Smart Innovation, Systems and Technologies 625

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Technological Trends in the AI Economy

International Review and Ways of Adaptation

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Introduction: The AI Economy: A New Model for the Development of Contemporary Economic Systems

The Fourth Industrial Revolution facilitated the transition to a new technological order—Industry 4.0. Its key feature is the ubiquity and prevalence of smart technology, the central element (core) of which is artificial intelligence (AI). In this regard, a new model of development of economic systems that have emerged in Industry 4.0 can be called the AI economy. The emergence of the AI economy created new technological trends.

These trends include ubiquitous (covering all areas of the economy) and total automation (covering the entire set of production and distribution and organizational and management processes) based on end-to-end Industry 4.0 technologies: robots, Big Data, Internet of Things, etc. This trend is contradictory. On the one hand, it contributes to the growth of labor productivity. On the other hand, it increases the capacity of financial and energy resources in all economic processes and causes social tension due to the need to improve skills or retrain with increased risks of unemployment.

The technological trends of the AI economy also include the mass creation of smart territories (cities and regions) controlled by machine vision, as well as smart houses controlled by mobile applications. This trend is also contradictory. It increases the transparency of governance of economic systems and their inclusiveness but requires redefining the boundaries of private and public life. Personal space needs to be reconsidered because people are surrounded by and dependent on smart devices in public places and even in their homes.

Another trend in the AI economy has to do with increasing threats and the growing importance of cybersecurity. The AI economy is based on digital data. On the one hand, the electronic format increases the convenience of collecting, processing, storing, and using this data. On the other hand, it makes data vulnerable to cyberthreats—malfunctioning technical devices, power supply, reliability of software, and cybercrime.

These technological trends require adaptation of today's economic systems to them to remain competitive in global high-tech markets, maintain a high quality of life, and use these technological trends in the interests of socioeconomic development.

First, it is necessary to establish a legal framework for the AI economy as a new model for developing economic systems. AI and smart technologies that rely on it constitute intellectual property. The state's legal system must simultaneously make advanced technologies widely available, protect the rights of their owners, and guarantee the payment of royalties to recoup investments in innovation and technology.

The difficulty is that AI and smart technologies based on it are atypical intellectual property objects. They represent not just technologies but a new kind of social agent that are subjects of the machine (through the Internet of Things) and man–machine (through the user interface and intelligent decision support) communications. Moreover, new knowledge, information, and technological solutions generated by AI are objects of intellectual property, a specific subject of law (rightsholder) of which is AI.

Second, it is advisable to modernize state regulation in the AI economy. The state apparatus cannot stay in place and must keep up with the times as society and the economy move into a digital reality. Monitoring of economic activities and taxation and the provision of public services should be automated through smart technology, which is reflected in the system of electronic government.

In this case, the difficulty is that government regulation of the AI economy must stimulate it and avoid restraining its development. A significant advantage of the AI economy is increased transparency of economic systems using digital finance, e-commerce, and digital taxation, which ensures the exit of the national economy from the shadow sector.

Third, significant funding is required for the AI economy. Technological trends are only possible with sufficient and continuous funding at all stages of the innovation process: from R&D to implementation and distribution in industry markets. The investment attractiveness of future innovation projects in the AI economy depends on the success of the commercialization of advanced technologies and the return on investment in them.

The state funding of science and higher education deserves special attention. The role of universities as centers of excellence and sources of digital talent has increased in the AI economy. University funding determines the future growth opportunities of the AI economy and its future technological trends.

Fourth, AI industries need to adapt technology to industry-specific features. Despite the universality of smart technology, each area of application requires unique applied solutions. This requires a much more flexible and detailed approach than a simple division of the economy into the industry, services, and agriculture. Each market of the AI economy is specific; even each enterprise must create its own organizational model for using smart technology.

The existing literature covers the Fourth Industrial Revolution, Industry 4.0, and digital technology in great detail. Nevertheless, there is still no scientific understanding of the new model of development of economic systems, formed under the influence of the Fourth Industrial Revolution and based on the digital technology of Industry 4.0. This is a gap in the literature that requires further scientific study.

Moreover, the existing publications consider the current technological trends separately. Existing knowledge in this area is scattered and fragmented, which also serves as a gap in the literature. The experience and prospects for adapting to these technological trends are poorly understood, which is also the research gap. All gaps identified in the literature are filled by this book, which is dedicated to systematizing existing information and adding to the scientific knowledge of contemporary technological trends through a more comprehensive and multidisciplinary view of them.

This book aims to explore and discuss international experiences and identify ways to adapt to technological trends in the AI economy. The novelty of this book lies in the fact that it first proposed a scientific concept to explain and designate a new model of development of contemporary economic systems in terms of Industry 4.0—the AI economy concept. In this way, the book has clarified and streamlined the categorical apparatus and opened up possibilities for a more focused study of contemporary technological trends.

The book is also unique in that it has formed a systemic view of the technological trends of the AI economy and a comprehensive study of them from the perspective of society, economy, and law. The practical significance of the book lies in the fact that it reveals the best international practices and contains practical industry cases of technological trends in the AI economy based on the recent Russian experience.

The noted benefits are consistently achieved in the five parts of the book. The first part systematizes technological trends in the AI economy and outlines its contribution to socioeconomic development. The second part explores the Regulatory Framework for the AI Economy. The third part focuses on government regulation of the AI economy. The fourth part reveals the Current Problems of Financing the AI Economy and Ways to Solve Them. The fifth part provides an Industry Overview of the AI Economy.

The primary audience for this book is scholars engaged in studying the issues of doing business in an Industry 4.0 environment. For them, the book offers a scientific-theoretical concept of the AI economy as a new model of development of contemporary economic systems, presents its current technological trends, and offers scientific and methodological recommendations for adapting to these trends. The book's multidisciplinarity makes it attractive to representatives of various fields of scientific knowledge, including innovation economy, business economy, state regulation of the economy, regional economy, management, finance, sociology, law, and information and communication technology (ICT).

An additional audience for this book is practicing experts. Public authorities will find in the book the author's recommendations for improving the state regulation of the AI economy at the level of countries and regions. Business entities operating in Industry 4.0 will find comprehensive applied recommendations for socioeconomic adaptation to the latest technological trends in the AI economy.

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Elena N. Makarenko graduated in 1988 with honors from the Faculty of Economics, ChIGU. L. N. Tolstoy with a degree in Accounting and Analysis of Economic Activity in Industry. Since 1988, she began her career as an assistant at the Department of Economics, Organization and Planning of Production at ChIGU named after L. N. Tolstoy. In 1988, she entered the full-time postgraduate study of the Rostov-on-Don Order of the "Badge of Honor" Institute of National Economy. In November 1988, she was accepted as a junior researcher of the Rostov-on-Don Order of the Badge of Honor of the Institute of National Economy. In 1991, she graduated from graduate school, defended her Ph.D. thesis and in the same year began work at the Department of Accounting and Analysis of Economic Activity in Industry as an assistant. In 1995, she moved to the position of senior teacher, and in 1996, she was elected to the position of assistant professor. Since 2008, she worked as a deputy dean of the Faculty of Accounting and Economics in full-time education. In 2011, she defended her thesis for the degree of Doctor of Economics. In February 2012, she was appointed as the acting dean of the UEF, and in July 2012, she was elected to the post of dean of the Accounting Faculty. On September 21, 2018, she was appointed to the post of first vice-rector—vice-rector for Academic Affairs of the Rostov State Economic University. Since January 24, 2019, she has been appointed as the acting rector of Rostov State Economic University. On March 14, 2019, at the Conference of Employees and Students of the Russian State University of Economics, she was elected to the post of rector. By order of the Ministry of Science and Higher Education of the Russian Federation, she was approved as the rector of the Rostov State Economic University since June 11, 2019. From 2012 to the present, she has been working part time as a professor at the Department of Accounting.

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Part I
Technological Trends in the AI Economy and Its Contribution to Socio-economic Development

Chapter 1
Innovation and High-Tech Trends and Their Contribution to the Transition to a New Quality of Economic Growth

Elena G. Popkova

Abstract The paper focuses on trends in innovation and high technology in the COVID-19 crisis and the contribution of these trends to the transition to a new quality of economic growth in the Decade of Action. The research is based on regression, correlation, trend analysis, and variation analysis on the example of the G7 and BRICS countries in 2019–2021. The article contributes to the literature by clarifying the scientific statements of the Theory of New Quality of Economic Growth from the perspective of innovation and high technology. It is proved that the COVID-19 crisis caused not a recession but a rethinking of innovation and high technology—changing their role from a catalyst for accelerating the rate of economic growth to a source of improving the quality of economic growth. The paper substantiates that the effects of the COVID-19 crisis are not so much related to a decrease in the rate but rather to an increase in the quality of economic growth. The author demonstrates that the prospects for a new quality of economic growth and its definition in the Decade of Action are determined not so much by economic crises as by innovation and high technology as mechanisms of economic crisis management. This offers great opportunities to improve the quality of economic growth in the Decade of Action through the management of innovation and high technology, which is much more manageable than economic crises.

1.1 Introduction

The adoption of the global Sustainable Development Goals (SDGs) and the proclamation of the Decade of Action denoted the demands of the global community under the auspices of the UN for a new quality of economic growth. Previously, economic growth was evaluated by quantitative criteria (growth rate and dynamics of its change). In turn, nowadays, qualitative criteria embodied in support of sustainable development have acquired an important role. The new quality of economic growth suggests that it can only be interpreted positively if the increase in GDP is

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accompanied by zero social and environmental costs and supports the implementation of the 17 UN SDGs.

Innovation is a vector of economic growth. The problem is that the COVID-19 pandemic has set the crisis tone of the Decade of Action. The complexity of the development of the innovation economy in the COVID-19 crisis has become a barrier to the transition to a new quality of economic growth, planned by the UN and prioritized by the Decade of Action. The paper aims to explore trends in innovation and high technology in the COVID-19 crisis and the contribution of these trends to the transition to qualitatively new economic growth in the Decade of Action. The working hypothesis of this research is that innovation and high technology can mitigate the negative impact of the COVID-19 crisis and, despite the unfavorable (crisis) context, provide a transition to a new quality of economic growth in the Decade of Action.

1.2 Literature Review

This paper is based on the New Quality Theory of Economic Growth. The current research works note the severe financial impact of the COVID-19 economic crisis [1, 2] and the critical depth of the crisis—a record GDP decline, the largest of declines [3, 4]. This raises the following three research questions (RQs):

- RQ_1: How has the COVID-19 crisis affected innovation and high-tech trends? In their works, Cristescu et al. [5], Komninos et al. [6], and Yordanova [7] note the limitation of opportunities for the decline of innovation activity of economic systems in the context of the COVID-19 pandemic and crisis. Some authors [8, 9] link the consequences of the COVID-19 pandemic and crisis in the Decade of Action to a slowdown in the innovative development of economic systems. Nevertheless, innovation and high-tech trends are not clearly defined in the available literature, which represents a research gap.
- RQ_2: What are the implications of the COVID-19 crisis for the quality of economic growth? From a quantitative point of view, the effects of the COVID-19 crisis on economic growth are covered in sufficient detail in the available works of Popkova et al. [10], Popkova et al. [11], and Popkova and Andronova [12]. Baneliene [13], Ghecham [14], and Nguyen et al. [15] link the effects of the COVID-19 pandemic and crisis in the Decade of Action to a slowdown in economic growth. From a qualitative point of view, these effects are insufficiently elaborated, which is another gap in the literature.
- RQ_3: What are the prospects for a new quality of economic growth, and how will it be defined in the Decade of Action? Khoruzhy et al. [16], Sachs and Sachs [17], and Van Tulder et al. [18] note that economic growth in the Decade of Action will be determined by crises of economic systems. This reveals a quantitative assessment of economic growth prospects. Nevertheless, a qualitative assessment

of these prospects in the Decade of Action remains unformed, which constitutes another gap in the literature.

Thus, the existing literature does not sufficiently answer the research questions posed; uncertainty about these research questions constitutes a gap in the literature. To fill the identified gaps, this paper examines trends in innovation and high technology in the COVID-19 crisis and identifies the contribution of these trends to the transition to a new quality of economic growth in the Decade of Action.

1.3 Materials and Methods

The posed research questions determined the logic and structure of this research. The author applied trend analysis to find the answer to RQ_1 and determine how the COVID-19 crisis has affected innovation and high-tech trends. Trend analysis is used to determine the dynamics of the following indicators in 2021 compared with 2019:

- Global innovation index (according to WIPO estimates [19]) as an indicator of innovation and high technology;
- Gross domestic product in constant prices (according to International Monetary Fund [IMF] [20]) as a quantitative indicator of economic growth;
- Sustainable development index (according to UNDP [21]) as a qualitative indicator of economic growth.

Using the variation analysis method, the author determines the degree of uniformity of trends in innovation, high technology, and economic growth in the COVID-19 crisis.

Correlation analysis is used to find the answer to RQ_2 and determine the effects of the COVID-19 crisis on the quality of economic growth. This method is used to determine the relationship (correlation) between the rate (in terms of GDP growth) and quality (in terms of the index of sustainable development) of economic growth and the index of sustainable development in 2019–2021.

The author applies regression analysis to find the answer to RQ_3 and determine the prospects for a new quality of economic growth and how it will be defined in the Decade of Action. It is used to compile a simple linear regression model reflecting the dependence of the quality of economic growth (EGqual: sustainable development index) on the innovation and high technology factor (IV&HT: global innovation index) in 2019–2021. The research model of this paper takes the following form:

$$\mathrm{EGqual} = \mathrm{a} + \mathrm{b} * \mathrm{IV\&HT} \tag{1.1}$$

The author also applies the least squares method to determine the prospective increase in the quality of economic growth in the Decade of Action due to innovation and high technology development.

