efficiency efforts in federal subjects of the Russian Federation and stimuli are developed for advancing the private funding market.

In terms of funding, the priority is set for projects at a pre-investment stage with a view to building conditions for attracting investment into the region. Government support measures are aimed at ensuring energy efficiency in the procurement of goods, works, services for providing government and municipal needs, improvement of requirements to energy-saving and energy efficiency programmers, higher energy efficiency levels, transformation of the system of energy surveys and adoption of energy consumption filings by public institutions, development of the state Energy Efficiency information system and others [3]. The extraction sector saw an increase in energy consumption by more than 10% over the past three years. In 2016, the decline in energy intensity levels was driven by the technology factor. The growth in energy consumption over the past two years was due to an increase in high-energy-intensity production [Fig. 2].

\*Corresponding Author  
Email:  
salko.m.g@mail.ru

Received: 1 Nov 2020  
Accepted: 3 Dec 2020  
Published: 8 Dec 2020

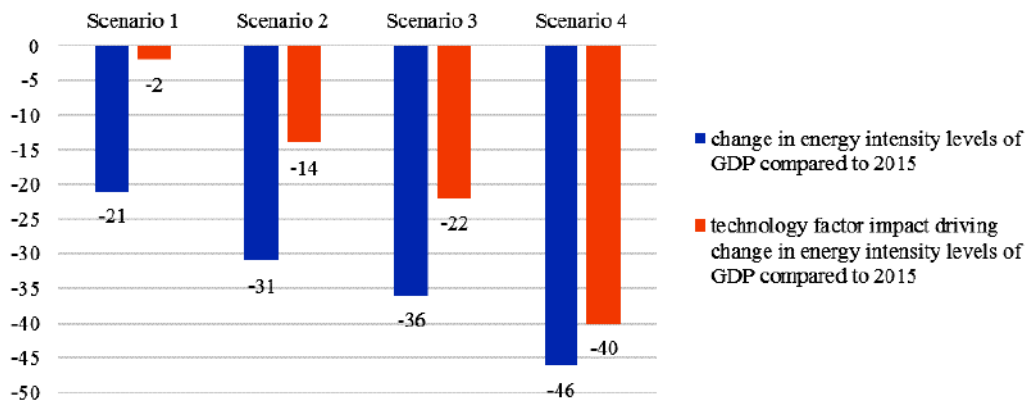


Fig. 1: Estimated reduction in energy intensity of Russian GDP, % [3]

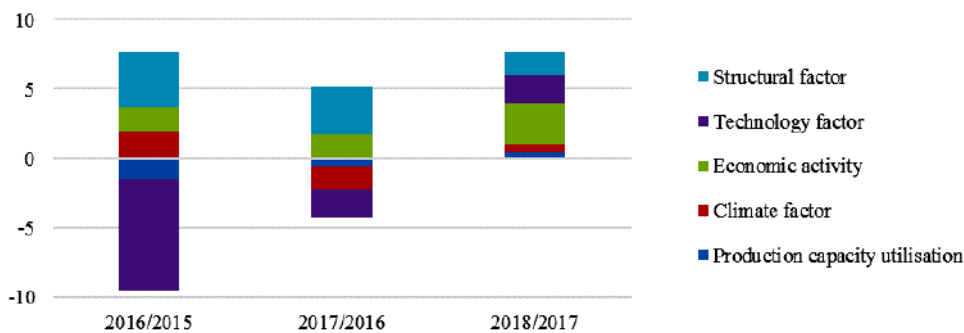


Fig. 2: Trends of factor impact on energy consumption in the extraction sector in the Russian Federation, millions of tons of oil equivalent [3]

The leaders of energy consumption growth in the extractive sector are oil and gas companies. In gas production, the growth in unit energy consumption is observed to grow by 5%, and in oil production, the figure is 1%. According to the biggest oil companies, the increase in energy consumption is mainly caused by technology and climate factors and higher costs of oil and gas extraction.

Overall, energy intensity levels of Russian GDP have by now declined by more than 12%. However, this figure significantly falls short of the target of 40% [3]. This proves the problem of energy efficiency is one of the priorities of government policies in Russia and substantiates the relevance of developing methodological approaches to managerial decision-making in the area for oil and gas companies.

### METHODS

Efficient decision-making is facilitated not only by setting straightforward objectives generating energy savings, i. e. the development and adoption of plans and programmes of energy efficiency measures, but also by tracking progress in the implementation of steps on saving energy resources. The founding principle of ESPs is to prioritise measures with optimal cost – effect ratios [4, 5]. However, the process of development of an ESP involves self-balancing and self-organisation, which provides for improved ultimate results in terms of "resources – energy efficiency" compared to the usual "cost-based" planning. Therefore, the following setbacks can be identified in ESP development:

- the system's scorecard does not include analysis or appraisal of labour efforts of the subjects of the energy efficiency programme [6, 7, 8];
- the limited scope of energy efficiency criteria for auxiliary production operations [9];
- uncertain analysis of energy-saving potential;
- incomplete analysis of innovative management engagement in energy-saving processes.

The authors' original methodological propositions are to use a systemic approach and programme-based management of enterprise-level energy savings through the acquisition of new knowledge and development of a new "product" to enhance and advance the energy efficiency programme structure. Management by objectives is based on the logical breakdown of several stages:

- i. Setting targets;
- ii. Development of a comprehensive programme;
- iii. Implementation and control of the developed programme.

The main aspect in management by objectives is the development of a hierarchical structure of programme elements to address the interim objectives aimed at the ultimate outcome [10]. Programme elements appear as a set of tools to achieve goals defined as specific measures and methods of their implementation. Another aspect of management by objectives is the possibility of adjustments to the established system of decision-making. The aspects of management by objectives in enterprise-level energy savings are as follows:

- determining the estimated forecast outcomes of ESP implementation and identifying inconsistencies with the set long-term plans and strategic objectives of the enterprise, which helps to set priorities in programme development;
- objective statement of the ESP comprises the line of the solution of the set problems with set deadlines and specific sets of action;
- analysis of resource requirements for energy-saving measures under a complex method taking into account the enterprise-level resource potential rather than individual divisions;
- priorities are assigned to measures based on the principle of maximum productive and economic effects and development of energy-saving potential;
- ESPs are not limited to meet the objectives of a single enterprise but seek to generate industry-level and cross-industry effects;
- every measure in the ESP is viewed as a local management object in the general organisational environment;
- energy efficiency measures can be excluded from the programme or rescheduled in case the enterprise's targets or priorities change.

The programming of the algorithm in the development and implementation of energy-saving measures should take into account several rules underlying the performance and functional aspects of management by objectives:

- i. development of the ESP structure and sequence taking into account national and industry trends of the Energy Strategy of Russia [11];
- ii. determining the procedure for justifying the planned measures of energy savings included in the programme;
- iii. development of the mechanism of implementation of energy-saving measures, scheduling procedure and appointment of responsible officials;
- iv. development of implementation performance criteria, including factor analysis of potential underperformance on targets across the stages of programme implementation;
- v. development of the algorithm of making adjustments to the programme in case of significant inconsistencies with the planned performance targets in the implemented measures.

The formal procedure of the above functions is rendered as an algorithm taking into account the targets, objectives and sequence of development and implementation of energy-saving measures, as well as the practice of oil and gas companies in running energy efficiency programmes [Fig. 3].

The planning of the ESP is based on determining the potential of energy saving in retrospective [12]. One of the main lines in structuring the programme is the alignment of coordination between energy-saving policy management and the industrial operations. The focus of running an energy-saving policy should be aligned with the main goal of the enterprise, i. e. ensuring reliable productive operations and economic potential in the industry [13].

The concept of an ESP focuses on identifying the aspects of its content and selecting the most flexible option of using energy resources in the context of enterprise operations [14]. Successful development and implementation of energy-saving measures are largely dependent on employees' commitment. Accordingly, the authors propose the following indicators as additional performance criteria for the ESP:

- i. employees' awareness of the ESP (understanding of the structural elements of the programme and currently implemented energy-saving measures, etc.);
- ii. loyalty to the programme measured as the percentage of employees approving it;
- iii. growth rate of efficiency proposals on energy saving (EP):

$$EP = \frac{V_0}{V_1} \cdot 100\% \quad (1)$$

where  $V_0$  and  $V_1$  are the number of efficiency proposals on energy saving in the base and reporting year, respectively;

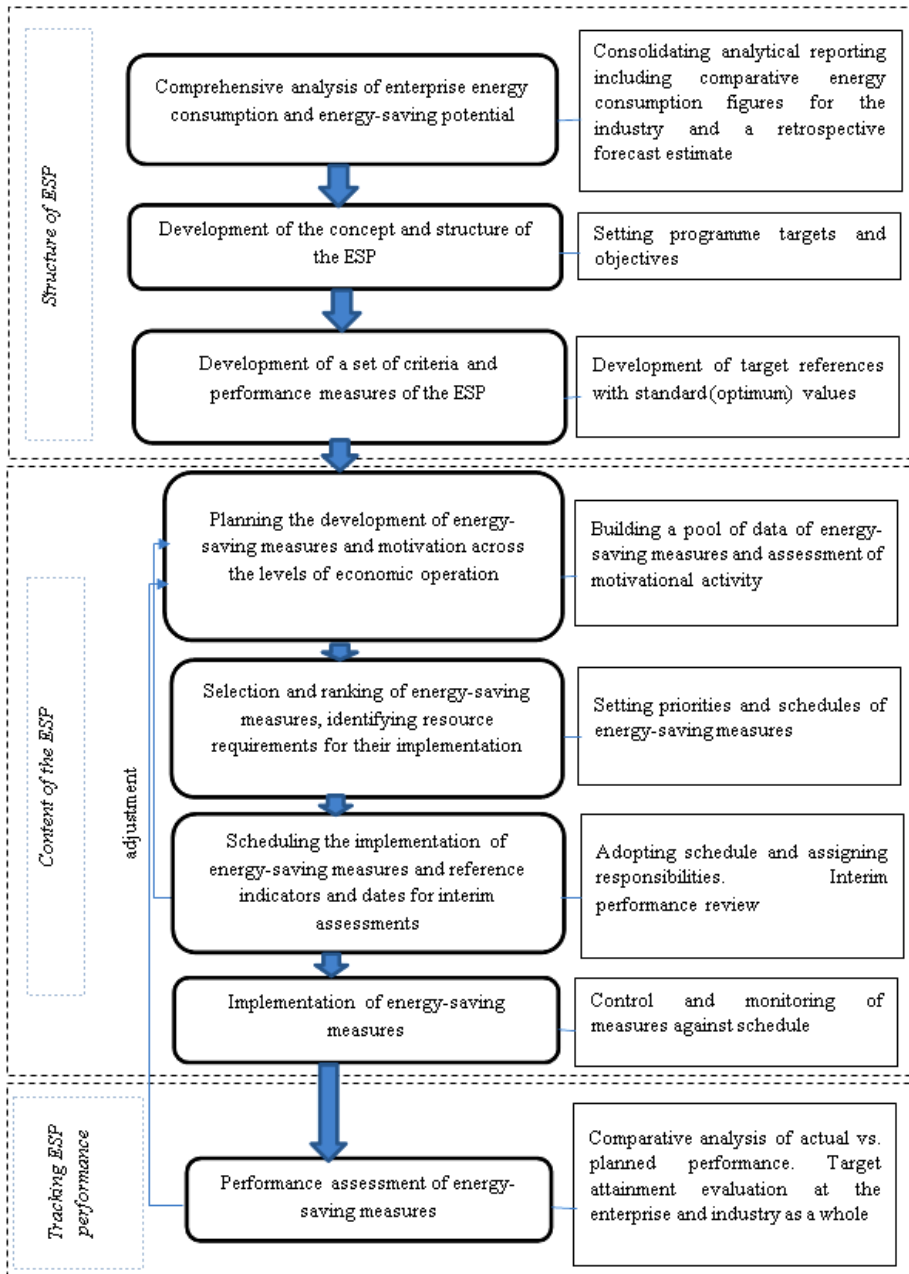


Fig. 3: Algorithm of development of ESP based on management by objectives

- share of efficiency proposals adapted in the ESP (EPad):

$$EP_{ad} = \frac{V_{ad}}{V_{total}} \cdot 100\% \quad (2)$$

where  $\overline{V_{total}}$  and  $\overline{V_{ad}}$  are the total efficiency proposals and approved efficiency proposals on energy saving, respectively.

Boosting the motivational activity of employees in the development and implementation of energy-saving measures involves the adoption of internal company regulations:

- regulations on incentives for energy saving including bonuses for employees based on their attainment of energy consumption reductions;
- introduction of fines for imprudent use of energy resources where standards are set.

Building a pool of measures provides the potential for choosing the most promising measures and ranking them by practicability and economic efficiency as follows [15]:



- i. zero-cost and low-cost measures implemented routinely as part of the current operation;
- ii. mid-size measures funded from local sources;
- iii. costly expensive measures requiring additional funding or investment and implemented with the use of loans and borrowings.

Scheduling of measures takes into account the selected programme scenario:

- i. all energy-saving measures are adopted simultaneously – this option is realised in case of optimistic forecasts and completely supported by the enterprise's internal funding;
- ii. lower-resource measures are prioritised before other measures with a higher level of resource requirements. The programme is implemented largely with borrowed funding;
- iii. most energy-saving measures are implemented with the use of both internal sources and liabilities.

Subject to changes in the scenario of the ESP due to force majeure, the schedule of implementation may be adjusted.

Control of the ESP is performed against the schedule and target attainment:

- i. investment size (capital expenditure);
- ii. annual energy-saving effects from the respective measure;
- iii. payback period for the measure;
- iv. energy efficiency of the measure: energy cost savings per 1 ruble of capital expenditure;
- v. cost savings on energy consumption (based on the applicable tariffs);
- vi. value-for-money coefficient:

$$C_{vfm} = \frac{C_{red}/100}{P_{meas}} \quad (3)$$

where Cred is the potential reduction in energy consumption, %, Pmeas is the price of the energy-saving measure (total cost), RUB;

- Other indicators characterizing the economic efficiency of the investment.

A comparative analysis of target attainment in energy-saving performance aims to identify potential reserves to improve efficiency and make adjustments in the future.

Managing the ESP by objectives opens the way for setting its role and place in the overall strategic domain for the Organisation, which results in improved efficiency in managing operations in general. Moreover, objective-driven programmes help to consolidate resources in the priority domains, which provides for high efficiency of the proposed methodological tools used for planning the ESP.

## RESULTS AND DISCUSSION

### Formation of a program of measures for energy saving of an oil pipeline transport enterprise

The above methodological proposals were tested for an enterprise in midstream oil operations. A central part of an ESP in the sector consists of analytical reporting on the trends and structure and forecast estimates of energy consumption to determine the energy-saving potential. The structure of energy consumption at the enterprise is laid out in [Fig. 4].



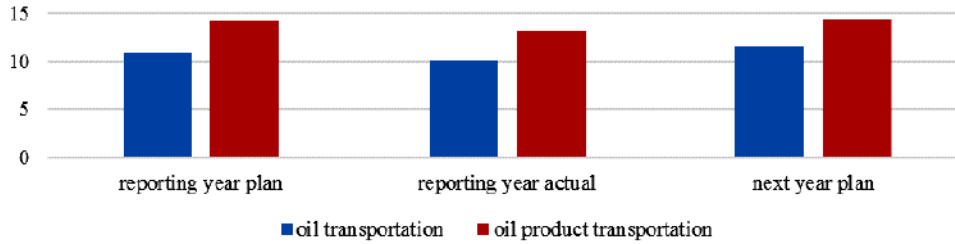
**Fig. 4:** Structure of energy consumption at a midstream oil enterprise in the reporting year, % (developed by the authors based on the enterprise's data)

The energy consumption structure by the types shows that the biggest energy-saving potential can be realised not in purchased electricity but fuel for internal use, specifically motor fuel for motor and special vehicles.

The target references for the midstream enterprise's energy-saving and energy efficiency programme are:

- reduction of unit electric energy consumption in transshipment, acceptance, handling and dispatching of oil and oil products;
- reduction of energy consumption for usage in serving local and technological needs in providing oil and oil product transportation services along trunk lines.

Last year's underperformance falling short of the targets of the ESP indicates that there is more room for raising the enterprise's energy potential [Fig. 5].



**Fig. 5:** Unit electric energy consumption under the ESP of the midstream oil enterprise

The programme block includes organizational and technical measures, a list of R&D efforts in energy saving and a list of priority objects in developing energy efficiency demonstration zones. The realization of employees' motivational activities is envisaged through the support of training and retraining in energy saving across the ranks and spreading the ideas of energy saving. Moreover, by integrating some regulations of the Energy-saving initiative in job descriptions across the ranks (primarily in the chief power engineer's department), the enterprise could improve the quality of the proposed measures.

Another proposition is to attach a separate addendum on energy saving to job descriptions relating to occupational, industrial and environmental safety.

The selection and ranking of efficiency proposals in energy saving submitted by employees for the planned period were conducted under the set criteria. A fragment of the ESP of the midstream oil and oil product enterprise is provided in [Table 1].

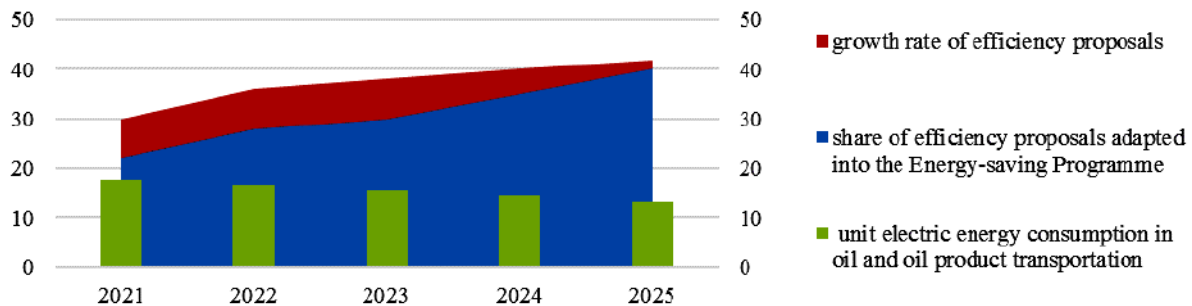
**Table 1:** Energy-saving action plan at the midstream oil enterprise (a fragment)

Measures	Funding size by the years, RUB million				
	2021	2022	2023	2024	2025
1. Pumping process optimisation:					
- modernisation of the pumping fleet for improved efficiencies	4.1	5.6	3.2	2.8	2.4
...	...	...	...	...	...
2. Energy savings in electric equipment:					
- application of digital synchronous motor field regulators	0.8	0.2	-	-	-
...	...	...	...	...	...
3. Process optimisation of oil storage:					
- equipping tanks with pontoons and floating roofs	1.2	1.9	-	-	0.4
...	...	...	...	...	...
4) Energy savings in heating energy generation:					
- modernisation of boiler equipment	0.4	2.2	2.4	1.8	1.1
...	...	...	...	...	...
5) Energy savings in heat and water supply systems:					
- adoption of high efficiency boilers	0.1	0.4	-	0.2	-
...	...	...	...	...	...
6) Energy savings in motor vehicle operations:					
- modernisation of vehicle fleet	2.4	2.9	4.0	3.8	1.2
...	...	...	...	...	...

The structure of the ESP includes technical and technological and organisational activities [16]. Each group includes subgroups of approved activities by the years and funding size. The amount of funding for each activity is substantiated by calculations of capital expenditures on their implementation and by indicators of the production programme, such as the amount of pumping of oil and oil products, operational capacity utilisation, construction and capital repairs of pipelines, reconstruction of pumping

stations and other operational capabilities, etc. The funding schedule is aligned with the cost budget of the midstream enterprise for several years.

The projected implementation of the measures taking into account employees' activity in putting forth efficiency proposals is shown in [Fig. 6].



**Fig. 6:** Projected implementation of energy-saving measures taking into account employees' activity at the midstream enterprise

The proposed ESP integrates several measures put forth by employees as ways to rationalise energy saving at the enterprise. This approach helped to identify the relationship between the amount of proposed and implemented measures and maximum efficiency of energy savings. The chart [Fig. 6] indicates growth in employees' activity and the number of efficiency proposals integrated into the ESP. Meanwhile, the target level of unit electric energy consumption shows a steady trend of decline, which confirms the practicability and significance of the authors' propositions.

#### Development of guidelines for the ESP formation

The authors' proposed algorithm of developing the ESP based on the method of management by objectives is rendered as a unified structure. The algorithm can be adapted by setting narrower objectives and functions in the decision-making system. The specifics of ESP development at oil and gas enterprises can be also identified across the stages of the algorithm. For example, the analysis of energy use can be extended beyond a single enterprise to the industry as a whole to assess the share of energy-saving potential of individual entities [17].

An important element of the programme for oil and gas enterprises is the development of the underlying concept given the dual nature of use and production of energy resources. The goals and objectives of ESPs for companies of the fuel and energy sector should take into account national and international balances of use and generation of energy [18].

Introducing the metrics of employees' engagement among the performance criteria of ESPs is the key element of raising social responsibility both in the organisation and society as a whole. An efficient motivation system in energy savings helps to broaden the range of efficiency proposals across the ranks of the production cycle. With the broad selection of energy-saving measures at hand, the company can select and systematise the most efficient ones by the lines of operation and provide for a complex outcome from their integration.

In the further development of the authors' propositions, there could be wider engagement in joint energy-saving initiatives between different industry structures committed to cost savings and adoption of renewable energy technologies. This approach is aimed at the rationalisation of the use of energy resources and the development of technologies for energy-generating operations [19, 20]. The priority is technologies with the best energy efficiency and environmental credentials.

## CONCLUSION

Improving the efficiency of managerial decision-making across the stages of such programme development would not only significantly contribute to lowering energy consumption levels but would help to improve the quality of solutions to the set problems.

The proposed approach to ESP development employing management by objectives would provide the following results:

- lower energy consumption levels across the operational cycle at oil and gas enterprises;
- justified implementation of energy-saving measures with maximum efficiency;
- objectivity and complex evaluation of the ESP for efficient decision-making in bringing down energy consumption;

- improved commitment and engagement of the employees as a result of modifications of motivational policies to use energy-efficient technologies;
- cost optimisation in ESPs as a result of the alignment of energy-saving measures with strategic priorities of oil and gas enterprises and the sector as a whole;
- quality planning system and timely implementation of energy-saving measures supported by target references and analytical performance indicators of the programme;
- improved efficiencies of energy-saving technologies providing for the rational use of resources and development of clean operations.

The practical significance of the proposed systemic approach to raising the efficiency of energy-saving processes is associated with the potential to uncover hidden reserves for more efficient use of fuel and energy resources. Steering energy savings toward strategic priorities of the oil and gas sector would provide for rational use of fuel and energy resources in the country and globally.

#### CONFLICT OF INTEREST

There is no conflict of interest.

#### ACKNOWLEDGEMENTS

None.

#### FINANCIAL DISCLOSURE

None.

### REFERENCES#

- [1] Glukhova MG, Zubarev AA. [2015]. Problems and ways to raise efficiency of energy-saving programme development at industrial operations in Russia. *Journal of Economy and entrepreneurship*, 6-2(59-2): 1087-1092.
- [2] Eltyshv DK, Khoroshev NI. [2014]. Systemic approach to development and implementation of energy-saving and energy efficiency programmes. *Fundamental research*, 5-4: 697-701.
- [3] Government report on the state of energy-saving and improvement of energy efficiency in the Russian Federation. [2019] Moscow: Ministry of Economic Development of the Russian Federation. 9(4):166-172.
- [4] Matiiashchuk VS. [2019]. Commentary on Federal law On Energy Conservation and Improving Energy Efficiency and Amendments to Certain Legislative Acts of the Russian Federation. Moscow.
- [5] Federal law "On Energy Conservation and Improving Energy Efficiency". [2012]. Moscow: Rid Grupp.
- [6] GOST 31531-2012 Energy conservation [2012]. Methods of assurance for energy efficiency indicators of energy consuming products to normative values. General requirements. Moscow.
- [7] GOST 31532-2012 Energy conservation. [2012] Energy efficiency. Composition of indicators. Basic concepts. Moscow.
- [8] GOST 31607-2012 Energy conservation. [2012] Regulatory and methodological principles. Basic concepts. Moscow.
- [9] GOST R 51749-2001. [2001] Energy conservation. Energy consuming equipment in general industrial application. Kinds. Types. Groups. Indicators of energy efficiency. Identification. Moscow.
- [10] Glukhova MG, Shumega VV. [2014] Managing by objectives as fundamental principle in developing energy-saving measures for midstream oil enterprises. *Innovation in managing regional and sectoral development, collection of scholarly papers*. Tyumen: TyumNGU (Tyumen State Oil and Gas University): 102-106.
- [11] Sviderskaya OV. [2016] Fundamentals of energy-saving. Moscow: TetraSistems.
- [12] Stefanov NG. [2009] Managing by objectives: theory and practice. Moscow.
- [13] Andronova IV. [2006] Managing by objectives in energy efficiency in oil and gas production sector of the economy. *Oil industry*, 9: 24-25.
- [14] Glukhova MG, Kartasheva AA. [2015] Enhancement of energy-saving programme of industrial enterprise. *Problems and trends of development of innovation economy: international and Russian practice, Materials of the Third international research and practical conference*. Ufa: Ufa State Petroleum Technological University: 123-125
- [15] Methodological recommendations on calculating the impact of energy-saving and energy efficiency efforts. [2016] Analytical Centre under the Government of the Russian Federation. Moscow: National Research University Moscow Power Engineering Institute.
- [16] Revel-Muroz P. [2015] Development of Energy-saving Technologies in Oil Pipeline Transportation. The International Committee for the History of Technology (ICOHTEC) 42 Annual meeting, IEEE-HISTELCON 4th meeting. Book of abstracts. Tel Aviv.
- [17] Methodological recommendations for governments in federal subjects of the Russian Federation on setting up energy-saving and energy efficiency efforts. [2019] Ministry of Economic Development of Russia. [Electronic source] Access mode: <http://docs.cntd.ru/document/560607531>
- [18] Frey D, et al. [2015] Measuring economic performance of energy savings. Theory and practice. Moscow: Teploenergetik.
- [19] Independent Evaluation Group. [2010] Energy Efficiency Finance: Assessing the Impact of IFC's China Utility-based Energy Efficiency Finance Program. IEG study series. Washington DC, USA.
- [20] Vreuls, H. [2005] International Energy Agency [IEA]. Evaluating Energy Efficiency Policy Measures & DSM Programmes.

#English translations of the references are presented.

## ARTICLE

# INFLUENCE OF UNIVERSITY ADVERTISING ACTIVITIES ON COMPETITIVENESS IN THE EDUCATIONAL SERVICES MARKET

Tat'yana Aleksandrovna Zamiralova<sup>1\*</sup>, Valeria Victorovna Sizikova<sup>2</sup>, Anastasia Vladimirovna Karpunina<sup>2</sup>, Yanina Vasilievna Shimanovskaya<sup>2</sup>, Angelina Anatolievna Kvitkovskaya<sup>2</sup>

<sup>1</sup>Omsk State Technical University, Prospect Mira, 11, Omsk, 644050, Russian Federation, RUSSIA

<sup>2</sup>Russian State Social University, Wilhelm Pieck Street, 4, bld.1, Moscow, 129226, Russian Federation, RUSSIA

## ABSTRACT

In the context of increased competition in the educational services market, in the process of discourse that is deployed in the educational environment of higher education in the field of quality, as well as an explicit struggle for state support, special attention of specialists is focused on creating a positive image of higher education institutions. The creation of a multidisciplinary educational platform for various segments of society can help increase interest in the services they provide. In this regard, one of the most important issues and the purpose of the research is to study the organization of university advertising activities. In the article, the authors, using the methods of analysis and synthesis of scientific literature, study the provisions of Russian legislation on advertising and scientific points of view on the stated problems. The authors determine that a significant part of the research concerning the topic does not fully reveal the importance of advertising campaigns, especially for universities financed from state budgets of all levels. The aforementioned allows the authors to effectively formulate their own vision of the content of this term with the isolation of its internal features. The key methods of advertising distribution are systematized, indicating the most effective ones in the field of higher education. The authors predetermine the need for the development of targeted advertising activities in accordance with the requirements of the modern educational environment, in a tough competition, especially among universities that offer training in identical areas, since this is where the importance of advertising becomes obvious. In the conclusion, conceptual recommendations are formulated for the formation of a positive image of a university, focusing on which, in practice, various departments of the university can receive positive results – attracting applicants and, consequently, increasing profits.

## INTRODUCTION

### KEY WORDS

advertising strategy,  
social networks, official  
website, promotion  
methods.

The modern sector of higher education is characterized by high competition, which causes the need not only to meet the requirements of the Russian Federal State Educational Standards but also to hold positions in both the national and international markets of educational services. This can be achieved only with the active use of external communications in functional activities. Unfortunately, their use is limited at the current stage of socio-economic development. This forms a certain problematic field since insufficient attention to advertising does not contribute to the stable and advanced development of a higher education institution and its success in the competition with other universities. Advertising is the engine for trade, including the sphere of educational services. That is why the urgency of considering the issues related to the organization of university advertising activities increases. Moreover, today, there are tremendous opportunities for a university to make it known, distribute information, and attract an audience.

First of all, it is important to define the notion of advertising activity and then analyze how it relates to higher education institutions. Analyzing the presented definition, one can define advertising as a set of activities aimed at drawing attention to the object of advertising, generating interest in it, and promoting it in the market. However, the presented definition is not universal. It reflects only some aspects of advertising activities. In the legislation of many European countries, there is neither a definition of “advertising activity”, nor a definition of “advertising”. However, in the scientific literature, the concept of “advertising” has the following meaning: it is one of the forms of communication with people, aimed at promoting sales of a certain product or service [1]. In other words, it is not any information transmitted through the established communication channels, but only information focused on drawing the audience's attention to the object of advertising. We can say that in Germany this concept has the same characteristics that are indicated in the legislation of the Russian Federation.

The analysis of the doctrinal definitions of the term by German scientists indicates that one of the main characteristics of advertising is the need to compare goods [2]. This allows delineating it from impersonal comparison and asserting its superiority. This means that an advertisement must mention two or more objects of the same category and compare their certain characteristics (attributes). The study by Yakovlev and Rangelova is of particular interest since it analyses creative advertising in the field of higher education based on the example of Russia and Bulgaria [3]. The scholars point out that a common feature for advertising activities carried out in the Russian Federation and Bulgaria is their image character. Moreover, this feature was formed during the socialist era. At that time, the educational service was not considered a good or an object to be purchased and sold. Despite this, brands of higher education institutions already existed. The fact is that even then, there was a competition between universities for resources provided by the state. Naturally, this could not but affect the formation of a positive image. Its creation directly influenced both the government, on which the funding depended entirely, and the applicants. Moreover, reports, submitted to the higher authorities, depended on the quality of the audience. To be chosen by the most capable and best-prepared students, a university had to make every

Received: 1 Nov 2020  
Accepted: 4 Dec 2020  
Published: 8 Dec 2020

\*Corresponding Author  
Email:  
zamiraloff.ta@yandex.ru

possible effort to create a favorable image. Today, the following methods of advertising can be distinguished: television advertising, radio advertising, advertising in newspapers and magazines, outdoor advertising, advertising in transport, Internet advertising.

In addition to the above-mentioned methods, Sankina [4] also mentioned public relations, organization and holding of various events, participation in thematic exhibitions, presentations, and fairs, as well as personal sales, which include counseling during the admission campaign and open days [5: 105]. Production of souvenirs with information about educational institutions is widely used (for example, notebooks, pens, flags, mugs, T-shirts, etc.). Selling souvenirs at open days and job fairs helps to achieve a positive effect in the form of attracting the target audience.