To get the most complete and reliable picture of the world economic system, the author formed a representative sample that includes developed (using the G7 countries as an example) and developing (using the BRICS countries as an example) countries. To incorporate the experience of these categories of countries evenly, the author considered the current participants and the candidates to join the BRICS (Argentina and Iran). This resulted in seven countries in each category. The empirical basis of the research for this sample is given in Table 1.1.

The working hypothesis of this study is considered proven if:

1. The coefficient of correlation of innovations and high technologies with the quality of economic growth will be higher than with the rate of economic growth.
2. A significant (more than 10%) increase in the quality of economic growth in the Decade of Action will be revealed due to the development of innovations and high technologies.

1.4 Results

To determine how the COVID-19 crisis has affected trends in innovation and high technology, as well as the impact of the COVID-19 crisis on the quality of economic growth, the author conducted a trend, correlation, and variation analysis of the studied indicators based on the data in Table 1.1. The results are summarized in Table 1.2.

The results obtained in Table 1.2 show that the trend of innovation and high-tech was negative in 2021 compared to 2019: The increase was—0.71% in the G7 countries and—2.17% in the BRICS countries. Nevertheless, the decline was typical only for the acute phase of the crisis (2020); in 2021 compared to 2020, it gave way to an upswing: the growth rate of the global innovation index in the G7 countries was 1.63%, and in BRICS countries—1.82%. Consequently, the rate of innovative development of the contemporary world economic system is so fast that even the COVID-19 pandemic and crisis cannot slow it down for long and have had only a weak and limited effect (which answered RQ_1).

The results of variation analysis indicated that the trends of innovation, high technology, and economic growth in the COVID-19 crisis were uniform. The variation in the studied trends was greater in developing countries but moderate overall. The exception was the economic growth rate in 2019–2020, which was high against the backdrop of GDP decline. Nevertheless, in 2021, against the backdrop of economic recovery, it declined to 43.43% in the G7 countries and to 38.57% in the BRICS countries.

The results of the correlation analysis indicate that the contribution of innovation and high technology to the quality of economic growth (correlation: 68.31%) in 2019–2021 is much greater than the rate of economic growth (correlation: 3.62%). Consequently, in the Decade of Action, there is indeed a transition to a new quality of economic growth in which innovation and high technology are focused more on supporting sustainable development than on GDP growth (which answered RQ_2).

Table 1.1 Statistics on innovation and high technology and the rate and quality of economic growth in 2019–2021

Category of countries		Country	Innovation and high-tech statistics			Statistics of economic growth rate			Statistics of the quality of economic growth		
			Global Innovation Index, score 0–100			Gross domestic product, constant prices, percent change			Sustainable Development Index, score 0–100		
			2019	2020	2021	2019	2020	2021	2019	2020	2021
G7		Canada	53.9	52.3	53.1	1.880	-5.233	4.563	77.9	78.19	79.2
		France	54.2	53.7	55.0	1.839	-7.987	6.978	81.5	81.13	81.7
		Germany	58.2	56.5	57.3	1.050	-4.560	2.787	81.1	80.77	82.5
		Italy	46.3	45.7	45.7	0.500	-9.026	6.636	75.8	77.01	78.8
		Japan	54.7	52.7	54.5	-0.240	-4.498	1.621	78.9	79.17	79.8
		UK	61.3	59.8	59.8	1.672	-9.270	7.441	79.4	79.79	70.2
		USA	61.7	60.6	61.3	2.289	-3.405	5.677	74.5	76.43	80.0
BRICS	Current participants	Brazil	33.8	31.9	34.2	1.221	-3.879	4.619	70.6	72.67	71.3
		Russia	37.6	35.6	36.6	2.198	-2.700	4.700	70.9	71.92	73.8
		India	36.6	35.6	36.4	3.738	-6.596	8.948	61.1	61.92	60.1
		China	54.8	53.3	54.8	5.951	2.244	8.080	73.2	73.89	72.1
		South Africa	34.0	37.2	32.7	0.113	-6.432	4.915	61.5	63.41	63.7
	Candidates	Argentina	31.9	28.3	29.8	-2.026	-9.895	10.200	72.4	73.17	72.8
		Islamic Republic of Iran	34.4	30.9	32.9	-1.340	1.762	4.011	70.5	71.81	70.0

Source Systematized and compiled by the author based on IMF [20], UNDP [21], WIPO[19]

Table 1.2 Results of trend, correlation, and analysis of variation

Category of countries	Indicator	Global Innovation Index (GII), score 0–100			Gross domestic product, constant prices, percent change			Sustainable Development Index, score 0–100		
		2019	2020	2021	2019	2020	2021	2019	2020	2021
G7	Arithmetic mean	55.76	54.47	55.36	1.28	−6.28	5.10	78.44	78.93	78.89
	Variation coefficient, (%)	9.50	9.34	9.18	69.76	−38.38	43.43	3.31	2.28	5.14
	Trend (2021/2019), (%)	–	–	−0.71 (1.63*)	–	–	297.14	–	–	0.56
BRICS	Arithmetic mean	37.59	36.11	36.77	1.41	−3.64	6.50	68.60	69.83	69.11
	Variation coefficient, (%)	20.81	22.70	22.53	200.37	−122.99	38.57	7.41	7.11	7.49
	Trend (2021/2019), (%)	–	–	−2.17 (1.82*)	–	–	361.42	–	–	0.75
14 countries	Correlation with GII, (%)	–	–	–	–	–	3.62	–	–	68.31

Note [a]Growth in 2021 compared to 2020, %
Source Calculated and compiled by the author

To determine what the prospects are for a new quality of economic growth and how it will be defined in the Decade of Action, the author obtained the following simple linear regression model using the method of regression analysis with reliance on statistics from Table 1.1 (for the entire sample of 14 countries for 2019–2021), which refined the research model (1.1):

$$\text{EGqual} = 56.61 + 0.38 * \text{V\&HT} \tag{1.2}$$

The resulting model is reliable at the 0.01 significance level (*F* significance was 0.000001) and indicates that the quality of economic growth increases by 0.38 points with the development of innovation and technology by one point. Using the method of least squares, the author established that at the fullest disclosure of the potential of innovations and high technologies development in the Decade of Actions (an increase of the global innovation index from 46.06 points on the average on a sample of 14 countries in 2021 to 100 points, that is 117.09%), the prospective gain in the quality of economic growth could reach 27.47% (the sustainable development index can increase from 74 points in 2021 to 94.33 points) (which answered RQ_3).

1.5 Conclusion

Thus, the paper answered all research questions and proved the working hypothesis. The correlation coefficient of innovation and high technology with the quality of economic growth (68.31%) will be higher than with the rate of economic growth (3.62%). The research also revealed a significant (27.47%) increase in the quality of economic growth in the Decade of Action due to the development of innovation and high technology. The paper has contributed to the literature by clarifying the scientific statements of the Theory of New Quality of Economic Growth from the perspective of innovation and high technology.

In contrast to Cristescu et al. [5], Komninos et al. [6], Yankovskaya et al. [8], Yankovskaya et al. [9], and Yordanova [7], the paper proved that in the COVID-19 crisis, the trend of innovation and high technology was negative only short term (in 2020) and was replaced by a positive trend already in 2021. Consequently, under the influence of the COVID-19 crisis, there was not a recession but a rethinking of innovation and high technology—changing their role from a catalyst for accelerating the rate of economic growth to a source of improving the quality of economic growth.

In contrast to Baneliene [13], Ghecham [14], and Nguyen et al. [15], the paper substantiates that the consequences of the COVID-19 crisis are related not so much to the decline of economic growth (a decline of GDP by 6.28% on average in the G7 countries and by 3.64% in the BRICS countries in 2020) as to the improvement of the quality of economic growth: a 0.56% increase in the sustainable development index in the G7 countries and by 0.75% in the BRICS countries in 2021 compared to 2019.

In contrast to Khoruzhy et al. [16], Sachs and Sachs [17], and Van Tulder et al. [18], the paper demonstrates that the prospects for a new quality of economic growth and how it will be defined in the Decade of Action are determined not so much by economic crises as by innovation and high technology as mechanisms of economic crisis management. This offers great opportunities to improve the quality of economic growth in the Decade of Action through the management of innovation and high technology, which is much more manageable than economic crises.

The theoretical significance of the obtained results is that they clearly identified trends in innovation and high technology and determined their contribution to the transition to a new quality of economic growth in the Decade of Action. The resulting econometric model can be used to predict future trends in innovation and high technology and their implications for the quality of economic growth under the ongoing COVID-19 pandemic and post-crisis recovery of the global economic system. The practical significance of the author's conclusions is that they allow to most fully reveal the potential of improving the quality of economic growth in the Decade of Action based on the recommended acceleration of the pace of innovation and high-tech development.

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Chapter 2
Technological, Economic, and Social Changes: The Role of End-to-End Technologies

Natalia G. Vovchenko, Olga V. Andreeva, Valeria D. Dmitrieva, Valeriya S. Kaptsova, and Venelin K. Terziev

Abstract The purpose of this chapter consists in analyzing the impact of end-to-end technologies (primarily, artificial intelligence) on economic development: Technological changes do not always lead to the desired results and, on the contrary, can cause economic and moral damage in some cases. A human who, by nature, always wants to work less and relax more finally gets this opportunity, but, for some reason, remains dissatisfied with the fact that the robots have taken their jobs away after all. The methodological and theoretical framework of the research is the tasks set by prominent contemporary economists: Zeira, Aghion, and Acemoglu, who consider artificial intelligence as one of the main factors of economic growth in the digital age. The authors of this chapter conclude that AI is more than just a factor in economic growth. It plays a dual role in socioeconomic development: as a stimulus for the growth of human employment, labor productivity, and, as a result, a reduction in employment. Both aspects are very important in the formation and adjustment of the policy to ensure the social security of any country at the present stage.

2.1 Introduction

The introduction of digital (end-to-end) technologies based on data (big data, artificial intelligence, blockchain, IoT, cloud computing, etc.) causes an inevitable transformation of the labor market. The entire structure of the production process and the sectoral balance is changing. The value is now created "as a result of the transformation of data into "'*digital intelligence*' *and the subsequent monetization in the process of their commercial use*" [13].

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Such technological changes fuel inequality: through job cuts and the destruction of entire jobs, as well as through wages and incomes, creating gaps between high-educated and low-educated workers, between workers and capital owners, and between organizations that use end-to-end technologies and firms that are limited in such opportunities.

Forced digitalization leads to the need to revise the current practices and industry, competition, investment, education, and social policies. It should be kept in mind that an active social policy leads to a moderate reduction in inequality and a decrease in innovation activity [7].

Meanwhile, the impact of digital transformation on economic growth is not clear. Technological progress turns out to be almost impossible to predict. N. Crafts optimistically notes that, due to the introduction of artificial intelligence and robotization, humans are being gradually displaced from the usual spheres of activity, but this same circumstance should lead to an increase in the productivity of (human) labor. Moreover, if computers and robotic systems will replace approximately 40% of jobs in the next 20–25 years, then we can talk about an increase in labor productivity of over 2% per year [8].

In recent history, there have already been situations when the expected economic growth against the background of a technical leap was not justified. Thus, the dramatic development of information and computer technologies in the USA in the 1970s and 1980s against the background of a significant and prolonged productivity slowdown became the subject of numerous economic studies. On the wave of positive expectations from the "new" economy and significant investment in ICT in the second half of the 1990s, there was an increase in labor productivity, but not in those industries where there had been the most noticeable drop a decade earlier, but in high-tech industries—industrial and electronic machinery [11, 12].

Despite the significant influx of investment in ICT, empirical research in the 1980s and 1990s has clearly demonstrated that in reality, in a given period, investments in digital technologies brought negative returns [6, 9, 10]; there was no actual evidence of a direct relationship between technology investment and productivity.

The purpose of this chapter is to analyze the impact of end-to-end technologies (primarily, artificial intelligence) on economic development: Technological changes do not always lead to the desired results and, on the contrary, can cause economic and social damage in some cases.

2.2 Methodology

End-to-end technologies are very diverse. They include artificial intelligence (AI), big data storage and analysis, distributed ledger technology, quantum computing, cloud computing, etc. They literally "permeate" all industries and significantly impact their transformation. End-to-end technologies can give a breakthrough effect: new high-tech markets and new opportunities for people, businesses, and the state appear. It is interesting that their list is constantly expanding. In just two years, decarbonization technologies, bionic engineering, geoinformation technologies, digital twin, 6G, and many others have been added to the list of end-to-end technologies provided for by the National Technology Initiative (NTI) program, in addition to the ones listed above.

Note that NTI involves systemic solutions to identify key technologies, necessary changes in rules and regulations, working measures of financial and human development, and mechanisms for engaging and rewarding carriers of necessary competencies [14].

Among end-to-end technologies, the most prominent is artificial intelligence, the implementation of which gradually replaces humans and excites the minds of economists, politicians, journalists, sci-fi writers, and futurists.

For economists, there is often no distinction between the technologies: ICT is only the species of technology, and AI is one of the kinds of ICT. Knowledge and technology are investigated as they are included in models as technical progress in general. The interest of economists in a sub-technology is extremely rare. Therefore, we note that the theoretical framework of this research is set by three works of prominent economists on the theory of economic growth, in which such an appeal is present. These works are as follows:

- "Workers, machines, and economic growth" [15];
- "The race between machine and man: Implications of technology for growth, factor shares and employment" [1];
- "Artificial intelligence and economic growth" [5].

As for the statistical sources, they are very limited. The study repeatedly emphasizes that data on the global implementation of specific digital technologies in country and time sections are scarce and incomplete.

2.3 Results

Among the various types of endogenous models of economic growth that include technologies and knowledge in one form or another, we can distinguish a special group of models that consider end-to-end technologies (primarily, artificial intelligence) as one of the main development factors [1, 3–5, 15, 16].

Zeira considers the automation of the production process as a critical factor in economic growth. All technological innovations help reduce production costs and increase production volumes, but not all innovations contribute to economic growth. Zeira names only two types of innovations that can make such a contribution: the first one—when machines (computers) replace people in production; the second—when high-educated labor replaces low-educated ones [15]. According to the researcher, only these two cases provide real changes in the structure of economic growth.

Acemoglu and Restrepo suggest that we create new tasks as quickly as we automate old ones; therefore, if the share of such tasks is constant, this will lead to stable economic growth [1]. In this model, based on the tasks, it is assumed that old automation tasks reduce employment, and the creation of new tasks leads to its growth. Although both types of technological change lead to changes in the rate of economic growth, they have different effects on income and employment [1].

The Acemoglu–Restrepo model assumes the heterogeneity of skills: High-educated labor has advantages in new tasks. The automation of old tasks creates discrimination and inequality, contributing to higher unemployment among low-educated workers. Nevertheless, the gradual standardization of new tasks opens up new opportunities for those workers. The second assumption introduces creative destruction into the model [2, 4], and the third one assumes that with an increase in wages, the firm will prefer to automate tasks to save money, while in the framework of social planning, it is necessary to involve the human labor rather than machines.

From the point of view of Ph. Aghion and his colleagues, artificial intelligence is a new form of automation that allows processing even those tasks that did not initially imply an automatic (automated) solution. Aghion considers the case where all tasks within the framework of the Acemoglu–Restrepo model are automated, and at the same time, automation represents the only possible technological change. Aghion explores the impact of robotization on employment and, following Acemoglu, confirms the idea of discrimination of low-educated workers. It means a need to rethink policies in areas such as education, labor, investment, and competition.

According to the authors of this research, the introduction of artificial intelligence into production can have temporary and permanent effects on economic growth, depending on how it is introduced. As AI increasingly replaces humans in the process of generating ideas, automation can eliminate the impact of population growth as a factor in economic growth.

Another controversial issue raised in this research is the theoretical possibility to reach the "technological singularity" in economic development (the infinite income in a finite period) due to the introduction of artificial intelligence. Aghion and his co-authors show that there is no need for complete automation since the non-competitiveness of knowledge increases the returns to scale. If at any stage of the innovation process, human R&D is required, then the development of super AI may slow down due to the exacerbation of industrial espionage, which will hinder human investment in innovation [5].

Continuing the reflections of prominent economists on the role of artificial intelligence as a factor in economic growth, it is necessary to note some important points:

(1) The limitations of the real implementation and application of AI in the manufacturing and tertiary sector: the state policy in the areas of education, labor, competition, innovation, and industry; in some countries, it has a deterrent effect on the AI development, bringing, thus, relative social stability.
(2) The lack of available, comparable in space and time statistics on the use of AI and the volume of AI investments for a number of countries for a thorough quantitative analysis.

Note that statistical data on ICT development and especially on the introduction of AI in some industries have begun to be actively aggregated by statistical agencies only 10–15 years ago.

Having rather scarce and averaged statistical data, it is impossible to build either an econometric model or assert the existence of long-term trends. Nevertheless, it is interesting to imagine the currently emerging situation.

Figure 2.1 provides data on the levels of global employment and corporate AI investment. Note here, for example, the correlation between GDP and total corporate AI investments: There are synchronous direct changes. Simultaneously, the employment trend is going to be the opposite.

Figure 2a presents a scatter plot to illustrate the correlation of two indicators: employment and corporate AI investment. This graph cannot be considered adequate and reliable because it is built on a small amount of data. Additionally, the coordinate point in the 2020 data is actually biased and should not be included in the model.

The graph shows a clear inverse relationship between the variables: An increase in corporate AI investment leads, in practice, to an insignificant decrease in employment.

It is really hard to tell if AI really replaces humans. In 2020–2021, there was a significant reduction in employment in the world due to the restrictive measures taken to prevent the spread of COVID-19. During this period, unemployment has become one of the most important economic issues and, at the same time, a stimulus for a technological breakthrough.

As a result, there arose two opportunities for ICT development:

(1) To organize remote access to the workplace and interaction for those who have kept their jobs and continued to work from home.
(2) To suggest a robot to replace an employee in those industries where it is already possible.

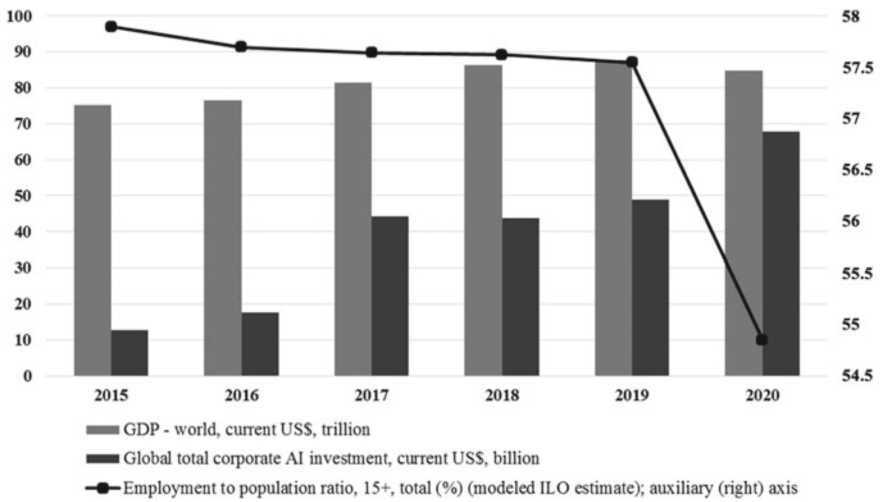

Fig. 2.1 Global total corporate AI investment and global employment, 2015–2020. *Source* Created by authors

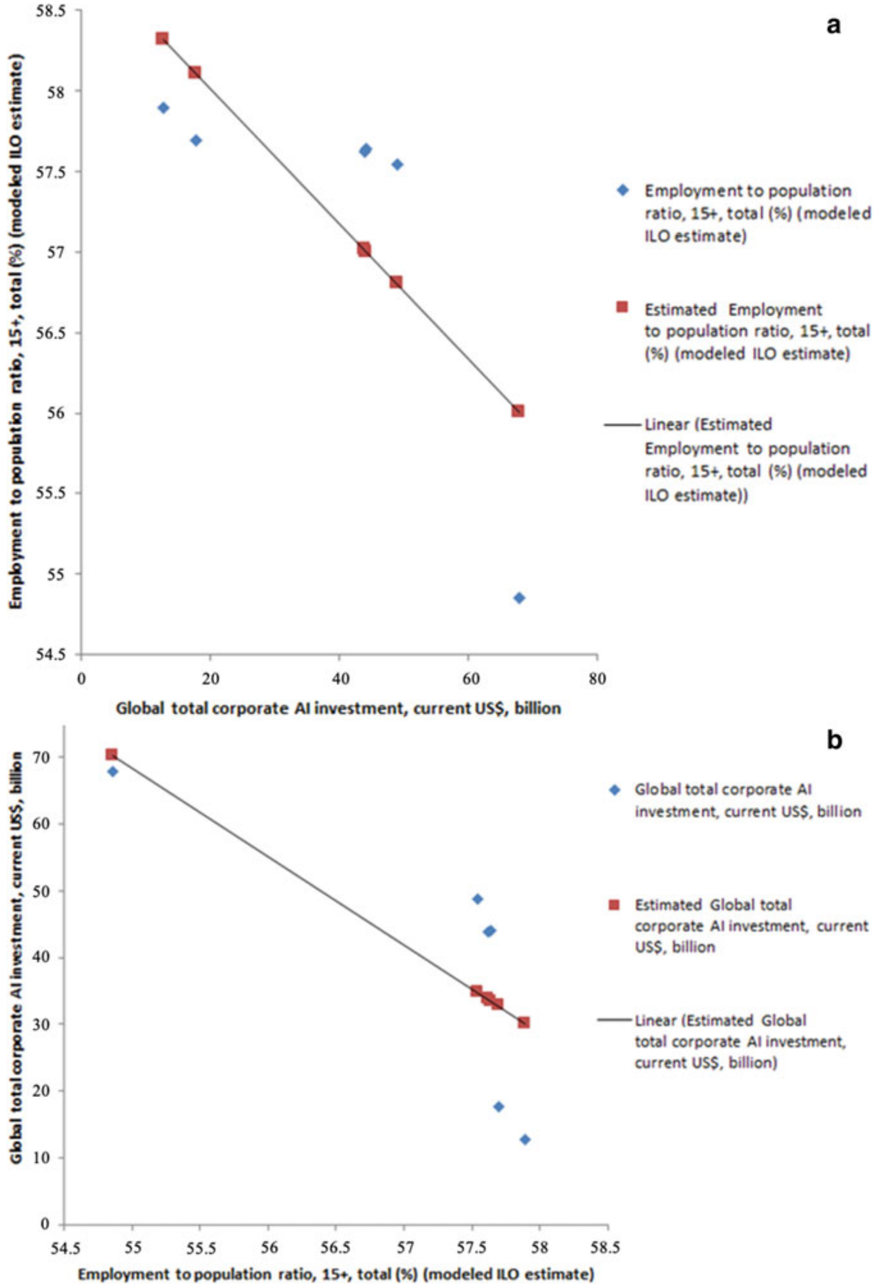

Fig. 2.2 Scatter plots: **a** global employment (Y) and global total corporate AI investment (X); **b** global employment (X) and global total corporate AI investment (Y). *Source* Created by authors

This was an attempt to replace humans from their natural sphere of activity. However, in this case, we should rather say not that the introduction of AI leads to a reduction in employment, but a reduction in employment leads to an accelerated introduction of AI.

Outstanding economists view the use of AI as one of the determinants of employment and, accordingly, a factor in economic growth. However, the issue can be viewed from another point: employment as a factor in the development of AI (Fig. 2b). It is possible to calculate the contribution to GDP of the value of products created with the participation of ICT (particularly AI).

Note that with a significant increase in corporate investments in AI and ICT, the share of exports of ICT goods (including those using AI and other end-to-end technologies) in the total volume of manufactured exports remains low—within 10–12%, which looks quite depressing against the backdrop of rapidly growing AI investments.

2.4 Conclusion

This chapter has attempted to explain the mutual influence of AI investment and employment on a global scale. Most economists view AI investment as a factor of economic growth. However, there is no empirical research to support this relationship.

The authors of this research note that the problem can be viewed from a different angle:

- Despite significant AI investments, the actual share of products manufactured with its participation is extremely low.
- A decrease in employment is a powerful incentive for the development of ICTs that replace human labor.

In many ways, the ideas of the chapter can be called preliminary; the authors have a wide field for further research. Nevertheless, some assumptions may contribute to rethinking and adjusting current economic policies in the areas of innovation and social security.

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Chapter 3
Fuzzy-Multiple Model of a Gamified Mobile Application "Smart Home" Based on Bartle's Classification of Players' Psychological Types

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Abstract The paper aims to develop the concept of a smart home application, which is an intelligent system that adapts to the user, can teach him or her in a game form, and facilitate the use of smart devices without deep knowledge of IT structures. The authors developed a fuzzy-multiple model for adjusting the interface of the smart home mobile application to the user's psychological type in accordance with the classification of gamers by R. Bartle. The authors selected the three main psychological types—Achievers, Socializers, and Explorers—in relation to the gamification of a mobile application. It was suggested to implement the adjustment based on the tabs settings in the mobile application menu: (1) Achievement level tab (primarily focused on Achievers), (2) Communication tab (focused on Socializers), and (3) System Information tab (focused on Explorers). It is proposed to implement three levels for each tab: basic, expanded, and psychotype oriented. The choice of the level is carried out based on the work of the system of productive rules, and the formation of fuzzy sets for the system is proposed to be formed based on the statistics of user calls during the control period to each of the tabs. The relevance of the work lies in the fact that it is aimed at developing an intelligent application that allows one to optimize the user experience with the smart home system, including the solution of one of the most important tasks—the creation of intelligent applications.

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3.1 Introduction

Currently, smart home technology is one of the most promising technologies [1, 2]. In the classical sense, the smart home system provides safety, resource conservation, and comfort for all users of residential premises. It consists of many subsystems that provide work with climate control, energy saving, lighting, security, house maintenance, watering, control over the adjacent territory, etc. Problems of functioning and maintenance of the smart home system are widely covered in the special literature, including the mathematical modeling of the corresponding systems.

The most important problem of the smart home system is its communication with the user. Currently, this problem is solved through the development, implementation, and commercialization of various mobile applications. Many different companies on the market try to capture this niche, namely such technological giants as Google (an application “Google Home”), Yandex (“Yandex Station”), Apple (“HomeKit”), and many others. Despite the elaboration of some general principles and concepts, they have a common problem: They are all designed for a typical user with a fairly high level of technical knowledge and skills. For example, “Yandex Station,” in theory, is designed to connect multiple devices.