## RESULTS AND DISCUSSION

In modern conditions, higher education institutions try to attract not only Russian applicants but also people from other countries. For this purpose similar means are used, as well as the distribution of leaflets and flyers in the foreign embassies, national organizations of alumni, cultural centers, diasporas, etc. Posting information about a university, areas of its activities, faculties, etc. on social networks by foreign students and alumni has a positive effect [5].

Over the past 20 years, the methods of interacting with the target audience have changed a lot. In the 1990s, the entire university advertising was printed out and today, it is focused on Internet promotion. At the same time, over the past decade, university official websites have become popular, where anyone can get acquainted with the information about a university, its main mission, management, faculties, and other important areas of the institution's activities.

The tendency to use Internet university advertising exists both in Russia and abroad. The research by O.V. Smirnova analyses in detail the advertising activities carried out by the Polytechnic University of Milan [6]. To promote its services, the university actively uses not only its exclusive official website but also social networks, in particular Facebook, LinkedIn, YouTube, and VKontakte. All accounts are active, in other words, content is regularly updated that attracts the target audience, information is fresh and relevant, etc. This institution is very popular among Italian and foreign students, to a large extent, because the university pays particular attention to advertising.

As for Russia, cooperation with Chinese higher education institutions is of great strategic importance. According to the administration of the Peoples' Friendship University of Russia (RUDN University) office in the People's Republic of China, Russian universities do not use their capabilities to the full extent. Their advertising in China is extremely inactive [7]. In the context of high competition, this leads to the fact that Chinese applicants are reluctant to become students of Russian universities, which are no longer recognized at the international level. On the contrary, American and British universities actively promote their services and brands.

The organization of effective university advertising activities deserves special attention. For this purpose, Kaftandzhiev et al. suggest considering the following conceptual points [8]:

- to choose carefully the key means and methods of communication with potential consumers of educational services, which are not only school graduates, but also people who seek to receive additional vocational education, improve competence and acquire another qualification;
- to approach the content and wording creatively, taking into account country-specific and intercultural characteristics of potential applicants;
- to develop advertising campaign and choose marketing communications according to the analysis of the strengths and weaknesses of a particular university, assess its competitive advantages and potential not only in the regional but also international market and focus on attracting foreign students;
- to use the Internet, including social networks, in advertising activities.

## CONCLUSION

In modern socio-economic conditions, universities face a very difficult task. Spiritual, intellectual, and scientific development is completely impossible in a highly competitive environment without activating advertising, which allows one to respond to modern challenges of society, and being in the world rating system. University advertising, along with increasing the efficiency of the provision of educational services and improving their quality, is one of the necessary and priority directions of its functional activity. It should be taken into account that a higher education institution, especially located in a region remote from the federal center, is often a multifunctional organization that is a unique service meeting educational needs. At the same time, other higher education institutions may offer similar educational programs for potential consumers. Hence, the development of the advertising services market becomes a significant part of strengthening the competitiveness of an educational institution. Advertising is of particular importance during admission campaigns. In turn, the use of image advertising tools is one of the stable signs demonstrating the significant position of an educational institution in the region. Therefore, this direction needs to be considered in detail. This is due to the fact that based on the quality of advertising campaigns,

the image of a university depends on its position among competitors at the regional and international levels. The more potential applicants are interested in a particular educational institution and enter it, the more profit it will receive. Profit, in turn, is the key goal of any commercial organization in market conditions.

#### CONFLICT OF INTEREST

There is no conflict of interest.

#### ACKNOWLEDGEMENTS

None.

#### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] Leven W. [2013]. Advertising, in: Gabler Wirtschaftslexikon. Wiesbaden.
- [2] Rennhak C. [2001]. The Effect of Comparative Advertising. German University Publishing House. Springer.
- [3] Yakovlev LS, Rangelova TsS. [2016]. Prospects of creative advertising in the system of higher education (comparative analysis on the example of Russia and Bulgaria). The Bulletin of the Volga Region Institute of Administration. 4 (55): 26-33.
- [4] Sankina AS. [2016]. Analysis of advertising and communication activities of universities in St. Petersburg. Current problems of economics and management. 3(11): 104-108.
- [5] Poleshchuk EV. [2015]. Advertising and informational work of university as an increasing efficiency factor of educational work of foreign students. The Civil Aviation High Technologies. 94 (12): 60-65.
- [6] Smirnova OV. [2016]. Techniques of promoting universities in social networks (convergent media): foreign experience: master's thesis, program code: 42.04.01. St. Petersburg: Peter the Great St. Petersburg Polytechnic University.
- [7] Russia has lost its positions in the education market of the PRC but promises to return. Appendix to the informational digest: politics, education, universities. January 31, 2013. Retrieved from: <https://kpfu.ru/docs/F1568233250/130131pril.pdf>
- [8] Kaftandzhiev KhN, Kurmanbaeva ZhA, Shustova EP. [2018]. Universities' advertising and marketing communications: intercultural aspects. Bulletin of the Kazakh Humanitarian Law Innovative University. 3 (39): 108-118.

## ARTICLE

# IMPROVING THE EFFICIENCY OF INNOVATION DEVELOPMENT AND IMPLEMENTATION

Ivan Konstantinovich Andronchev\*, Maksim Alekseevich Garanin, Viktoriya Vladimirovna Bolgova, Vitaly Viktorovich Asabin, Andrey Aleksandrovich Bulatov

Samara State Transport University (SSTU), 2 V Svoboda Street, 443066, Samara, Russian Federation, RUSSIA

## ABSTRACT

In the existing ecosystem of creating and implementing innovations that is currently being formed in Russia, the leading role should belong to Universities, which should become centers for creating innovations and developing territories. To ensure this new role, universities need the transformation – they need to create new tools that provide the process of creating innovations. The article discusses modern management problems and proposes methods for solving them. At the stage of developing new technologies, the potential of the University is huge, but as the technology advances, the opportunities are reduced, since large investments are required and guarantees of subsequent returns are not always obvious. Businesses are interested in projects at the last stages of development, when the time to enter and get the effect is reduced. It turns out to be a kind of "valley of death" – the stage of creating innovations, when the University's capabilities are exhausted, and the business is not ready to finance the project. The purpose of the research is to improve the efficiency of development and implementation of innovations by universities. The article provides an overview of the current situation related to the implementation of scientific and innovative activities by universities, analyzes the University's capabilities and business interest in implementing the main elements of the "Science and innovation" business block, considers the problems of developing and implementing innovations, and offers a portfolio of mechanisms that allow generating and bringing ideas to the level of technological readiness required by business. As one of the mechanisms for solving the problem, it is proposed to create information and management crowdsourcing platforms, one of which is being created on the basis of the Samara State Transport University.

## INTRODUCTION

The existing problem of developing and implementing innovations by higher education institutions is that the University's ability to create innovations is usually limited to the levels of a prototype or technical solution, and the decision point to start business financing scheme responds to the prototype and design documentation. University's opportunities and business interests are of the opposite nature. At the very beginning of technology development, the University's capabilities are huge: collecting ideas, sifting them out, discussing them, and presenting them at conferences. As technology advances, opportunities are reduced, because large investments are required, and guarantees of subsequent returns are not always obvious. Business is interested in projects at the last stages of development, when the time to enter and get the effect is reduced. It turns out a kind of "valley of death" – the stage of creating innovations, when the University's capabilities are exhausted, and the business is not ready to finance the project [2, 5].

To overcome the "valley of death" (building a bridge) at the University, it is necessary to build mechanisms that allow generating and bringing ideas to the level of technological readiness demanded by business. The aim of the research is to improve the efficiency of development and implementation of innovations by universities. To achieve this goal, the following tasks have been set and solved:

- Review of the current situation related to the implementation of scientific and innovative activities by Universities.
- Analysis of the University's capabilities and business interest in the implementation of the main elements of the business block "Science and innovation".
- Consideration of the problem of development and implementation of innovations.
- Development of a portfolio of mechanisms that ensure the generation and delivery of ideas to the level of technological readiness required by the business.

## OVERVIEW OF CURRENT SITUATION

A large number of publications are devoted to research on the process of improving the University management system in the context of transformation. We can distinguish the following [1-7]. From the point of view of converting input flows into output, scientific and innovative activities are opposite to each other [Fig. 1]. Scientific activity is an activity aimed at obtaining new knowledge. The source of new knowledge is financial resources: budgetary and extra-budgetary. Innovation activity is an activity aimed at converting new knowledge into innovation, aimed at making a profit [2].

Scientific (research) activities – activities aimed at obtaining and applying new knowledge, including:

- basic (fundamental) scientific research – experimental or theoretical activity aimed at obtaining new knowledge about the basic laws of the structure, functioning and development of a person, society, and the environment;



- applied scientific research - research aimed primarily at applying new knowledge to achieve practical goals and solve specific problems;
- exploratory research - research aimed at obtaining new knowledge for the purpose of their subsequent practical application (oriented research) and (or) the application of new knowledge (applied research) and conducted by performing research works [2].

Innovation activity - activities (including scientific, technological, organizational, financial and commercial activities) aimed at implementation of innovative projects, as well as creating innovative infrastructure and ensuring its activities [2].

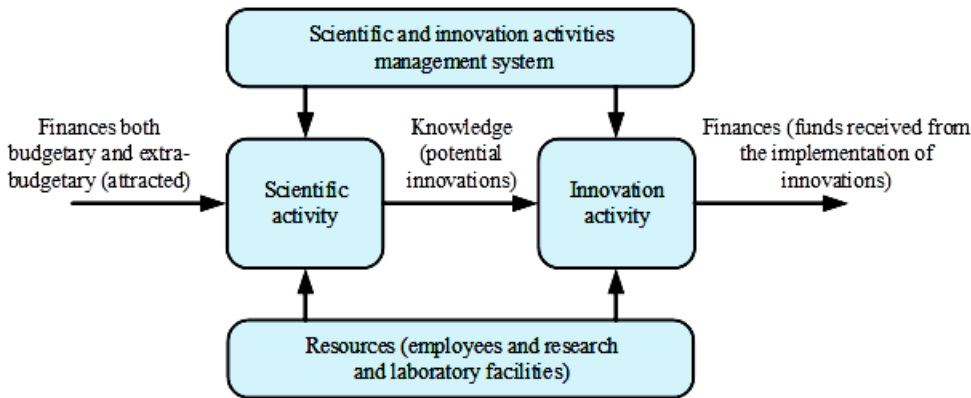


Fig. 1: Structural diagram of the business block "Science and innovation" [1]

We will analyze the University's capabilities and business interest in implementing the main elements of the "Science and innovation" business block [Fig. 2]. The University's capabilities decrease as the level of technological readiness of developments increases. On the contrary, business interest, and, consequently, the availability of funding, increases as the level of technological readiness of developments increases. This is because the risk of getting a ready-made development with a proven economic effect increases as the level of technological readiness increases. Thus, at the level of "Research work" (R & D), work should be financed primarily from the budget. To compensate for the lack of business funding, funds raised from various funds and grant-givers can be used.

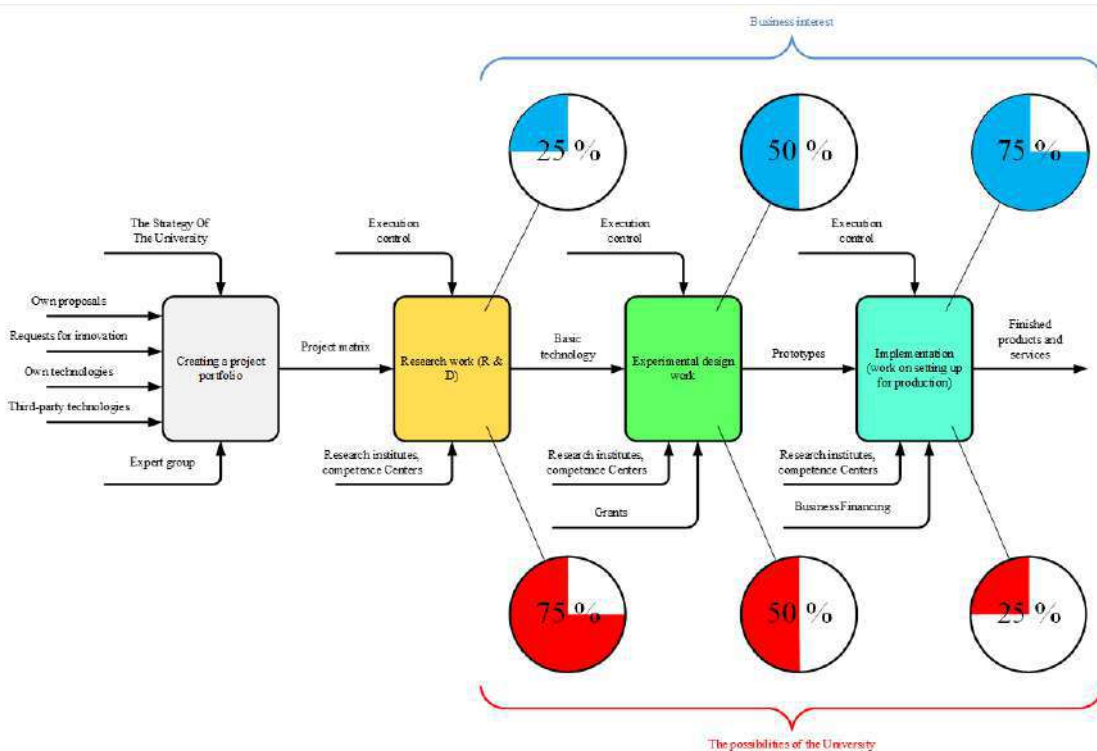


Fig. 2: Analysis of the University's capabilities and business interest in implementing the main elements of the "Science and innovation" business block [2].

As technology advances, opportunities are reduced, because large investments are required, and guarantees of subsequent returns are not always obvious. Business is interested in projects at the last stages of development, when the time to enter and get the effect is reduced [2].

### PROBLEMS OF INNOVATION DEVELOPMENT AND IMPLEMENTATION

The process of research and development of technologies (Research & Development) can be represented as levels of technological readiness (Technology Readiness Level, TRL): from the first to the ninth level. The result (product) at each level of technology readiness is [Table 1, Fig. 3].

**Table 1:** Result and amount of work at each of the TRL levels (developed by the author of the article as part of the research) [5]

TRL	Result and amount of work	Result and amount of work
1	Idea	Evaluating the impact of a new technology
2	Technical study, technological concept	Comparison of alternatives, choice of concept
3	Basic technology	Identification of key technology, risk assessment
4	Laboratory prototype, mathematical, physical model	Experimental verification in the laboratory
5	Design of units and modules	Testing the model in conditions close to real conditions
6	First prototype, similar to the expectations	Testing under simulated operating conditions
7	Pilot version	Experimental testing of the prototype
8	Final prototype, ready for pilot / small series (Pre-Production)	Field (factory) tests of a full-scale sample
9	Putting into production, launching a small series, commercialization	Operational testing of a full-scale sample

There are two approaches to the designation of stages of work performed: foreign and domestic (Russian approach).

The foreign approach uses the following terminology: TRL 1 – phase of basic research, TRL 2-4 – phase of technology development, TRL 5-6 – phase of technology demonstration, TRL 7-9 – phase of creating a new sample. Enlarged: TRL 1-4 – phase of scientific research and research, TRL 6-8 – pre-seed phase (Pre-Seed), TRL 9 – seed phase (Seed). The Russian approach uses the following terminology [Fig. 3]: TRL 1-3 – research work (R & D), TRL 4-6 – development work (R & D), TRL 7-9 – work on putting into production. TRL 1-6 – R & D (research and development work) is allocated in a larger way.

The existing problem is that the University's capabilities are usually limited to levels TRL 1-3, and the decision point on starting business financing corresponds to the end of the TRL 6 phase. This is shown schematically in [Fig. 3]: University opportunities and business interests are of the opposite nature. At the very beginning of technology development, the University's capabilities are huge: collecting ideas, sifting them out, discussing them, and presenting them at conferences (red curve). As technology advances, opportunities are reduced, because large investments are required, and guarantees of subsequent returns are not always obvious. For businesses, projects in the last stages of development are interesting, when the time to enter and get the effect is reduced (blue curve). The curves overlay shows the "valley of death". This phase is very conditional and in [Fig. 3] it is in stages TRL 4-6.

#### TIME TO "BUILD BRIDGES"

To overcome the "valley of death" (to "build bridges") at the University, it is necessary to build mechanisms [Fig. 4]: business incubation of projects - creating "hothouse" conditions for long-term project development (1-2 years); project acceleration - rapid development of projects to the necessary phase that is interesting for business (1-2 months); support for startups through a grant system; formation of techno-parks to attract research groups to their site for startup development; development of internal groups of techno brokers, etc. [2, 5].

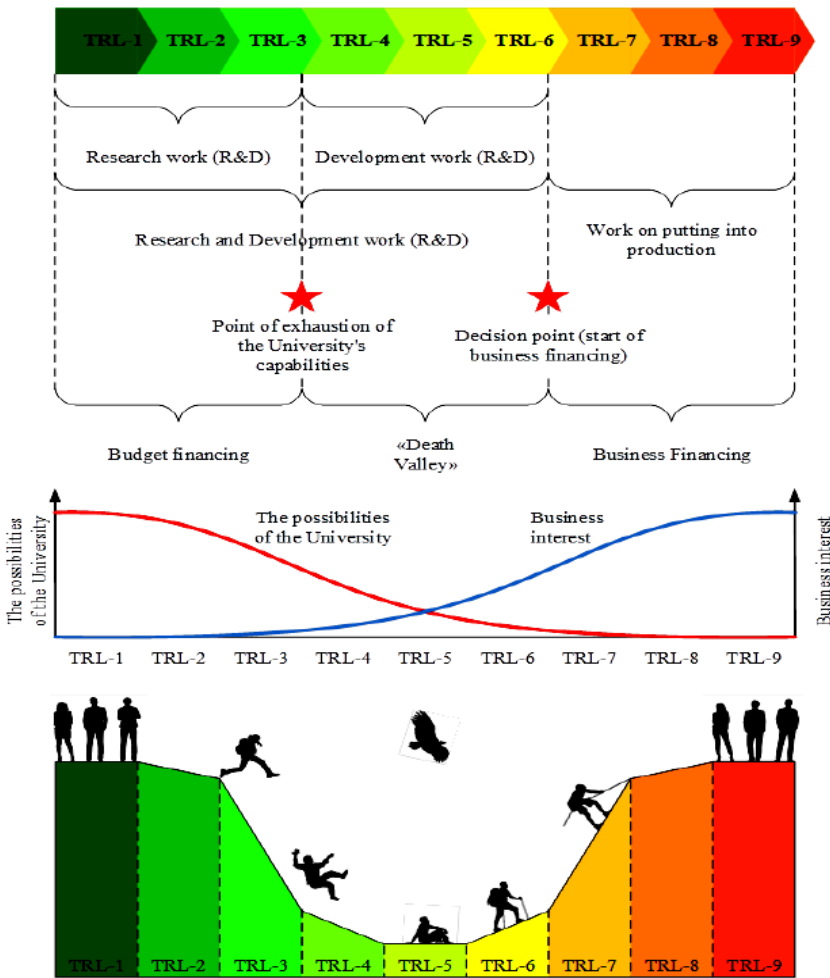


Fig. 3: levels of technological readiness [5]

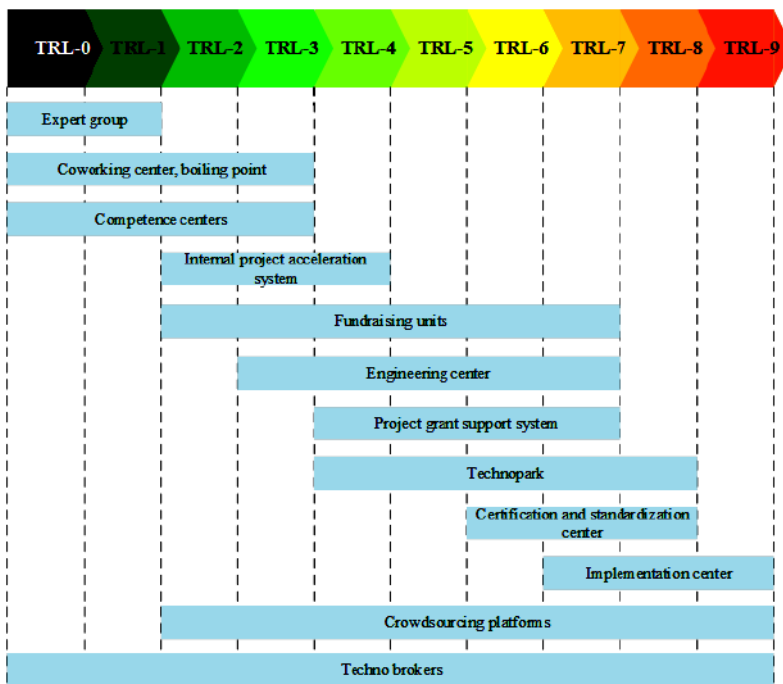


Fig. 4: Formation of mechanisms for overcoming the "Valley of death" (the author's drawing).

One of the mechanisms for solving the problem is the creation of information and management crowdsourcing platforms, one of which is being created on the basis of the Samara State Transport University. The unified inter sectoral information and management platform (hereinafter referred to as the Digital platform) is an automated information system with a set of digital services. Services are defined as the ability of customers (certain participants and partners) and competence centers to solve problems of developing and implementing innovations.

Digital platform objectives are: 1) expert and technical support for the effective work of railway equipment manufacturers, operating organizations and scientific organizations; 2) B2B solution for active market participants who do not have a clear idea of what set of technological operations will be required to perform their tasks and/or what the cost of these works is.

## CONCLUSION

The research is aimed at improving the efficiency of development and implementation of innovations by Universities. The considered mechanisms for overcoming the "valley of death" make it possible to ensure the effectiveness of the development and implementation of innovations. Mechanisms that support innovation at TRL levels 4-6 are of the greatest interest, since this is the most vulnerable phase of development. The creation of an information and management crowdsourcing platform, implemented by Samara State Transport University, will form an effective tool for bringing innovative solutions to the level of technological readiness that is in demand among businesses. In the future, such a platform can become a platform for supporting innovative solutions in the transport industry.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

The article was prepared as part of the state budget research work carried out by the Samara State Transport University in the direction of «Unified inter sectoral information and management platform "Science-production-operation" of railway equipment» in 2020 on the instructions of the Federal Agency for Railway Transport.

### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] Asabin VV, et al. [2019] "Blue Ocean" For A Higher School. Dilemas Contemporáneos: Educación, Política y Valores, 6:1-14
- [2] Garanin MA, Sandler DG. [2020] System of support for managerial decision-making at the University on the example of the group of processes "Science and innovation". Prospects of science and education. 3(45): 527-543.
- [3] Garanin MA. [2019] Industrial transport University - center of space for innovation and territorial development: monograph. Samara: SamGUPS.
- [4] Garanin MA. [2019] Model of University management as a center of competence development. Creative economics. 13(1): 183-194.
- [5] Garanin MA. [2019] Transformation of the University into the center of innovation implementation space. Voprosy innovatsionnoi ekonomiki. 9(3): 955-968.
- [6] Garanin MA. [2020] Institutional aspects of resource management of branch universities. Economics and entrepreneurship. 7(120):1150-1156.
- [7] Garanin MA. [2020] Model of interaction between the Ministry of science and higher education and the Ministry of transport in terms of personnel support for transport. Creative economics. 14(6):1055-1078.

## ARTICLE

# CROWDSOURCING PLATFORM FOR CREATING INNOVATIONS IN TRANSPORT INDUSTRY

Ivan Konstantinovich Andronchev\*, Maksim Alekseevich Garanin, Viktoriya Vladimirovna Bolgova, Vitaly Viktorovich Asabin, Andrey Aleksandrovich Bulatov

Samara State Transport University (SSTU), 2 V Svoboda Street, 443066, Samara, Russian Federation, RUSSIA

## ABSTRACT

Transport is the connecting link of the economy of any state. For its successful development, the transport industry must use the achievements of science and modern technologies. Nowadays, there are contradictions that do not allow us to use effectively the potential of transport Universities in the interests of the transport industry. The article is devoted to the development of a unified cross-industry information and management platform (digital platform) ensuring effective interaction between research teams of Universities and transport enterprises. The digital platform is a crowd sourcing platform designed to bring together customers and performers of scientific and innovative projects. The purpose of the study is to develop a digital platform that allows railway equipment manufacturers, operating and repair organizations to interact with industry universities in order to attract their scientific personnel to implement innovative developments to improve the reliability, resources and cost reduction at each stage of the creation, operation and maintenance of rolling stock. The article considers the existing contradictions of scientific and innovative work implemented by industry transport Universities of Russia, defines the tasks of the digital platform, defines the list of possible Roles of participants, forms a list of services and regulations for working in the digital platform, develops a structural diagram of the digital platform.

## INTRODUCTION

### KEY WORDS

Information platform,  
intersubjective reliability,  
interaction between  
business and science,  
creation of innovations,  
scientific personnel

Currently, the transport complex of the Russian Federation is a collection of companies providing Currently, the transport complex of the Russian Federation is a combination of enterprises that provide transportation services, logistics companies that operate transport services, transportation departments, transport agencies that regulate processes in the field of transport, manufacturers of transport equipment and transport infrastructure, and industry transport Universities that provide training and scientific research for transport. To date, the lack of a unified information system does not allow us to fully use the potential of industry transport Universities to solve industry problems, introduce innovative developments in the creation of new models of equipment, carrying out repair works, and use the potential of regional enterprises. Samara State Transport University is developing a single inter-industry information and management platform (hereinafter referred to as the "digital platform") with the participation of the Federal Agency for Railway Transport, State Transport Universities, enterprises of JSC "Russian Railways", large regional industrial enterprises with the possibility of accessing the system of third-party contractors and enterprises.

At its core, a digital platform is a crowdsourcing platform designed to bring together customers and performers of scientific and innovative projects. There is a wide variety of foreign crowdsourcing platforms [1-4]. Existing systems do not allow for the organization of interaction between railway equipment manufacturers, operating and repair organizations with industry universities in order to attract their scientific personnel to implement innovative developments to improve reliability, resource and reduce cost at each stage of creation, operation, and repair of rolling stock.

A small amount of research in our country has been devoted to creating crowdsourcing platforms. The works [5-11] are of interest for research. The purpose of the research is to develop a digital platform that allows railway equipment manufacturers, operating and repair organizations to interact with industry universities in order to attract their scientific personnel to implement innovative developments to improve reliability, resource and reduce cost at each stage of creation, operation, and repair of rolling stock. To achieve this goal, the following tasks were set and solved:

- Consider the contradictions of scientific and innovative work implemented by industry transport universities in Russia.
- Define the tasks of the digital platform.
- Define a list of possible Roles for participants.
- Create a list of services and regulations for working in the digital platform.
- Develop a block diagram of the digital platform.

\*Corresponding Author  
Email:  
iva194@mail.ru

The study used the methods of expert estimations, method of analysis and synthesis, numerical simulation. The object of research is an information system. The subject of the study is the interaction of participants of the process.

Received: 3 Nov 2020  
Accepted: 7 Dec 2020  
Published: 10 Dec 2020

## GENERAL REQUIREMENTS FOR A UNIFIED CROSS-INDUSTRY INFORMATION AND MANAGEMENT PLATFORM: SCIENCE-PRODUCTION-OPERATION

Let's consider the contradictions of scientific and innovative work carried out by industry transport Universities in Russia. During the long period of the late Soviet period 1970 – 1990 and the early Russian period 1990 – 2000, Universities received relatively easy funding for research activities. At the same time, the results of scientific work were not always translated into innovations in the sectors of the national economy. A significant part of the scientific work ended with reports that had no further implementation. The main performance indicators were: the scientific level of work, economic and technical effects, as well as the facts of obtaining documents on registration of intellectual property objects in the country and scientific publications. Funding was allocated mainly on a non-competitive basis. An important role was played by the authority of the heads of scientific schools and its relationship with employers who allocate funds for scientific work. There was practically no competition in scientific work.

At the beginning of the 21-st century, University science found itself in an unusual situation. The market economy gradually led to competition in scientific work. Almost all types of scientific work were distributed on a competitive basis. The main criteria for the effectiveness of scientific work included in the tender documentation are: achievement of targets and economic efficiency of scientific work. The target indicators were the effectiveness of the resulting innovations, such as: reducing customer costs, increasing labor productivity, increasing profits, etc. Such indicators as the level of scientific study of the topic, the number of scientific publications, etc., have ceased to be of value to the customer, since they are not the final result, but only an intermediate one. Personal connections no longer matter. In fact, the customer became less interested in scientific work. There is an increased interest in the end result – innovation.

Let's consider the current situation and the place of University science in the development and implementation of innovations. It can be schematically depicted in the diagram of [Fig. 1], where the abscissa scale shows the conditional level of scientific novelty of the work performed, and the scale of the results of the work is shown on the ordinate scale.

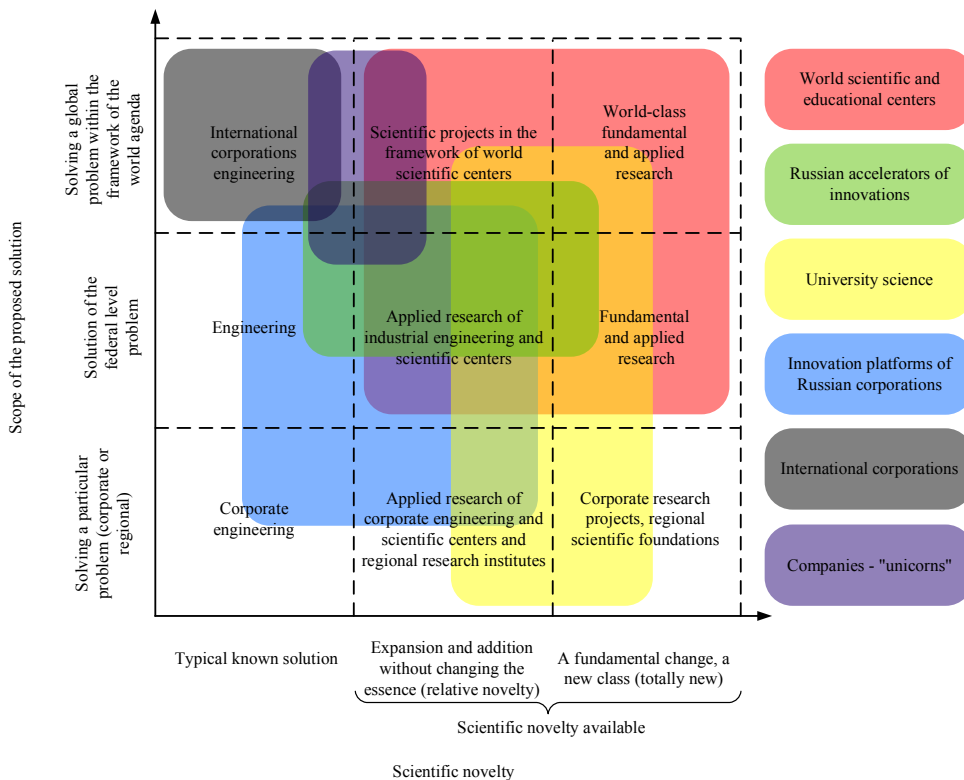


Fig. 1: Contradictions of scientific and innovative work implemented by universities (author's drawing).