Such mobile applications as Livicom are designed to connect a wide range of equipment, but they have an overloaded interface, a rather complex manual, and, ultimately, are difficult to understand for an unprepared user. These problems lead to the fact that smart home technologies are not yet popular; they are used in a truncated form by an extremely limited circle of users. Thus, the main obstacle to the widespread use of smart home systems, despite their obvious advantages, is the human factor, low preparedness of users, or difficulty in the perception of electronic home control systems.

Consequently, the main task of the developers of the smart home application is not so much the programming of the technical control system but the consideration of human psychology in the creation of such systems and the creation of a friendly interface that adapts to specific users, their proficiency in computer technology, and their psychological characteristics and preferences, unobtrusively teaching them in easy-to-understand and “playful” form [3–5].

This problem is conceptually addressed by this research.

In the study, a conceptual model of the smart home mobile application has been developed, which recognizes the user’s psychological type and their level of ICT proficiency to choose the most user-friendly interface. Illustrative descriptions of application modifications for different levels and types of users are provided.

Based on the conceptual model, the authors developed a mathematical model of a mobile application that recognizes the level of ICT proficiency of the users and their psychological characteristics according to several criteria and selects the interface of the mobile application based on a system of fuzzy inferences.

The developed concept and the fuzzy-multiple model that implements it aim at adjusting the interface of the smart home mobile application to the user’s psychological type in accordance with R. Bartle’s classification. The authors selected the three main psychological types—Achievers, Socializers, and Explorers—in relation to the gamification of a mobile application. It is proposed to implement the adjustment based on the settings of the tabs in the mobile application menu:

(1) Achievement Level tab (focused primarily on Achievers);
(2) Communication tab (focused on Socializers);
(3) System Information tab (focused on Explorers).

For each tab, it is proposed to implement three levels. The choice of the level is carried out based on the work of the system of productive rules. Fuzzy sets for the system are proposed to be formed based on the statistics of user calls during the control period to each of the tabs.

The mobile application model offers a system of sequential training of the user to work with the application. Three levels (beginner, basic, and advanced) have also been introduced to assess the ICT proficiency of a user. Each level is characterized by its own adaptation of the mobile application interface and provides for the transition from one level to another, with subsequent complication and training of the user. Teaching the user about the proposal is carried out based on gamification, that is, the theory of serious games. The game elements are a classic set of tools such as achievements, leaderboards, rating, and tests presented in a playful way and with a hint system. The implementation takes place through the use of each of the tools, adjusted for the user based on their psychological type (i.e., Socializers, Explorers, and Achievers).

A method for the formation of an appropriate system of fuzzy inferences was developed based on the Mamdani algorithm. Statistics of experimental data were obtained based on the testing of a control group of users. Additional methods have been developed for the application to assess the level of anxiety and the level of forgetfulness of the user, designed to optimize the mobile application in cases where the user has atypical reactions.

The proposed model is implemented on a specific example, with obtaining numerical results and their linguistic recognition in fuzzy logic. The developed model is universal and can be transferred to other educational electronic systems without significant changes.

3.2 Methodology

3.2.1 Conceptual Model of Accounting for the User's Level of ICT Proficiency in the Smart Home Application

It is proposed to introduce the following levels of ICT proficiency of the user: beginner, basic, and advanced.

Advanced users (experienced) are allowed to turn on/off the system of prompts. Moreover, the system allows such users to unload statistics for a month, week, or day. It also suggests possible options for energy saving.

For basic users, the system informs about new features.

For beginners, the system guides the user, visually demonstrating the capabilities of the application, hiding all redundant functions, and revealing them to the user as needed while learning from an intuitive interface.

3.2.2 Fuzzy-Multiple Model of User Level Recognition by the Smart Home Application

Let us introduce a system of designation of user levels of possession of the smart home mobile application:

- Y_1—initial;
- Y_2—basic;
- Y_3—advanced.

To assess the knowledge, skills, and abilities available to the user, a fuzzy-multiple variable X is introduced—"Level of mastery of the smart home application." It is proposed to introduce the following system of fuzzy rules:

- Rule 1: If $X = X_1$ ("The level of mastery of the smart home system is low"), then $Y = Y_1$ ("The user's level is initial");
- Rule 2: If $X = X_2$ ("The level of mastery of the smart home system is average"), then $Y = Y_2$ ("The user's level is basic (classic");
- Rule 3: If $X = X_3$ ("The level of mastery of the smart home system is high"), then $Y = Y_3$ ("The user's level is advanced (experienced)."

The corresponding fuzzy sets are formed based on statistics of user actions and reflect the number of points scored by him or her for the considered period. Possible variants of the scale are as follows:

- 1 to 25—the development of the initial user, where the 25th level is the transition to the basic user;
- 26 to 75—the development of the basic user;
- 76 to 100—the development of the advanced (experienced) user.

After choosing the estimation intervals corresponding to the user levels, the centers of the corresponding intervals are determined and fuzzy sets are formed. The next stage is the recognition of the user's level based on the system of productive rules described above.

3.3 Results

3.3.1 Theoretical Foundations of Gamification Based on the Consideration of the Psychological Type in Accordance with Bartle's Classification

We consider the four psychological types indicated by Richard Bartle, their driving motives, and potential leverage on them in the game.

Achievers or careerists. For them, it is important to accumulate power, money, and cool artifacts—any game benefits and resources.

Killers. For them, the main motivation is superiority over other players, dominance, and domination.

Explorers. They are interested in studying the game world and discovering its secrets. This class is focused on knowledge, the absorption of game content, and the study of game mechanics and game capabilities.

Socializers or party people. For these users, the most important aspects are communication with other players, social interaction, and mutual understanding.

This classification is effective in the game. However, the classification is simplified in relation to the mobile application. The Killer and Accumulator classes are characterized by the level of achievement in using the mobile application: the amount of information acquired, the level achieved, the position in the number of accumulated benefits and bonuses, as well as superiority in these areas over other users of the application. The combined class is proposed to be named Achievers.

Thus, we have identified three classes of users of the smart home mobile application: Achievers, Socializers, and Explorers.

3.3.2 Mathematical Model of Adjusting the Application to the user's Psychological Type in Accordance with Bartle's Typology Based on a System of Productive Rules

In accordance with the introduced classification, it is proposed to introduce three tabs in the mobile application menu:

(1) Achievement Level tab (focused on Achievers);
(2) Communication tab (focused on Socializers);
(3) System Information tab (focused on Explorers).

However, almost every user is a combination of several psychological types. Therefore, the interface of each tab should be expanded for each user, considering their needs.

In accordance with this, it was proposed to develop three levels for each of the tabs: (1) basic, (2) expanded, and (3) psychotype oriented. Thus, we get three interfaces of the tabs:

- *A1 (Basic Achievements)*—minimum information about the levels passed in mastering the application, accumulated points and bonuses;
- *A2 (Detailed Achievements)*—detailed information about the levels passed during the mastering of the application, accumulated points and bonuses; elements of leaderboards and badges when assessing achievements, taking into account the user's wishes;
- *A3 (Psycho-oriented Achievements)*—detailed information about the levels passed, accumulated points and bonuses; active use of leaderboards and badges in a playful way, in comparison with other users of the application;
- *S1 (Basic Communication)*—access to the forum, the ability to communicate and consult with other users;
- *S2 (Expanded Communication)*—access to the forum, expanded communication with other users, the ability to participate in collective games based on the application;
- *S3 (Psycho-oriented Communication)*—extensive communication with other users on the forum and in social media, participation in collective games based on the application;
- *E1 (Basic Information)*—basic information about the system and its capabilities;
- *E2 (Expanded Information)*—expanded information about the system, access to the library, a system of suggestions for studying the system;
- *E3 (Psycho-oriented Information)*—detailed information about the system, including in a game form, access to the library, a system of suggestions for studying the system, quests and levels showing the level of proficiency in the mobile application.

On each tab, it is proposed to introduce an automatic scoring system upon contact. Moreover, the accumulation of points is carried out in such a way that various actions are assessed with a different number of points. For example, 1 point is awarded for simple access to the forum; 2 points are awarded for participation in the discussion of the problem; 5 points are given for inviting a friend to a group, etc. After that, a correspondence is established between the levels of the interface and the number of points accumulated by the user for the assessed period, based on expert assessments. For the intervals established in this way, the centers of gravity are calculated and, on their basis, fuzzy sets are formed: SX_1—"social activity is low," SX_2—"social activity is average," and SX_3—"social activity is high."

After that, the rules of fuzzy production are formed to select the interface of the Communication tab:

- RULE Soc1: IF $X_1 = SX_1$ ("Social activity is low"), THEN $Y_1 = SY_1$ ("interface Basic communication");
- RULE Soc2: IF $X_1 = SX_2$ ("Social activity is average"), THEN $Y_1 = SY_2$ ("interface Communication expanded");
- RULE Soc3: IF $X_1 = SX_3$ ("Social activity is high"), THEN $Y_1 = SY_3$ ("interface Communication psycho-oriented").

Similarly, based on the analysis of statistics of work with the Achievement Level tab, its interface is formed:

- RULE Ach1: IF $X_2 = AX_1$ ("The level of interest in achievements is low"), THEN $Y_2 = AY_1$ ("interface Basic achievements");
- RULE Ach2: IF $X_2 = AX_2$ ("Level of interest in achievements is average"), THEN $Y_2 = AY_2$ ("interface Achievements expanded");
- RULE Ach3: IF $X_2 = AX_3$ ("Level of interest in achievements is high"), THEN $Y_3 = AY_3$ ("interface Achievements psycho-oriented").

Accordingly, based on the analysis of statistics of working with the Information tab, its interface is formed:

- RULE Exp1: IF $X_2 = EX_1$ ("The level of interest in information is low"), THEN $Y_2 = EY_1$ ("interface Basic information");
- RULE Exp2: IF $X_2 = EX_2$ ("The level of interest in information is average"), Then $Y_2 = EY_2$ ("interface Information expanded");
- RULE Exp3: IF $X_2 = EX_3$ ("The level of interest in information is high"), THEN $Y_3 = EY_3$ ("interface Information psycho-oriented").

The result of the work of the production rules is the choice of the interface of the mobile application for the user for a certain regulated period. The initial interface of the application (for a control period) can be selected in accordance with the results of user testing according to Bartle's method.

3.3.3 Implementation of Customization of the Application for the User's Psychological Type in Accordance with Bartle's Typology Based on a System of Productive Rules

Stage 1. Experimental material: Test results are presented in a group of 100–120 people according to Bartle's test. In the control group, the number of people was as follows:

(A) Achievers (it combines such psychological types as the Accumulator and the Killer): 30—a pronounced Achiever; 65—a moderately pronounced Achiever; 25—a weakly pronounced Achiever;

(B) Socializers: 32—a pronounced Socializer; 58—a moderately pronounced Socializer; 10—a weakly pronounced Socializer;
(C) Researchers: 20—a pronounced Researcher; 64—a moderately expressed Researcher; 16—a weakly expressed Researcher.

For *A*, *B*, and *C*, the original group is divided into expert groups. In each expert group, a survey is conducted to identify preferences in choosing the appropriate tab (for X from 0 (min) to 1 (max)).

Stage 2. In the Achievers, the preferences in choosing the type of the Achievements tab are investigated, for the user type Socializers—the Socialization tab, and for the Researchers—the Documentation tabs.

Characteristics of the Achievements tab are as follows:

- Min—the minimum service for evaluating achievements, that is, the points scored, achievements, and the minimum level of the user (corresponds to $X = 0$);
- Middle—leaderboards, achievement levels, rating tables, obtaining a seasonal rating with the possibility of monetization, in the form of partner discounts (corresponds to $X = 0.5$);
- Max—leaderboards, badges, showing the results of ratings in the Socialization tab, posts in social networks, monetization in the form of purchasing merchandise (branded clothing), purchasing scripts from other users to automate their processes (corresponds to $X = 1$).

Characteristics of the Socialization tab:

- Min—access to the forum, the ability to communicate and consult with other users (corresponds to $X = 0$);
- Middle—access to the forum, extensive communication with other users, the ability to participate in collective games based on the application (corresponds to $X = 0.5$);
- Max—extensive communication with other users on the forum and in social media, participation in collective games based on the application (corresponds to $X = 1$).

Characteristics of the Documentation tab:

- Min—basic information about the system and its capabilities (corresponds to $X = 0$);
- Middle—detailed information about the system, access to the library, a system of suggestions for studying the system (corresponds to $X = 0.5$);
- Max—detailed information about the system, including in a game form, access to the library, a system of suggestions for studying the system, quests and levels showing the level of proficiency in the mobile application (corresponds to $X = 1$).

Thus, experts in each group can choose one of the three main types of the investigated tab corresponding to Min, Middle, Max, or intermediate values between these

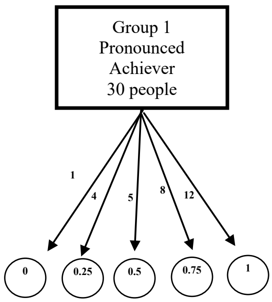

Fig. 3.1 Selection statistics "Preferred tab type for Achievers." *Source* Compiled by the authors

types: Min–Middle ($X = 0.25$) or Middle–Max ($X = 0.75$). Selection statistics are recorded, and fuzzy sets of preferences are compiled on its basis. For example, Fig. 3.1 illustrates the process of forming a fuzzy set "Preferred type of tab of the Socialization tab." Thus, in group 1 (a pronounced Achiever), the distribution was as follows: the Min tab type was chosen by 1 person; Min–Middle—by 4 people; Middle—by 5 people; Middle–Max—by 8 people; Max—by 12 people.