[Fig. 1] shows the place occupied by participants in scientific and innovative work, among them: world-class scientific and education centers, Russian innovation accelerators, Universities (University science), innovation platforms of Russian corporations, international corporations and unicorn companies. Unicorn is a private company, a startup valued at \$1 billion or more. The term was first used in 2013 by well-known venture entrepreneur and founder of Cowboy Ventures, Eileen Lee, who chose this mythical animal as a vivid image to represent the statistical rarity of such successful companies.

[Fig. 1] shows the contradictions between scientific and innovative work implemented by universities. They can be formulated as follows:

- Lack of tools for creating innovations of the level of technological readiness required by business. Universities are able to bring most of the developments to the level of technological readiness that is not in demand for business.
- Low business interest in scientific work aimed at obtaining new knowledge used to create innovations. Funding for scientific work can be assumed by the state. And the financing of innovative activities can be assumed by business.
- World-class scientific and educational centers created in Russia are capable of occupying the niche of University science in the next 10-15 years. It is obvious that the most successful research and teaching staff can become the human resources of such centers.
- Innovation platforms of Russian corporations and Russian innovation accelerators on the one hand and Universities on the other have a rather narrow area of mutual interest. The reason is the low interest of Russian corporations in scientific work and, on the contrary, the high interest in innovations of a high level of technological readiness.

The digital platform being created is an automated information system with a set of digital services. The digital platform is a tool for improving the efficiency of scientific and innovative activities of transport Universities in Russia. The digital platform is based on the following main strategic documents: "Transport strategy of the Russian Federation for the period up to 2030"; "Strategy for scientific and technological development of the Russian Federation"; "Strategy for the development of railway transport of the Russian Federation until 2030" , etc.

The digital platform is considered as a complex of services available to all its main participants. Services are defined as the ability of certain participants and partners, described below as Roles, to solve specific tasks using the digital platform.

In addition to services, the interaction of the Competence Centers of the digital platform participants is supposed to be based on internal (existing for the participants of the digital platform) and external (regulatory framework of the digital platform) regulations that will create the most convenient conditions for working with the customer.

The first and key purpose of the digital platform is to provide expert and technical support for the effective work of railway equipment manufacturers, operating organizations, and scientific organizations. To do this, the platform must enable the digital platform management company to quickly configure the Competence Centers to ensure that the contract can be executed.

The second task of the platform is a B2B solution for active market participants who do not have a clear idea of what set of technological operations will be required to complete their task and/or what the cost of these works is. To do this, the platform should provide such customers with the possibility of online ordering, the formation of the best execution option for a number of parameters and a preliminary estimate of the final cost - a filter for selecting options.

The work of all elements of the system should be subject to a single Quality Management System. The Competence Centers of the digital platform are required to harmonize their business processes in accordance with the requirements of the Quality Management System.

The digital platform provides jobs for the following possible Roles of participants [Fig. 2]:

- Customer
- Competence Center
- Digital Platform Administrator

Participants of the digital platform interact, which is shown in the right part of the [Fig. 2]. Industry transport Universities form the configuration of their Competence Centers for the customer. The customer gets the most effective result due to the flexible configuration system of the contractor based on the existing Competence Centers and their competition among themselves.

The main effect of the digital platform is that the differentiation of the performer of scientific and innovative work is carried out not at the level of the organization (enterprise), but at a lower level of Competence Centers. This is possible thanks to agreements concluded between Universities. The agreements provide for a similar format of work. The principles described by the authors Garanin M. A. and Sandler D. O. are embedded in the digital platform [10, 11].

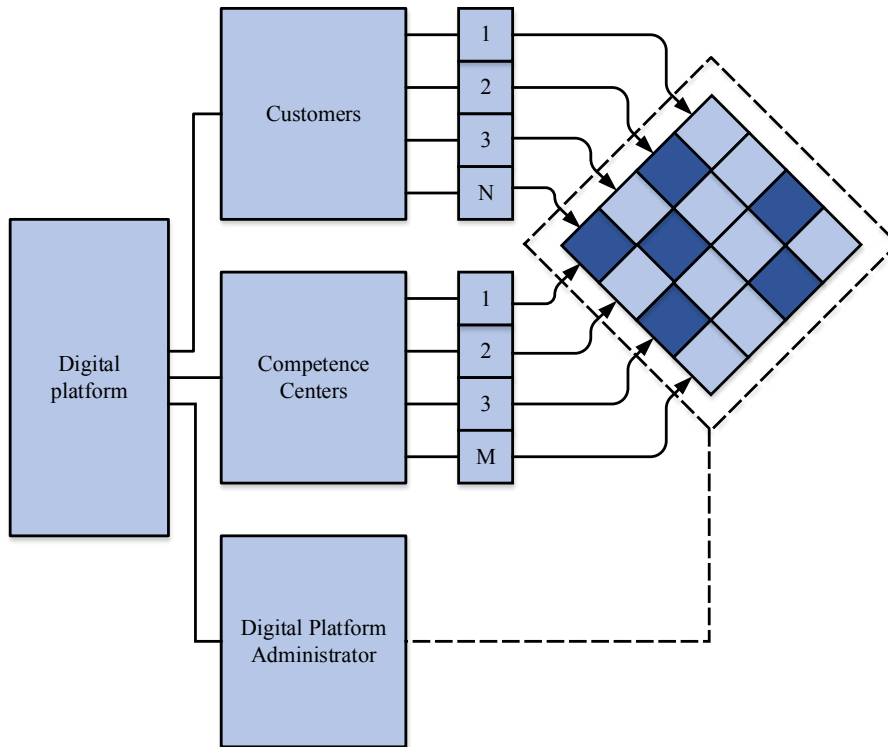


Fig. 2: Roles of digital platform participants (author's drawing)

### LIST OF SERVICES AND REGULATIONS FOR WORK IN THE DIGITAL PLATFORM

The digital platform provides specialized services to the various Participant Roles. The work of participants when working in the system is based on process regulations. A consolidated list of services and work regulations in the digital platform is presented in the [Table 1].

Table 1: Consolidated list of digital platform services and regulations

Roles	Service	Regulations
Customer	Initial registration and maintaining your profile	Customer Relationship Management ( CRM ) Policy
Customer	View the full database of available competencies, portfolio of completed projects	Customer Relationship Management ( CRM ) Policy
Customer	Description of the order in a structured way	Order management regulations
Customer	Viewing possible combinatorics of order execution, clarification of parameters and optimization criteria, order submission	Order management regulations
Customer	Monitoring the logistics of the order execution process - the stages of execution, the staff of the performers, their obligations in terms of time and quality, intermediate results	Order management regulations
Customer	Working communication with the Management company of the digital platform	Customer Relationship Management ( CRM ) Policy
Customer	Conclusion and support of contracts	Contract management regulations
Competence Center	Initial registration, maintaining your profile and describing your competencies in a structured form	Customer Relationship Management ( CRM ) Policy
Competence Center	Description of its capacity and schedule of availability over time	Production capacity management regulations
Competence Center	Ability to refuse subcontracting (with a drop in the reliability rating)	Contract management regulations
Competence Center	Opportunity to obtain subcontracting on a competitive basis (if there are several Competence Centers with the same competence)	Contract management regulations
Competence	Monitoring the logistics of the order	Engineering and design work



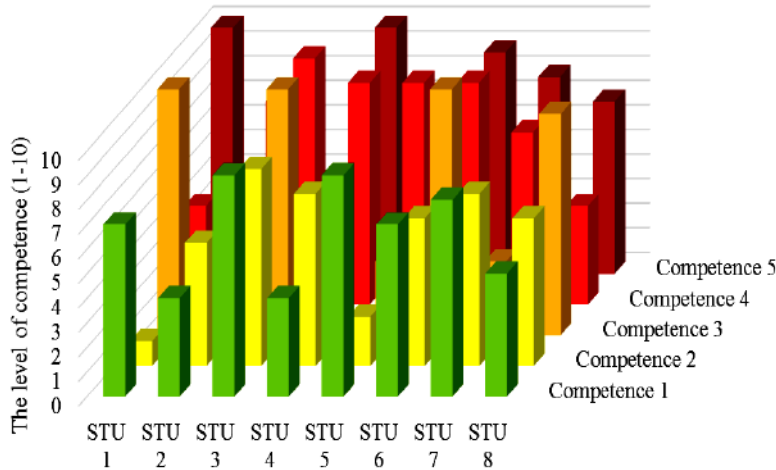
Center	execution process - the stages of execution, the staff of the performers, their obligations in terms of time and quality, intermediate results	management regulations
Competence Center	Receiving and transferring the results of work to other participants in the technological chain in electronic form	Customer Relationship Management ( CRM ) Policy
Competence Center	Working communication with the Single Window and with permission from the Management Company - with other CCs and the Customer	Customer Relationship Management ( CRM ) Policy
Competence Center	Conclusion and support of contracts	Contract management regulations
Administrator	Data directories management (types of competencies, technologies, equipment, value groups, etc.) and business rules (logical conditions according to which the regulations are automatically executed)	Regulations for working with data directories and business rules
Administrator	Entering the parameters of the technical specifications for electronic trading in the system, further manual adjustment of the order if necessary	Regulations for interaction with electronic trading platforms
Administrator	Automated assessment of execution opportunities (forming a logistics chain) of order fulfillment	Order management regulations
Administrator	Formation of the primary set of documentation for participation in electronic trading	Order management regulations
Administrator	Confirmation of the correctness of the order placed by the Customer independently	Order management regulations
Administrator	Conclusion and maintenance of contracts with customers	Contract management regulations
Administrator	Conclusion and support of subcontracts with Competence Centers	Contract management regulations
Administrator	Monitoring the progress of orders	Contract management regulations
Administrator	Maintaining a structured portfolio of completed projects	Customer Relationship Management ( CRM ) Policy
Administrator	Obtaining "big data" of the digital platform for subsequent data analytics	All regulations
Administrator	Management of access and rights of participants of the digital platform	Information security management regulations
Administrator	Providing information security of services	Information security management regulations

### STUDY OF THE STRUCTURAL DIAGRAM OF THE DIGITAL PLATFORM

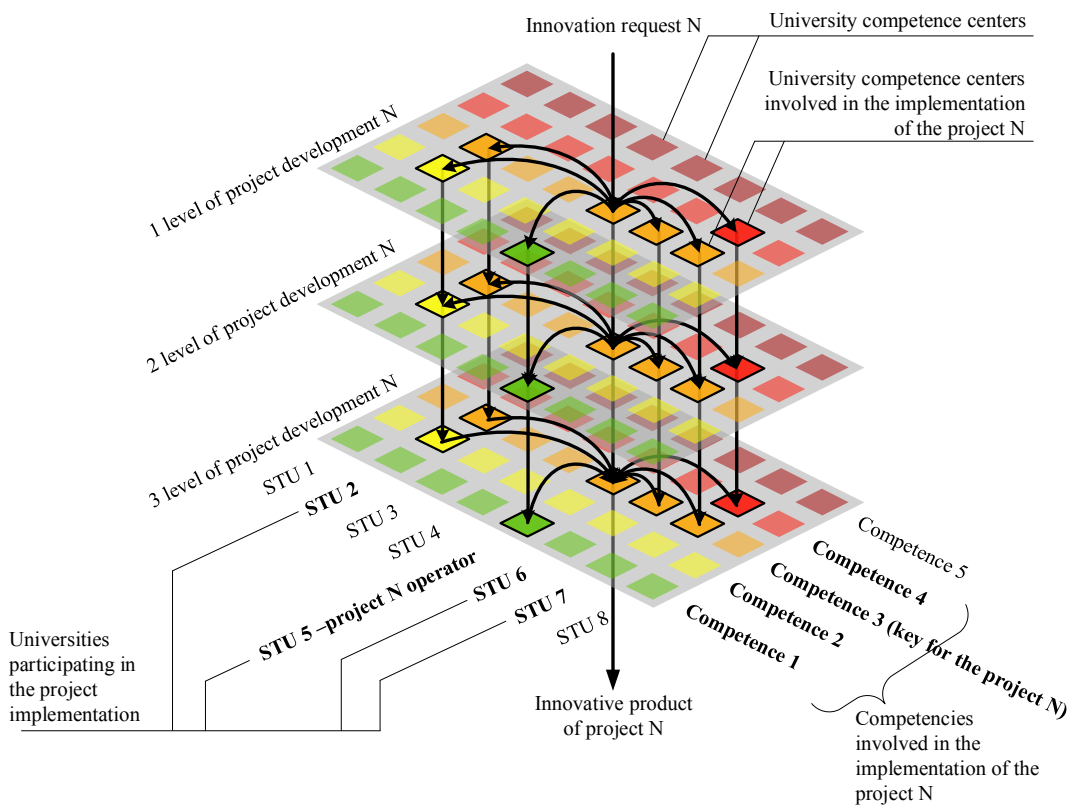
The digital platform is aimed at solving the problem when scientific and innovative projects do not reach the decision point due to insufficient funding. The reasons for this are complex: the unwillingness of businesses to finance early-stage projects, insufficiently high-quality marketing study of the issue, not fully assessed risks when making a decision to launch a project, and many others.

To create innovative solutions, the resources of several Centers of Competence (laboratories, scientific research centers) are required. At the same time, the levels of proficiency in the competencies of higher education institutions are different (this is the scientific and laboratory base, the level of training of specialists). The current situation can be presented in the form of a diagram [Fig. 3], where the heterogeneity of the Centers of Competence of higher education institutions is clearly visible. State Transport Universities (STU) are used as higher education institutions.

At the same time, the customer needs a transparent innovation creation management system that is understandable to the partner and helps to evaluate the progress of developing an innovative solution. [Fig. 4] shows a model for creating an innovation with the participation of several competence centers. For example, according to the legend, the request for innovation is received by the University under the conditional number 5, while the competence number 3 is the key for this work. At the stage of project implementation, which in our case includes 3 stages, and the competence centers of other universities are connected. Thus, the project involves 4 universities, three types of competence centers (for example, it can be power engineering, IT-block, and others). This increases the efficiency of project implementation and the quality of product development.



**Fig. 3:** Heterogeneity of University competence centers. Universities and their centers of competence are represented on the X and Y scale. On the Z scale, the diagram conventionally refers to the level of competence in a particular University.



**Fig. 4:** Block diagram of the digital platform

The digital platform allows participants to combine efforts in the development and implementation of innovations in railway transport within the framework of the program, the main directions of which are:

- development and implementation of comprehensive research programs and integrated scientific and technical programs;
- ensuring legal protection of the management of rights to the results of intellectual activity;
- commercialization of the obtained results of intellectual activity, including marketing research and search for partners to promote products to markets, including foreign ones;
- transfer for free use or provision on special conditions of the infrastructure of universities to its Participants;
- information and consulting support on certification and standardization issues;

- provision of engineering services, including accelerated design and implementation of innovations;
- carrying out an examination of the quality of innovative projects;
- participation in activities aimed at supporting the export of innovations.

## CONCLUSION

The proposed digital platform is aimed at increasing the scientific and innovative activities implemented by Russian transport Universities in the interests of the transport industry. The use of the digital platform is considered by the authors as a tool for creating innovations of the level of technological readiness that is in demand among businesses. This will increase business interest in scientific work aimed at obtaining new knowledge used to create innovations. The digital platform enables to provide funding from the state for scientific work. This is a mechanism for stimulating science. In the future, the digital platform can become a platform for interaction between world-class research and education centers, University research schools, and innovation platforms of Russian corporations and Russian innovation accelerators. Currently, these parties have a fairly narrow area of mutual interest. Work on the creation of a digital platform is being carried out by Samara State Transport University as part of the state budget research in 2020. The work is carried out in 2 stages. At the first stage, it is planned to develop the structural and functional schemes of the information and control platform, and develop the interface of the main software modules. At the second stage - programming and creating an information and management platform, debugging and testing the work, filling in and collecting information for the work of the platform.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

The article was prepared as part of the state-funded research work carried out by the Samara State Transport University on the topic "Creating a unified inter sectoral information and management platform "Science-Production-Operation" of railway equipment" in 2020 on the instructions of the Federal Agency for Railway Transport.

### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] Pankratova LS, Shakarbieva SV. [2018] Communication technologies of crowdsourcing in contemporary global and Russian public policy. Bulletin of the Volgograd state University. Series 4: History. Regional studies. International relations. 23(6):208-216.
- [2] Himanshu P. [2018] Comparison of usage of crowdsourcing in traditional and agile software development methodologies on the basis of effectiveness. Reliability: Theory & Applications. 13(3(50)):32-44.
- [3] Baker D. [2013] Crowdsourcing business model innovation using social media platforms. Management problems in social systems. 6(9):59-70.
- [4] Powell D. [2015] A new tool for crowdsourcing. MIR (Modernization. Innovations. Development). 6(2-2(22)):65-68.
- [5] Dolzhenko RA, Yurkova A. [2018] Efficiency of crowdsourcing at enterprise (for example, Sberbank of Russia). Economics Profession Business. 1:15-20.
- [6] Dolzhenko RA. [2016] Some pricing issues on multi-party crowdsourcing platforms. NGUEU Bulletin. 3:137-152.
- [7] Sukharev MV. [2018] Crowdsourcing, block chain, and artels. Creative economics. 12(10):1687-1702.
- [8] Titov VV. [2012] Legal aspects of crowdsourcing. Actual issues of economic Sciences. 25-2:245-248.
- [9] Egerev SV, Zakharova SA. [2015] Crowdsourcing in science. Sociological almanac. 6:311-322.
- [10] Garanin MA. [2019]. Transformation of the University into the center of innovation implementation space. Issues of innovative economics. 9(3):955-968.
- [11] Garanin MA, Sandler DG. [2020] Management decision support system at the University on the example of the group of processes "Science and innovation". Prospects of science and education. 3(45): 527-543.

ARTICLE

# APPLICATION OF THE ECONOMETRIC MODEL AS A MECHANISM OF MANAGEMENT OF SOCIO-ECONOMIC SYSTEMS

Lyudmila Valentinovna Bolshakova<sup>1\*</sup>, Alexander Nikolaevich Litvinenko<sup>1</sup>, Evgeniya Vladimirovna Baturina<sup>1</sup>, Inna Kazemirovna Sidenko<sup>2</sup>, Alexander Nikolaevich Ivanov<sup>3</sup>, Farid Abdulalievich Dali<sup>3</sup>, Grigori Leonidovich Shidlovsky<sup>3</sup>

<sup>1</sup>St. Petersburg University of the Ministry of Internal Affairs of Russia, St. Petersburg, RUSSIA

<sup>2</sup>Russian State Hydro meteorological University, St. Petersburg, RUSSIA

<sup>3</sup>St. Petersburg University of the State Fire Service EMERCOM of Russia, St. Petersburg, RUSSIA

## ABSTRACT

The problem of the adequacy test criteria for the econometric model obtained from the sample has been considered. The adequacy testing methods have been shown. Particular attention has been paid to the adequacy testing method for the model using the value of the average approximation error, and significant drawbacks of this method which can lead to erroneous results in the analysis and forecasting have been revealed. In modern conditions, when management decisions are made based on the analysis of statistical, incomplete information, the use of econometric modeling and analysis methods is not only justified but also necessary. Econometric models are applied both at the level of organizations' activities and at the level of planning and analysis of aspects of the economic activity of the region and the country as a whole. The study is aimed at building econometric models to obtain an effective tool for forecasting, analysis and decision making. In the analysis of specific statistical data, the methods of correlation-regression analysis and forecasting are used. The paper highlights and describes the characteristic features of forecasting based on econometric models. Econometric methods and models allow assessing the impact of changes in the internal and external environment on the resulting indicator, analyzing the cause-and-effect relationships between indicators, and performing forecasting. The quality assessment of the model can be obtained not only by the value of the average approximation error but also by the value of the determination coefficient, as well as by verifying the significance of the regression equation by the Fisher's criterion. The simultaneous manifestation of an erroneous assessment of the quality of the regression model for all the listed values of the coefficients and criteria is highly doubtful. Therefore, in order to obtain more objective assessment of the adequacy of the regression model under consideration, it is worth calculating all the coefficients and testing the corresponding statistical hypotheses. Verifying the adequacy of the model can also include checking the feasibility of the assumptions by the least-squares method, which is used to find estimates of the coefficients of the regression equation. If any of the prerequisites is impracticable, the estimates of the coefficients may significantly differ from their actual values.

## INTRODUCTION

Econometric methods and models are integral parts of any modern support system for making economic and managerial decisions. Today, econometric methods are used for diagnostics of the state of the enterprise, when solving problems of management of corporate finance and risks, assessing the efficiency of investment and innovation activities, the value of assets and business, analyzing the dynamics of prices and living standards, as well as assessing the parameters of economic and mathematical models of logistics.

An econometric model, represented by an equation or a system of equations and inequalities, is a mathematical analogue of an object, taking into account all the most important aspects and features of the object functioning, according to which the best option for the development of this object can be found. Obviously, the more detailed the essence and content of the object, the relationship of its elements and their influence on the final result of the activity or the functioning of the object are considered, the more accurate and acceptable for application and implementation in practice will be the solution.

Econometric methods allow answering two main questions: what can happen in the future (forecast, foreseeing the development of the economic situation) and how a change in one value can affect another - the task of analysis for managing economic processes.

The construction of an econometric model that explains the relationship between various factors is one of the most important tasks in conducting research both at the micro- and macroeconomic levels. The main element of the model - the sample regression equation - is further used to analyze and forecast the possible values of attributes (factors) describing a particular economic process. However, since the elements of not the entire general population, but only of its part - the sample - are used in the construction of the model, it leads to a question of how the constructed model corresponds to reality. As such, the problem of assessing the quality of the resulting regression equation arises after the model construction. This problem is the most important one in econometric analysis, because the conclusions and forecasts obtained from a low-quality model will be far from reality [1, 2].

Various coefficients and statistical hypotheses are used to find out how well the obtained model describes the real situation, and conclusions are drawn about the adequacy of the obtained model, based on their values and results.

### KEY WORDS

average approximation error, coefficient of determination, coefficient of correlation, Fisher's F-test

Received: 4 Nov 2020  
Accepted: 6 Dec 2020  
Published: 11 Dec 2020

\*Corresponding Author  
Email:  
bolshakoval.v@bk.ru

## METHODS

The quality of the regression model is most often assessed by the values of the coefficients of correlation and determination, by the average approximation error, as well as by the results of testing statistical hypotheses about the significance of the entire regression equation by the Fisher's F-test and the significance of individual coefficients by the Student's t-test.

These criteria can be briefly described for a paired linear regression.

Let us assume that a paired linear relationship between two characteristics is examined: the resultant Y and the factor X. A sample of volume n is taken from the general population:

**Table 1:** Samples

Element number	1	2	3	...	n
Value of attribute X	x <sub>1</sub>	x <sub>2</sub>	x <sub>3</sub>	...	x <sub>n</sub>
Value of attribute Y	y <sub>1</sub>	y <sub>2</sub>	y <sub>3</sub>	...	y <sub>n</sub>

The sample equation of the paired linear regression  $\hat{y} = b_0 + b_1x$  was found based on the obtained sample, using the Excel application [3]. The quality of the resulting equation can be tested using the following criteria.

A preliminary and lax conclusion about the dependence can be drawn from the correlation field. If the points of the correlation field are located not far from the regression line, then the existence of a linear relationship between the attributes can be assumed, which corresponds to the assumption of the adequacy of the model.

Further, the coefficients of correlation and determination and the average approximation error are also found using the Excel applications [3], and their characteristic properties necessary to test the adequacy of the model are described.

The sample linear coefficient of correlation  $r_s$  describes the existence and strength of a linear relationship between the attributes. The closer is the value of this coefficient to  $\pm 1$ , the stronger is the dependence and the more reasons are there to consider the model to be adequate. However, the closer  $r_s$  is to zero, the weaker the linear dependence is, and the quality of the model significantly decreases.

The sample coefficient of determination R, expressed as a percentage, shows which percentage of the changes in the resulting attribute Y occurs due to the influence of the factor attribute X. It is obvious that if R is less than 50%, then the model cannot be considered adequate.

The average approximation error is one of the simple coefficients that allows to briefly describe how much the simulated process corresponds to the real one.

The average approximation error is understood as either the average absolute approximation error, determined by the formula

$$A_{aaa} = \frac{1}{n} \sum_{i=1}^n \left| \frac{y_i - \hat{y}_i}{y_i} \right| \cdot 100\%,$$

or the mean-square approximation error, determined by the formula

$$A_{ms} = \frac{1}{\bar{y}} \sqrt{\frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2}{n}} \cdot 100\%,$$

where  $y_i$  is the actual values of attribute Y;

$\bar{y}$  is the average value of the observations;

$\hat{y}_i$  is the theoretical values of attribute Y, found by the regression equation; and n is the sample size.

It is obvious that the values of coefficients  $A_{aa}$  and  $A_{ms}$  for the same problem differ. It is generally accepted that if any of these errors does not exceed 14%, the regression model is considered to be of good quality, i.e. is adequate to reality, and real forecasts can be built based on it.

The assumption about the adequacy of the model can be confirmed or refuted by testing the following statistical hypotheses.

The statistical hypothesis about testing the significance of the regression equation generally involves testing the main hypothesis that the resulting regression equation is insignificant (inadequate, of poor quality).

This hypothesis is tested according to the general scheme:

- The main hypothesis is formulated:  
H<sub>0</sub>: the regression equation is significant.
- 2. The level of significance  $\alpha$  is selected.
- 3. The criterion is determined – a random variable distributed according to the Fisher's law (F distribution).
- 4. The sample value of the criterion is found using the following formula:

$$F_s = \frac{r_s^2}{1 - r_s^2} \cdot (n - 2).$$

5. The right-sided critical range is determined, and the critical point  $F_{cr}$  is found according to the Fisher's distribution table with parameters  $v_1 = 1$  and  $v_2 = n - 2$ .

6. A statistical conclusion is made:

If  $F_s < F_{cr}$ , then there is no reason to reject the main hypothesis and recognize the equation as significant. In this case, the poor quality of the model is confirmed.

If  $F_s > F_{cr}$ , then the main hypothesis should be rejected as contradicting the sample data, and the regression equation should be considered significant. In this case, the good quality of the model is confirmed

## RESULTS AND DISCUSSION

As noted above, the quality of the model can be judged by the results of testing statistical hypotheses about the significance (difference from zero) of various coefficients – in particular, the coefficient of correlation  $r_g$  and the coefficient of regression  $\beta_1$ . The values  $r_g$  and  $\beta_1$  are characteristics of the entire general population, while their estimates  $r_s$  and  $b_1$ , respectively, are found from the sample data. Such hypotheses can be tested similarly to the hypothesis about the significance of the equation in general, with the corresponding changes in the test criteria. The Student's t-test is used instead of the Fisher's F-test in these cases. The general scheme will be considered only to test the hypothesis about the significance of the coefficient of correlation for the general population, because the results of testing the hypothesis about the significance of the general coefficient of regression completely coincide with the results of testing the above hypothesis about the significance of the equation in general.

- The main and alternative hypotheses are formulated  
H<sub>0</sub>:  $r_g = 0$ , H<sub>1</sub>:  $r_g \neq 0$ .
- The level of significance  $\alpha$  is selected.
- The criterion is determined – a random variable distributed according to the Student's law (T distribution).
- The sample value of the criterion is found using the following formula:

$$T_s = \frac{r_s}{\sqrt{1 - r_s^2}} \cdot \sqrt{n - 2}.$$

5. The two-sided critical range is determined, and the critical point  $t_{cr}$  is found according to the Student's distribution table with a parameter (number of degrees of freedom)  $v = n - 2$ .

6. A statistical conclusion is made:

If  $|T_s| < |t_{cr}|$ , then there is no reason to reject the main hypothesis and recognize the equation as significant, i.e. different from zero. In this case, the poor quality of the model is confirmed.

If  $|T_s| > |t_{cr}|$ , then the main hypothesis should be rejected as contradicting the sample data, and the correlation coefficient is significantly different from zero. In this case, the good quality of the model is confirmed.

### Solution

Each of the above methods of testing the adequacy has a number of drawbacks that can lead to both a significant underestimation of the quality of a "good" model and an overestimation of the quality of a "bad" model. Most often, this drawback manifests itself when checking the adequacy of the model using the value of the average approximation error.

Possible erroneous situations when using the average approximation error can be examined using the example of a paired linear regression.

Of course, erroneous situations do not always arise. There are many examples of high-quality models for which the average approximation errors do not exceed 14% and, conversely, there are examples of poor-quality models with approximation errors significantly more than 14%.

However, in practice, there are situations in which the average error values provide an incorrect idea of the quality and properties of the resulting models. Consequently, the conclusions or predictions made using such models will be far from reality. Below are all possible situations confirming the above.

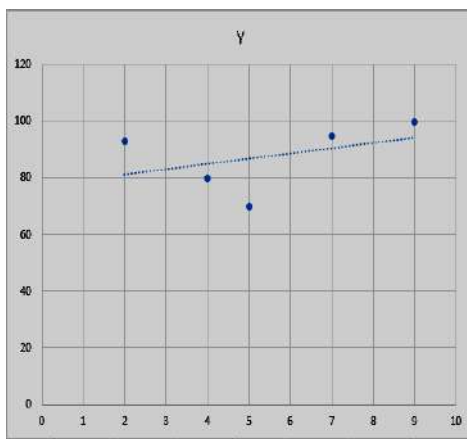
Let us consider three samples of size  $n = 5$ . Let us note that results similar to those described below can be obtained for large samples as well.

Example 1. A sample with the following values is examined [Table 2].

**Table 2:** Values

X	5	4	2	7	9
Y	70	80	93	95	100

For clarity, a correlation field is built first [Fig. 1], using Excel tools [3]:



**Fig. 1:** Correlation field

It can be seen in the correlation field that the linear relationship between the attributes is not strong (the scatter of points around the regression line is too large). Therefore, according to the preliminary conclusion, the paired linear regression model can significantly distort the real picture. Let us find the sample regression equation using the least square method:

$$\hat{y} = 77.28 + 1.91x.$$

The sample coefficient of determination will be equal to  $R = 17.62$ , from which it follows that only about 18% of the change in attribute Y is determined by the influence of attribute X. The value of the coefficient of determination confirmed the preliminary conclusion about the poor quality of the model.

A weak linear relationship between the attributes is also indicated by the correlation coefficient  $r_s$ , which is approximately equal to 0.42.

Let us test the statistical hypothesis about the adequacy of the model according to the Fisher's F-test:

1.  $H_0$ : the regression equation is insignificant.
2. The generally accepted level of significance  $\alpha = 0.05$  is selected.
3. Fisher's F-test (F distribution).
4. The sample value of the criterion:

$$F_s = \frac{r_s^2}{1 - r_s^2} \cdot (n - 2) = \frac{(0.42)^2}{1 - (0.42)^2} \cdot 3 \approx 0.6418.$$

5. The right-sided critical range is determined, and the critical point  $F_{cr}$  is found according to the Fisher's distribution table with parameters  $v_1 = 1$  and  $v_2 = 3$ :

$F_{cr} = 10.1$ .

6. A statistical conclusion is made:

$F_s = 0.6418 < F_{cr} = 10.1$ , which means that there is no reason to reject the main hypothesis and recognize the equation as significant. In this case, the poor quality of the model is confirmed.

Finally, the significance of the coefficient of correlation is tested.