Based on the given statistics, fuzzy sets AY_1 ("Achievement basic interface"), AY_2 ("Achievement interface deployed"), and AY_3 ("Psychotype-oriented communication interface") are formed (in reverse order to Fig. 3.1).

$$AY_1 = 0\backslash\frac{10}{25} + 0.25\backslash\frac{7}{25} + 0.5\backslash\frac{3}{25} + 0.75\backslash\frac{3}{25} + 1\backslash\frac{2}{25}$$
$$AY_2 = 0\backslash\frac{4}{65} + 0.25\backslash\frac{6}{65} + 0.5\backslash\frac{15}{65} + 0.75\backslash\frac{30}{65} + 1\backslash\frac{10}{65}$$
$$AY_3 = 0\backslash\frac{1}{30} + 0.25\backslash\frac{4}{30} + 0.5\backslash\frac{5}{30} + 0.75\backslash\frac{8}{30} + 1\backslash\frac{12}{30}$$

Stage 3. In the "Achievers" groups, statistics on the number of points earned by accessing the "Achievements" tab are examined for 30 days. According to Fig. 3.2, in Group 1: 3 people scored 10 points; 4–30 points; 6–50 points; 7–70 points; 10–90 points.

Based on statistical scores for 30 days, three fuzzy sets are compiled: AX_1 ("the level of interest in achievements is small"), AX_2 ("the level of interest in achievements is medium"), and AX_3 ("the level of interest in achievements is high").

$$AX_1 = 10\backslash\frac{10}{25} + 30\backslash\frac{6}{25} + 50\backslash\frac{5}{25} + 70\backslash\frac{3}{25} + 90\backslash\frac{1}{25}$$
$$AX_2 = 10\backslash\frac{7}{65} + 30\backslash\frac{4}{65} + 50\backslash\frac{28}{65} + 70\backslash\frac{13}{65} + 90\backslash\frac{6}{65}$$
$$AX_3 = 10\backslash\frac{3}{30} + 30\backslash\frac{4}{30} + 50\backslash\frac{6}{30} + 70\backslash\frac{7}{30} + 90\backslash\frac{10}{30}$$

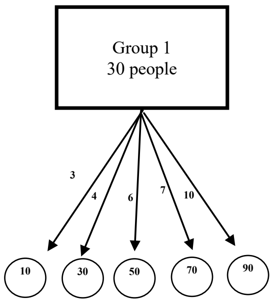

Fig. 3.2 Statistics of the distribution of users by the number of points scored. *Source* Compiled by the authors

As a result, we form a system of fuzzy inferences:

- RULE Ach1: IF $X_2 = AX_1$ ("the level of interest in achievements is low"), THEN $Y_2 = AY_1$ ("Achievement interface is basic");
- RULE Ach2: IF $X_2 = AX_2$ ("the level of interest in achievements is average"), THEN $Y_2 = AY_2$ ("Achievement interface is expanded");
- RULE Ach3: IF $X_2 = AX_3$ ("the level of interest in achievements is high"), THEN $Y_3 = AY_3$ ("Achievement interface is psycho-oriented").

Similarly, based on the analysis of the statistics of working with a tab in the control groups, systems of fuzzy inference are formed for the Socialization and Documentation tabs.

Working with productive rules for a specific user. The choice of the type of tab for a specific user is based on the statistics of points scored by him for 30 days.

$$AX = 10\backslash\frac{3}{30} + 30\backslash\frac{5}{30} + 50\backslash\frac{12}{30} + 70\backslash\frac{8}{30} + 90\backslash\frac{2}{30}$$

where *AX*—input fuzzy set.

The system of productive rules answers the "Which tab (and with what probability) would the user prefer, based on the available statistics?" We get the answer in the form of a fuzzy set:

$$AY = 0\backslash m1 + 0.25\backslash m2 + 0.5\backslash m3 + 0.75\backslash m4 + 1\backslash m5,$$

where m1, *m*2, *m*3, *m*4, and *m*5 are calculated based on Mamdani's fuzzy inference: The procedure for calculating *mi*, $i = 1$–5, is as follows $\max(((AX, AY)))$

(1) Building a matching matrix for each of the 3 rules

$$AX_1 \circ AY_1 = \begin{pmatrix} 0.40.240.20.120.040.280.120.120.08 \\ 0.240.120.120.080.20.120.120.080.120.120.120.08 \\ 0.040.040.040.04 \end{pmatrix}$$

$$AX_2 \circ AY_2 = \begin{pmatrix} 0.0620.0620.0620.0620.0620.0920.1070.1070.107 \\ 0.0620.0620.0620.0620.0920.380.430.15 \\ 0.0920.20.20.150.0920.0920.0920.092 \end{pmatrix}$$

$$AX_3 \circ AY_3 = \begin{pmatrix} 0.030.030.030.030.030.10.10.10.10.130.130.130.13 \\ 0.130.160.20.20.130.160.230.230.130.160.260.33 \end{pmatrix}$$

(2) We find the logical sum of three matches (max is a composition of 3 matrices):

$$(AX_1 \circ AY_1) \vee (AX_2 \circ AY_2) \vee (AX_3 \circ AY_3) = AX \circ AY = AX$$
$$= \begin{pmatrix} 0.40.240.20.120.062 & 0.280.120.120.107 & 0.240.130.130.13 \\ 0.20.160.20.2 & 0.130.20.230.23 & 0.130.160.230.33 \end{pmatrix}$$

The statistics of points scored by the user for 30 days are drawn up in the form of a vector. We make a max-composition *AX* and *AXY*: (0.1; 0.17; 0.4; 0.27; 0.07).

$$m1 = \max(0.1; 0.17; 0.12; 0.12; 0.07) = 0.17$$
$$m2 = \max(0.1; 0.17; 0.13; 0.13; 0.07) = 0.17$$
$$m3 = \max(0.1; 0.17; 0.16; 0.2; 0.07) = 0.2$$
$$m4 = \max(0.1; 0.13; 0.2; 0.23; 0.07) = 0.23$$
$$m5 = \max(0.062; 0.13; 0.16; 0.26; 0.07) = 0.26$$

Thus, at the output, we get a fuzzy set of hypothetical preferences of the user in question, determined on the basis of a given system of fuzzy inferences:

$$AY = 0\backslash 0.17 + 0.25\backslash 0.17 + 0.5\backslash 0.2 + 0.75\backslash 0.23 + 1\backslash 0.26$$

As we can see, the fifth type (psychotype oriented) is the most probable. However, it is impossible to neglect the statistics of other preferences, so we center the fuzzy set:

$$g = \frac{0 * 0.1 + 0.3 * 0.17 + 0.5 * 0.2 + 0.75 * 0.23 + 0.9 * 0.26}{0.17 + 0.17 + 0.2 + 0.23 + 0.26} = 0.55$$

At the output, as a result of recognizing the obtained estimate, the set gets the preferred average level, that is, "middle".

3.4 Conclusion

The methodological foundations have been developed for adjusting the smart home mobile application to the user level to ensure its most effective work and optimize training in working with the system. Three levels are highlighted: beginner, basic, and advanced. Each level has its own sequence of work with the system, permissible actions, and opportunities for working with the smart home, as well as training moments in work. It is assumed that training in working with the system is organized in such a way that the user can eventually move from one level to another.

To recognize the user's level, we used a system of productive rules and fuzzy inferences based on statistics of daily actions of the user in working with the smart home system. Thus, a mathematical model of an automated mobile application is presented that provides the most effective user interaction with the smart home mobile application.

The proposed methodology is universal and can be transferred to other educational electronic systems without significant changes.

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Chapter 4
Developing Competitive Strategies Based on Scenario Analysis with the Use of AI Capabilities

Nikolay A. Dimitriadi, Oleg I. Shchepilov, and Almaz K. Atabekov

Abstract This study aimed at developing a methodology for a scenario analysis based on artificial intelligence (AI) is meant to be implemented and includes an assessment of stakeholders' game interaction. Based on the analysis of expert opinions, the authors developed a modified concept of a scenario analysis, including the use of a market map (which allows identifying participants in the value chain, as well as the influence of stakeholders outside the chain) and the use of game theory methods. The authors consider generating secondary/tertiary projections (identified during the PEST analysis) of scenario forming drivers as a result of stakeholders' response to protecting their goal and interests and suggest using an original matrix "Stakeholder group/Stakeholder interests/Map fragments market." The authors propose an approach to form the competitive strategy content based on the analysis of secondary/tertiary projections and the selection of appropriate "anchor" and "additional" functional strategies using the analysis of their compatibility. According to the authors, the proposed technique for scenario analysis can be successfully implemented based on artificial intelligence.

4.1 Introduction

Competitive strategies determine the activities of a company in the target market and are aimed at generating competitive advantages [1]. Effective implementation of competitive strategies can improve the competitiveness of companies [2–6] and the competitiveness of the goods produced by them [7–10]. The company's competitiveness largely depends on the effectiveness of the choice of activities, along with the specifics of activities in the target markets [11]. Effective creation of a competitive

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strategy requires the use of strategic tools [4, 12–15]. Simultaneously, a significant part of strategic tools is mainly focused on assessing the current situation in the markets, which, to a certain extent, complicates the development of promising strategies. This context prompts specialists to use flexible strategies within the strategic management framework, and these strategies must be adjusted while being implemented [8]. As an alternative approach, scenario analysis is used to research possible ways of developing the situation in the industry of interest to the company [16–21].

To designate driving forces behind scenario development, experts use a concept of "drivers"—components of the external environment that affect a significant part of its elements. Experts also highlight "uncertainties"—elements of the external environment, and the instability of which can cause the development of significant changes in the structure of the environment in which the company operates. The following overview process of generating scenarios when developing a strategy is offered (Fig. 4.1).

It should be noted that in the business environment, each transformation of the driver provokes the formation of certain projections (of the given driver), which are nothing but changes in other components of the studied environment. Projections provoked by the driver's influence are classified as "primary." Real scenarios are formed under the conditions of the interaction of primary, secondary, and other (subsequent) projections representing the response of participants on the given market to the action of drivers and their primary projections.

Note that the formation of secondary/tertiary projections may, in our opinion, be the result of stakeholders' responses [22] to influences of drivers/uncertainties, as well as of primary projections. In this regard, the application of the game theory [23–25] in scenario development and the corresponding strategies seems to be quite reasonable. The complexity of the process of "generating" projections of various levels may require the use of artificial intelligence. The paper aims to develop an AI-based implementation-oriented modified scenario analysis methodology using stakeholders' game interaction assessment.

4.2 Methodology

The basic research method was the use of an expert survey (ES) with the participation of 16 experts (11 men and 5 women aged 33–46 of 14 to 18 years' experience) in developing strategies and conducting scenario analysis. The experts were asked to describe the major stages of scenario analysis conducted as part of the strategic process. All ES participants were recruited based on the personal contacts of the authors.

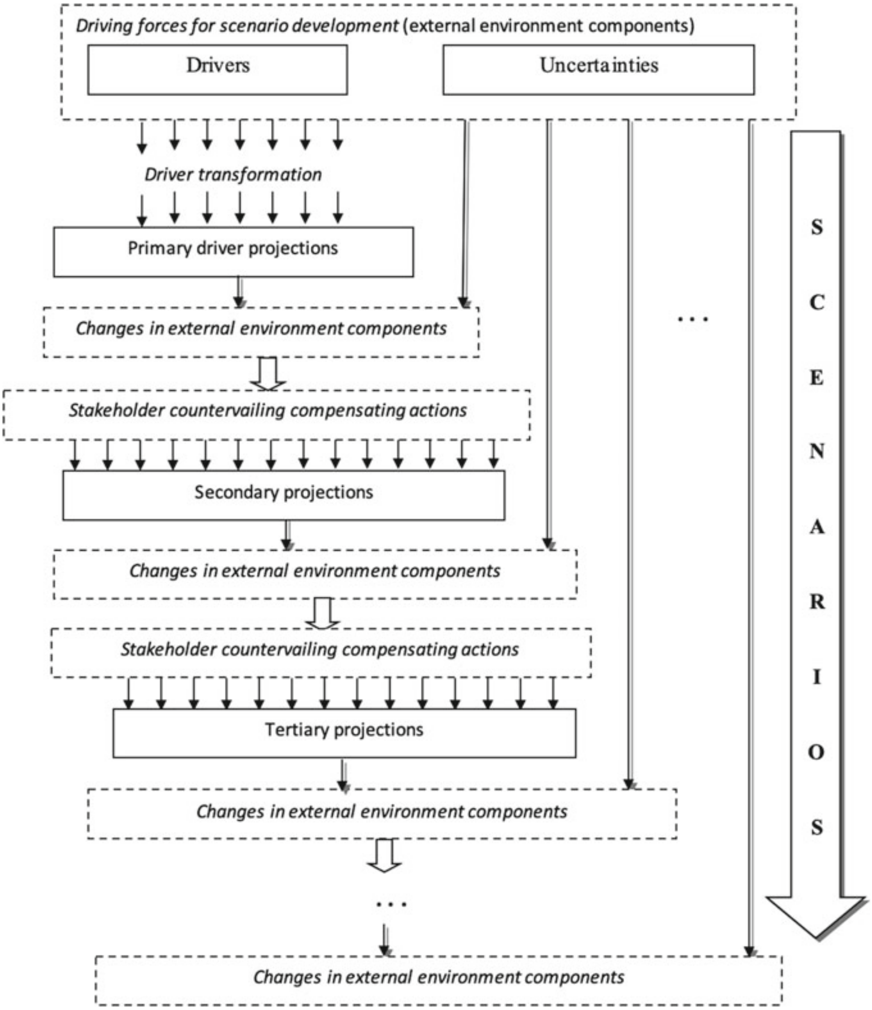

Fig. 4.1 Overview process of generating scenarios when developing a strategy. *Source* Developed and compiled by the authors

4.3 Results

The ES result was presented by the experts' description of scenario forming features in the development of the market situation as given below:

1. Contemporary value chains

1.1 Most existing markets have developed an infrastructure represented by producers of raw materials/components and manufacturers of finished products, as well as financial institutions and a distribution chain that includes wholesalers, retailers, and transport companies.
1.2 The activities of specific companies and markets are generally influenced by stakeholder groups that pursue their interests.
1.3 Stakeholders determine the distribution of functions and interaction of companies included in the structure of a particular market.