1.  $H_0: r_g = 0, H_1: r_g \neq 0$ .
2. Level of significance  $\alpha = 0.05$ .
3. Student's t-test (T distribution).
4. The sample value of the criterion:

$$T_s = \frac{r_s}{\sqrt{1 - r_s^2}} \cdot \sqrt{n - 2} = \frac{0.42}{\sqrt{1 - (0.42)^2}} \cdot \sqrt{3} = 0.8016.$$

5. The two-sided critical range is determined, and the critical point  $t_{cr}$  is found according to the Student's distribution table with a parameter (number of degrees of freedom)  $v = 3: t_{cr} = 3.18$ .

6. A statistical conclusion is made:

$|T_s| = 0.8016 < |t_{cr}| = 3.18$ , which means that there is no reason to reject the main hypothesis and recognize the equation as significant, i.e. different from zero. In this case, the poor quality of the model is confirmed.

As such, all the main methods of testing the adequacy of the model indicated its poor quality.

However, the following results were obtained when calculating the average approximation errors:

Aaa = 10.62; Ams = 11.40,

which indicated the good quality of the model.

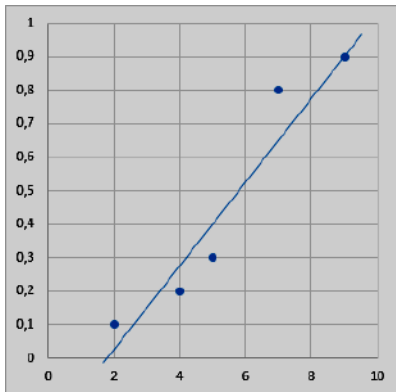
Thus, there was a significant underestimation of the average approximation errors as a result of which the model could be recognized as adequate to reality. In this case, the forecasts made using this model would be far from reality.

Example 2. A sample with the following values is examined [Table 3]:

**Table 3:** Values

X	5	4	2	7	9
Y	0.3	0.2	0.1	0.8	0.9

A study similar to the first example is conducted for this sample. The correlation field is as follows [Fig. 2]:



**Fig. 2:** Correlation field.

It can be seen from the correlation field that the linear relationship between the attributes is quite strong (a scatter of points around the regression line is small). Therefore, according to the preliminary conclusion, the paired linear regression model can be considered adequate to reality. The sample regression equation is found using the least square method:

$$\hat{y} = -0.24 + 0.12x.$$

The sample coefficient of determination will be equal to  $R = 91.98$ , from which it follows that only about 92% of the change in attribute Y is determined by the influence of attribute X. The value of the coefficient of determination confirmed the preliminary conclusion about the very good quality of the model.

A strong linear relationship between the attributes is also indicated by the correlation coefficient  $r_s$ , which is approximately equal to 0.96.



Let us test the statistical hypothesis about the adequacy of the model according to the Fisher's F-test:

1. The main hypothesis H0 is formulated: the regression equation is insignificant.
2. The generally accepted level of significance  $\alpha = 0.05$  is selected.
3. The criterion is determined – a random variable distributed according to the Fisher's law (F distribution).
4. The sample value of the criterion is found:

$$F_s = \frac{r_s^2}{1 - r_s^2} \cdot (n - 2) = \frac{(0.96)^2}{1 - (0.96)^2} \cdot 3 \approx 34.4.$$

5. The right-sided critical range is determined, and the critical point Fcr is found according to the Fisher's distribution table with parameters  $v_1 = 1$  and  $v_2 = 3$ :

Fcr = 10.1.

6. A statistical conclusion is made:

$F_s = 34.4 > F_{cr} = 10.1$ , which means that the main hypothesis should be rejected as contradicting the sample data, and the regression equation should be considered significant. In this case, the good quality of the model is confirmed.

It can also be made sure that the significance of the coefficient of correlation is confirmed.

As such, all the main methods of testing the adequacy of the model indicated its adequacy to reality.

However, the following results were obtained when calculating the average approximation errors:

Aaa = 35.02; Ams = 20.08,

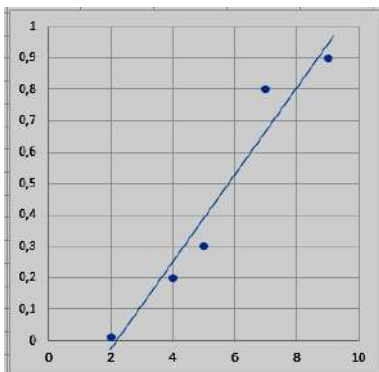
which indicated the poor quality of the model – therefore, it could not be applied for further analysis. As such, there was a significant overestimation of the values of the average approximation errors, as a result of which the model adequate to reality was rejected.

Example 3. A sample with the following values is examined [Table 3]:

**Table 3:** Values

X	5	4	2	7	9
Y	0.3	0.2	0.1	0.8	0.9

A study similar to the first and second examples is conducted for this sample. The correlation field is as follows (Figure 3):



**Fig. 3:** Correlation field.

It can be seen from the correlation field that the linear relationship between the attributes is quite strong (a scatter of points around the regression line is small). Therefore, according to the preliminary conclusion, the paired linear regression model can be considered adequate to reality. The sample regression equation is found using the least square method:

$$\hat{y} = -0.31 + 0.14x.$$

The sample coefficient of determination will be equal to  $R = 94.78$ , from which it follows that only about 95% of the change in attribute Y is determined by the influence of attribute X. The value of the coefficient of determination confirmed the preliminary conclusion about the very good quality of the model.

A strong linear relationship between the attributes is also indicated by the correlation coefficient  $r_s$ , which is approximately equal to 0.97, and the hypothesis about the significance of the general coefficient of correlation will also be confirmed.

Let us test the statistical hypothesis about the adequacy of the model according to the Fisher's F-test:

1. The main hypothesis  $H_0$  is formulated: the regression equation is insignificant.
2. The generally accepted level of significance  $\alpha = 0.05$  is selected.
3. The criterion is determined – a random variable distributed according to the Fisher's law (F distribution).
4. The sample value of the criterion is found:

$$F_s = \frac{r_s^2}{1 - r_s^2} \cdot (n - 2) = \frac{(0.97)^2}{1 - (0.97)^2} \cdot 3 \approx 54.42.$$

5. The right-sided critical range is determined, and the critical point  $F_{cr}$  is found according to the Fisher's distribution table with parameters  $\nu_1 = 1$  and  $\nu_2 = 3$ :

$F_{cr} = 10.1$ .

6. A statistical conclusion is made:

$F_s = 54.42 > F_{cr} = 10.1$ , which means that the main hypothesis should be rejected as contradicting the sample data, and the regression equation should be considered significant. In this case, the good quality of the model is confirmed.

As such, all the main methods of testing the adequacy of the model indicated its adequacy to reality.

However, the following results were obtained when calculating the average approximation errors:

$A_{aa} = 102.3$ ;  $A_{ms} = 17.96$ ,

which indicated the poor quality of the model – therefore, it could not be applied for further analysis. As such, there was a significant overestimation of the values of the average approximation errors, as a result of which the model adequate to reality was rejected.

The analysis of the third sample indicates that the average approximation error can be greater than 100% for a sufficiently good quality model.

The above regression equations for all three samples were built using the least square method, which gave the best estimates of the coefficients of regression. However, examples of samples can also be provided for which the model of the regression equation built using the least square method gives larger average approximation error than the model of the equation with randomly selected coefficients, which clearly contradicts the theory [8-10].

Let us indicate some general cases for which the values of the average approximation errors can be overestimated or underestimated.

It is easy to see that the mean-square approximation error  $A_{ms}$  depends significantly on the average value of observations of attribute Y. If the average value turns out to be close enough to zero, then the value of  $A_{ms}$  can increase significantly, which will lead to an incorrect assessment of the quality of the constructed model.

The values of the average absolute approximation error  $A_{aa}$  to a large extent depend on the sample values of attribute Y. If any of these values turn out to be close to zero, then  $A_{aa}$  will be overestimated, and the quality of the model will also be assessed incorrectly.

A significant underestimation of both errors can occur in the case when the values of attribute Y are large enough, for example.

## CONCLUSION

An incorrect assessment of the quality of the model can result not only from the value of the average approximation error but also from the value of the coefficient of determination, as well as when testing the significance of the regression equation using the Fisher's F-test. However, the latter is extremely rare. Moreover, the simultaneous manifestation of an erroneous assessment of the quality of the regression model for all the listed values of the coefficients and criteria is unlikely. Therefore, it is worth estimating all the coefficients and testing the corresponding statistical hypotheses in order to obtain a more objective assessment of the adequacy of the considered regression model. Finally, it must also be stressed that testing the adequacy of the model can also include testing the feasibility of the assumptions of the least square method, which is used to find estimates of the coefficients of the regression equation. If any of the prerequisites is unsatisfied, the estimates of the coefficients may differ significantly from their actual values. However, the discussion of this problem is beyond the scope of this article and will be considered in subsequent works of the authors. Econometric methods are currently one of the tools for solving

problems of analysis and forecasting of economic systems. A well-built econometric model based on a reliable analysis of the existing economic data allows predicting and controlling the economic situation, as well as elaborating options for future development.

#### CONFLICT OF INTEREST

There is no conflict of interest.

#### ACKNOWLEDGEMENTS

None.

#### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] Dougherty C. [1999] Introduction to Econometrics. Moscow: INFRA-M.
- [2] Eliseeva II. [2007] Ekonometrika [Econometrics]: Textbook. Moscow: Finance and Statistics.
- [3] Lavrenov SM. [2003] Excel: Sbornik primerov i zadach [Excel: Collection of examples and tasks]. Moscow: Finance and Statistics.
- [4] Bolshakova LV, Yakovleva NA. [2018] Mathematical and statistical methods for processing experimental data in scientific research: guidelines, in 3 parts. Part 2. SPb.: Publishing house of the St. Petersburg University of the Ministry of Internal Affairs of Russia.
- [5] Xue J, Ji X, Zhao L, Yang Y, Xie Y, Li D, Wang C, Sun W. Cooperative econometric model for regional air pollution control with the additional goal of promoting employment. Journal of Cleaner Production. DOI: 10.1016/j.jclepro.2019.117814
- [6] Basu R, Ferreira J. [2020] Understanding household vehicle ownership in Singapore through a comparison of econometric and machine learning models. Transportation Research Procedia, 48: 1674-1693.
- [7] Yang Y, Schmidt P. [2020] An econometric approach to the estimation of multi-level models. Journal of Econometrics, DOI: 10.1016/j.jeconom.2020.04.012
- [8] Amusan LM, Charles AK, Adeyemi E, Joshua O, Raphael OA. [2018] Data on expert system-econometric entropy informatics model for adjudicating residential building project costs, Data in Brief. 20: 1721-1729.
- [9] Chernyshov KR, Jharko EPh. [2016] Entropy Criteria in the Econometric Model Identification. IFAC-PapersOnLine. 49(12): 827-832.
- [10] Morland C, Schier F, Janzen N, Weimar H. [2018] Supply and demand functions for global wood markets: Specification and plausibility testing of econometric models within the global forest sector. Forest Policy and Economics. 92: 92-105.

ARTICLE

# SMM IN THE TOURISM INDUSTRY AFTER LOCKDOWN: STRATEGIES AND TOOLS FOR PROMOTING B2C MARKETING

Salekh Aysayevich Khodzhaliev<sup>1\*</sup>, Tatiana Ivanovna Zvorykina<sup>2,3</sup>, Liliya Beloglazova<sup>4</sup>

<sup>1</sup>*Chechen State University, Sheripova Street, 32, Grozny, 364024, RUSSIA*

<sup>2</sup>*Institute of Business Technologies, Russian New University, Radio Street, 22, Moscow, 105005, RUSSIA*

<sup>3</sup>*Institute for Regional Economic Research, Sivtsev Vrazhek per., 29/16, Moscow, 119002, RUSSIA*

<sup>4</sup>*Peoples' Friendship University of Russia (RUDN University), Miklukho-Maklaya Street, 6, Moscow, 117198, RUSSIA*

## ABSTRACT

COVID-19 has caused an unprecedented crisis in the travel industry. At the same time, social media is a dynamic crisis management tool. This allows addressees to "own their story" and determine how digital audiences value an organization's performance during the crisis while providing them with a powerful platform to inform their community and position themselves as influencers through timely content. The purpose of the study is to analyze the preferred strategies and tools of social media marketing in the tourism industry in B2C marketing after the restrictions due to the coronavirus epidemic. To solve the tasks set in the work, general scientific methods were used: a) theoretical: analysis of peer-reviewed scientific and analytical sources on the problem of using SMM in tourism; b) empirical: an expert survey. Experts were asked the following main questions: name and describe the tools and practices of SMM in tourism during and after the lockdown, suggest and justify the strategies of SMM in the tourism industry during and after the lockdown. The study analyzes the essence of SMM and the consequences of restrictions due to the coronavirus pandemic. The need to use SMM in the current environment is determined. Based on the expert survey, the tools and practices of SMM in the field of tourism are identified, and its strategies during and after lockdown are shown and concretized. It is concluded that social media has become an integral part of travel marketing. It is proven that to overcome the negative consequences of the coronavirus pandemic, it is necessary to introduce new marketing strategies in SMM, involving the maximum number of social media.

## KEY WORDS

social media, social media marketing, SMM, pandemic, travel industry, marketing strategy, user-generated content, gamification

## INTRODUCTION

In modern conditions of the development of information technologies, the popularity of the Internet is growing more and more actively, and the number of Internet users is increasing daily. For several years of its existence, social media have become the most popular Internet sites.

Social media are various forms of online media in which people with common interests, goals, and practices engage in social interactions by creating personal profiles and sharing information and experiences. These can be full-fledged social media that allow sharing updates and photos, joining events, and performing many other activities (e.g. Facebook, VKontakte), photo sharing sites (e.g. Flickr, Photobucket), sites for creating and sharing videos (e.g. YouTube, Ustream), online communities, as well as microblogging tools that allow people to share short messages, or "updates", with others (e.g. Twitter), social tags (e.g. Digg), newsreaders (e.g. Google Reader), public internet forums, review/rating sites (e.g. TripAdvisor), blogs/moblogs, tagged sites, podcasting, wikis, and standalone websites. One of the most important functions of social media is that they provide a web application where users can easily create and publish various contents in the form of texts, photos, videos, etc. [1].

SMM (social media marketing) is one of the most successful and nonstandard ways of promoting any type of goods or services in the world today [2]. For successful operation in modern economic systems, an enterprise needs to build an effective communication strategy and constantly adjust it depending on the results. The implementation of this task is impossible without using social media. It is social media that make it possible to better understand the interests of the target audience, its needs, desires, intentions, motives, ambitions, fears, and the like. That is, based on the social media capabilities of the industrial society, a socio psychological image of a potential consumer should be formed and effective mechanisms for interaction with them should be designed [3].

The advent of internet-based social media technologies has made it possible for tourists to quickly and conveniently share their travel experiences. General social media information is considered an important source of information that can influence travel decisions for potential travelers [4]. Results showed that identification and internalization are important determinants that positively increase the actual sharing of travel experiences on social media mediated by perceived pleasure [5]. At the same time, restrictions and self-isolation, travel and event cancellations caused by the spread of the COVID-19 virus have presented tourism marketers with serious problems and uncertainties about the future of the travel and tourism industry [6].

Tourism is one of the most affected industries during the ongoing COVID-19 pandemic. Travel agencies, airlines, museums, and tourist destinations are now suspended. Any recession could be a hard blow to the travel industry, as less disposable income always means fewer travel and leisure opportunities. This time,

Received: 3 Nov 2020  
Accepted: 2 Dec 2020  
Published: 11 Dec 2020

\*Corresponding Author  
Email:  
hodzhaliev\_saleh@mail.ru

the situation is even more serious, as even those who can afford to travel cannot leave for their desired destination. Closed borders and canceled flights and events predict big losses for airlines, travel agencies, hotels, and tourist attractions. Many businesses in the tourism industry are closing, but the number of companies quitting their marketing is even more radical and surprising. Many companies have even gone silent on social media. At the same time, some travel brands are not only using social media to cope with the effects of the pandemic but also conquer the market [7].

SMM is a relatively new field of activity for modern manufacturers of goods and services, which they are actively exploring regardless of the scale and specifics of their activities. There is no single and generally accepted definition of this concept [Table 1].

**Table 1:** Scientific approaches to defining SMM

Definition	References
Content creation activities carried out to attract attention to the brand, expand the circle of consumers, increase the popularity of the brand	[8]
The process of getting traffic for the site, introducing marketing through social media	[9]
Activities to promote the site, attract consumers	[10]
A special Internet marketing tool that involves promoting a product, service, company, or brand through the use of social media, the content of which is created and updated by the efforts of their visitors	[11]
The goal of SMM is consumer interest, creating a positive brand image, positioning the company, for which the primary task is not to make a profit but to meet the needs of consumers, gain their trust and affection	[12]

According to researchers [13], there are two main reasons for using SMM during a pandemic: 1. People are social and do well in social groups. Due to quarantines and travel restrictions, the urge to maintain social connections has increased. As a result, the use of social media has increased significantly; 2. How brands deal with the crisis now will have a direct impact on their business in the future. Consumers look to trusted brands to keep them safe when they add value, act responsibly, and do the right thing. Companies that are now interacting with their customers and followers will not only gain recognition but be remembered when the markets begin to recover.

The purpose of the study is to analyze the preferred strategies and tools of SMM in the tourism industry in B2C marketing after the restrictions due to the coronavirus epidemic.

The objectives of the study:

- identify tools and practices of SMM in the tourism sector during and after lockdown;
- describe the strategies of SMM in the tourism industry during and after lockdown.

The hypothesis of the study: to overcome the negative consequences of the coronavirus pandemic, it is necessary to introduce new marketing strategies in SMM, involving the maximum number of social media.

## METHODS

To solve the objectives of the study, general scientific methods were used:

**a) Theoretical:** an analysis of peer-reviewed scientific and analytical sources on the issue of telemedicine implementation; **b) Empirical:** an expert survey. The experts were asked the following main questions: name and describe tools and practices of SMM in tourism during and after lockdown, suggest and justify the strategies of SMM in the tourism industry during and after lockdown. At the first stage, the available scientific and analytical sources on the problem of using SMM in tourism were studied. Based on the study of sources, the relevance of studying the features of SMM in the field of tourism during the COVID-19 pandemic and after it was determined. An analysis of scientific approaches to the definition of SMM was carried out. At the second stage of the study, communication with experts was carried out online. The survey was conducted in Russian on October 1, 2020.

### Expert survey: description of the data collection procedure

The survey was attended by experts (28 people) – managers and employees of travel companies with at least 7 years of experience in the tourism industry. All survey participants were warned about the purpose of the survey and that the organizers of the study planned to publish its results in a generalized form. The selection of experts for participation in the online survey was based on publications (at least three) in peer-reviewed journals. The experts were asked to voluntarily fill out a semi-formalized questionnaire with questions aimed at determining the tools and practices of SMM in tourism, SMM strategies in tourism before and after the lockdown, as well as recommendations on the aspects of activities that the tourism business should focus on at present.

**Data processing stage:** At the stage of data processing, the experts' answers were systematized and arranged in a tabular form, taking into account the number of expert references.

## RESULTS AND DISCUSSION

### SMM tools

The experts pointed out that all travel brands and organizations need to understand that they must continue to attract their customer base, both during the entire period of quarantine and self-isolation and after their completion. Consumers need to feel that the travel business is offering them something truly new to make them want to experience it. Rethinking marketing strategies, in the long run, is critical to staying connected with consumers. According to one of the experts (Nikolai K., head of a travel company, 15 years of experience), this is also “a great time to use social media to support local travel brands and develop their businesses. At this time, it is also necessary to be a reliable source of information for consumers. Being careful with social media posts helps avoid spreading misinformation during the pandemic”. The experts identified the main social media, tools, and practices that will help improve their presence on social media and which, in their opinion, should be given special attention when implementing SMM [Table 2].

**Table 2:** Tools and practices of SMM in tourism

No	Social media	%*	Tools and practices
1	Facebook, VKontakte	85.7%	Creating a page and filling it with content, news, photos, and videos. Promoting/organizing events, creating special offers, adding apps to attract customer reviews, or creating an app to make online booking easier. Regular updates with photos, video clips, blog posts, and information about tours or activities can keep customers interested and help potential tourists learn more about the travel offer. Experts recommend publishing a maximum of twice a day, seven days a week, from 10 AM to 3 PM
2	Twitter	78.6%	Publication of messages/news, the attraction of experts in the field of tourism, bloggers, and people who are interested in travel. Making it easier to find with Twitter's search functions by compiling a list of keywords that best describe the business and industry and using hashtags to accompany tweets. For example, #travel, #kayaking, and #[destination] can help attract followers
3	YouTube	75%	Creating a YouTube channel, uploading videos, and giving them audiovisual meaning to engage an audience. Sharing YouTube videos can increase loyalty, inspire potential customers to learn more about a company, and make it easier to link to videos on Facebook, Twitter, and other social media platforms
4	Instagram	67.9%	Downloading the best photos and short clips and permission to share. The ability to include company information in multiple sentences in the bio along with a direct link to the website or booking page. Tagging photos with relevant destination hashtags using keywords like tours and industry
5	Foursquare	57.1%	Allowing users to post information to their social media from their mobile phones
6	Tripadvisor	53.6%	Introducing the company to the online travel community and promoting the brand through visitor comments. Customer feedback can help manage reputation and increase sales

Note: compiled based on the expert survey; \* percentage of expert mentions

### Analysis of SMM strategies

According to experts, to maximize the potential of social media, the following SMM strategies should be followed both during and after lockdown due to the coronavirus pandemic [Table 3].

**Table 3:** SMM strategies

No	SMM strategies	%*
1	Stay active on social media and be aware of the difficult situation	92.6%
2	Collect user-generated content and use it to connect with the audience	78.6%
3	Increase engagement and social media presence with comment-based giveaways	71.4%
4	Increase consumer engagement through gamification	53.6%
5	Inspire customers with discount codes and suggest directions	50%

Note: compiled based on the expert survey; \* percentage of expert mentions

Let us consider the proposed strategies in more detail.

According to the experts, while self-isolated people are far more likely to spend more time on social media; the latter should be the starting point for any travel business. It is important to stay connected with one's followers and be aware of the current situation.

Here is an example of an Instagram post posted to the official Visit California account. A beautiful photograph of Kings Canyon National Park is accompanied by a short text that successfully strengthens the relationship between the brand and its followers: "While we can only appreciate our beautiful state's parks from afar this year, we hope you can take solace in the fact that they'll be here waiting for us when the time is right" [14].

User-generated content is also known as the most authentic content travel brands can share [15]. This is still true both during the ongoing pandemic and after it ends. In this connection, according to one of the experts (Daria O., head of a travel company, 10 years of experience), "you need to encourage your subscribers in social media to share images, videos, or texts that can then be published on your pages. User-generated content increases customer loyalty and trust and creates an emotional attachment to the brand".

For example, the Museum of the City of New York asked its subscribers on social media to share photos taken after the adoption of protective measures, "documenting personal experience during this difficult time". The campaign was approved by the audience, with over 2,700 photos posted to date [16]. Another use case for user-generated content is Lonely Planet, a popular travel guide publisher. The brand invited its audience to join the "Scavenger Hunt", where members share photos of old souvenirs, first passports, hiking boots, and more. This is a great way to engage with followers and maintain brand presence and awareness on social media. Many people joined the challenge as they wanted to share photos of their travel memories and also be featured on the Lonely Planet website [17].

As one of the respondents (Stanislav N., travel agency employee, 8 years of experience) notes, "one needs to focus on sharing unique and interesting user-generated content that subscribers will want to share on their social media. This could be a video of chefs preparing food for a food tour, something as simple as a photo gallery with a preview of upcoming tours this season, or a short article on what to expect in a particular area this tourist season". Posting this type of content that visitors end up sharing on their own is direct marketing in action on social media that will help retain loyal followers for a long time [18].

The experts believed that giving out gifts on social media is the easiest way to increase presence and engagement, including during self-isolation. Depending on the type of business, there are many different prizes to offer in social media lotteries:

- free entrance tickets to museums, theaters, exhibitions, or amusement parks;
- discount coupons for holiday packages and airplane tickets;
- free holiday packages and airplane tickets;
- travel accessories [19].

Here's an example from The Journey Bound, a personalized travel planning company. The company invited its audience to join their Instagram feed based on comments. Members have joined the promotion for the chance to win a 50% discount on The Journey Bound's next trip planning services when it's safe to travel again. The requirements for the participants were simple: the organizers asked them to subscribe to their account, mention three friends in the comments section, and explain where they would like to go [20]. Brand games, according to experts, are another form of interactive promotion on social media. Brand gamification allows companies to work on social media brand awareness and lead generation [21].

### How should the tourism business operate?

The tourism business should focus on the following aspects:

- a) Use minigames to inform the audience. There is no doubt that after the restrictions are lifted, people will want to go on a tour. However, it is quite predictable that many places will continue to take protective measures. Responsible tourism will take on a new meaning as tourism destinations become more hygienically safe than before. To make travelers know how to behave, one can add brand minigames.
- b) Build brand awareness through gamification. Brand games are great not only for informing but also for entertaining the online audience. Today, people are spending more time on computers and video games due to COVID-19 restrictions. This is why incorporating a brand minigame into the marketing strategy will be successful. For example, vacation rental company Plum Guide launched an online Easter egg hunt as part of its Easter campaign, offering its audience the chance to win a £200 loan from Plum Guide. In addition to building brand trust and loyalty, they expanded their mailing list and increased brand awareness.

## CONCLUSION

Implementation of effective marketing communication campaigns on social media is an important factor in the successful promotion of a tourism enterprise, brand, or offer on the market, aimed at expanding the target audience and developing, improving, and protecting the reputation of the travel agency through the formation of consumer loyalty to the enterprise. Social media have become an integral part of travel marketing. This new way of communicating with customers has revolutionized the industry and largely replaced traditional customer communication and interaction. Now, not only industry experts post their reviews on travel-related websites and channels, but ordinary Internet users also rate destinations, create content, write reviews, share experiences, post their videos and photos, and more. Social media are valuable tools for travel companies as they can help promote services at a lower cost, grab the attention of users, and, above all, create buzz around brands, services, or travel destinations. As the results of the expert survey showed, the most promising strategies for SMM in the field of tourism are currently being active on social networks and aware of the complexity of the situation; collecting user-generated content and using it to connect with the audience; increasing engagement and presence on social media through giveaways based on comments; increasing consumer engagement through gamification; motivating customers with discount codes and proposing new tourist destinations. The results have confirmed the hypothesis of the study that to overcome the negative consequences of the coronavirus pandemic, it is necessary to introduce new marketing strategies in SMM, with the involvement of the maximum number of social media.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] Berthon RP, Pitt FL, Plangger K, Shapiro D. [2012] Marketing meets Web 2.0, social media, and creative consumers: Implications for international marketing strategy. *Business Horizons*, 55:261–271.
- [2] Constantinides E [2014]. Foundations of Social Media Marketing. *Procedia - Social and Behavioral Sciences*, 148:40-57.
- [3] Sheth JN, Sharma A. [2005] International e-marketing: opportunities and issues *International Marketing Review*, 22(6):611-622.
- [4] Schroeder A, Pennington-Gray L. [2014] The Role of Social Media in International Tourist's Decision Making. *Journal of Travel Research*, 54:584–595.
- [5] Dwityas NA, Briandana R. [2017] Social Media in Travel Decision Making Process. *International Journal of Humanities and Social Science*, 7:193–201.
- [6] Vaisakh J, Abirami LS, Krishnachandran C, Arun K. [2020] Tourism Marketing Through Social Media After Covid-19 in Kerala. *International Journal of Advanced Science and Technology*, 29(7):11481-11486.
- [7] U SC, So YC. [2020] The impacts of financial and non-financial crises on tourism: Evidence from Macao and Hong Kong. *Tourism Management Perspectives*, DOI: 10.1016/j.tmp.2019.100628.
- [8] Hafele N. [2011] Social Media Marketing: Interaction, Trends & Analytics. *ICT 511 Fall*, 51(3): 1-6.
- [9] Hill PR, Moran N. [2011] Social marketing meets interactive media: lesson for advertising company. *International Journal of Advertising*, 30(5): 815–838.
- [10] Bansal R, Masood RZ, Dadhich V. [2014] Social Media Marketing-A Tool of Innovative Marketing. *Journal of Organizational Management*, 3(1): 1-7.
- [11] Gurau C. [2008] Integrated online marketing communication: implementation and management. *Journal of Communication Management*, 12(2): 169-184.
- [12] Chen Y, Fay S, Wang Q. [2011] The role of marketing in social media: How online consumer reviews evolve. *Journal of interactive marketing*, 25(2): 85-94.
- [13] Katsikari C, Hatzithomas L, Fotiadis T, Folinas D. [2020] Push and Pull Travel Motivation: Segmentation of the Greek Market for Social Media Marketing in Tourism. *Sustainability*, DOI: 10.3390/su12114770.
- [14] Tuclea C, Vrânceanu DM, Năstase CE. [2020] The Role of Social Media in Health Safety Evaluation of a Tourism Destination throughout the Travel Planning Process. *Sustainability*. DOI: 10.3390/su12166661.
- [15] Munar AM, Jacobsen JKS. [2014] Motivations for sharing tourism experiences through social media. *Tourism Management*, 43:45-54.
- [16] Lalicic L, Huertas A, Moreno A, Jabreel M. [2020] Emotional brand communication on Facebook and Twitter: Are DMOs successful? *Journal of Destination Marketing & Management*. DOI: 10.1007/978-3-319-72923-7\_13.
- [17] Joo Y, Seok H, Nam Y. [2020] The Moderating Effect of Social Media Use on Sustainable Rural Tourism: A Theory of Planned Behavior Model. *Sustainability*, DOI: 10.3390/su12104095.
- [18] Tham A, Mair J, Croy G. [2020] Social media influence on tourists' destination choice: Importance of context. *Tourism Recreation Research*, 45:161–175.
- [19] Tham A, Croy G, Mair J. [2013] Social media in destination choice: Distinctive electronic word-of-mouth dimensions. *Journal of Travel and Tourism Marketing*, 30:144-155.
- [20] Gálvez-Rodríguez M, Alonso-Cañadas J, Haro-De-Rosario A, Caba-Pérez C. [2020] Exploring best practices for online engagement via Facebook with local destination management organisations (DMOs) in Europe: A longitudinal analysis. *Tourism Management Perspectives*, DOI: 10.1016/j.tmp.2020.100636.
- [21] Michaelidou N, Siamagka NT, Christodoulides G. [2011] Usage, barriers and measurement of social media marketing: An exploratory investigation of small and medium B2B brands. *Industrial marketing management*, 40(7):1153-1159.



ARTICLE

# ESTIMATION OF THE INFLUENCE OF DEMOGRAPHIC INDICATORS ON DEVELOPMENT OF REGIONAL ECONOMY USING ARTIFICIAL NEURAL NETWORKS

Vitaly Mikhailovich Tatyankin\*, Vadim Faruarovic Islamutdinov

Yugra State University, Chekhova Street, 16, Khanty-Mansiysk, 628012, RUSSIA

## ABSTRACT

**Background:** This article describes the use of artificial neural networks for analysis of quantitative and qualitative interrelations between demographic and economic systems of northern resource-extracting region in the Russian Federation. This work is aimed at determination of demographic indicators having key influence on development of economic sectors of northern resource-extracting region in the Russian Federation. **Methods:** Methods of machine learning based on artificial neural networks were used in this work. A deep-belief neural network with sigmoid activation function was considered. The number of processing layers and neurons in them was selected according to preliminary analysis of learning sample. The learning sample and reference values were normalized with respect to the range from 0 to 2/3. The learning sample was based on data characterizing demographic indicators of the region. The indicators of economic sectors of the region were used as reference values. **Results:** An algorithm of econometric studies based on machine learning including development of mathematical model of the considered object as well as interpretation of the obtained results, was proposed. Coefficients of importance and coefficients of influence of demographic indicators on performances of development of economic sectors were obtained. Conditional correlation coefficient was determined. The obtained mathematical model of economic development of a northern resource-extracting region as a function of dynamics of demographic indicators was characterized by high degree of adequacy, which was confirmed by root mean square error of simulation equaling to 0.069 %. **Conclusion:** Assessment and verification of the proposed algorithm confirmed its high capabilities to reveal complicated interrelations between demographic indicators and performances of economic sectors of the region. The indicators of dynamics of birth rate and average income of inhabitants were the most important for development of economic sectors of a northern resource-extracting region in terms of artificial intelligence.