2. Factors that form market development scenarios

2.1 When developing scenarios, specialists analyze market development drivers and uncertainties.
2.2 Drivers and uncertainties may come from existing stakeholders, or they can originate from other sources.

3. Scenario formation

3.1 Primary projections, reflecting the impact of drivers and uncertainties on the market, play a significant role in scenario formation.
3.2 The mismatch between the interests of a particular stakeholder and the outcome of a driver, uncertainty, or primary forecast prompts stakeholders to take certain compensatory actions that form secondary/tertiary forecasts; each stakeholder option is limited by the resources it can use.
3.3 Market development scenarios are generated in the form of complexes of interrelated and compatible primary/secondary/tertiary projections.

Based on the analysis of expert opinions, the concept of scenario analysis has been developed (Fig. 4.2), which includes three main blocks:

(A) Analysis of components of the market environment, based on the construction of a map of the selected market to study it and identify its main participants and drivers along with primary and secondary projections.
(B) Identification of several iterations of compatible projections that are most likely to be implemented and cause the response of stakeholders and on the basis of which scenarios will be formed. For this purpose, at each step of the iterative process, a game model of two players—the "stakeholder" and the "uncertainty-related change projections"—is used. The game model is formed for the activities of each stakeholder and is solved by the "mixed strategies" method.
(C) Generation of scenarios and development of a strategy for each of them.

According to the presented concept, the authors have developed a modified methodology of scenario analysis, the stages of which are described below (references to the methods of implementing each stage are indicated in brackets):

1. Identification of the studied market based on defining its borders [26].
2. Development of the market map/identification of the main stakeholders [27].

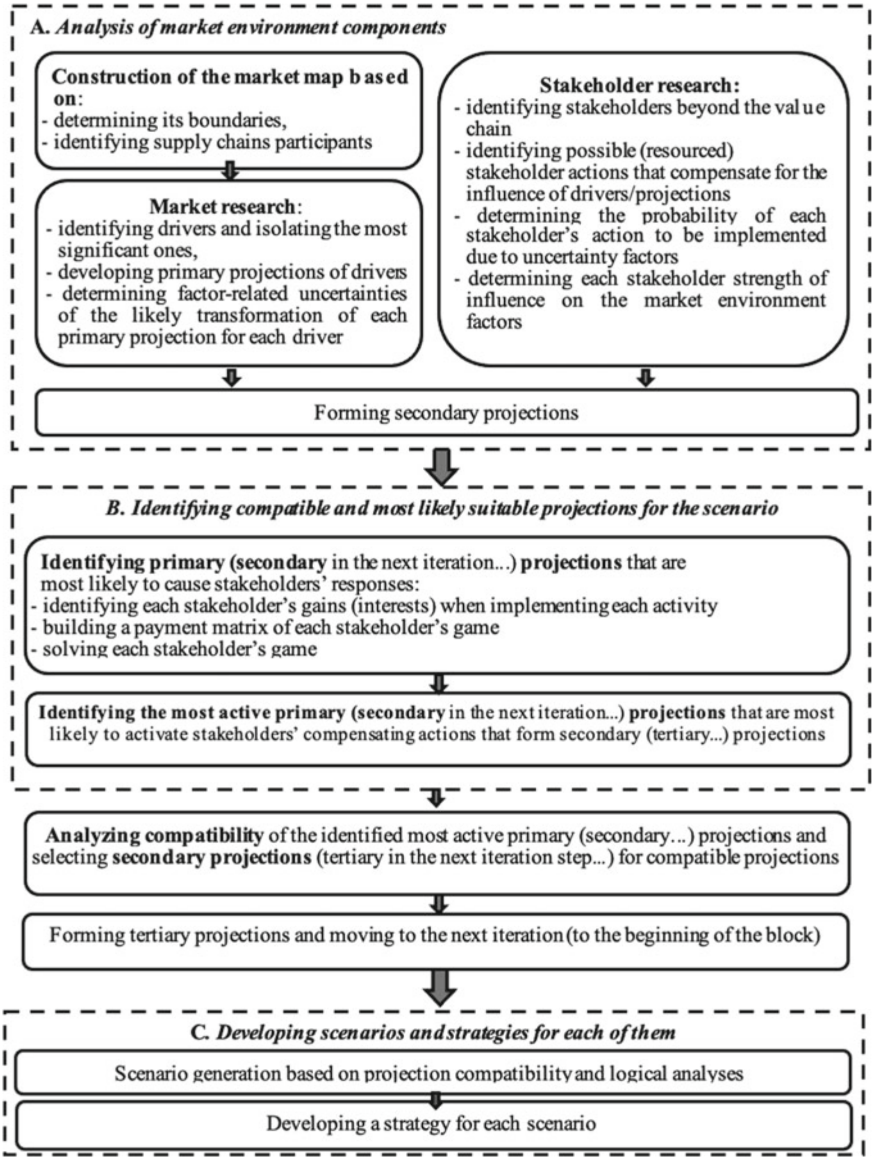

Fig. 4.2 Concept algorithm of scenario analysis. *Source* Developed and compiled by the authors

3. PEST analysis, identification of drivers, and uncertainties [17, 28].
4. Identification of most significant drivers based on the analysis of their relationship [17, 28].
5. Identification of primary projections of most significant factors [28].

6. (*Beginning of the iteration process)* identification of possible secondary (at the next iteration—tertiary, etc.) projections, as a product of stakeholder's reaction to the implementation of primary (at the next iteration—secondary, etc.) projections based on the use of a 3D matrix "Stakeholder Group/Stakeholder Interests/Market Map Fragments" [29]. The following concept algorithm of scenario analysis is offered (Fig. 4.2).
7. Identifying stakeholder responses to changes of drivers/projections; defining implementation probabilities for each of those activities and degrees of influence of each stakeholder on market factors (based on expert assessments).
8. Identifying probabilities of uncertainty-determined changes of each primary (the next iteration of secondary, etc.) projection for each driver (based on expert evaluations).
9. Identifying stakeholders' gains after implementing their reciprocal compensatory actions (on the basis of expert estimations).
10. Forming payment matrices, solving games for each stakeholder by means of the "mixed strategies" method, and finding those primary (in the next iteration secondary, etc.) projections that will most likely activate stakeholders' reciprocal activities.
11. Analyzing compatibility (on the basis of the projection compatibility matrix [28]) of identified projections; identifying projections; choosing the most active projections from compatible ones by means of the comparative method, and selecting for them corresponding secondary (at the next iteration, tertiary, etc.) projections from the previously identified list.
12. Going back to the beginning of the iteration process (item 6). Completion of iterations is carried out based on logical analysis.
13. Analyzing compatibility of the obtained projections based on the corresponding matrix [28]; generating primary scenario drafts.
14. Using logical analysis to form real scenario drafts.
15. Developing strategies focused on each scenario:
    - Identifying most significant key factors for success (in a given market) within each scenario [30];
    - Choosing the optimal template of a competitive strategy for each scenario and forming a set of functional strategies using a compatibility scale (functional strategies) [31].

4.4 Conclusion

Thus, the authors proposed a modification of the scenario analysis approach when developing a competitive strategy. The main additional elements introduced in this methodology are as follows:

- Use of the market map (which allows identifying participants in the value chain and the influence of stakeholders outside the chain);

- Use of the game theory method to identify projections that provoke stakeholders' compensatory reactions;
- Mechanism of forming secondary/tertiary projections (based on the use of the original matrix "Stakeholder Group/Stakeholder Interests/Market Map Fragments")
- Development of the strategy based on the scenario analysis results using the content structuring of a competitive strategy by identifying the "anchor" functional strategy and selecting components of the competitive strategy based on the analysis of their compatibility.

Effective scenario analysis requires thorough reflection on an extensive amount of information, while decision-making at this level of complexity may require the application of AI technologies [32, 33].

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Chapter 5
Analysis of Business Data and Cybersecurity as New Areas of Activity for Business Analysts in the Context of Digital Transformation

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Abstract The current development of the economy is marked by a significant increase in the volume of information and digital data. This manifests itself at the macro- and micro-levels. The context in which today's business exists has changed globally; the use of descriptive, predictive, or normative analytics is no longer enough. Therefore, new approaches are needed that will ensure its successful development. World practice in the field of business analysis shows that it already covers many areas to solve business problems, such as agile technologies, data analysis using digital technologies, analysis in the field of cybersecurity, and the use of the capabilities of data mining. The paper discusses the newly listed areas of business analysis and defines its capabilities in terms of business data analysis and in the field of cybersecurity analysis.

5.1 Introduction

Nowadays, the number of information flows in the world is increasing. Any organization's existence is accompanied by a recording of all details of its activities. This amount of information needs to be productively processed because the streams of "raw" data are practically useless. There are the following peculiarity and specificity of current requirements for large amounts of information for its processing:

- Unlimited amount of data;
- Large amounts of data are heterogeneous (quantitative, qualitative, and textual);
- The results of data processing should be specific and understandable;
- Tools for processing "raw" data should be easy to use.

Today's analytical data processing requirements must meet different needs to provide the best business results for the organization. World practice in the field

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of business analysis shows that it already covers many areas. There is an increase in its presence in agile technologies, product ownership, data analytics based on data mining, digital technologies, and cybersecurity [1]. According to the LinkedIn network, business analysis is in sixth place in ranking professional skills and soft skills of employees that organizations currently need the most.

5.2 Methodology

Along with the change in information support and information processing needs, the tasks of analysis in the organization have also significantly changed. First, it should be aimed at solving specific problems arising in the organization, which determines its uniqueness in each case. It is no longer enough to use descriptive, predictive, or normative analytics. The current development of the economy has globally changed the context in which today's business exists. Therefore, new approaches are needed that will ensure its successful development.

Business analysis was created by the need of the business to develop and be successful. In the 1920s, for the business to remain successful, it was enough for the organization to calculate profitability. In the 1960s, it was enough to conduct a SWOT analysis. In the 1980s, it was enough to assess the company's value. At the turn of the century, these measures were no longer enough for companies to ensure successful development and competitive advantages. It became apparent that to be successful, a business must be able to change along with the external environment in which it is located. Therefore, we need a special business analyst who will be able to ensure these changes, find not only the problem but also its true cause, develop a solution based on data, and ensure the transition of the organization from the current state to the desired future state.

5.3 Results

In fact, the business analysis combines all previously developed and "separately" applied management and analysis technologies. It also uses and helps implement new flexible practices of working on projects, data analysis using digital technologies, data mining capabilities, and cybersecurity analysis to solve business problems.

Business analysis can be carried out within the framework of a specific project, during the organization's activities, and at the industry level. Business analysis ensures that changes are made in the organization to meet the needs of stakeholders and justify decisions describing possible ways to implement changes. Business analysis allows one to find the real cause of the problem—that is, exactly what prevents the business from developing. Moreover, it allows one to offer not just a solution but a solution that is consistent with the capabilities of the organization, which considers the risks of changes as much as possible, which will allow getting the maximum benefit from its implementation for this organization and describing possible scenarios for business development, considering its strategy and available resources (capabilities) and external threats [2].

The analysis of the current situation shows that in the conditions of the crisis caused by the COVID-19 pandemic, business analysis has already helped many organizations to quickly adapt to the changed economic consequences, thanks to their use of digital and big data supporting the changing needs of the new ecosystem. The relevance of the competencies of business analysts and business analytical capabilities has increased, which has demonstrated that this analysis can quickly adapt and flexibly develop in accordance with changes in the surrounding world.

Digital transformation plays an essential role in the activities of organizations. In 2020, IIBA conducted a study among practicing business analysts [3], which showed that 77% of respondents noted that their organization has implemented digital technologies or is at the planning stage of their implementation. Simultaneously, according to estimates made in 2020, more than 70% of digital transformations fail, and the main reason for this is the lack of competent analytical interpretation and the use of the data obtained. Consequently, there is an increasing need for specialists in Business Data Analytics.

Digital initiatives mainly affect such business functions as basic business processes and operations, customer service, marketing, finance, sales, maintenance, and logistics. The activities in which business analysts are involved in digital initiatives include planning, vision development (envisioning), business case development, analysis, execution, rollout, and testing. About 70% of business analysts surveyed indicated that they are involved or heavily involved in digital initiatives in the organization.