## INTRODUCTION

### KEY WORDS

Machine learning; deep-belief neural networks; demography; economic sectors; northern resource-extracting region

Social and economic systems are developed in unbreakable bond between economic and social constituents of economy. The social constituent manifests itself in statistics in the form of demographic indicators: birth rate, mortality rate, expectancy of life, etc. Therefore, it is very important to determine the influence of demography on development of a northern resource-extracting region.

At present, there are few scientific studies devoted to this topic. The work by Abdyusheva [1] should be highlighted, where regression models are proposed for birth rate and expectancy of life as a function of economic indicators. Belyaevskii [2] describes the approaches to analysis of the impact of market processes on demography and reverse impact. The mathematical apparatus is also comprised of regression analysis. In the work by Molchanova and Kruchek [3], the regression models of medical and demographic indicators are presented as a function of economic indicators. It is demonstrated that average expectancy of life directly depends on economic development. Procedural foundations of mathematical simulation of interrelation between demographic and economic indicators are considered in the thesis by Ketova [4].

Similar situation is observed in foreign publications. The works devoted to this topic are not numerous [5, 6]. In general, they state the benefits of demography development for overall national economy, however, they do not attempt to estimate qualitative and quantitative constituent of each demographic indicator.

The performed analysis of the investigated topic has demonstrated that simulation of interrelations between demographic and economic indicators is narrowly focused and applied either to single regions or to a whole country. It should be mentioned that all proposed approaches are based on regression analysis. Using this approach, it is possible to analyze the interrelation between indicators of development of economic sectors and demographic indicators of a northern resource-extracting region. However, this approach has its limitations and disadvantages. For instance, the use of standard statistic methods does not allow to reveal the implicit logically unexplainable interrelations. The implicit interrelations are revealed well by more intelligent methods, for instance, neural networks of deep learning.

In addition, the use of correlation regression analysis requires high purity and confidence of initial data, where as in the case of neural networks, errors and missed data are not so critical.

Artificial neural networks as an independent theoretical field were formed in 1950–1960 due to the works by McCulloch, Pitts, Wiener, and Rosenblatt [7–9]. Practical interest to neural networks was attracted in late 1990-s, when the backpropagation method was significantly improved simultaneously by two groups of scientists [10–11]. Almost all learning algorithms of artificial neural networks are based on this method. In 2006 G. Hinton et al. [12] proposed algorithms of deep learning of multilayer neural networks, which initiated a new stage of development of artificial neural networks. According to the scientists of Massachusetts Technological Institute, the proposed algorithms are included in the list of ten most challenging technologies capable to modify human life [13].

\*Corresponding Author

Email:

tatyankin.v.m@mail.ru

Received: 5 Nov 2020  
Accepted: 8 Dec 2020  
Published: 14 Dec 2020

At present, artificial neural networks are used for solution to the following problems: image recognition, decision making, clusterization, approximation, data compression, and content-addressable memory [14]. Despite the fact that no separate trend of application of artificial neural networks in econometrics is highlighted, there are some popular works devoted to this subject [15-21].

The considered aspects confirmed high generalizing capabilities of artificial neural networks, especially upon solution to hardly formalized problems. A disadvantage of the considered solutions was that they were narrowly focused and did not allow solving the problems formulated in this work. Therefore, the algorithm has been developed to estimate the influence of demographic indicators on the indicators of development of economic sectors using artificial neural networks (hereinafter: the algorithm).

## METHODS

### Algorithm

The developed algorithm includes the following: description of the set of input data for econometric analysis, algorithm of the use of artificial neural networks for determination of mathematical model of the considered object, as well as interpretation of the obtained results. The algorithm assumes consecutive execution of the following actions:

- i. Preparation of primary data for analysis. They can be borrowed from various databases of international statistics [22].
- ii. Formation of learning sampling and references from collected primary information in Issue 1. During formation of learning sampling and references the data should be normalized with regard to the range from 0 to 0.5.
- iii. Selection of neural network architecture. Deep-belief neural network is proposed as the basic type, where autoencoder method is used for pre-learning. Sigmoid should be used as activation function. In order to determine neural network architecture, the recommendations in [23] should be used.
- iv. Learning of neural network to predefined error.
- v. Analysis of the obtained results. This is aided by the three-step procedure:

Single signal for each neuron of input layer is passed separately through the trained neural network obtained in Issue iv. This results in the importance matrix of the indicators:

$$\text{Importance\_matrix}_{ij}, \quad (1)$$

where  $i$  is the number of neurons in output layer of the neural network,  $j$  is the number of elements in input layer of the neural network. Using the importance matrix, we arrange the importance matrix of the considered indicators using the following equations:

$$[a_i, b_i] = \max(\text{Importance\_matrix}_i), \quad \text{for each } i(2)$$

$$\text{IM\_Investigated\_Indicators}_{b_i 2} = +1, \quad \text{for each } i(3)$$

$$[d_i, e_i] = \min(\text{Importance\_matrix}_i), \quad \text{for each } i(4)$$

$$\text{IM\_Investigated\_Indicators}_{e_i 1} = +1, \quad \text{for each } i(5)$$

where  $a_i$  is the maximum value of the string  $i$  of the matrix Importance\_matrix,  $b_i$  is the number of column with the maximum  $a_i$  in the string  $i$  of the matrix Importance\_matrix,  $d_i$  is the minimum value of the string  $i$  of the matrix Importance\_matrix,  $e_i$  is the number of column with the minimum  $d_i$  in the string  $i$  of the matrix Importance\_matrix, IM\_Investigated\_Indicators is the importance matrix of the considered indicators.

- The number of negative and positive weight coefficients of the input layer of trained neural network is calculated. In terms of importance, the indicators are ranked in ascending order of weight coefficient of input layer. This is a consequence of the use of sigmoidal function.
- The conditional correlation coefficient is calculated. This indicator allows to estimate the obtained regularities by common interval of correlation from -1 to 1. It is calculated from the assumption that the influence coefficients are distributed over sigmoid for which the value of 0.5 corresponds to the absence of influence (the consequence of normalization with regard to 0.5). The following equation is used for the calculations:

$$CCC = (CI - 0.5) * 2, \quad (6)$$

where CCC is the conditional correlation coefficient, CI is the coefficient of influence. Respectively, the coefficient of influence below 0.5 corresponds to negative values of conditional correlation coefficient.

### Description of input data

In order to assess and to verify the developed algorithm, the problem of determination of interrelation between indicators of development of economic sectors and demographic indicators of northern resource-extracting region was solved using the example of Khanty–Mansi Autonomous Okrug–Yugra (KhMAO–Yugra). The following main economic sectors were considered:

- Mineral extraction.
- Processing companies.
- Wholesale and retail companies, including small business.
- Construction and production of construction materials.
- Transport.
- Financial activity.
- Agriculture, fishery, fish farming, hunting and forestry.
- Information and communication technologies.
- Production and distribution of electric energy, gas, and water.
- Service sphere, including such types of economic activity as provision of other public, social, and personal services; health care and social services; education; state management and provision of military security; real estate operations, leasing and service rendering; hotels and restaurants.

The following indicators were considered for each economic sector:

- Value added of the sector.
- Number of companies in the sector.
- Number of employees in the sector.
- Fixed assets in the sector.
- Deterioration rate of the fixed assets in the sector.
- Turnover of the companies in the sector.
- Number of shipped products in the sector.
- Import of the sector.
- Export of the sector.
- Profit and loss in the sector.
- Specific weight of unprofitable companies in the sector.
- Profitability of products in the sector.
- Investments into the sector.

### Example of input data

In total 96 indicators for all sectors were derived from 2005 to 2015. Not all economic sectors were characterized by all aforementioned indicators. The initial data for mineral extraction sector are exemplified in [Table 1]. All numerical indicators of the economic sectors are summarized at GitHub [24].

**Table 1:** Indicators of mineral extraction industry

Indicators	Years										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Value added, RUB bln	1,048	1,151	1,201	1,267	1,149	1,242	1,635	1,835	1,823	1,870	1,978
Number of companies	323	380	432	449	621	599	744	830	855	916	869
Number of employees, thousand persons	150.8	161.2	161.6	170.4	169	195	194.1	197.7	200.3	204.2	212.3
Fixed assets value, RUB bln	1,255	1,497	1,879	2,209	2,657	2,970	3,339	3,945	4,681	4,646	5,153
Deterioration rate of fixed assets, %	58.1	59.2	57.6	54.8	56.6	56.5	57.9	59	62	65	65.7
Turnover of the sectoral companies, RUB bln	1,285.1	1,486.2	1,539	1,831.2	1,725.1	1,904.5	2,428.5	2,767.9	2,676	2,785	3,136
Shipped amount, RUB bln	3,062	3,721	4,489	5,272	5,091	6,218	8,020	8,950	9,214	9,691	11,170
Import, USD mln	393.8	446.9	570	809.1	1,285.6	946.4	1,335.4	976	1,071.4	1,227.9	801.5
Export, USD mln	10.2	10.7	5.6	8.5	179.4	195.9	17.8	83	64.9	160.4	521.1
Profit, RUB bln	288	660	377	366	393	353	559	520	644	1,318	1,229
Specific weight of unprofitable companies, %	25	23.9	12	29.4	31.3	30.9	34.5	28.8	33.1	45.2	36.2

Product profitability, %	43.4	34	32.7	20.7	28.6	23.2	24.6	24.5	20.5	16.5	21.1
Investments, RUB bln	140	205	259	320	314	351	459	462	478	510	576

The following demographic indicators were used [Table 2]:

- Population, birth rate, per 10 thousand persons;
- Birth rate, per 10 thousand persons;
- Mortality rate, per 10 thousand persons;
- Expectancy of life, years;
- Marriage rate, per 10 thousand persons;
- Divorce rate, per 10 thousand persons;
- Migration gain, per 10 thousand persons;
- Average income of inhabitants, RUB.

The data source was the Federal State Statistics Service [25].

**Table 2:** Demographic indicators of KhMAO–Yugra

Indicators	Years										
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	1,468	1,488	1,505	1,520	1,539	1,537	1,561	1,584	1,597	1,612	1,626
2	13.6	13.7	14.6	15.3	15.6	16.4	16.4	17.7	17.5	17.2	16.6
3	7.1	6.8	6.7	6.8	6.6	6.8	6.5	6.3	6.3	6.4	6.4
4	67.82	68.84	69.35	69.91	70.45	70.30	70.91	71.79	72.23	72.27	72.58
5	9.7	10.5	11.5	10.6	10.7	11.3	12	10.6	10.5	10	9.3
6	6.7	6.9	7	7.1	7	7.1	7.1	6.6	6.3	6.3	5.7
7	-27	-1	34	11	32	8	57	32	-29	-16	-11
8	18,115	22,380	27,110	32,872	32,263	32,385	33,926	36,345	39,292	41,503	44,538

## RESULTS AND DISCUSSION

The numerical assessment of the proposed method using the data of KhMAO–Yugra resulted in deep-belief neural network with the learning error of 0.069 %.

[Table 3] summarizes the results for the importance matrix of the considered indicators. The weight coefficients of input layer of trained deep-belief neural network are analyzed. Detailed analysis of the obtained numerical results can be found at GitHub [24].

**Table 3:** Importance matrix of the considered indicators

Indicators	Less important	Most important	Difference
Population	0	2	2
Birth rate	21	42	21
Death rate	39	13	-26
Expectancy of life	6	7	1
Marriage rate	9	11	2
Divorce rate	9	5	-4
Migration gain	9	2	-7
Average income of inhabitants	3	14	11

According to [Table 3], the birth rate is the most important indicator for development of sectors in KhMAO–Yugra, the average income of inhabitants occupies the second position. The indicators of the least influence are the mortality rate, the migration gain, and the divorce rate. The influence of such indicators as the expectancy of life, the marriage rate, and the population is weak, if any. The migration gain should be considered separately. Its weak influence on economic development is stipulated mainly by the fact that this indicator is negative, that is, higher number of persons leave the Okrug in comparison with newcomers. Moreover, this is highly volatile indicator, which influences the simulation quality.

Analysis of [Table 4] confirmed the trends revealed upon consideration of [Table 3]. The birth rate is again the most important indicator for development of economy sectors. The second position is shared by the average income of inhabitants and the marriage rate. The mortality rate also leads by a wide margin with respect to negative influence on development of economy sectors.

**Table 4:** Statistics of input layer of trained deep-belief neural network

Indicators	Negative dependence	Positive dependence	Average weight coefficients
Population	8	7	-0.32
Birth rate	11	4	-4.91
Death rate	9	6	0.71
Expectancy of life	8	7	-0.05
Marriage rate	8	7	-2.50
Divorce rate	9	6	-1.65
Migration gain	9	6	-1.01
Average income of inhabitants	7	8	-3.10

### Conditional correlation coefficient

[Tables 5–8] summarize the conditional correlation coefficients for the birth rate and the average income of inhabitants.

**Table 5:** Conditional correlation coefficient for birth rate. Indicators of sectors with positive influence

Indicators of sectors	Coefficient of influence	Conditional correlation coefficient
Specific weight of unprofitable agricultural companies	0.999896	+0.999792
Product profitability of power engineering companies	0.971219	+0.942438
Fixed assets of mineral extraction companies	0.961313	+0.922626
Turnover of construction companies	0.958428	+0.916856
Turnover of wholesale and retail companies in KhMAO–Yugra	0.953416	+0.906832

Analysis of [Table 5] demonstrated significant direct influence of the birth rate on the specific weight of unprofitable agricultural companies, the product profitability of power engineering companies, and the fixed assets of mineral extraction companies. However, this is attributed to certain random factors, whereas the interrelation of the birth rate with such indicators as the turnover of construction companies and the turnover of wholesale and retail companies in KhMAO–Yugra is attributed to increase in consumer demands in the considered sectors.

**Table 6:** Conditional correlation coefficient for birth rate. Indicators of sectors with negative influence

Indicators of sectors	Coefficient of influence	Conditional correlation coefficient
Passengers transported by motor vehicles	0.0590	-0.881
Export, USD mln	0.0629	-0.874
Profit, loss in mineral extraction sector	0.1409	-0.718

In [Table 6] the interrelation of birth rate with the number of transported passengers and financial results of mineral extraction sector is random, whereas the negative dependence of export can be attributed to increased consumption in the region.

**Table 7:** Conditional correlation coefficient for average income of inhabitants. Indicators of sectors with positive influence

Indicators of sectors	Coefficient of influence	Conditional correlation coefficient
Shipped products in construction industry	0.999972	+0.999944
Fixed assets of processing companies in KhMAO–Yugra	0.996754	+0.993508
Balanced financial result (profit, minus, loss) for economy in total	0.996221	+0.992442
Fixed assets of construction sector	0.995303	+0.990606
Cost of products of processing companies in KhMAO–Yugra	0.992645	+0.98529

In [Table 7] the positive influence of average income of inhabitants on balanced financial results could be probably attributed to coincidence of income dynamics of inhabitants and companies. And the positive influence of average income of inhabitants on the indicators of construction and processing companies is

quite obvious, since the income increase results in increase in consumption. Perhaps, in the region this is expressed in increased expenses for purchase and construction of housing as well as products of processing companies.

**Table 8:** Conditional correlation coefficient for average income of inhabitants. Indicators of sectors with negative influence

Indicators of sectors	Coefficient of influence	Conditional correlation coefficient
Profit and loss in transportation sector	0.000878	-0.998244
Norm of federal spending (taxation)	0.071524	-0.856952
Amount of freight transport by road	0.116699	-0.766602

Negative influence of average income of inhabitants on indicators of transportation sector in [Table 8] can be attributed to the fact that with the increase in incomes, the structure of consumption of transportation services varies in favor of personal vehicles. The negative influence on federal spending is attributed to the fact that the region is a budget donor, high portion of rent is withdrawn in the form of taxes (about 90%). Therefore, the increase in the incomes of inhabitants in the region is possible only with the decrease in tax burden, when more money is retained in the region.

### Novelty of the research

The analysis of the subject area has shown that there are no works devoted to the definition of demographic indicators that have key impact on the development of economic sectors in the northern resource-extracting region of the Russian Federation. In order to solve this problem, an econometric research algorithm based on machine learning has been developed, which allowed identifying implicit, logically inexplicable relationships. The peculiarity of the algorithm consists in determining the coefficients of importance and the coefficients of demographic indicators influence on the indicators of the development of branches of the regional economy using the parameters of the trained neural network.

## CONCLUSION

An algorithm for econometric research based on machine learning has been proposed, including the construction of a mathematical model of the object under study, as well as the interpretation of the results obtained. Approbation and multiple verification of the proposed algorithm have confirmed its high ability to identify complex patterns between demographic indicators and indicators of sectors of the regional economy. The mathematical model of development of sectors of a northern resource-extracting region as a function of dynamics of demographic indicators, developed by means of deep-belief neural network, is characterized by high rate of adequacy. This is confirmed by the root mean square error of simulation equaling to 0.069%. The coefficients of importance and coefficients of demographic indicators influence on the indicators of development of the regional economy branches have been obtained. The most important for the development of economic sectors of the northern resource-extracting region from the point of view of artificial intelligence are indicators of the dynamics of "birth rate" and "average income of inhabitants." At the same time, the mortality rate is by far the leader in terms of negative impact on the development of economic sectors. Conditional coefficients of correlation between the "birth rate" and "average income of inhabitants" indicators for the sectors of the economy have been calculated. Further development of the obtained method consists in the expansion of geography of studies by addition of new regions. This would improve the simulation quality as a consequence of building up of primary data for analysis. Such increase in the data amount and, respectively, forecast quality can be achieved by using data for shorter time intervals: quarter, month, if they are available. In addition, a very challenging trend is involvement of information from big databases as well as free online data into scientific turnover. Separate investigation is planned regarding the influence of demographic indicators on the properties of development of regional economic sectors using standard econometric approaches.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES<sup>#</sup>

- [1] Abdyusheva SR. [2015] Estimation of interrelation between demographic and economic indicators. Proceedings of 4th All-Russian Conference Devoted to the 75th Anniversary of Faculty of Physics and Mathematics. Ufa, RU.
- [2] Belyavskii IK. [2014] Social demographic marketing: problems, objectives, analysis. *Ekonomicheskaya teoriya, analiz, praktika*, 3:92–111.
- [3] Molchanova EV, Kruchek MM. [2015] Estimation of interrelations of medical and demographic with social and

- economic indicators of regional developments using economic and mathematical methods. Proceedings of 6th Ural Demographic Forum: Demographic Processes in Post-Soviet Territory, RU
- [4] Ketova KV. [2004] Optimum distribution of capital investments with consideration for demographic forecast: cand. thesis. Izhevsk.
- [5] Lucas RE. [1988] On the mechanics of economic development. Journal of Monetary Economics, 22:3–42.
- [6] Schultz ThW. [1981] Investing in People. The Economics of Population Quality. Berkeley: University of California Press, USA.
- [7] Wiener N. [1961] Cybernetics: Or Control and Communication in the Animal and the Machine. Paris: Hermann & Cie, Camb. Mass. (MIT Press), USA.
- [8] Rosenblatt F. [1986] Principles of neurodynamics; perceptrons and the theory of brain mechanisms. In: Palm G, Aertsen A (eds) Brain Theory. Springer, Berlin, Heidelberg. DOI: 10.1007/978-3-642-70911-1\_20.
- [9] McCulloch WS, Pitts W. [1943] A logical calculus of the ideas immanent in nervous activity. Bull Math Biophys, 5:115–133.
- [10] Rumelhart DE, Hinton GE, Williams RJ. [1986] Learning Internal Representations by Error Propagation, in: Parallel Distributed Processing, Cambridge: MIT Press, USA, p318 – 362.
- [11] Bartsev SI, Okhonin VA. [1986] Adaptive data processing networks. Krasnoyarsk: Institute of Physics, Academy of Sciences of the USSR, Siberian Branch, RU
- [12] Hinton GE, Osindero S, Teh YW. [2006] A fast learning algorithm for deep belief nets. Neural Computation, 18(7):1527–1554.
- [13] Golovko V. [2015] From multilayers perceptrons to deep belief neural networks: Training paradigms and application, Lectures on Neuroinformatics, Golovko, VA. (Edt.), Moscow: NRNU MEPhI, p47–84.
- [14] Artificial neural network. Retrieved from: [https://en.wikipedia.org/wiki/Artificial\\_neural\\_network](https://en.wikipedia.org/wiki/Artificial_neural_network)
- [15] Kuan CM, White H. [1994] Artificial neural networks: An econometric perspective. Econometric Reviews, 13(1):1–91.
- [16] Luxhøj JT, Riis JO, Stensballe B. [1996] A hybrid econometric-neural network modeling approach for sales forecasting. International Journal of Production Economics, 43(2–3):175–192.
- [17] Hruschka H. [1993] Determining market response functions by neural network modeling: A comparison to econometric techniques. European Journal of Operational Research, 66(1):27–35.
- [18] Moshiri S, Cameron N. [2000] Neural network versus econometric models in forecasting inflation. Journal of Forecasting, 19(3):201–217.
- [19] Church KB, Curram SP. [1996] Forecasting consumers' expenditure: A comparison between econometric and neural network models. International Journal of Forecasting, 12(2):255–267.
- [20] Frey UJ, Rusch H. [2013]. Using Artificial Neural Networks for the Analysis of Social-Ecological Systems. Ecology and Society, 18(2):40.
- [21] Mohammadfam I, Soltanzadeh A, Moghimbeigi A, Savareh BA. [2015] Use of Artificial Neural Networks (ANNs) for the Analysis and Modeling of Factors That Affect Occupational Injuries in Large Construction Industries. Electron Physician, 7(7):1515–1522.
- [22] Databases of international statistics. Retrieved from: [http://lib.isert-ran.ru/files/lib/indexes\\_and\\_stats.pdf](http://lib.isert-ran.ru/files/lib/indexes_and_stats.pdf)
- [23] Golovko VA, Krasnoproshin VV. Neurosetevye tekhnologii obrabotki dannykh [Neural Network Data Processing Technologies]. Minsk BGU.
- [24] GitHub, Inc. Retrieved from: <https://github.com/VitalyHMAO/Data>
- [25] Federal State Statistics Service, Statistical reports. Retrieved from: [http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/publications/catalog](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog)

<sup>#</sup>English translations of the references are presented.

## ARTICLE

# CYBER-PHYSICAL SYSTEMS AT THE INTERSECTION OF HUMAN AND ARTIFICIAL INTELLIGENCE

Vladimir Grigorievich Prudskiy<sup>1,2\*</sup>, Andrei Mikhailovich Oshchepkov<sup>1</sup>, Maxim Alexandrovich Zhdanov<sup>1</sup>

<sup>1</sup>Department of Management, Perm State University, Bukireva Street, 15, Perm, 614990, RUSSIA

<sup>2</sup>Perm Branch, Institute of Economics of Ural Division, Russian Academy of Sciences, Baramzinoi Street, 42/2, Perm, 614046, RUSSIA

## ABSTRACT

The era of the global deployment of the fourth industrial revolution and the transition to cyber-physical systems, experienced by society in the 21<sup>st</sup> century, globally raised the question of the role and place of artificial intelligence in the emerging digital economy. At the same time, the question arose about the relationship between artificial and human intelligence, managerial artificial intelligence and managerial human intelligence, human individual management intelligence and human command and control intelligence. Modeling and analysis of the relationship between the evolution of artificial intelligence and the transformation of human and managerial human intelligence have acquired particular importance. This article presents a study of the interdependencies between the historical progress of technical resources in social production and human intellectual development, as well as the interrelationships between the development of artificial and human intelligence, managerial artificial and managerial human intelligence in the transition to cyber-physical organizations.

## INTRODUCTION

The technical and economic basis of the fourth industrial revolution, which takes place in modern industrial countries, is objectively connected with the transition of these countries' economies to cyber-physical systems that form a qualitatively new material and technical basis of social reproduction.

Cyber-Physical Systems (CPS) are systems consisting of various natural objects, artificial subsystems and operating controllers that allow representing these elements as a whole. CPS provides a close communication and coordination between computing and physical resources. Computers monitor and control physical processes using a feedback loop where events in physical systems affect computation and vice versa» [1]. Technically, the transition of social reproduction to using cyber-physical systems is based on the expansion of the integrated development in digital technologies, automatic electromechanical devices (robots), the Internet and artificial intelligence. As a result, this assimilation and spread of cyber-physical systems in the economies of industrial countries objectively stimulates deep structural changes in them - first, production-technological and spatial-sectorial, and then socio-economic and institutional-managerial. Historically, industrial and technological structural shifts are of a worldwide universal nature and are directed by global industrial and technical development. This development happens in several stages and is manifested in the transition of all countries and territories from manual tool labor to machine-mechanical one. The first stage took place in the XIX century and consisted in the transition to steam-mechanical labor. The second stage showed first the transition to electromechanical labor (XX century), and then - to the automated electromechanical one with the widespread use of the information technology (last quarter of XX - first half of XXI century). Production and technological structural shifts (and the subsequent spatial and sectoral economic changes) at first, historically stimulate the changes in the technical equipment and organization of social labor, then – quantitative and qualitative social and personal transformations – the development of human intelligence. It resulted in the shifts in social and economic system of social reproduction.

Consequently, the transition to cyber-physical systems of reproduction, which use artificial intelligence, should be objectively accompanied not only by the transformation in the organization of social labor and socio-economic relations, but also by the corresponding development of human intelligence, coupled with the evolution of artificial intelligence.

## THE INTERRELATION OF TECHNICAL RESOURCES OF PRODUCTION AND INTELLECTUAL DEVELOPMENT OF A PERSON

### The evolution of the technical resources of production

Socio-economic systems are the social relations systems of people as participants in joint production, and the human's role in these relations is to act as subjects of individual complexes, possessing the corresponding intelligences. Qualitative changes in the social economy's means of production influence both the development of socio-economic systems of human interaction and their personalities with their inherent human intelligences. In prehistoric times, the industrial and technological shifts in social economy (the development of primitive tools of labor - sticks, stones, bones) influenced the transition from savagery

**KEY WORDS**  
cyber-physical systems,  
cyber-physical  
organisations, artificial  
intelligence, human  
intelligence, managerial  
human intelligence

Received: 3 Nov 2020  
Accepted: 11 Dec 2020  
Published: 14 Dec 2020

\*Corresponding Author  
Email:  
pvg@psu.ru



to primitive appropriating production (hunting and gathering). Industrial and technological structural shifts associated with the domestication of animals and plants led to the transition to primitive reproduction (primitive agriculture and animal husbandry). The emergence of metal tools gave impetus to the transition of human society to instrumental reproduction. The appearance of steam and electric engines led to the transition of mankind to machine reproduction.

In the first half of the 21st century, the humanity made a transition to cyber-physical reproduction thanks to the creation of electronic computing technology. The development of this technology led to the emergence of artificial intelligence, which later caused the integration of artificial intelligence with electromechanical technology and the Internet. It is historically inevitable that changes in the organization of social labor and in the structure of social reproduction as a socio-economic system give impetus to the progress of human personalities as key elements in the socio-economic system of social production and the development of their human intelligence as a necessary resource for participation in social production. The transition of humanity to primitive appropriating production objectively forced primitive man to master the skills and abilities, the elements of intelligence necessary for rational public participation in joint hunting and gathering in the primitive herd conditions. The development of primitive reproduction (primitive agriculture and animal husbandry) gave an impulse to developing in people the elements of both individual and group intelligence, which are necessary for planning and coordinating joint agricultural activities in the context of the tribal organization of social management and cyclically changing natural environment. The advent of metal tools gave impetus to the development of human intelligence, necessary to ensure the effective use of instrumental technology and rational participation in the intensively deepening division and expanding cooperation of social labor. The transition to machine production and the increase in the share of the mental labor there in the structure of social labor costs forced the intensive development of educated and creatively oriented human intelligence, which ensures that the complex machine technology has the economically efficient use in the conditions of periodically changing industrial cycles and technological modes of industrial production.

### The need to develop human intelligence

In the first half of the XXI century the mankind made a transition to the sixth technological order of industrial production, to cyber-physical technical systems of reproduction, that use artificial intelligence. This should require the corresponding development of human intelligence. Industrial countries expand the development of cyber-physical systems and digital technologies of the sixth technological mode of industrial production. In its economic essence, this development represents their historical transition from automated electromechanical production to cyber-physical (using artificial intelligence) social labor and production. This transition is related to the ongoing qualitative leaps in the economic content of two interrelated aspects of social labor - technical and technological (the system of human influencing the objects of labor with tools of labor) as well as social and personal (the system of interaction between people in the labor process). Production and technical systems are beginning to form in the technical and technological content of labor (impact on nature). They integrate not only electromechanical tools, high-tech materials, electric motors, means of transmitting electricity over distances, automated control systems, but also controllers through the Internet and information technologies, physical and technical formations of artificial intelligence. In turn, the progress of the social labor's technical and technological content should objectively determine the transformation of its social and personal content (human interaction). Qualitative changes are observed in the systems of economic, organizational and managerial relations, in the nature of work, in the competencies and intelligence of workers. In this case, the intellectual and creative competences of employees are of particular importance.

Thus, it is becoming critical that the transition to a social economy based on the expanding use of cyber-physical systems is conditioned by the development of artificial intelligence in production and technical systems, and by the development of intellectual and creative abilities in workers in socio-organizational ones.

### The interrelation between the two categories

The development of the social labor content (impact on nature) consistently determines, structural changes in social reproduction, followed by systemic transformations at enterprises and in the national economies of individual countries and, as a consequence, in the world economy as a whole. Cyber-physical trends and processes are driving «a gradual blurring of the boundaries between the industrial and service sectors. Hybrid industrial and service corporate giants are emerging. They simultaneously produce physical products, maintain powerful network and computer infrastructure, and at the same time, develop software products and services, sell services and serve customers [2]. Industries and enterprises undergo cyber-physical technological integration based on expanding the implementation of digital technologies. This process will objectively give an impetus to developing full life cycles chains of science-intensive products within industrial complexes, including science-intensive services, extraction of raw materials and production of construction materials, manufacturing finished products, after-sales service and conventional services, waste disposal and environmental service.

This should give a corresponding impetus to the transformation of small and medium-sized businesses, which are developing under the influence of integration into these cyber-physical full life cycles chains of science-intensive reproduction.

Production systems of individual economic entities accumulate structural changes which inevitably gives an impetus to the growth of structural and systemic transformations in national economies. This is manifested in an increase in the share of science-intensive goods and services in the reproduction structure of the gross national product. A highly educated middle class transforms into the main social stratum in the structure of labor resources reproduction. It is engaged in knowledge-intensive innovative labor, based on the widespread use of cyber-physical production means.

The transformation processes of property relations will play the leading role in the structure of economic relations reproduction as well as in institutional and managerial organizational forms of social production. As a result, socio-organizational systems are beginning to be of key importance for economic growth, providing cost-effective and competitive cyber-physical integration of industries and enterprises based on the expansion of the implementation of digital technologies, Internet capabilities, artificial intelligence, as well as the development of creative and intellectual competencies of workers. The development of structural and systemic changes in national economies causes qualitative changes in the structure of the world market economy, in the system of global market economy and in global competition. Gradually, the development and implementation of cyber-physical strategic competitive competencies are becoming the key factors of global competitive success. As a result, the transformation of monocentric globalization is growing and it turns into a polycentric one. The latter is aimed at balancing the development of the world and national economies on the basis of successes in the competitive development of cyber-physical systems and industries. The course of this structural and systemic development in society (as a social system) and in its basic elements (organizations) consistently transforms the corresponding interrelated and interacting components (internal systems).

- First, it transforms the material and technical system (technological links) of interaction between the means of production.
- Secondly, it changes the reproduction system of personal social and labor resources in social systems (organizational and personal relations), providing intellectual development of new material and technical capabilities of social production.
- Thirdly, it modifies the socio-economic system (economic relations and institutions), which ensures the socio-economic interaction between the subjects of production activity (workers and organizations).

These systems are interconnected in each organization (social structure). They interact and develop continuously, acting as subsystems of a controlled social system.

At the same time, according to the system approach, these systems act as correspondingly interconnected and interacting subsystems in the structure of the organization as a social system. Thus, theoretically, a cyber-physical organization represents a specific form of a social system. The corresponding production and labor processes are carried out within this organization, and they form its internal dynamic content. As it was already mentioned, there are two main components in the content of social labor as a result of the interaction between technical and human factors of production. The first is technical and technological, the second one is social and personal.

These components develop dialectically in the context of public economy transition to cyber-physical systems and digital technologies. This objectively generates dialectically interconnected qualitative changes in them. On the one hand, artificial intelligence organizations emerge and develop in the production and technical systems. On the other hand, creative human intelligence emerges and develops in the social and labor systems.

In the first half of the XXI century, the social system that originated in primitive society resulted in the emergence and development of the components of the system, where people interact with nature and with each other in the production process. These components are interconnected and play the key role in the cyber-physical management. This historical development is based on socio-economic progress, which is the result of the dialectical interaction between technical and human factors of production. The content of the technical (materialized) factor distinguishes such interrelated components as tools of labor, objects of labor and the technology of the tools of labor influence on objects of labor. The content of the human (living) factor distinguishes such interrelated components as systems of socio-economic relations, forms of labor organization, institutional methods of coordination (management) of labor and human intelligence as the basis of purposeful social interaction in the labor process. The interrelated historical development of the technical (materialized) and human (living) factors of social reproduction is ultimately aimed at the historical development of man.

Human development represents the essence of the historical process. Therefore, the ontological (anthropological) basis of socio-economic development is the irresistible tendency of human development in accordance with their universal generic essence [3]. In turn, an increase in the scale and culture of consumption determines the historical development of a man. This increase is due to a rise in the production scale, and it manifests itself densely in new rounds of cultural and intellectual development of the personalities of people employed in social production. The transition to cyber-physical systems using artificial intelligence should require the corresponding development of human intelligence.

## CYBER-PHYSICAL ORGANIZATIONS, ARTIFICIAL AND HUMAN INTELLIGENCE

### The formation of cyber-physical systems

The transition of the modern economy to cyber-physical systems using artificial intelligence historically acts as the next stage in the expansion of social reproduction on a qualitatively new technological basis. This expansion of social reproduction is determined by the action of the corresponding economic laws and patterns, which determine the direction and nature of the trends in modern economic development.

Theoretically, certain economic laws and regularities define the dynamics of the production scale growth and the improvement in the structure of social production. Among these laws one can single out the laws of the rise in needs, the necessity to satisfy needs, and the growth of labor productivity.

The economic law of the rise in needs reflects a deep internal relationship between production and needs. Human development forms the basis of the society progress; whose economic basis is the satisfaction of people's growing needs. Satisfaction of needs, in turn, stimulates the growth of production, the expansion of which leads to an increase in human needs [4]. The economic law of the necessity to satisfy needs is the first precondition of life itself. This law operates due to the driving force contained in the need and determining the necessity to produce material and spiritual goods for its satisfaction. Ultimately, the need visibly appears in the results of labor as specific products that directly satisfy specific needs. The law of necessity to satisfy needs determines the manifestation nature of most market phenomena. It underlies the exchange interactions of market relations participants [5]. The law of growth in labor productivity expresses internally necessary, stable and significant links between the progress of the technological production mode (production technologies and their individual elements) and the efficiency of production activities in the process of creating goods and services (or the amount of labor to manufacture a unit of production).

Taking into account the synergistic effect, all factors affecting labor productivity can be divided into the following main groups. They are factors associated with living labor, factors connected with the means of labor, factors associated with the introduction of the latest forms in organization of production and labor, factors connected with the improvement of technical and economic relations, factors associated with the improvement of labor objects, factors involving structural changes in the national economy [6]. The factors under consideration are characterized by their functional and labor essence, manifesting materialized and living labor. Each of them has a specific content that includes the corresponding elements, components and connections. Moreover, historically, their content is in continuous and interconnected development.

### The impact of technological progress on social progress

The technological production mode (techniques and production technologies) is an integral part of the social production mode - the socio-economic form (system) of combining direct producers with the means of production, where technical production means dialectically interact with human resources.

Consequently, technical progress should determine the social progress in production, which manifests itself in the development of organizational forms of interaction between workers and their human intelligence, interconnected with it.

The resources associated with the use of technical labor means (materialized labor) dialectically interact with the resources associated with the use of living human labor in the process of expanding social reproduction. In the author's opinion, this interaction should be considered as an objective economic law.

This regularity reveals the mechanism for the growth of labor productivity and production, followed by the possibilities to satisfy the rising needs, because of the systemic (interdependent) interaction between material, technical, social, and personal factors (elements) of the growth in social labor productivity and reproduction volumes.

### The connection of different intelligences

Quantitative and qualitative changes in the evolution of material and technical factors (resources) should be dialectically ensured by corresponding quantitative and qualitative changes in the development of social and personal (human) factors (resources) for the growth of labor productivity and the scale of social production. The content of material and technical factors allows to single out such developing components as labor tools, technical energy sources (engines), electronic computing means for automated engine control (ACS), technical means of transferring energy from engines to tools (transmissions), intellectual means (artificial intelligence) of programming and optimizing the ACS operation, technologies and means of information transfer from AI to ACS.

According to modern scientific approaches, artificial intelligence is the ability of a digital computer or computer-controlled robot to perform tasks normally associated with intelligent beings. The term is often applied to a project for the development of systems endowed with human-specific intellectual processes, such as the ability to reason, generalize, or learn from experiences. In addition, the definition of the AI (artificial intelligence) concept is reduced to a description of a set of related technologies and processes, such as machine learning, virtual agents and expert systems [7].

### Artificial management intelligence presents a specific type of artificial intelligence

Artificial management intelligence is an intelligent management system for organizations. It is based on the construction of a rational labor relations model, which makes it possible to equate the interests of the company (employer) and employees. According to modern researchers, the main tool for creating Artificial Management Intelligence is a rational model of labor relations. This is a personnel management system that changes the organizational culture in the company and equates the interests of the company (employer) and employees by changing the imperfect system of labor relations. After implementing the model, each employee gets the opportunity to satisfy their own interests through a high-quality work for the benefit of the company [8].

The content of social and personal factors allows singling out several developing components. They are a socio-economic component that implements the possibilities of division, cooperation and coordination of people's joint work, an institutional and managerial component that provides goal-setting and rational coordination of interaction between people and technology as well as among people themselves; social and labor component - people with their human intelligence, knowledge, skills and abilities. According to modern scientific literature, human intelligence is the mental ability of the human body, expressed in its ability to solve various challenges, cope with problems, carry out cognitive activities, adapt to changing environmental conditions and control them. Human mental intelligence is a set of accumulated knowledge, the ability to apply it correctly, as well the ability to think broadly and to find logical solutions.

From the author's point of view, rational intelligence can be distinguished in the structure of human intelligence. This is the ability to identify structure, formalize problem situations, factor in and predict logical solutions to problems of social development.

In addition, according to modern researchers, a person has a certain level of emotional intelligence. This is the ability to identify subtexts, hidden meanings, the interlocutor's manipulations by reading their emotions, facial expressions, gestures, and posture. Modern science also singles out social intelligence. This is the ability to understand people's behavior correctly. It is essential for effective interpersonal interaction and successful social adaptation. Human intelligence develops in society when people interact with other each other, exchange experiences, and adopt cultural traditions [9].

### Managerial human intelligence is a specific form of human intelligence

According to the results of modern scientific research, managerial human intelligence has a narrow and a broad meaning. In the narrow sense, it is the intellectual ability to effectively develop and make optimal management decisions and organize public (joint) production and labor activities of subordinates to implement these decisions, i.e. to plan, delegate, motivate, control and coordinate fulfillment of the tasks assigned to them. In the broad sense, managerial human intelligence is a special combination of several properties of social and general intelligence, an alloy of logic and intuition, predominantly synthetic, analytical and practical style of thinking.

These special properties include the ability to identify cause-and-effect relationships and the main link, grasping which you can solve various problems in the interests of your organization. They also involve the ability to build processes, anticipate the development and consequences of situations associated with the activities of the organization, and make adequate managerial decisions. One more property is the understanding of the people's interests, motives and psychology, the ability to select personnel for key positions, unite and direct their efforts to solve the problems that the organization is facing. Another factor is the ability to operate with a large number of variable factors, plan the organization's work for both short and long terms.

The most important properties of managerial human intelligence are critical self-assessment, the ability to learn from one's own mistakes, understanding the essence of management principles. Most of the management abilities are given to humans by nature, while the rest of them are acquired through training and work experience. If a person does not possess natural abilities, acquired ones are not able to compensate for them [10]. The latest studies of managerial human intelligence note that the relative predominance of the 1st or 2nd signaling system (right or left hemisphere of the brain) objectively determines different types of thinking. As a result, the individual characteristics of managers' thinking are reflected in different relationships between different types of thinking, which must be taken into account when selecting and placing management personnel.

In this connection, cyber-physical organizations (the ones using cyber-physical production systems) must take into account the specifics of the division, cooperation and coordination of intellectual managerial labor. In particular, modern research note, that such circumstances must be taken into account that

workers with visual-effective or concrete-sensory abilities must command machines, things, mechanisms; workers with visual-figurative (speculative-specific) abilities are more suitable for leading people; workers capable of abstract modeling are more appropriate for design and engineering work [10]. As the organization of social labor is developing in the context of spreading cyber-physical systems in general and artificial intelligence in particular, it will urgently require deep consideration of the levels of the individual's intellectual actions.

### Modern psychology also knows the concept of levels of intellectual activity and intellectual actions

Researchers distinguish three levels of intellectual activity. The first one is the stimulus-productive level, when mental activity is conditioned only by the influence of external factors. The second level is the heuristic one, which means a spontaneous cognitive activity leading to the discovery of a number of regularities. The third level is the creative one representing the highest level of mental activity, where there is a full penetration into the essence of the things being studied, the solution of existing problems and the setting of new tasks.

Two levels of intellectual actions are also distinguished. The first one comprises personal actions at the level of the social individual, where the human activity is determined by the task and the desired results. The second level includes the actions of a creative person. In this case, the result turns out to be wider than the set goal and it generates new tasks [11].

### These levels of personal actions determine the employees' differentiation into leaders and performers

Appearing in material and technical production systems, such component as artificial intelligence stimulates qualitative changes in the content of production processes. This inevitably affects the human factor of production, which is revealed in the corresponding requirements for improving managerial work, increasing its efficiency. As a result, the development of human managerial intelligence is put on the agenda. At the same time, this is not only the issue of individual managerial intelligence, but also a purposeful increase in the efficiency of managerial work based on the development of command-managerial human intelligence. The importance of teamwork and, as a consequence, of team (group) intelligence increases significantly in the context of expanding cyber-physical integration between industries and economic entities, the increase in complexity and urgency for management problems, the scale of processing the necessary management information. The provision of intellectual productivity and efficiency of team management work becomes particularly important.

Consequently, the problem arises how to develop and implement models of optimal interconnection and interaction systems between artificial intelligence of technical systems and the human intelligence of both individual workers and the group intelligence of teams that implement the corresponding projects and strategies for the competitive and economic development of controlled organizations. The controlled organizations management brings the issue of developing organizational models and schemes (division, cooperation and coordination) of social labor to the agenda. Including intellectual and managerial labor, these systems must correspond to the requirements of cyber-physical production systems and the expanding use of artificial intelligence most adequately. They must as well provide coordinated interdependent development of artificial and human intelligence, artificial managerial and human managerial intelligence. At the same time, the problem raises in the management systems of cyber-physical organizations how to develop modeling and rational structuring of the human individual-managerial and human command-managerial intelligences ratio, their relationship with the evolution of artificial intelligences. This should consist in an increase in the productivity of social labor in general and an increase in the efficiency of managerial labor in particular.

## CONCLUSION

Thus, if we proceed from the economic regularity of the growth in labor productivity and production as a result of the systemic (interdependent) interaction between material-technical (including artificial intelligence) and social-personal factors (including human intelligence) of social labor and reproduction, we can draw the following conclusion. Among other reasons, the growth of labor productivity and production is largely the result of the dialectical interaction of artificial intelligence and human intelligence. In their interaction, these factors induce and optimize production and labor processes within social systems. In modern economy, the Industry 4.0 passes on to cyber-physical systems and the increasing use of artificial intelligence. This requires the development of research on ways to modernize human intelligence, primarily managerial human intelligence, as well as ways to combine it with the evolution of the artificial intelligence implementation. There is a need to intensify the development of theoretical and methodological principles, scientific methods and methods of managing the functioning of organizations using cyber-physical systems, the processes of interaction between material-technical (cyber-physical) and social-personal factors of production in them. We also should develop human intelligence adequately to expanding opportunities of artificial intelligence.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

The research is conducted with the financial support of the RFBR in the frames of the scientific project № 18-010-00955 «The development of the model to manage cyber-physical organizations».

## REFERENCES

- [1] Cyber-physical systems. Retrieved from: <https://www.tadviser.ru/index.php/>
- [2] Shekhovtsev M. [2016] What promises the Internet of things to the world. *Expert*. 48:20–27.
- [3] Musaelyan LA. [2016] Historical process and globalization. Perm: Perm State University Publishing, RU.
- [4] Economic law of rising needs. The library of Russian student's books. Retrieved from: [http://uchebnikirus.com/politekonomia/ekonomichna\\_teoriya\\_politekonomiya\\_-\\_bazilevich\\_vd/ekonomichnyy\\_zakon\\_zrostannya\\_potreb.htm](http://uchebnikirus.com/politekonomia/ekonomichna_teoriya_politekonomiya_-_bazilevich_vd/ekonomichnyy_zakon_zrostannya_potreb.htm)
- [5] Law of the necessity to satisfy need. In Madras. Retrieved from: <https://madrace.ru/teoriya-kommertsii/kurs-teoreticheskie-osnovi-kommertsii/potrebnosti-zakon-neobchodimosti-udovletvoreniya-potrebnostey>
- [6] Economic law of rising productivity, The library of Russian student's books. Retrieved from: [http://uchebnikirus.com/ekonomika/ekonomichna\\_teoriya\\_-\\_mocherniy\\_sv/zakon\\_zrostannya\\_produkivnosti\\_pratsi.htm](http://uchebnikirus.com/ekonomika/ekonomichna_teoriya_-_mocherniy_sv/zakon_zrostannya_produkivnosti_pratsi.htm)
- [7] What is artificial intelligence: defining the concept with simple words. Theory and practice. Retrieved from <https://theoryandpractice.ru/posts/17550-cto-takoe-iskusstvennyy-intellekt-ii-opredelenie-ponyatiya-prostymi-slovami>
- [8] Artificial management intelligence. The free dictionary. Retrieved from: <https://dic.academic.ru/dic.nsf/ruwiki/1508475>
- [9] Human intelligence. The encyclopedia for economists. Retrieved from: <https://www.grandars.ru/college/psihologiya/intellekt-cheloveka.html>
- [10] What is a management intelligence? Retrieved September 28, 2020 from <https://professional.ru/Soobschestva/tsentr-razvitiya-karjery/cto-takoe-upravlencheskij-intellekt/>
- [11] Intelligence – what it is, its kinds, ways to define and develop. Retrieved September from: <https://psylogik.ru.turbopages.org/s/psylogik.ru/195-intellekt.htm>

ARTICLE

# METHODOLOGY OF SPECIFIC ACCOUNTING OF FINANCIAL AND ECONOMIC ACTIVITY RESULTS

Evgeniya Vladimirovna Kabitova\*

*Department of Economics of Mechanical Engineering, Kazan National Research Technical University, named after A.N. Tupolev-KAI, Kazan, RUSSIA*

## ABSTRACT

The final result of the activity of an industrial enterprise, the amount of production costs and added value are created by the structural divisions performing the main production process. Therefore, the emphasis in creating a system of specific accounting of the results of financial and economic activities should be made precisely on the core production, which determines the need for the implementation of specific financial results calculation as a management accounting tool in the practice of an industrial enterprise. In order to improve the efficiency of enterprise management, it is necessary to introduce new management technologies that will provide a quick response to changes in the operating conditions and contribute to the optimization of the final parameters of the business entity. The research is aimed at development of a proposal for the implementation of specific accounting of the results of financial and economic activities in the context of structural divisions of the core production of an industrial economic entity. The currently existing methods allow identifying individual aspects of studying this issue; however, a holistic approach to the problem of specific accounting of the results of financial and economic activities in the context of structural divisions has not yet been formed. The situation for a conditional industrial enterprise, the core production of which has a standard structure consisting of  $n$  number of workshops and workshop sections, is simulated in the research. The existing methodology for calculating and assessing the results of financial and economic activities, deterministic relationships of the studied financial parameters, as well as the use of the method of specific indicators have allowed developing a methodology for accounting the specific results of financial and economic activities of structural divisions of an economic entity. An experimental calculation of specific economic parameters in the context of structural divisions of the enterprise has been carried out. The research has proved that the organization of specific accounting of the results of financial and economic activities provides for timely identification of particular negative trends and optimization reserves of both divisions and the enterprise as a whole.

## KEY WORDS

business and financial performance indicators, specific economic indicators, weighted-average accounting of financial performance, direct-costing method

## INTRODUCTION

An industrial enterprise is a complex production system consisting of many structural divisions. Accounting of business and financial performance in the aggregate for the entire economic entity is considered in the Russian Accounting Standard (RAS) being generally accepted [1]. But if a complex production system has auxiliary and service divisions that conditionally affect the financial result of the entire enterprise, then the divisions of the main production turn the input of the system into an output, and can differentially affect the final total financial result [2]. This can be expressed in both costs of resources involved and financial results. Therefore, it seems necessary to implement a differentiated approach with due account of business and financial performance indicators for individual divisions of core production [3]. The relevance of the research topic lies in the fact that the organization of weighted-average accounting of financial performance allows detecting particular downward trends and optimizing reserves of the divisions and the entire enterprise in general.

In order to efficiently manage enterprises, it is necessary to introduce new management technologies that will provide a quick response to changes in the operating conditions and contribute to the optimization of the final parameters of the object's activity. The performance of management functions is provided by one of the main tools - management accounting. A management system means both a set of management objects and a set of implemented management functions in relation to these objects. The complexity of the functioning and versatility of business entities and the variety of implemented management functions predetermine the absence of standard management system and management accounting. An individual, necessary list of objects and management functions is formed in each management system [4].

The information system that meets the needs of the enterprise management for the development and adoption of management decisions is management accounting. Management accounting is a kind of approach to the existence of an information system of an economic entity, focused on a specific user. The purpose of management accounting is to assist the organization's management in developing and making effective management decisions. Management accounting assumes information support of all management functions and is based on the use of a variety of methods of operational and strategic planning, analysis, accounting and statistical accounting, which allows performing comprehensive study of the past, present and future general and particular processes of a multidisciplinary production system [5].

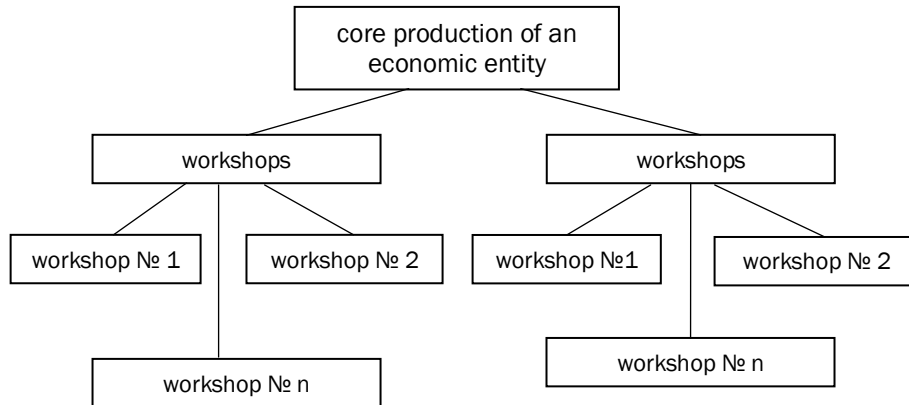
The complexity of business entities determines the need to assess the financial performance of each division. The relevance of the implementation of the method of specific indicators lies in the fact that the organization of specific accounting of the results of financial and economic activities allows eliminating the results of the functioning of the structural elements of a complex business structure. The application of weighted-average accounting of financial performance should begin with accounting for actual costs and production (work performance) volumes in the context of structural divisions [6]. To accurately determine the cost of production (work) and identify reserves for its reduction, it is necessary to carry out cost

Received: 7 Nov 2020  
Accepted: 11 Dec 2020  
Published: 16 Dec 2020

\*Corresponding Author  
Email:  
ekabitova@bk.ru

accounting using the direct-costing method, when costs that directly fluctuate under the influence of production volumes are attributed to variables, while costs related to a certain reporting period but independent of production volumes are treated as fixed quantities [7]. The capabilities of direct-costing include the calculation of gross (marginal) profit and marginal rate of return both in general for the enterprise, and its divisions, products, and lines of activity [8]. It also becomes possible to determine the break-even point, the profit (loss) zone size for the particular division, as well as the entire enterprise in general. Calculation of the critical product price, threshold values of fixed and variable costs allows finding the most favorable combinations of price, cost, and volume [9].

The main result of the activity of an industrial enterprise, the amount of production costs and added value are created by structural divisions performing the main production process. Therefore, the emphasis in creating a system of specific accounting of the results of financial and economic activities (as an element of management accounting) should be placed on the core production. The general view of the structure of the core production of an industrial economic entity is shown in [Fig. 1] [2].



**Fig. 1:** General view of the structure of the core production of an industrial economic entity

The research is aimed at development of a proposal for the implementation of specific accounting of the results of financial and economic activities in the context of structural divisions of the core production of an industrial economic entity. This work allows conducting individual studies of specific aspects of enterprises' activities, identifying the most significant factors in the formation of an integral indicator [10]. The situation for a conditional industrial enterprise, the core production of which has a standard structure consisting of N number of workshops and N number of workshop sections (for example, with 8 structural divisions) will be simulated in the research.

**METHODS**

**Methodology for organizing specific cost accounting as the main object of management accounting**

Since it is the costs that are recognized as the primary object of management accounting, the implementation of the methodology for the specific accounting of the results of financial and economic activities must begin with accounting for costs and volumes of production (work performed) in the context of structural divisions of the core production [11]. Cost accounting is experimentally simulated. Let us assume that the main structural divisions generate the following types of costs. All costs are classified in [Table 1] according to the capabilities of the enterprise's accounting policy and the direct-costing method.

**Table 1:** Costs classified by the activities of workshops and workshop sections of the core production of an industrial enterprise (experimental simulation)

No.	Cost items	Cost accounting by divisions of the core production	Cost type
1	Wages	separately for each workshop and workshop section	Variable costs
2	Insurance premiums		
3	Materials		
4	Transport services		
5	Transfer services of workers		
6	Maintenance and upkeep		
7	Rental of engineering equipment		
8	Depreciation deductions		
9	Engineering support	in general, for the core production	Fixed costs
10	General production costs		
11	General economic expenses		



Variable costs are determined and accounted separately for each workshop and workshop section. They include the cost of wages and insurance premiums, the cost of transport and transfer services of workers, maintenance, and upkeep, as well as rental of engineering equipment [12]. Fixed costs are proposed to be taken with regard to the core production in general. They include depreciation deductions for equipment, engineering support costs, general production costs, and general economic expenses [13].

The organization of the specific accounting of financial results by workshops and workshop sections will be carried out according to the following rules:

- item-by-item cost calculation according to the specifics of the work performed by the workshops and workshop sections;
- classification and cost accounting using the direct-costing method;
  - semi-variable costs are accounted for in account 20 "Core production",
  - semi-fixed costs are accounted for in account 25 "General production costs" and account 26 "General economic expenses", as well as account 02 "Depreciation of fixed assets" [14];
- only variable costs are taken into account individually for each workshop section, while fixed costs are taken into account for the core production;
- quantitative accounting (physical units of measurement: tons, standard hours, meters, etc.);
- ability to calculate financial results (revenue, variable costs, marginal profit, the marginal rate of return) for each workshop and section;
- ability to calculate revenue, costs, profit from sales, full profitability (since fixed costs are taken into account) for the core production as a whole;
- item-by-item accounting allows determining indicators of the efficiency of using various resources (specific labor productivity of division, specific material consumption) by workshops and workshop sections, as well as by the core production as a whole [15].

#### Methodology of specific accounting of the results of financial and economic activities

Let us develop the rules for the implementation of the methodology for the specific accounting of the results of the financial and economic activities of workshops and workshop sections, as well as the core production in general.

**Table 2:** Rules for the implementation of the methodology of specific accounting of the results of financial and economic activities

No	Rule	Individual workshop sections	Entire VPGC Service Division
1	Item-by-item cost calculation according to the specifics of the work performed	Yes	Yes
2	Direct-costing method (classification of costs into variable and fixed costs)	Only variable costs	Yes
3	Quantitative accounting	Standard hour	Standard hour
4	Accounting of the workshop section's income (revenue)	Yes	Yes
5	Calculating the marginal profit of the workshop section	Yes	Yes
6	Calculating the marginal rate of return of the workshop section	Yes	Yes
7	Calculating the sales profit of the workshop section	-	Yes
8	Calculating the full rate of return of the workshop section	-	Yes
9	Calculating the break-even point, and the safety zone of workshop section	-	Yes
10	Weighted-average accounting of financial performance per one standard hour (cost, variable costs, income, and profit per one standard hour)	Yes	Yes
11	Calculating performance indicators of using workshop resources (labor productivity, and material consumption)	Yes	Yes

It is proposed to conduct an item-by-item cost calculation according to the specifics of the work performed for all workshop sections and the entire core production.

Implementation of the direct-costing method, i.e. the division of all costs into variable and fixed costs [16] has been conducted. At that, for the workshop sections, only variable costs are taken into account, while for the entire core production – variable and fixed costs are considered. Quantitative accounting, i.e. accounting for the volume of work performed in natural units of measurement, is carried out in standard hours.

Accounting for variable costs and income separately for each workshop section allows determining the marginal profit and marginal rate of return of each object [17]. Accounting for all costs also allows determining the sales profit and the overall rate of return of the entire core production. This means that industrial enterprise management has the ability to assess the rate of return of each division and make timely specific managerial decisions.

Conducting quantitative accounting and weighted-average accounting of financial performance also makes it possible to determine the specific indicators of costs, income, and financial results, i.e. the value of these indicators per one standard hour. Dividing expenses into the variable and fixed costs makes it possible to use the margin analysis method when performing analytical calculations, and thereby calculate the break-even point and the safety zone of the entire core production performance (it is not applied separately for workshop sections, since fixed costs are not taken into account when calculating). Item-by-item calculation allows identifying certain types of costs separately for each workshop section, thereby calculating the efficiency indicators of resource use by a particular workshop section [18].

### Methodology for calculating the specific results of financial and economic activities

The existing methodology for calculating and assessing the results of financial and economic activities [19, 20], the authors' knowledge of the essence of the financial parameters under study and their deterministic relationships, as well as the use of the method of specific indicators allow developing a methodology for calculating the specific results of financial and economic activities of structural divisions of an economic entity [Table 3].

Specific indicators are considered as secondary, i.e., specifying the indicators of the first order, which are volumetric parameters. The specific indicator is a relative value derived from the corresponding volumetric indicator, characterizing in its essence the degree of occurrence of the phenomenon in a certain environment. The method proceeds from the assumption that there is a direct proportionality between the dependent indicator and the parameter argument.

**Table 3:** Methodology for calculating the specific results of financial and economic activities

No.	Indicator	Formula	Comments, information sources
1	Hours (H)	-	accounts and records of structural division
2	Revenue (R)	-	accounts and records of structural division
3	Amount of variable costs (Cvar)		accounts and records of structural division
4	Marginal profit (MP)	$MP = R - Cvar$	Line 2 – Line 3
5	Marginal rate of return (MR)	$MR = MP / R * 100\%$	Line 4 / Line 2*100
6	Revenue per one standard hour	$R \text{ 1 st.h.} = R / H$	Line 2 / Line 1
7	Cost of one standard hour	$C \text{ 1 st.h.} = Cvar / H$	Line 3 / Line 1
8	Profit per one standard hour (P 1st.h)	$P \text{ 1st.h} = MP / H$	p.4 / p.1
9	Number of employees of the workshop section (NE)	-	accounts and records of structural division
10	Labor productivity at the workshop section (LP)	$LP = R / NE$	Line 2 / Line 9
11	Specific consumption of materials (CM)	$CM = MC / R$	Material cost (accounts and records of structural division) Line 2

## RESULTS AND DISCUSSION

Experimental calculation of the specific results of financial and economic activities of organization's structural division

Table 4 presents experimental calculations for one of the structural divisions of the core production of an industrial enterprise.

**Table 4:** The results of financial and economic activities of the structural division (SD) of the core production No. 1

No.	Cost items	Value, thousand rubles		Cost structure, %		Variation		
		conditional year 1	conditional year 2	conditional year 1	conditional year 2	Absolute, thousand rubles	Relative, %	In structure, %
1	Wages	2,343.6	2,430.0	33.6	30.8	86.4	3.7	-2.8
2	Insurance premium	703.1	729.0	10.1	9.2	25.9	3.7	-0.8
3	Materials	1,908.1	2,581.4	27.4	32.7	673.3	35.3	5.4
4	Transport services	526.5	584.5	7.6	7.4	58.0	11.0	-0.1
5	Transfer services of workers	223.6	249.6	3.2	3.2	26.0	11.6	0.0
6	Maintenance and upkeep	421.6	436.9	6.0	5.5	15.3	3.6	-0.5
7	Rental of engineering equipment	846.8	878.6	12.1	11.1	31.8	3.8	-1.0
8	Total production costs (variable)	6,973.3	7,890.0	100.0	100.0	916.7	13.1	-

According to [Table 4], in 2017, the total amount of variable costs attributable to the workshop section No. 1 was 6,973.3 thousand rubles, of which the main shares were accounted for wages and insurance premiums – a total of 43.7%, or 3,046.7 thousand rubles, as well as material costs for 1,908.1 thousand rubles with a share in the total cost of 27.4%.