The use of digital advantages certainly brings additional value to the organization. However, according to the experience of implementing IT technologies, there was some paradox at the stage of their emergence: The implementation of projects using the latest technologies did not bring the desired result and almost did not add value to the organization. This situation was typical until the benefits of the role of a business analyst in IT projects were recognized. Currently, most of these projects are already being carried out with the participation of a business analyst. In these projects, the business analyst identifies the real needs of the business and the leading causes of problems and suggests alternative solutions and recommendations that will bring great value.

With the advent of big data processing technologies, wide possibilities of their application, and high potential value, the previous scenario is practically repeated—the use of big data and data-driven decision-making, without the participation of a specialist (business analyst) who knows how to work with it, interpret it, and integrate it into the solution, does not bring the desired positive effect.

Data scientists perform work on predicting the future state based on data, using statistical, mathematical, and programming skills for this purpose. Simultaneously, business analysts are also needed to effectively use the results obtained in the development of a solution. These specialists perform the role of a business data analyst and work closely with data scientists to develop and support data-driven solutions, thereby providing business value.

Business data analysis is a practice that applies a specific set of methods, competencies, and procedures to continuously study and research past and current business data to obtain business information that can lead to better decisions. The basis of business decisions and improvements is the evidence obtained from the data. That is, evidence is not selected to support a "biased opinion" or a point of view, but a point of view is formed based on data. Competencies in the field of business data analysis are not limited only to the organization's ability to perform analytical activities. They also include capabilities such as innovation, creating a culture of data analysis, and process design.

Business data analytics provides evidence-based identification of problems and their solution. It includes six main actions related to data:

- Access to data;
- Study (data research);
- Aggregation;
- Data analysis;
- Interpretation of data;
- Presentation of results.

Business data analytics focuses on data collection and analysis within the framework of questions: who, what, when, where, what, why, and how. These questions determine the preliminary study of the data. After that, the question arises in the following approximate format: If something happens (or does not happen), then it will happen (or will not happen) as a result of an event (the result of something, etc.) that is different from (something, for example, existing) or will affect (something). That is, business data analytics requires a further business analysis based on the data generated by it to ensure that data analysis will provide valuable information for solving essential business situations (problems or opportunities).

According to the IIBA survey, about 38% of business analysts are already involved in business data analytics. They note that the most important areas of business data analysis are as follows:

- Identification of research issues—74%;
- Work with data sources—86%;
- Data analysis—90%;
- Interpretation of reporting results—87%;
- Use of analysis results for business decision-making—87%;
- Guidance on business development strategy—84%;
- Data analytics—67%.

The main reasons for the development of business data analytics are the use of its results in creating a development strategy, improving customer experience, developing and delivering products that customers need, ensuring revenue growth from taking advantage of innovations, obtaining additional competitive advantages, and improving the efficiency of the organization as a whole.

Thus, the role of a business analyst in digital transformation projects has become extremely relevant. Therefore, the certification in business data analytics (IIBA–CBDA) was opened, which confirms the competence of business analysts in the field of data analysis for successful digital transformation.

In 2021, cybersecurity issues became more acute—cyberattacks occur every minute, while at least half of them are aimed at small businesses, which most often do not have sufficient capabilities to protect themselves from them. Even basic data protection is at risk. The most significant number of cyberattacks falls on organizations providing financial services compared to organizations of other types of activity (300 times more). Only 16% of managers say that their organizations are well prepared to deal with cyber risks.

By understanding and researching the challenges faced by the cybersecurity industry, it becomes possible to close security gaps and prevent future attacks.

The main problems of cybersecurity for organizations are as follows:

1. Remote work attacks—the cybersecurity problem that arose in 2021 is related to the consequences of COVID-19 when many organizations switched to remote work, which significantly increased the number of cyberattacks committed by compromising vulnerable networks among employees working remotely. The solution for companies is to double their use of identity access management (IAM) by deploying smart tools. These tools analyze user actions, connection habits, corporate staff, and resource requests. This approach ensures accurate authentication and privileged access for legitimate users.
2. File-free attacks: File-free ransomware programs are designed to embed themselves into legitimate software or memory. This allows them to avoid detection and infiltrate protected systems. They use approved software tools or platforms implemented in the system to infect the corporate network.
3. Cyberattacks related to the compromise of business processes: Cybercriminals compromise systems or devices on the target network and then scan business transaction flows in search of vulnerabilities. Attacks on business processes are often discrete in nature; the business process continues to function, so it is difficult to detect attacks in time. An example of an attack on a business process could be changing a bank account to transfer funds to a cybercriminal's account.
4. Brute force attacks are one of the oldest but most common cybersecurity problems. For example, distributed denial of service (DDoS) attacks to disable corporate networks. In the second half of 2020, the number of these attacks increased by 12%, mainly targeting small businesses and government agencies.
5. Attacks on cloud services: In the context of the COVID-19 pandemic, many organizations have developed work-at-home strategies to ensure business continuity, introduced new remote access methodologies, collaboration software, and cloud services. Such a rapid transition from a local to a cloud environment did not allow organizations to conduct a full audit before implementing cloud solutions or to verify the reliability of suppliers to ensure security. Cloud services (e.g., cloud storage and server applications) usually do not have good protection and are the primary targets for cyberattacks.

6. Support on external sides: Many organizations work within a common ecosystem that is vulnerable to cybersecurity issues. Forecasts show that due to technological trends (intelligent systems, Internet of things (IoT), mobile devices, and 5G networks), the number of connected devices and IT providers increases significantly every year. This increases the number of possible entry points for cybercriminals throughout the digital ecosystem, thereby increasing the possibility of cyberattacks.
7. Insufficient expertise in cybersecurity issues: The COVID-19 pandemic has exacerbated and increased the growth rate of cyberthreats. Preventive measures for these attacks require careful analysis and preparation for their prevention, as well as the development of emergency measures to restore business in case of their occurrence. Organizations need to create a proactive cybersecurity infrastructure based on a detailed analysis of their weaknesses and capabilities.

As threats continue to become more complex, the importance of robust cybersecurity will continue to grow. For example, security is by default crucial for a successful business. Nevertheless, the acute lack of cybersecurity expertise and the high cost of maintaining one internal unit are still a problem for most enterprises, exposing them to numerous cyberthreats and risks.

Business analysis in the context of cybersecurity aims to ensure the security of every aspect of the organization, identify needs, and provide solutions. In 2020, about 18% of business analysts who participated in the survey noted that their activities are related to cybersecurity in the organization and highlighted that the most important skills needed to work in this area are risk management and knowledge of regulatory requirements.

In 2020, IIBA, together with Institute of Electrical and Electronics Engineers (IEEE), developed and launched an innovative program to support practicing business analysts for whom cybersecurity has become an urgent component of their activities. This program allows one to get basic knowledge for understanding cybersecurity from the point of view of business analysis. In addition to this program, a certificate in cybersecurity analysis (IIBA–CCA) was opened, confirming the relevant competencies of business analysts in cybersecurity.

5.4 Conclusion

Cybercrime is a transnational cybersecurity issue because the Internet allows cybercriminals to carry out their attacks from any part of the world. The main reasons for cyberattacks, as noted, are insufficiently reliable security measures in Internet of things (IoT) devices, low awareness of organizations in the field of protection against cyberattacks, and insufficient attention to the risks associated with digitalization. The results of many ongoing studies in the field of cybersecurity predict a significant number of vacant jobs in this area because most organizations do not have advanced skills in the field of cybersecurity.

In 2021, organizations in the private and public sectors, faced with complex and increased cybersecurity risks, recognized that cybersecurity should become their priority in the interests of preserving their sustainable development and national security in general. The number of technically competent cybercriminals is steadily increasing and requires stakeholders to implement effective structures and principles that provide protection against cybercrime. This indicates a significant increase in the need for cybersecurity specialists and specialists capable of identifying bottlenecks in the organization in this area—business analysts, and this need is increasing, along with the growth of vulnerability.

One of the tasks of ensuring cybersecurity for each organization is to identify the most likely areas of an attack, predict possible attack scenarios, and develop measures to prevent them and rapid response scenarios in the event of a cyberattack. Simultaneously, it is necessary to develop scenarios even before the onset of the cyberattack so that the organization does not have to make hasty and erroneous decisions in a crisis and stressful situation. This activity should be carried out by business analysts in cooperation with the IT services of the organization so as not to repeat the ineffective experience in the use of digital technologies, data mining without the involvement of business analysts, which, as experience has shown, have not brought the desired effect.

Each organization must take measures to preserve cybersecurity at the strategic level. The expansion of technology in business and life has made cybersecurity analysis one of the most important issues of organizations, governments, and individuals and has led to the inclusion of cybersecurity as part of a holistic analysis in business analysis.

Conducting a business analysis will allow one to identify and consider the full range of risks and threats in matters related to cybersecurity, justify and formulate measures to counter cyberattacks, and increase resilience to threats in this area. Organizations should take advantage of a cross-collaborative and inclusive approach that brings together teams of IT services and business analysts in the field of cybersecurity, which will ensure that an acceptable level of protection against this threat is achieved.

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Chapter 6
Investigation of a Singularly Perturbed Task Solution in an Unbounded Domain

Saly Karimov and Gulzhamal M. Anarbaeva

Abstract The system of singularly perturbed equations is encountered in many applied tasks. For example, in the theory of oscillations, the theory of radio engineering devices, the theory of automatic regulation, quantum mechanics, hydrodynamics, etc. The authors studied the solution of a singularly perturbed problems in case of change in the stability condition. The authors considered cases of a critical point that are the end points of delay times. In this paper, the authors have investigated unresolved problems. Solution was studied in the irregular case that has singular points located on the boundaries of the region. The solution of the problem under bounded consideration is proved. Asymptotic expansions of the considered problem solution were constructed.

6.1 Introduction

Interest in studying the asymptotic behavior of differential equation [1] system solutions with a small parameter and high derivatives is closely related to demands of physics and technology, where such systems are often applied [6].

In the case of a change in stability, singularly perturbed problems arise as mathematical models in many applied problems. In particular, in the problems of chemical kinetics, they describe fast bimolecular reactions.

Problems of singular perturbation equations are of common occurrence in all branches of applied mathematics [2, 12, 15]. The singular perturbation theory for ordinary differential equations has been studied earlier [3, 7, 8]. Also, the numerical solution of singularly perturbed nonlinear partial differential equations was reported

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[13]. Solutions of the Cauchy problem for a class of nonlinear integrodifferential equations [4], the critical nonlinear Schrödinger equation [5], and for nonlinear Schrödinger equations in modulation spaces [14] were performed.

Karimov and Anarbaeva [10] described solutions for singularly perturbed linear systems considered in a particularly critical case. The matrix of a linear system has complex conjugate eigenvalues. A proved lemma was used for evaluation of functions. A uniform approximation was constructed for the solution of the initial Cauchy problem in a particularly critical case with a certain degree of accuracy. Karimov and Anarbaeva [11] presented a reporting study of the solution for a singularly perturbed nonlinear system of differential equations. In this paper, solutions of a singularly perturbed nonlinear system are considered in a particularly critical case. The matrix of a linear system has complex conjugate eigenvalues. A uniform approximation was constructed for the solution of the initial Cauchy problem in a particularly critical case with any degree of accuracy. The results were also obtained for a specific task.

6.2 Materials and Method

We consider the singularly perturbed problem studied in the work [9]

$$\varepsilon \dot{z} = A(t)z + h(t), \tag{6.1}$$

$$z(t_0, \varepsilon) = z_0(\varepsilon), \tag{6.2}$$

where $0<\varepsilon$—small parameter, $0 < \varepsilon \leq \varepsilon_0$—const, $A(t) = \begin{pmatrix} \sin t & a\cos t \\ -a\cos t & \sin t \end{pmatrix}$; $0 < a, a \neq 1$; $h(t)$—given analytic function.

Matrix $A(t)$ has eigenvalue:

$$\lambda_1(t) = \sin t + ia\cos t;\ \lambda_2(t) = \sin t - ia\cos t;\ -\frac{\pi}{2} \leq t_0 < 0.$$

Unperturbed system

$$A(t)\tilde{z} + h(t) = 0 \tag{6.3}$$

has a solution $\tilde{z}(t) = -A^{-1}(t)h(t) \equiv g(t)$, and besides $g(t)$ has eigenvalues, where $\lambda_1(t) = 0$ or $\lambda_2(t) = 0$.

$$A^{-1}(t) = \frac{1}{\Delta}\begin{pmatrix} \sin t & -a\cos t \\ a\cos t & \sin t \end{pmatrix},$$
$$\Delta(t) = \sin^2 t + a^2\cos^2 t.$$

Let $K = \begin{pmatrix} 1 & i \\ i & 1 \end{pmatrix}$, $z = g(t) + Kx$. Then, the tasks (1) and (2) are equivalent to the task:

$$\varepsilon \dot{x} = D(t)x + \varepsilon f(t), \tag{6.4}$$

$$x(t_0, \varepsilon) = x_0(\varepsilon) = O(\varepsilon), \tag{6.5}$$

where $f(t) = -K^{-1}\dot{g}(t)$; $K^{-1} = \frac{1}{2}\begin{pmatrix} 1 & -i \\ -i & 1 \end{pmatrix}$; $D(t) = \mathrm{diag}(\lambda_1(t), \lambda_2(t))$.