In 2018 there was an increase in all cost items, and their amount increased by 13.1% amounting to 7,890 thousand rubles at the end of the year. Because the increase in the volume of works (standard hours) was 9.6%, the overall increase was due to the increase in costs per standard hour. The largest increase from 1,908.1 to 2,581.4 thousand rubles (by 35.3%) was noted in material costs. Besides, the transport and transfer services of workers increased by 11%. Consequently, the reason for the faster increase in costs was primarily an increase in material costs, and secondly – transport and transfer services of workers. The increase in labor costs at a constant number of employees of the workshop section No. 1 was associated with an increase in the average monthly wages. The cost of maintenance and rental costs also increased, not having to outpace the growth in work volumes.

**Table 5:** Results of financial and economic performance (workshop section No.1)

No.	Indicator	Unit of measurement	of conditional year 1	conditional year 2	Absolute variation	Relative variation, %
1	Hours	Standard hour	2,141	2,347	206	9.6
2	Revenue	Thousand rubles	8,097.2	9,287.8	1,190.6	14.7
3	Amount of variable costs	Thousand rubles	6,973.3	7,890.0	9,16.7	13.1
4	Marginal profit	Thousand rubles	1,123.9	1,397.8	273.9	24.4
5	Marginal return	%	13.88	15.05	1.2	8.4
6	Revenue per one standard hour	Thousand rubles	3.782	3.957	0.175	4.6
7	Cost of one standard hour	Thousand rubles	3.257	3.362	0.105	3.2
8	Profit per one standard hour	Thousand rubles	0.525	0.596	0.071	13.5
9	Number of employees of the workshop section	Employees	9	9	0.0	0.0
10	Labor productivity at the workshop section	Thousand rubles	899.7	1032.0	132.3	14.7
11	Material consumption at the workshop section	Ruble/Ruble	0.236	0.278	0.042	17.9

In conditional year 1, the working time of structural division No. 1 was 2,141 standard hours, while in conditional year 2, with an increased rate of 8.6%, the working time increased to 2,347 standard hours. An increase in the time worked had led to an increase in the revenue of the structural division performance. The amount of variable costs in conditional year 1 was 6,973.3 thousand rubles, while in conditional year 2 they increased to 7,890 thousand rubles. Revenue increased faster and more than costs, which led to an increase in margin profit from 1,123.9 to 1,397.8 thousand rubles. The need to determine the marginal values of profit and revenue was because only variable costs were taken into account in the financial results of the structural divisions.

Taking into account only variable costs and calculating marginal profit make it possible to estimate the marginal rate of return of structural division. In conditional year 1, 13.88 kopecks of profit were received from each ruble of revenue. In conditional year 2, the growth of the indicator to 15.05% characterized the increase in the performance efficiency of workshop section No. 1. The reason was the outpacing growth of revenue and profit relative to variable costs.

The method of weighted-average accounting of financial performance makes it possible to calculate and analyze financial indicators per one standard hour of work. In conditional year 1, each working hour of structural division No. 1 generated average revenue of 3,782 thousand rubles, while in conditional year 2, this indicator increased to 3,957 thousand rubles. During conditional year 2, the costs of one standard hour had increased from 3,257 to 3,362 thousand rubles. The main reason was the increase in material costs and wages with deductions. In conditional year 1, the unit cost exceeded the unit revenue by 0.525 thousand rubles, i.e. the profit per one standard hour was 0.525 rubles. In conditional year 2, the revenue exceeded the prime cost that had led to an increase in the unit profit to 0.596 thousand rubles per one standard hour.

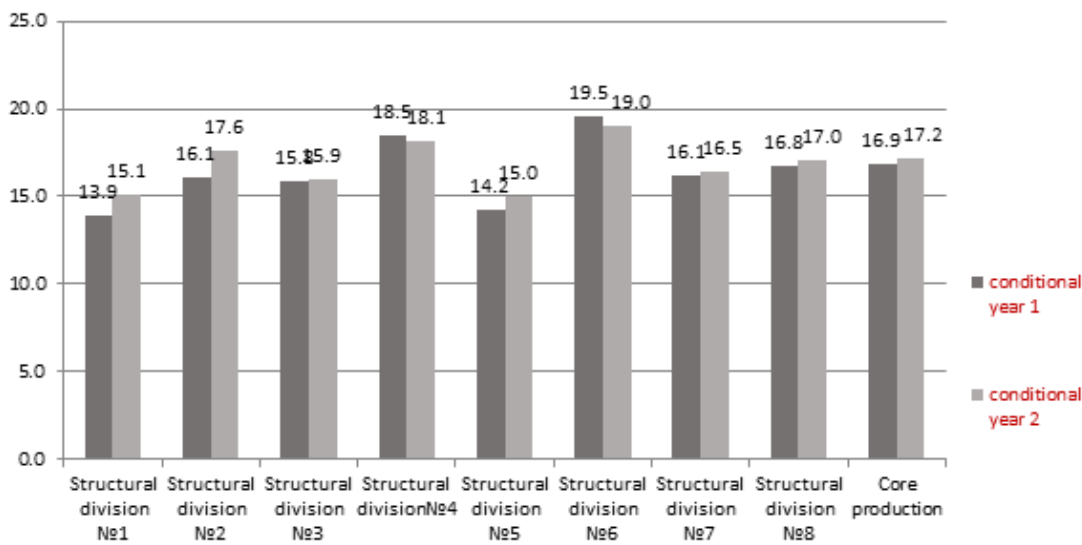
Also, the method of weighted-average accounting of financial performance makes it possible to calculate indicators of resource efficiency at the workshop section. In conditional year 1, the labor productivity of structural division No. 1 was 899.7 thousand rubles, i.e. the average revenue received from performing works amounted to 899.7 thousand rubles per each employee. In conditional year 2, the efficiency of workforce management had increased to 1,032 thousand rubles due to revenue growth at a constant number of workers in structural division No. 1.

The efficiency of using material resources is determined by the indicator of material intensity. Thus, the material consumption in conditional year 1 was 0.236 rubles, i.e. to get one ruble of revenue one needed to commit material costs for 0.236 rubles. In conditional year 2, the growth of material costs outstripped the growth of revenue that had led to a decrease in the efficiency of using material resources at structural division No. 1. This was caused by an increase in material consumption to 0.278 rubles.

**Experimental implementation of the method of specific accounting of the results of financial and economic activities of structural divisions of the organization**

Performing trial accounting and calculations for eight structural divisions of a conventional industrial enterprise allows determining the marginal profit of each division and draw conclusions about individual trends and the reasons for its change.

All structural divisions were characterized by making a profit during two years; therefore, in general, the activities of the core production were profitable. The smallest profit values were obtained for structural divisions No. 1 and No. 5. The highest marginal profit values were obtained for structural divisions No. 2, 4 and 6. An increase in profit was observed for all divisions during conditional year 2, which was based on the excess of the absolute increase in revenue over costs. The ratio of the marginal profit indicators for the workshop sections corresponded to the ratio in the volume of work performed. The highest values of workload and profit were determined for structural division No. 6, the lowest ones – for structural division No. 5.



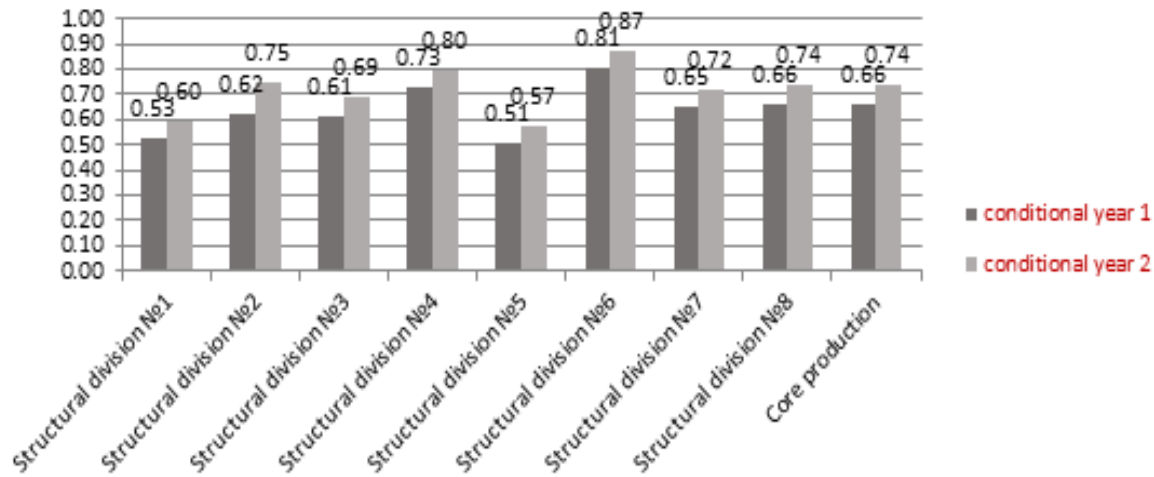
**Fig. 2:** Marginal profitability of structural divisions, %.

The calculation of the marginal profit allows assessing the efficiency of the activities of structural units based on the indicator of marginal profitability.

Since the activities of all structural divisions were defined as profitable, the profitability had positive values. Structural divisions No. 4 and 6 had the highest values of marginal profitability; however, unlike other structural divisions, their margins were decreasing. The reason was the outstripping pace of changes in costs relative to the increase in revenue and profit. For all other structural divisions, marginal profitability was growing due to outstripping growth of marginal profit relative to revenue and costs. The calculation of the marginal profitability in general for the core production had shown that the share of profit in the proceeds of the main production was 16.9% in conditional year 1; in conditional year 2, it rose to 17.2%. The profitability determined for the entire core production was a kind of averaged indicator of the marginality for all structural divisions. While on the whole it was increasing for the core production, negative trend was outlined for structural divisions No. 4 and 6. In these situations, it is necessary to apply the methodology of specific (item-by-item) accounting of the results of financial and economic activities [21], since general indicators revealed positive dynamics of marginality, and the specific indicators allowed identifying problem objects of the core production.

Methodology of specific accounting of the results of financial and economic activities of structural divisions of the organization allows the calculation of the following indicators:

- specific revenue (per 1 standard hour) of a structural division,
- specific prime cost (1 standard hour) of a structural division,
- specific margin profit (per 1 standard hour) of a structural division.



**Fig. 3:** Specific marginal profit (per 1 standard hour) of workshop sections, thousand rubles / standard hours

In general, with regard to the entire core production, the marginal profit gained from one standard hour was 0.66 thousand rubles during the conditional year 1, and during the conditional year 2, its value had increased to 0.74 thousand rubles, which was caused by faster increase in revenue relative to the growth of costs. The most profitable was the performance of workshop sections No. 4 and 6, while the lowest values of specific profit were typical for workshop sections No. 1 and 5.

## CONCLUSION

Specific accounting of the results of financial and economic activities in the context of structural divisions has not been considered in the literature, which determined the relevance of the research. The research included studying the following methods:

- method of economic analysis of the results of financial and economic activities by G.V. Savitskaya [9]: description of the methodology for the marginal analysis of the general parameters of activities, the allocation of specific variable costs, the calculation of the marginal profit of the product;
- direct-costing method by A.V. Ilyina, N.N. Ilysheva [4] used for the system of accounting: unconventional calculation of costs was considered, taking into account the specifics of direct costing;
- method for calculating deviations from cost standard in the direct-costing model presented in the works of V.E. Kerimov [18].

The work performed has proved the need to implement the calculation of specific financial results as a tool for management accounting in the practice of an industrial enterprise. The proposed methodology has revealed the feasibility of switching to the accounting of specific results of financial and economic activities, which allowed timely identification of particular negative trends and optimization reserves of both divisions and the enterprise as a whole. Accounting the specific results of financial and economic activities by the structural divisions of the core production has revealed that the lowest financial indicators were typical for structural divisions No. 1 and No. 5; and for structural division No. 3, financial indicators were determined to be below average by the divisions of the core production. Therefore, it was necessary to start searching for reserves for optimizing the activities of both the entire economic entity and the core production precisely from structural divisions No. 1, 3 and 5. Thus, the application of accounting for the results of financial and economic activities in the context of workshop sections has allowed calculating specific indicators of the financial condition of structural divisions, which will further allow making specific economic decisions to optimize the situation at the enterprise.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

None.

### FINANCIAL DISCLOSURE

None.

## REFERENCES #

- [1] Basova, AV, Nechaev AS. [2018] Business (managerial) accounting. Textbook, INFRA-M, Moscow, RU.
- [2] Fatkhutdinov RA. [2020] Manufacturing process management. Textbook, INFRA-M, Moscow, RU.
- [3] Gorfinkel VYa, Shvandar VA. [2017] Economy of organizations (enterprises): Textbook for universities. YUNITI-DANA, Moscow, RU..
- [4] Ilyina AV, Ilysheva NN. [2016] Management accounting: study guide. Yekaterinburg: Ural University Publishing House, RU.
- [5] Beztsennaya YeF. [2014] Development of management accounting tools in multidisciplinary commercial structures. Vse dlya bukhgaltera. 4(280):27-33.
- [6] Boronenkova SA, Chepulyanis AV. [2013] Methods of strategic cost accounting. Bulletin of the Ural State University of Economics. 5(249):60-67.
- [7] Egorova SE, Yudanova IA. [2015] Comparative analysis of new methods and systems for cost accounting and product cost calculation. Bulletin of Pskov State University. 2:94-105.
- [8] Gerasimova EB. [2020] Performance analysis of the economic entities. Textbook, INFRA-M, Moscow, RU.
- [9] Savitskaya GV. [2018] Economic analysis: textbook. Textbook, INFRA-M, Moscow, RU.
- [10] Kabitova EV, Yudina SV. [2019] Technologies of managing the operating assets. International Journal of Recent Technology and Engineering (IJRTE). 8(2):4652-4661.
- [11] Zavyalova ES. [2015] Methods of accounting for production costs. Scientific Research Publications. 12(35):13-19.
- [12] Chernyavskaya SA. [2020] Accounting and analysis of financial results. Natural Sciences and Humanities Research. 27(1):310-315.
- [13] Chernukhina TN. [2016] Organization of cost accounting for product production and sale. Young Scientist. 11(115):1070-1072.
- [14] Berezhnaya IV, Kroklicheva GE, Lesnyak VV. [2020] Management accounting. study guide, Moscow, RU.
- [15] Kogdenko VG. [2017] Methodology and technique of economic analysis in the commercial organization management system. UNITY-DANA, Moscow, RU.
- [16] Trubochkina MI. [2020]. Enterprise cost management. Textbook, INFRA-M, Moscow, RU.
- [17] Larionova SI. [2020] Accounting for financial results of the enterprise's performance. Young Scientist, 16(306):253-255.
- [18] Kerimov VE. [2019] Management accounting: Textbook for bachelors. Dashkov & Co, Moscow, RU.
- [19] Basovsky LE, Basovskaya EN. [2019] Comprehensive economic analysis of economic activity. Textbook, INFRA-M, Moscow, RU.
- [20] Boronenkova SA, Melnik MV. [2018] Comprehensive economic analysis in enterprise management. Textbook, INFRA-M, Moscow, RU.
- [21] Kabitova EV. [2019] Methodology for the economic analysis of the solvency of enterprises: in the continuum of deterministic and discriminant models. Economics and Entrepreneurship. 9:1151-1159.

#English translations of the references are presented.

## ARTICLE

# SUPPLY CHAIN MANAGEMENT IN RETAIL CHAINS

**Marina Afanasievna Lapina\***, **Mariya Vladimirovna Belyaeva**, **Karine Yurevna Bagratuni**,  
**Marianna Tolevna Belova**

*Financial University under the Government of the Russian Federation, 49 Leningradsky Prospekt, Moscow,  
125993, RUSSIA*

### ABSTRACT

One of the main trends in the modern economy is the strengthening of the position of retail chains, which is due, on the one hand, to the marketing requirement of maximum satisfaction of customers' needs at one location and, on the other – to the constant growth of retail turnover. Nowadays, the world's leading retail chains are among the largest corporations. This trend can be fully attributed to the Russian economy. In its turn, the enlargement of retail chains and globalization of retail trade require a significant reformatting of the supply chain management system. The purpose of the article is to generalize the conceptual apparatus of the supply chain management system in retail chains and to study the influence of the participants in the chain on the efficiency of its functioning and the methods of interaction between the links of the supply chain in a retail chain. In the course of the research, such research methods were applied as analysis of scientific literature on the problem of supply chain management in retail chains and an expert survey to determine the tasks facing retail chains in organizing supply chains, the main economic effects from the introduction of the supply chain management concept into the work of retail chains, the possibility of implementing supply chain management taking into account the principles of category management and the prospects for outsourcing the logistics functions of retail chains. Based on the expert survey, retail chain tasks in the organization of supply chains are defined; the main economic effects of implementing the supply chain management concept in the work of retail chains are identified; opportunities for implementing the supply chain management concept with consideration of category management principles are defined; prospects for transferring logistics functions of retail chains to outsourcing are established. As a result of the study, it was found that supply chain management in the retail network allows for integrated planning and management of information and material flows from suppliers of goods through distribution centers to the end consumer.

### INTRODUCTION

The appearance of retail chains in Russia was caused, on the one hand, by changes in social and economic conditions during the 1990s and, on the other hand – by the logic of development of Russian business, including the introduction of marketing elements into company management [1-5]. The diversity of opinions of scholars makes it necessary to determine the place of logistics in the management of an enterprise, in particular, a retail chain [6, 7]. A retail chain provides for joint ownership of two or more trade facilities and taking part in decisions on their activities in a centralized manner [8]. Khokhlova [9] defines a retail chain as a new complex form of organization of interaction between economic entities, which provides for the unification of their resources and business activities to create additional competitive advantages in the market by implementing management decisions in the form of certain projects. Considering the specific features of the retail chain organization, we will consider the concept, principles, and methods of supply chain management (SCM). The concept of SCM is inextricably linked with the complexity of logistics operations in an integrated structure [10]. In this case, SCM is considered to be much broader than just a form of integration, which occupies an intermediate position between vertical integration and individual enterprises [11].

For the first time, the concept of SCM in industrialized economies was applied to trade and fast food networks, and eventually, it was spread to other industries [12, 13]. The term "SCM" was first introduced in the early 1980s by Oliver and Weber who proposed to consider material flows from raw material producers to consumers as part of an integrated strategy, calling it SCM [14, 15]. One of the first to provide an interpretation of the concept of SCM were Oliver and Weber, who considered the supply chain and its management as a scheme of direct thinking, i.e. management and control is carried out from the supplier, passes through the producer and distribution channels, and ends up bringing them to the consumer [16]. It is necessary to note that a considerable part of researchers who were studying the SCM were adherents of the direct thinking scheme, the so-called classical management pyramid (on the first place – interests of the producer) [17–19]. Among researchers, there are also supporters of the opposite, inverted management pyramid where the needs of consumers are put forward in the first place [20, 21]. Thus, Lambert and Polen give the expanded explanation of the SCM concept and focus attention on the consumer as the key element of a chain, i.e. the supply chain is represented as the scheme of the opposite thinking [22].

Another key feature of SCM is the concept of integration, as many scholars focus precisely on integration. Thus, Larson noted that SCM is a new approach to systems that require integration rather than interaction [23]. According to Ellram, SCM is the integration of processes, systems, and organizations to plan and control material flows from the supplier to the consumer without loss [24]. Panaydes [25] defined SCM as the coordination of production, inventory, location, and transportation among supply chain participants to achieve an optimal combination of efficiency and effectiveness of the market served. Beske et al. [26] understand under SCM the management of a network of mutual relations both within the enterprises and between the independent organizations and the business elements connected with material deliveries, purchases, production capacities, logistics, marketing, and systems adjacent to them, promoting formation

#### KEY WORDS

supply chain management, retail chains, supply chain, supply chain management of retail chains, category management, product category

Received: 1 Nov 2020  
Accepted: 9 Dec 2020  
Published: 16 Dec 2020

\*Corresponding Author  
Email:  
lapina.m.a@bk.ru

and flows of direct and return material, financial, and information streams from the original producer to the consumer with the reception of benefits in the form of additional value, maximization of profit for efficiency, and achievement of consumer satisfaction. At the current stage of the SCM concept research, the emphasis is on the fact that SCM is aimed at providing competitive advantages in the market. Thus, Waart and Peter [27] noted that the main function of SCM is to increase the competitiveness of a product or service.

The objective of the article is to generalize the conceptual apparatus of the system of SCM of retail chains; to study the influence of the chain participants on the efficiency of its functioning and the ways of interaction of the chain of supply links of a retail chain. The hypothesis of research: in a retail chain the SCM concept allows to carry out integrated planning and management of information and material flows from suppliers of goods through distribution centers to consumers. According to the research results, it can be concluded that the objective set in the research has been achieved.

## METHODS

In the course of the research, the following research methods were applied:

- analysis of the scientific literature on SCM in retail chains;
- expert survey to determine the tasks faced by a retail chain in the organization of supply chains; the main economic effects of the introduction of the SCM concept in the work of retail chains; the possibility of implementing the SCM concept, considering the principles of category management; prospects for transferring logistics functions of retail chains to outsourcing.

In the expert online-survey, 50 experts, top and middle managers of retail chains responsible for the performance of logistical functions took part.

At the first stage of the study, the selection of information sources was carried out, including the opinions of researchers on SCM in retail chains (articles from peer-reviewed scientific journals indexed in Scopus and Web of Science over the past 10 years). At the second stage, we contacted 50 experts, top and middle managers of retail chains responsible for performing logistics functions. The selection criteria for the experts were the availability of relevant work experience of at least 5 years. E-mails were sent to the experts asking them to answer the questions of a semi-formalized questionnaire. At the third stage, the selected sources of information and the obtained survey data were analyzed and their interpretation was carried out.

## RESULTS

### Conceptualization of the main provisions for the implementation of the SCM concept in retail networks

Considering the specific features of logistics activities of retail chains, the experts formulated the following definitions. Retail chain supply is an ordered set of producers, intermediaries, suppliers, and stores of a retail chain that are united by a common goal and logistics operations to bring goods from one logistics system to another. SCM in a retail chain is the complex process of planning, creating, and controlling the material, information, and business processes in the supply chain to meet the needs of the consumers of a retail chain at the lowest logistic cost. Based on the expert survey, the main tasks faced by a retail chain in organizing supply chains were identified [Table 1].

**Table 1:** Tasks faced by a retail chain in organizing supply chains

No	Tasks	%*	Range
1	determination of consumer demand for goods	90%	1
2	minimization of inventories at warehouses, considering the sales volumes of products, primarily the products of active demand	85%	2-3
3	assortment policy of retail chain	85%	2-3
4	division of all goods into groups, and commodity groups into categories	80%	4
5	retail chain and assortment positioning	75%	5-6
6	price policy development	75%	5-6
7	merchandising optimization	70%	7

Note: based on the expert survey; \* — the percentage of expert references

According to the majority of the experts (80%), the introduction of the SCM concept is associated with the development of new organizational and functional schemes of the interaction of all enterprises, and their participation in the chain is one of the decisive factors in maintaining and improving income levels and competitiveness in the market. Based on the expert survey, the main economic effects of the introduction of the SCM concept were identified [Table 2].



**Table 2:** Efficiency of the SCM concept introduction in a retail chain

No	Directions to increase the efficiency of retail chain activity	Sources of improvement of retail chain efficiency	%*	Range
1	Increase in sales and corresponding order volumes.	Improvement of planning quality through unified information channels	90%	1
2	Decrease in companies' current and insurance reserves.	Improved operational management through continuous monitoring of the entire chain, timely identification of deviations and malfunctions	85%	2
3	Decrease of risks, increase of probability of performance of planned indicators of sales and deliveries.	Reduction of product delivery costs by eliminating business processes associated with uncertainty in procurement, warehousing, and sales	80%	3

Note: based on the expert survey; \* — the percentage of expert references

**Using the concept of category management in retail network SCM**

According to the majority of the experts (85% of the respondents), it is reasonable to carry out interaction and mutually beneficial cooperation in the supply chains of retail chains considering the principles of category management. The basic concepts of category management are the rules for forming the product range and maintaining the necessary level of commodity stocks to maximize the demand of consumers. The stages of implementation of the category management are the following: the selection of categories, the definition of category meaning, category evaluation, setting goals for categories, selection of the category strategy, the definition of the appropriate tactics, implementation of planned actions, and analysis of results. The experts proposed to use the basic principles of category management and assortment management to strengthen integration between the main links of the supply chain of retail chains. This requires a comprehensive analysis of the assortment, which will result in the division of goods into groups. In the future, a strategy for the management of selected commodity groups based on SCM principles will be developed.

The basic indicators of the analysis of an assortment policy are profit and commodity turnover. However, in the experts' opinion, it is necessary to analyze these indicators simultaneously. The growth of the actual volume of turnover cannot always be regarded as a positive trend. The turnover is a value expression of the mass of sold goods and, as any value indicator, is directly influenced by the price factor. This means that for the development strategy of the company, it is important to evaluate not only the profitability of goods but also the structure of the range of the most profitable goods. The majority of the experts (70% of the respondents) believed that, for this purpose, it is appropriate to use the method of ABC-analysis to calculate the contribution of each commodity group to the turnover and profit of the enterprise. The method of ABC-analysis is based on the concept of category management, which involves the formation of the enterprise's assortment based on the study of consumer needs and demand.

According to the concept of category management, the formation of the assortment is carried out following the principle of the joint consumption of goods. Therefore, the value of efficiency of inventory management in stores increases, which can be achieved through the method of ABC-analysis. Based on the results of the analysis, assortment positions are ranked and grouped depending on the size of their contribution to the aggregate effect.

The results of the ABC-analysis should be used for drawing up assortment matrices of retail chain stores, plans for merchandising activities, and determining the terms of cooperation with suppliers. In practice, the specification of product items is not reasonable (as the assortment can reach 8,000 names), therefore, we will first analyze it at the level of product groups: A, B, C. However, the commodity groups occupying an insignificant share in turnover can bring simultaneously high profit. Therefore, to better characterize the assortment, it is advisable to conduct the ABC-analysis on the contribution of each commodity group to the profit. The method of ABC-analysis allows one to classify the assortment in more detail and provides additional advantages in making managerial decisions. For better and more detailed classification, it is necessary to combine the analysis on the contribution of commodity groups in profit with the analysis on the contribution to the turnover.

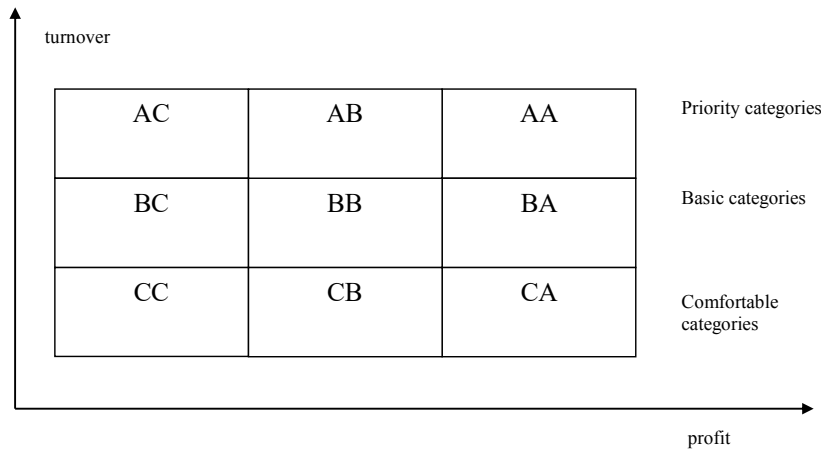
Such proportions are offered by experts for a retail chain [Table 3].

**Table 3:** Distribution of goods by group by turnover/profit

Product group	Characteristics	Group requirements
Group A	very important products that deliver 75% of results	should always be available on the shelves of the store, i.e. security stock should be created, require detailed planning, continuous record-keeping, and control (more frequent inventory, control, etc.)
Group B	goods of average importance, bring 20% of the result, have moderate	it is necessary to have sufficient safety stock for the products of this group. Recording and control

	sales volumes, complement the assortment of the trade enterprise, allow attracting new customers	at the same level as for group A goods, but some omissions are possible (e.g., less frequent inventories)
Group C	least important goods; produce 5% of the result, have low sales volumes	the products that are to be excluded from the assortment or new products, it is necessary to order them with caution, set a small surcharge, organize measures to promote sales. If the goods are not transferred to another group after the promotion, it is necessary to dispose of them

Based on this methodology, nine groups can be identified, considering different combinations of ABC-parameters. In our case, the turnover parameters of commodity groups and their profitability have been combined [Fig. 1].



**Fig. 1:** Combination of the matrix fields by turnover and profit

The main purpose of the ABC-analysis is to ensure a balanced range of products in stores, considering the turnover and profitability of each item. In this connection, it is proposed to form an assortment considering the objectives of product categories [Table 4].

**Table 4:** Objectives of product categories

Product category	Objective	Recommended ratio in an assortment
Unique	creating and maintaining the image of the store, impulse purchases, creates competitive advantages	1-3%
Priority	maintaining profitability and attracting the main flow of customers, determines the overall specialization of the store	20%
Basic	maintaining high turnover and attracting the main flow of customers, forms the basis of the store assortment	40-60%
Periodical	assortment renewal, attracting and retaining customers	Up to 20%
Comfortable	ensuring a constant flow of customers, the complexity of the purchase, convenience for the customer, auxiliary goods	5-10%

Note: based on the expert survey; \* — the percentage of expert references

Based on the expert survey, the main principles of building relationships with suppliers depending on the category of supplied goods are given in [Table 5].

**Table 5:** SCM depending on the category value

Product category	Level of cooperation with the supplier	Features of the goods delivery process
Unique	High/medium	<ul style="list-style-type: none"> <li>- establishing partnerships with suppliers;</li> <li>- ensuring the permanent availability of goods in this category for sale;</li> <li>- carrying out joint actions with suppliers to stimulate sales;</li> <li>- creation of an insignificant safety stock;</li> <li>- the reserve supplier;</li> <li>- residue control.</li> </ul>
Priority	High	<ul style="list-style-type: none"> <li>- careful selection of suppliers;</li> <li>- establishing partnerships with suppliers;</li> <li>- joint information system with the supplier;</li> <li>- study of demand fluctuations;</li> <li>- frequent inventories, monitoring of inventory data;</li> </ul>

		- low safety stock; - a reserve supplier is possible.
Basic	High	- partnerships with suppliers; - joint information system with the supplier; - a stock with a small surplus; - residue control; - reserve supplier.
Periodical	Low	- custom delivery; - reserve suppliers; - prompt delivery; - control of commodity balances; - conducting joint sales promotion activities with suppliers.
Comfortable	Low	- fixed order; - consignments with an extended delivery interval; - a small safety stock.

Note: based on the expert survey

To avoid shortages or surplus of goods, it is proposed to forecast sales and control fluctuations in consumer demand. A detailed analysis of inventories will help to determine the optimal supply consignments, balance order cycles, and reduce logistics costs.

### Using outsourcing in retail network SCM

According to the experts, three management models currently exist and are actively used in SCM in retail chains:

- an organized (debugged, centralized) SCM model;
- an unorganized (decentralized) SCM model in retail chains;
- a cross-docking SCM model.

According to the majority of the experts (75%), the most common way to manage logistics chains is to manage them in an orderly and well-organized manner. In this case, the company creates its own distribution center, and management is carried out through a separate link in the logistics chain. Otherwise, logistics functions for the distribution of goods are transferred to a logistics operator – outsourcing of logistics functions. In the case of this management method, according to one interviewee, "transport costs are reduced, the cost of storing goods in the network is also reduced, and suppliers lower prices for goods by reducing transport costs". Outsourcing of any retail chain process always implies an economically sound solution, since the main idea of outsourcing is trust and transfer of responsibility for material and nonmaterial values. When transferring one or several logistic functions for outsourcing to a logistic operator, it is necessary to realize that control over the performance of these functions belongs to logistic operators.

Based on the expert discussion, an algorithm for managing logistic chains using outsourcing of logistic functions was developed. At the initial stage, it is necessary to evaluate the competitiveness of a retail chain and find ways to improve it. If a retail chain loses its competitive advantage among other market players, it is advisable to increase competitiveness through effective management of logistics chains. In this case, a retail chain may turn to internal project development or use the services of logistics operators. When deciding to outsource logistics functions, retail chain managers weigh all the advantages and disadvantages of their performance of functions and the advantages of delegating logistics functions.

At the next stage, there is an issue of transferring logistics functions and processes to outsourcing, identifying problems and goals of transfer, and planning the transfer of functions to outsourcing. As a result of the decision on the transfer of logistics functions to outsourcing, it is necessary to conduct a detailed analysis of problem areas. Considering this, it is expedient to focus on the identification of the main reasons which promote the transfer of logistics functions to outsourcing. The experts have identified the main reasons and motives for outsourcing and the refusal of outsourcing [Table 6].

**Table 6:** Main reasons and motives for outsourcing logistics functions and refusing it

No	Reasons and motives for outsourcing logistics functions	%*	Range
1	willingness to stay focused on core activities	90%	1
2	necessity to reduce the costs of doing business	85%	2-3
No	Reasons and motives to refuse to outsource	%*	Range
1	economic disadvantage of the transfer of certain business functions	80%	4
2	uncertainty in the professionalism of the potential contractor	75%	5-6
3	potential leakage of confidential information	75%	5-6

Note: based on the expert survey; \* — the percentage of expert references

We believe that the reasons for refusing to outsource are evidence of an underdeveloped market for outsourcing services, as well as the fact that some enterprises for certain reasons do not adapt to modern methods of logistics chain management and do not search for new forms of business management.

During the next stage, it is necessary to assess the alternative to outsourcing, so it is required to carry out a detailed analysis of all the functions of transformation in time, space, and organizational structure of management and select criteria for the effectiveness of the outsourcing project.

It should be noted that as a result of changes in society's needs, the requirements for SCM have also changed. According to Holdorson and co-authors, the statement that SCM is primarily responsible only for procurement management, as well as order and information flow management, is not relevant, because modern customer orientation and increased social responsibility dictate new requirements. Researchers believe that today, all additional aspects, such as the improvement of customer service, reduction of risks in the supply chain, reduction of waste, better design of goods, and better service of goods, are considered as integral parts of SCM [28].

The modern SCM concept is widely used in most economically developed countries as it is an effective tool for doing business. SCM provides such opportunities and benefits as:

- cost reduction, contractual discipline, and increased management efficiency by transforming an existing linear, consistent supply chain into a reactive supply chain;
- improvement of product quality and customer service throughout the supply chain by integrating the business processes of development, delivery, and production and distribution support to all participants in the supply chain;
- achievement of customer focus of business processes and their openness to sharing knowledge among business partners;
- reduction of time for entering the market and elimination of costly mistakes and unsuccessful initiatives through close cooperation in the field of planning, organization, motivation, and control throughout the supply chain [29, 30].

## CONCLUSION

The concept of SCM can be seen as a systematic strategic approach to ensuring the effective movement of material and corresponding information flows in the supply chain, the objective of which is to improve the performance of supply chains and, as a consequence, the participating enterprises. The application of the SCM concept provides an opportunity to better satisfy the needs of customers and achieve the objective of a retail chain by presenting the individual elements of the supply chain connected in a single integrated process. The application of the SCM concept also ensures the effective management of not only processes within a retail chain but also increases the efficiency of partner companies, because the delivery is carried out at the right time, at the right place, in the right quantity, and of the right quality, which together increases the efficiency of the entire supply chain. The results of the study confirmed the hypothesis that the SCM concept in a retail chain allows for integrated planning and management of information and material flows from suppliers of goods through distribution centers to consumers. To sum up, we can say that there are several approaches to SCM in retail chains. The models, methods, and principles of SCM of retail chains show that, in modern conditions, centralized management becomes more competitive and widespread. The development of retail chains now depends on the effective SCM of retail chains as a factor of success in a competitive environment. Analysis of the impact of SCM on the competitiveness of a retail network may become a prospect for further research.

### CONFLICT OF INTEREST

There is no conflict of interest.

### ACKNOWLEDGEMENTS

The authors are thankful to Hon'ble Dean and Management

### FINANCIAL DISCLOSURE

None.

## REFERENCES #

- |   |   |
|---|---|
| <p>[1] Balalova EI. [2020] E-Commerce development prospects in the entrepreneurship of the Russian Federation. <i>Revista Inclusiones</i>, 7:342-349.</p> <p>[2] Lukiyanchuk IN, et al. [2020] Development of online retailing logistics flows in a globalized digital economy. <i>Revista Inclusiones</i>, 7:407- 416.</p> <p>[3] Barmashov KS. [2019] The Industrial and Trade Policy of an Enterprise: Research of Principles and Methods and Change Depending on Geographical Features. <i>Amazonia Investiga</i>, 8(20):242-248.</p> | <p>[4] Nikolskaya EYu, et al.. [2020] Perfection of Quality Management of Hotel Services. <i>Journal of Environmental Management and Tourism</i>, 11(2):417-421.</p> <p>[5] Litvinova TM, et al. [2020] Supply chain of the imported ginseng medicinal plant materials for the pharmaceutical industry of the Russian federation. <i>Uncertain Supply Chain Management</i>, 8:225-230.</p> <p>[6] Deputatova YeYu, et al. [2020] Methodical Approach to Identifying Buying Motives within Various Sales Channels Based on Behavioral Segmentation. <i>Journal of Advanced Research in Law and Economics</i>, 10(2):515-526.</p> |
|---|---|

- [7] Mayorova AN, et al. [2018] Analyzing regional differences in the condition and development of trade in Russia. *Entrepreneurship and Sustainability Issues*, 6(2):927-938.
- [8] Starov SA. [2013] Management of Your Own Brands in Retail Networks]. Izd-vo «Vysshaya shkola menedzhmenta», Saint Petersburg, RU..
- [9] Khokhlova TP. [2016] Analysis and ways to increase the competitive potential of the trade organization of a network format. *Ekonomicheskii analiz: teoriya i praktika*, 4(451):85-96.
- [10] Habib M. [2010] Supply chain management: theory and its future perspectives. *International Journal of Business, Management and Social Sciences*, 1(1):79-87.
- [11] Janvier-James AM. [2012] A New Introduction to Supply Chains and Supply Chain Management: Definitions and Theories Perspective. *International Business Research*, 5(1):194-207.
- [12] Demchenko AI, Okolnishnikova IYu. [2018] Process-oriented logistics systems as the basis for interaction with partners in retail network, In "Retail network logistics: Collection of Art". Izd-vo UGEU, Ekaterinburg: 13-17.
- [13] Fotache D, Hurbean L. [2006] Supply Chain Management: from Linear Interactions to Networked Processes. *Informatică Economică*, 4(10):73-77.
- [14] Singha H, Garga RK, Sachdeva A. [2018] Supply chain collaboration: A state-of-the-art literature review. *Uncertain Supply Chain Management*, 6: 149-180.
- [15] Agus A. [2015] Supply Chain Management: The Influence of SCM on Production Performance and Product Quality. *Journal of Economics, Business and Management*, 3(11):1046-1053.
- [16] Burgess K, Singh OJ, Koroglu R. [2006] Supply Chain Management: A Structured Literature Review and Implications for Future Research. *International Journal of Operations and Production Management*, 26(7):703-729.
- [17] Tan TC, Lyman SB, Wisner JD. [2002] Supply chain management: a strategic perspective. *International Journal of Operations & Production Management*, 22(6):614-631.
- [18] Ketchen JrG, Hult TM. [2006] Bridging organization theory and supply chain management: The case of best value supply chains. *Journal of Operations Management*, 25(2):573-580.
- [19] Fawcett SE, Magnan GM, Fawcett AM. [2010] Mitigating resisting forces to achieve the collaboration-enabled supply chain. *Benchmarking: An International Journal*, 17(2):269-293.
- [20] Angerhofer B, Angelides M. [2006] A model and a performance measurement system for collaborative supply chains. *Decision Support Systems*, 42(1):283-301.
- [21] Ageron B, Lavastre O, Spalanzani A. [2013] Innovative supply chain practices: the state of French companies. *Supply Chain Management: An International Journal*, 18(3):265-276.
- [22] Lambert D, Pohlen T. [2001] Supply chain metrics. *International Journal of Logistics Management* 12(1):1-19.
- [23] Larsson PD, Halldorsson A. [2004] Logistics versus Supply Chain Management. An International Survey. *International Journal of Logistics, Research and Applications*, 7(1):17-31.
- [24] Ellram LM, Carter CR. [2003] Thirty-Five Years of the Journal of Supply Chain Management: Where have We Been and where is We Going? *The Journal of Supply Chain Management*, 39(2):27-39.
- [25] Panayides P. [2006] Maritime logistics and global supply chains: Towards a research agenda. *Maritime Economics & Logistics*, 8(1):3-18.
- [26] Beske P, Land A, Seuring S. [2014] Sustainable supply chain management practices and dynamic capabilities in the food industry: A critical analysis of the literature. *International Journal of Production Economics*, 152:131-143.
- [27] Vaart TV, Pieter D. [2003] Buyer-focused operations as a supply chain strategy. *International Journal of Production and operation Management*. 26(1): 8-23.
- [28] Halldorsson A, Kotzab H, Mikkola JH, Skjoett-Larsen T. [2007] Complementary theories to supply chain management. *Supply Chain Management: An International Journal*, 12(4): =284-296.
- [29] Cao M, Vonderembse MA, Zhang Q, Ragu-Nathan TS. [2010] Supply chain collaboration: conceptualization and instrument development. *International Journal of Production Research*, 48(22):6613-6635.
- [30] Chen J, Sohal AS, Prajogo DI. [2013] Supply chain operational risk mitigation: a collaborative approach. *International Journal of Production Research*, 51(7):2186-2199.

*#English translations of the references are presented.*

ARTICLE

## SMART CITY: INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES

Natalia Grigoryevna Bondarenko<sup>1\*</sup>, Aleksandr Oleynik<sup>2</sup>, Vladimir Aleksandrovich Biryukov<sup>3</sup>,  
Elena Eugeniievna Tarando<sup>4</sup>, Tatiana Borisovna Malinina<sup>4</sup>

<sup>1</sup>*Institute of Service, Tourism and Design (branch) FGAOU VO, North-Caucasus Federal University, 40 Let Oktyabrya Street, 56, Pyatigorsk, 357000, RUSSIA*

<sup>2</sup>*Management Academy of the Ministry of the Interior of Russia, Zoi and Aleksandra Kosmodemyanskikh Street, 8, Moscow, 125993, RUSSIA*

<sup>3</sup>*Moscow Polytechnic University, Bolshaya Semyonovskaya Street, 38, Moscow, 107023, RUSSIA*

<sup>4</sup>*Saint-Petersburg State University, Universitetskaya quay, 7-9, Saint-Petersburg, 199034, RUSSIA*

### ABSTRACT

Rapid environmental degradation, substantial complication of municipal facilities and urban interrelations result in increased interest to the problem of steady economic development regarding metropolitan agglomerations, which assumes implementation of three interrelated constituents in the frames of smart city concept: economic, environmental, and social. The research is aimed at determining smart city concept in terms of environmental development and ecosystem sustainability. In order to achieve the goal set in the research, the authors have defined approximate set of theoretical (analysis, synthesis, comparison, generalization) and empirical (survey) methods. Theoretical methods implied studying scientific literature on the state of the research problem; while the main research method was surveying. Students and experts were invited to fill in a semi-formalized questionnaire on a voluntary basis. The main provisions of the problem have been theoretically analyzed in this article, including analysis of smart city concept and its properties. On the basis of expert survey, the main constituents of smart cities have been determined, the actions required for implementation of smart eco-city concept have been defined, and the existing project types of smart eco-cities in the world have been identified. The research results have shown that currently quite a few cities have adopted the "smart city" concept as the main direction of their activities; however, significant obstacles to the implementation of the smart city concept are created by a lack of funds and legislative incentives. The results of the research have confirmed that the implementation of the smart eco-city concept is possible after implementing specific measures and using the existing foreign experience depending on the natural conditions of the territory.

### INTRODUCTION

**KEY WORDS**  
smart city; environment;  
environ mentalization;  
smart eco-city; Internet  
of Things

Nowadays the term "smart city" is used more and more widely in reports of politicians and governmental officers, in titles of public discussions, scientific conferences, as well as in mass media [1, 2]. According to Allwinkle and Cruickshank [3], in recent decades due to wide access to Internet and miniaturization of electronics, development of nanotechnologies, the smart city concept has been mainly used for presentation of a city as an efficient robot. This concept was created in hi-tech corporations, such as IBM, Cisco, Microsoft, and Software AG, which expected to acquire significant profit from municipal contracts [4]. One of the most common scientific definitions of smart city has been proposed by R. Hollands [5]: smart city is a city perspective in terms of economy, population, management, mobility, environmental protection, and quality of life, based on successful combination of contributions and activity of purposeful, independent, and conscious citizens.

Batty et al. [6] defined the smart city as instrumented, interrelated, and intelligent city. Tools provide data acquisition and collection using sensors, personal devices, cameras, smartphones, implanted medical devices, Internet, and other data collection systems, including social networks as human sensors. Interaction means integration of these data into the system of corporate settlements and interrelation of these data with municipal services. Intelligence means involvement of complex analytics, simulation, optimization, and visualization in operational business processes aiming at adoption of best operative decisions. Dameri and Benevolo [7] believe that smart city can be considered as large organic IT system, which combines numerous integrated subsystems and components. Deakin and Al Waer [12] compare smart city with a body with an artificial nervous system, which allows the city to perform intelligent and coordinated actions. Vanolo [8] concentrates attention on improvement of stability and ordering (availability for life) of the city. Lombardi P. et al. [9] consider smart city as a combination of intelligent computation techniques for infrastructure services. Such techniques present new generation of integrated equipment, software, and network technologies, which allow to use IT system online aiming at optimization of business projects [10-12]. Capra [13] believes that the smart city concept means efficiency based on intelligent management and integrated information and communication technologies, as well as active participation of citizens. New type of management is considered – real participation of citizens in governmental policy [14-16].

The researchers in [17] summarized the properties of smart city: the use of network infrastructure aiming at improvement of efficiency of economic and political spheres of urban life, as well as promotion of social

Received: 5 Nov 2020  
Accepted: 12 Dec 2020  
Published: 20 Dec 2020

\*Corresponding Author  
Email:  
di\_a@mail.ru

and cultural transformations; ability and possibility to attract and deploy new business projects; implementation of innovations for social integration; coexistence and complementarity of hi-tech equipment and infrastructure; attention to the role of social and relational capital; provision of environmental stability. Shapiro [18] concentrated attention on interrelation between various properties of smart city, including social and intellectual capital, health, and management. The applied approach was based on the triple helix model. Another point of view is shared by the researchers in [19] who consider social innovations as the main goal of smart city, and the smart city itself is developed for creating managerial, infrastructural, and engineering conditions for implementation of social innovations, solution of social problems aimed at economic growth, including improvement of quality of life, with participation of various local entities: citizens, business, and corporations.

This research is aimed at analysis of the smart city concept in terms of development of environment and stability of ecosystems. The considered hypothesis is as follows: implementation of the smart eco-city concept is possible after execution of certain actions and application of existing foreign experience depending on natural conditions of territory. Based on the obtained results, it is possible to conclude that the formulated aim of the research has been achieved.

## METHODS

In order to achieve the formulated target, the authors determined approximate set of theoretical and empirical research methods: theoretical methods (analysis, synthesis, comparison, generalization) to analyze scientific publications devoted to the state of research problem; empirical methods (survey). Surveying was the main method. Students and experts were proposed to fill voluntarily semi-formalized questionnaire. Experts (40 persons), officers of municipal authorities, employees of IT companies involved in implementation of information technologies into operation of municipalities for more than 10 years, participated in the survey. The experts were proposed to answer a number of questions concerning environmentalization of smart cities, opportunity to implement the concept of smart eco-city in Russia, as well as international experience of implementation of smart eco-city concept. All participants in the surveys were informed about the final aim of survey and about intention to publish the survey results in generalized form.

The study of the smart city concept in terms of environmental development and ecosystem sustainability was carried out in three stages: preparatory, during which the goal and hypothesis of the research were formulated, the questions posed to the experts were developed; the main one, which was carried out within 20 days and included the practical implementation of an expert online survey, the final one, which provided for the analysis and interpretation of the data obtained.

## RESULTS

### Main constituents of smart cities environ metallization

According to the opinion of surveyed experts, the main constituents of smart cities environ metallization are as follows [Table 1]:

**Table 1:** Main constituents of smart cities environ mentalization

No.	Environmentalization constituents	%*
1	Development of renewable power generation within the city boundaries, namely: wind, solar, geothermal, etc., depending on natural conditions of territories	90%
2	Construction of energy efficient buildings consuming minimum electrical and thermal power	87.5%
3	Decreasing demand in automotive transport due to optimum planning of territory, development of bicycle transport, as well as accurate operation of municipal transport	85%
4	Provision of high portion of green areas in cities and stability of natural systems and biodiversity in their frames	82.5%
5	Minimization of formation of solid wastes, provision of their classification and maximum deep reprocessing	80%

Note: based on expert survey; \* – percent of expert references

### Measures to implement the smart eco-city concept

For the full implementation of the smart eco-city concept in a single modern Russian city, experts listed the actions shown in [Table 2].

Efficient execution of all listed actions should be based on wide promotion activity among citizens, mainly regarding the aspects of green construction and necessity to increase the cost of energy carriers and transport services. It would be appropriate to oblige developers to apply modern technologies and environmentally safe materials for construction of new buildings. Taking into account long-term pay-off period of such investments, it is necessary to develop exemption scheme for house owners.

**Table 2:** Actions of smart eco-city concept implementation

No.	Action	Substantiation
1	Development of experimental passive house adapted to local climatic conditions	This would initiate new projects in this field and increase popularity among population. In some years it would be possible to develop experimental residential complex based on the concept of passive house at affordable prices
2	Obligatory insulation of houses with simultaneous reconstruction of facades and repair of utility systems	It is important most of all for historic areas of cities, practical implementation can be facilitated by private investors interested in development of facilities of touristic infrastructure
3	Development of electric transport	This can be supplemented by ordering of transport traffic, in particular, by administrative prohibition of traffic in certain places and at certain times
4	Modernization of heat supply system	Among other things, this should stipulate opportunity to operate using various fuels, including renewable power sources

Note: on the basis of expert survey

### Experience in implementing the smart eco-city concept

The experts' opinion is that the smart eco-city concept should not be considered as absolutely new since it is directly interrelated with the concept of steady development, which assumes achievement of balance between environmental and social constituents upon provision of economic growth. In addition, according to one of the surveyed persons, close relation with green economy is observed since traditionally cities are sources of economic life and it is the economy of cities that should be modified accounting for critical pollutions of all environmental components. The experts believe that an important issue is as follows: should smart eco-cities be considered as an ideal model which cannot be implemented in the nearest future, or as the trend of practical activity, which should be reflected in program documents and implemented in projects and urban specifications?

The experts' survey demonstrated that the incentives regarding construction of environmental settlements in the last 20 years were received from public organizations, governments of countries with high economic growth (China, United Arab Emirates), construction companies, and territorial communities. The existing models of eco-cities are quite different in terms of scale, target purpose, the rate of environmental safety and others.

The experts highlight four project types of smart eco-cities [Table 3].

**Table 3:** Projects of smart eco-city

No.	Project of smart eco-city	Name, location	Peculiar features of smart eco-city
1	Extensive future projects	Masdar City, United Arab Emirates	Not completed. Total conversion to renewable power sources (solar and wind) and total reprocessing of wastes. The city area will be 700 ha with 50 thousand inhabitants. After completion of the project the main specialization of the city will be scientific and educational activities in the field of eco-technologies.
2	Smart eco-cities near developed municipal settlements	Dongtan, Shanghai (China)	The city is located 15 km from Shanghai. The project would provide for 80% recycling and 100% power supply from renewable sources. The basis of the economy is eco-industry, R&D projects in the field of eco-technologies, management of wastes, etc. Population of the city is 25 thousand inhabitants (the first stage was commissioned in 2010).
		Songdo, Seoul (South Korea)	The city has certain specialization: tourism, international trading of high-tech products, logistics. Peculiar attention is paid to transport and modern telecommunications, which should be used everywhere. Environmental characteristics: high level of energy efficiency, collection and reprocessing of wastes, efficient use of water resources.
3	Retrofitting of municipal areas	Vauban, Freiburg (Germany)	Former French military base, completely reconstructed in 2000. The main principles: no transport except for bicycles, power generation from renewable sources (mainly solar power).
4	Development of small eco-settlements in environmentally clean areas	St David's (Wales, Great Britain)	The smallest town in Great Britain located in Pembrokeshire Coast National Park. The town community initiated conversion of local economy to low carbon model of development.

Note: on the basis of expert survey.



The performed analysis of foreign experience of implementation of smart eco-city concept allows to state that the concept was transformed from an ideal resource consuming model to the problem with several acceptable pragmatic solutions. For Russia with wide spectrum of environmental urbanistic problems, according to the opinion of most surveyed experts (85%), the most acceptable are the third and the fourth types of smart eco-cities. Evolutional approach to solution to energy saving issue, solution to the issue of domestic wastes, reasonable use of natural zones are at present the most preferred actions in Russia concerning environ metallization of cities. As mentioned by Zygiaris [20], modern understanding of smart city concept assumes higher environmental safety in several dimensions: a) public services and behavior of consumers; b) environmental efficiency of industrial production; c) incentives for consumers; d) support for research in the field of innovative use of environmentally friendly technologies. Thus, in North America these are San Francisco (USA) and Vancouver (Canada). The latter receives 90% of electric power from renewable sources.

The concept of smart eco-city is developed most intensively in the countries of Northern Europe, where numerous projects are proposed: decentralized electricity supply (Denmark); electric transport (Germany); smart meters (Sweden); combined generation of heat and electricity (Sweden and Denmark); centralized heat supply by means of natural energy sources (Denmark); combustion of biomass in order to obtain electricity (Germany); generation of energy from wastes (Sweden) [21]. When establishing ratings of the quality of life in cities around the world, environmental factors are primarily taken into account: the availability of renewable energy sources, the energy efficiency of buildings, the state of the transport infrastructure, and access to healthy (organic) food. The citizens of Western Europe and North America are interested in economic performances only in combination with environmental components, which is the quintessence of the smart city concept [22]. The scientists believe [23] that smart cities will be major places of IoT activity, such companies as Cisco expect significant business opportunities with respect to provision of wide range of technologies and services required for creation of really smart city: sensors, networks, communications, programs, information panels, data standards, safety, analytics of data, etc. required for all these things aiming at their efficient combination.

Despite the experts' opinion that smart eco-city is just a concept rather than reality, numerous cities initiated programs and projects under the aegis of various incentives [24]. According to the experts' opinion, though there are attempts to develop from scratch new eco-cities (for instance, Masdar City), in most cases the smart eco-city concept is implemented in already existing cities. Their transformation requires for stage-by-stage approach with consideration for existing environmental and social structures. Despite the fact that long-term planning is of decisive importance, it should include identification and determination of preferred steps to be executed to achieve success.

The main initiator of reconstruction of regular cities into smart eco-cities is European Union. Thus, in 2011 European innovation partnership on smart cities and communities became valid, which resulted in development of new frame incentives stimulating implementation of energy efficiency principles and environmental safety in municipal power generation and transport (wind and solar power generation, capture and storage of carbon, a package of energy efficient and environmental standards for vehicles, etc.). In this regard numerous cities execute real projects. For instance, in Copenhagen municipal administration together with businessmen perform the policy of promotion and obligations concerning environmentally safe logistics, decrease in power consumption, environmentally safe energy generation. In Vienna combined efforts of governmental authorities and entrepreneurs resulted in Climate Protection Program aimed at development of integrated, comprehensive and electronic system of transport, logistics and servicing [19]. In Barcelona, one of the leaders of implementation of IoT concept into municipal management, the trash containers monitor amount of waste and optimize routes of garbage collection, new sensors can detect harmful and dangerous wastes [25]. The experts mention that most projects of smart eco-cities in this or that way are related with transport, in particular with reduction of CO<sub>2</sub> emissions. Thus, in London, which is a leader of implementation of digital technologies into municipal management in European smart cities, the Green Quarter experiment was initiated: validation of area of restricted access in the city center, which allowed to significantly reduce the amount of harmful atmospheric emissions due to increase in vehicle speed by 15-20% and decrease in traffic jams [26].

In addition, in the frames of the smart eco-city concept, European countries widely use the ideology of passive house, which is partially attributed to implementation of the respective directive regarding energy performances in construction adopted by EU in December, 2009 (stipulates approach of all new buildings to energy neutrality, that is, construction of at least passive houses) [27]. In particular, the experts mentioned that experimental passive houses were constructed in Denmark, USA, Sweden, Canada, Germany. Nowadays accelerated development of the concept is observed in Germany, Austria, Sweden, where passive houses become consistent element of cityscape.

## CONCLUSION

There exists urgent necessity to implement projects in the frames of smart eco-city concept in Russia, which is stipulated by high level of pollution of major environmental components and mismatch between activity of numerous entrepreneurs and modern environmental regulations. Among the analyzed types of ecological settlements, in Russia the most acceptable projects are comprised of reconstruction of municipal areas and development of small eco-settlements in environmentally clean zones as less

expensive variants. Implementation of modernization and construction can be funded by private investments and budgetary ones. In order to promote reasonability of own cities, numerous countries introduce regulations aimed at implementation of power saving technologies, increase in efficiency of municipal services and environmental safety of townscape. Many cities accepted the concept of smart city as primary trend of their activities and had already achieved positive results. However, in most countries, implementation of the smart city concept is inhibited by insignificant funding and legislative incentives, which should facilitate modernization actions. Therefore, the research hypothesis has been confirmed that implementation of the smart eco-city concept is possible in the case of execution of certain measures and application of existing foreign experience depending on natural conditions of territory. The advantage of the research has been the definition of conceptual framework for smart cities environmentalization. The novelty of the research lies in the definition and substantiation of measures for implementing the smart eco-city concept.

#### CONFLICT OF INTEREST

There is no conflict of interest.

#### ACKNOWLEDGEMENTS

None.

#### FINANCIAL DISCLOSURE

None.

## REFERENCES

- [1] Beatley T, Collins R. [2000] Smart growth and beyond: transitioning to a sustainable society. *Virginia Environmental Law Journal*, 19(3):287-322.
- [2] Letaifa SB. [2015] How to strategize smart cities: revealing the smart model. *Journal of Business Research*, 68(7):1414-1419.
- [3] Allwinkle S, Cruickshank P. [2011] Creating smart-er cities: an overview. *Journal of Urban Technology*, 18(2):1-16.
- [4] Solovev SG, Kireev VV, Sotnikova LV. [2019] Relevant Problems of Legal Regulation of IT Modernization of Local Self-Government Technologies in Russia. *Journal of Advanced Research in Law and Economics*, 10(3):917-921.
- [5] Hollands R. [2008] Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City*, 12(3):303-320.
- [6] Batty M, Axhausen KW, Giannotti F, Pozdnoukhov A, Bazzani A, Wachowicz M, Ouzounis G, Portugali Y. [2012] Smart cities of the future. *The European Physical Journal. Special Topics*, 214:481-518.
- [7] Dameri RP, Benevolo C. [2016] Governing Smart Cities: An Empirical Analysis. *Social Science Computer Review*, 34:693-707.
- [8] Vanolo A. [2013] Smartmentality: the smart city as disciplinary strategy. *Urban Studies*, 51(5): 883-898.
- [9] Lombardi P, Giordano S, Farouh H, Yousef W. [2012] Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, 25(2):137-149.
- [10] Kosevich AV, Novikova NG, Gladkikh VI, Sharonin PN, Smirnov MA. [2020] Improving Economic and Legal Regulation in the Tourism Sector. *Journal of Environmental Management and Tourism*, 11(4):979-984.
- [11] Krivova AL, Kurbakova SN, Afanasyev VV, Rezakov RG. [2020] Capabilities of Cloud Services and Webinars Effectiveness of Teaching Humanities Students. *Utopía y Praxis Latinoamericana*, 25:135-146.
- [12] Deeva TV, Nikiporets-Takigawa G, Lustina TN, Podsevalova EN, Didenko EN. [2020] Blockchain Technologies and Smart Contracts: New Technological Methods to Regulate Transactions and Trade Operations. *International Journal of Emerging Trends in Engineering Research*, 8(7): 3659-3664.
- [13] Capra CF. [2016] The Smart City and its Citizens. *International Journal of E-Planning Research*, 5:20-38.
- [14] Fiofanova OA. [2020] New literacy and data-future in education: advanced technology smart big-data. *Revista Inclusiones*, 7:174-180.
- [15] Lyshchikova JV, Stryabkova EA, Glotova AS, Dobrodromova TN. [2019] The 'Smart Region' Concept: The Implementation of Digital Technology. *Journal of Advanced Research in Law and Economics*, 10(4):1338-1345.
- [16] Kirillova E, Bogdan V, Lagutin I, Gorevoy E. [2019] Estado legal de los contratos inteligentes: características, papel, significado. *JURÍDICAS CUC*, 15(1):285-300.
- [17] Benouaret K, Valliyur-Ramalingam R, Charoy F. [2013] CrowdSC: Building Smart Cities with Large-Scale Citizen Participation. *IEEE Internet Computing*, 17(6):57-63.
- [18] Shapiro JM. [2008] Smart cities: quality of life, productivity, and the growth effects of human capital. *The review of economics and statistics*, 88(2):324-335.
- [19] Mora L, Deakin M, Reid A. [2019] Strategic principles for smart city development: A multiple case study analysis of European best practices. *Technological Forecasting and Social Change*, 142:70-97.
- [20] Zygiaris S. [2011] Smart city reference model: Assisting planners to conceptualize the building of smart city innovation ecosystems. *Journal of the Knowledge Economy*. 4(2):217-231.
- [21] Caragliu A, Del Bo C, Nijkamp P. [2011] Smart cities in Europe. *Journal of Urban Technology*, 18(2):65-82.
- [22] Angelidou M. [2017] The Role of Smart City Characteristics in the Plans of Fifteen Cities. *Journal of Urban Technology*, 24:3-28.
- [23] Zanello A, Bui N, Castellani A, Vangelista L, Zorzi M. [2014] Internet of Things for Smart Cities. *IEEE Internet of Things Journal*, 1(1): 22-32.
- [24] Brand P. [2007] Green subjection: the politics of neoliberal urban environmental management. *International Journal of Urban and Regional Research*, 31(3):616-632.
- [25] Bakic T, Almirall E, Wareham J. [2012] A smart city initiative: the case of Barcelona. *Journal of the Knowledge Economy*, 4(2):135-148.
- [26] Caprotti F, Cowley R. [2019] Varieties of smart urbanism in the UK: Discursive logics, the state and local urban context. *Transactions of the Institute of British Geographers*, 44:587-601.
- [27] Batty M, Axhausen KW, Giannotti F, Pozdnoukhov A, Bazzani A, Wachowicz M, Ouzounis G, Portugali Y. [2012] Smart cities of the future. *The European Physical Journal*, 214:481-518.