Let $h(t) = \mathrm{colon}(h_1(t), h_2(t))$; $h_k(t)$—analytical functions;

$$x_0(\varepsilon) = \mathrm{colon}\left(x_1^{(0)}(\varepsilon), x_2^{(0)}(\varepsilon)\right); x(t, \varepsilon) = \mathrm{colon}(x_1(t, \varepsilon), x_2(t, \varepsilon)).$$

$$H_0 = \left\{(t_1, t_2) : \mathrm{Re}\int_{t_0}^{t} \lambda_k(s)\mathrm{d}s \le O(k = 1, 2)\right\}.$$

$$K_\varepsilon = \left\{(t_1, t_2) : \mathrm{Re}\int_{t_0}^{t} \lambda_k(s)\mathrm{d}s \le \varepsilon \ln \varepsilon (k = 1, 2)\right\}.$$

Then $f(t) = -K^{-1}\left(-A^{-1}(t)h(t)\right)' = \left(K^{-1}A^{-1}(t)h(t)\right)' = \mathrm{colon}(f_1(t), f_2(t))$, where $f_1(t) = \frac{1}{2}\left(\frac{h_1(t)-ih_2(t)}{\lambda_1(t)}\right)'$; $f_2(t) = \frac{-i}{2}\left(\frac{h_1(t)+ih_2(t)}{\lambda_2(t)}\right)'$.

Let $h_1(t) = \frac{1}{2}(\lambda_1 + \lambda_2)\varphi(t)$, $h_2(t) = \frac{i}{2}(\lambda_1 - \lambda_2)\varphi(t)$, w here $\varphi(t)$—any analytical function to H_0. Then, $f_1(t) = \frac{1}{2}\varphi'(t)$; $f_2(t) = -\frac{i}{2}\varphi'(t)$. Consequently $f_k(t) = O(1)$ to H_0, that is, there is a regular case.

Tasks (4) and (5) are equivalent to the task

$$x_k(t, \varepsilon) = E_k(t, t_0, \varepsilon)x_k^{(0)}(\varepsilon) + \int_{t_0}^{t} E_k(t, \tau, \varepsilon) f_k(\tau)\mathrm{d}\tau (k = 1, 2) \tag{6.6}$$

where $E_k(t, \tau, \varepsilon) = \exp\left(\frac{1}{\varepsilon}\int_{\tau}^{t} \lambda_k(s)\mathrm{d}s\right)$.

Let $k = 1$; $t = t_1 + it_2$; $\tau = \tau_1 + i\tau_2$; t_1, t_2; τ_1, τ_2—valid variables.

Equitable

$$\mathrm{Re}\int_{t_0}^{\tau} \lambda_1(s)\mathrm{d}s = -\cos\tau_1[ch\tau_2 + ash\tau_2] + \cos t_0;$$

$$\left|\int_{t_0}^{t} E_1(t,\tau,\varepsilon)[h_1(\tau)-ih_2(\tau)]\mathrm{d}\tau\right| \le O(1)$$

$$\left|\int_l \exp\frac{1}{\varepsilon}[-\cos t_1(cht_2+asht_2)+\cos\tau_1(ch\tau_2+ash\tau_2)]\sqrt{\mathrm{d}\tau_1^2+\mathrm{d}\tau_2^2}\right|,$$

where l—intigation path, linking points t_0, t.

Let $A(t_0,0)$; $B(0,\tilde{\alpha}_0)$; $C(-t_0,0)$; $D(0,\alpha_0)$; $A_1(t_0,\alpha_0)$; $T_1(t_1,\alpha_0)$; $T(t_1,t_2)$; $l_1 = p[A,A_1]$—straight segment, linking points A, A_1; $l_2 = p[A_1,T_1]$; $l_3 = p[T_1,T]$; $l = l_1\cup l_2\cup l_3$, where $\tilde{\alpha}_0 = -\ln(1-a)+\ln\Big(\cos t_0+\sqrt{\cos^2 t_0-\big(1-a^2\big)}\Big)$; $\alpha_0=-\tilde{\alpha}_0$.

Notice that $H_0=\left\{(t_1,t_2): Re\int_{t_0}^{t}\lambda_k(s)\mathrm{d}s\le 0(k=1,2)\right\}=[ABCD]$—curved quadrilateral with vertices in points A, B, C, and D, where $\lambda_1(0,\alpha_0)=0$; $\lambda_2(0,\tilde{\alpha}_0)=0$.

Now, we will evaluate the integral: $I_1(t,\varepsilon)=\int_{t_0}^{t}E_k(t,\tau,\varepsilon)[h_1(\tau)\mp ih_2(\tau)]\mathrm{d}\tau$.

Since $h_k(t)(k=1,2)$ is the analytic function on the considered multitude, then it can be assumed that $h_k(t)=O(1)$ with those t values where it takes.

Let $R(t,\varepsilon)=\exp\Big(\frac{1}{\varepsilon}\mathrm{Re}\int_{t_0}^{t}\lambda_1(s)\mathrm{d}s\Big)=\exp\big(\frac{1}{\varepsilon}[-\cos t_1(cht_2+asht_2)+\cos t_0]\big)$. Then, $|I_1(t,\varepsilon)|\le O(1)R(t,\varepsilon)\Big|\int_l\exp\Big(-\frac{1}{\varepsilon}\mathrm{Re}\int_{t_0}^{\tau}\lambda_1(s)\mathrm{d}\tau\Big)\cdot|\mathrm{d}\tau|\Big|$, where $l=l_1\cup l_2\cup l_3$. Here, $\mathrm{Re}\int_{t_0}^{\tau}\lambda_1(s)\mathrm{d}s=-\cos\tau_1[ch\tau_2+ash\tau_2]+\cos t_0$.

Now, we will estimate the following integrals: $I_1^{(1)}(\varepsilon)=\Big|\int_{l_1}\exp\Big(-\frac{1}{\varepsilon}\mathrm{Re}\int_{t_0}^{\tau}\lambda_1(s)\mathrm{d}\tau\Big)\cdot|\mathrm{d}\tau|\Big|$; $I_1^{(2)}(\varepsilon)=\Big|\int_{l_2}\exp\Big(-\frac{1}{\varepsilon}\mathrm{Re}\int_{t_0}^{\tau}\lambda_1(s)\mathrm{d}\tau\Big)\cdot|\mathrm{d}\tau|\Big|$; $I_1^{(3)}(t,\varepsilon)=R(t,\varepsilon)\Big|\int_{l_3}\exp\Big(-\frac{1}{\varepsilon}\mathrm{Re}\int_{t_0}^{\tau}\lambda_1(s)\mathrm{d}\tau\Big)\cdot|\mathrm{d}\tau|\Big|$.

As it is $l_1:\tau_1=t_0; 0\ge\tau_2\ge\alpha_0$, then $I_1^{(1)}(\varepsilon)=\int_{\alpha_0}^{0}\exp\big[\frac{1}{\varepsilon}\cos t_0(ch\tau_2+ash\tau_2-1)\big]\mathrm{d}\tau_2$.

Let $\phi(x)=chx+ashx-1$. Then, $\phi'(x)=shx+achx$; $\phi''(x)=chx+ashx>0$ in any x and $\phi'(\alpha_0)=0\le\phi'(x)\le a=\phi'(0)$, consequently, $\phi(x)$ increases in the segment $[\alpha_0,0]$. As it is $\phi(0)=0$, then the segment $[\alpha_0,0]$ will be divided into two: $[\alpha_0,0]=[\alpha_0,-\delta]\cup[-\delta,0]$, where δ—const at that $0<\delta<\tilde{\alpha}_0$. Let $\phi(-\delta)=-b, b>0$. Then, $\int_{\alpha_0}^{-\delta}\exp\big[\frac{1}{\varepsilon}\cos t_0(ch\tau_2+ash\tau_2-1)\big]\mathrm{d}\tau_2\le\int_{\alpha_0}^{-\delta}\exp\big[-\frac{1}{\varepsilon}\cos t_0\cdot b\big]\mathrm{d}\tau_2=\exp\big(-\frac{b}{\varepsilon}\cos t_0\big)(\tilde{\alpha}_0-\delta)=O(\varepsilon)$.

$$\int_{-\delta}^{0}\exp\left[\frac{1}{\varepsilon}\cos t_0(ch\tau_2+ash\tau_2-1)\right]\mathrm{d}\tau_2$$
$$=\frac{\varepsilon}{\cos t_0}\int_{-\delta}^{0}(sh\tau_2+ach\tau_2)^{-1}\mathrm{d}\exp\left[\frac{1}{\varepsilon}\cos t_0(ch\tau_2+ash\tau_2-1)\right]$$

$$= \frac{\varepsilon}{\cos t_0}\left[\frac{1}{a} - (-sh\delta + ach\delta)^{-1} \cdot \exp\left(-\frac{b}{\varepsilon}\cos t_0\right)\right]$$
$$+ \frac{\varepsilon}{\cos t_0}\int_{-\delta}^{0}(ch\tau_2 + ash\tau_2)(sh\tau_2 + ach\tau_2)^{-2}$$
$$\times \exp\left[\frac{1}{\varepsilon}\cos t_0(ch\tau_2 + ash\tau_2 - 1)\right]\mathrm{d}\tau_2 = O(\varepsilon).$$

Thus, the estimated $I_1^{(1)}(\varepsilon) = O(\varepsilon)$.

For $l_2 : \tau_2 = \alpha_0; t_0 \le \tau_1 \le t_1$. That is why $I_1^{(2)}(\varepsilon) = \int_{t_0}^{t_1} \exp\frac{1}{\varepsilon}[\cos\tau_1(ch\alpha_0 + ash\alpha_0) - \cos t_0]\mathrm{d}\tau$.

There is equality $ch\alpha_0 + ash\alpha_0 = \cos t_0 = \sqrt{1-a^2}$. Consequently, $I_1^{(2)}(\varepsilon) = \int_{t_0}^{t_1}\exp\left[\frac{1}{\varepsilon}\cos t_0(\cos\tau_1 - 1)\right]\mathrm{d}\tau_1$. As it is $-\frac{\tau_1^2}{2} \le \cos\tau_1 - 1 \le -\frac{\tau_1^2}{2}\left(1 - \frac{\tau_1^2}{12}\right)$, then $\int_{t_0}^{t_1}\exp\left(-\frac{\tau_1^2\cos t_0}{2\varepsilon}\right) \le I_1^{(2)}(\varepsilon) \le \int_{t_0}^{t_1}\exp\left[-\frac{\cos t_0\cdot\tau_1^2\left(1-\frac{\tau_1^2}{12}\right)}{2\varepsilon}\right]\mathrm{d}\tau_1$.

Let $c_0 = \frac{\cos t_0}{2\varepsilon} = \frac{\sqrt{1-a^2}}{2\varepsilon} = \frac{\gamma_0^2}{\varepsilon}, \gamma_0 = \frac{1}{\sqrt{2}}\left(1-a^2\right)^{\frac{1}{4}}$; $b_0 = \frac{\cos t_0}{2\varepsilon}\left(1 - \frac{t_0^2}{12}\right) = \frac{1}{2\varepsilon}\left(1-a^2\right)^{\frac{1}{2}}\left(1 - \frac{t_0^2}{12}\right) = \frac{\beta_0^2}{\varepsilon}$, $\beta_0 = \frac{1}{\sqrt{2}}\left(1-a^2\right)^{\frac{1}{4}} \cdot \left(1 - \frac{t_0^2}{12}\right)^{\frac{1}{2}}$. Then, $\int_{t_0}^{t_1}\exp\left(-c_0\tau_1^2\right)\mathrm{d}\tau_1 \le I_1^{(2)}(\varepsilon) \le \int_{t_0}^{t_1}\exp\left(-b_0\tau_1^2\right)\mathrm{d}\tau_1$; $\int_{t_0}^{t_1}\exp\left(-c_0\tau_1^2\right)\mathrm{d}\tau_1 = \frac{\sqrt{\varepsilon}}{\gamma_0}\int_{\sqrt{c_0}t_0}^{\sqrt{c_0}t_1}\exp\left(-x^2\right)\mathrm{d}x = O\left(\sqrt{\varepsilon}\right)$; $\int_{t_0}^{t_1}\exp\left(-b_0\tau_1^2\right)\mathrm{d}\tau_1 = \frac{\sqrt{\varepsilon}}{\beta_0}\int_{\sqrt{b_0}t_0}^{\sqrt{b_0}t_1}\exp\left(-x^2\right)\mathrm{d}x = O\left(\sqrt{\varepsilon}\right)$;

Estimate $I_1^{(2)}(\varepsilon) = O\left(\sqrt{\varepsilon}\right)$. is performed. This estimate is unimprovable. For $l_3 : \tau_1 = t_1; \alpha_0 \le \tau_2 \le t_2; |\mathrm{d}\tau| = \mathrm{d}\tau_2$. Therefore, $I_1^{(3)}(t,\varepsilon) = R(t,\varepsilon)\left|\int_{l_3}\exp\left(-\frac{1}{\varepsilon}\mathrm{Re}\int_{t_0}^{\tau}\lambda_1(s)\mathrm{d}s\right)\cdot|\mathrm{d}\tau_2|\right| = \int_{\alpha_0}^{t_2}\exp\left[-\frac{1}{\varepsilon}\cos t_1(cht_2 + asht_2 - ch\tau_2 - ash\tau_2)\right]\mathrm{d}\tau_2 = \int_{\alpha_0}^{t_2}\exp\left[-\frac{1}{\varepsilon}\cos t_1(sh\xi + ach\xi)(t_2 - \tau_2)\right]\mathrm{d}\tau_2$, where $\tau_2 < \xi < t_2$.

Let $y = \psi(x) \equiv shx + achx$; $y' = \psi'(x) = chx + ashx > 0$ in any x. Therefore, $\psi(x)$—increasing function on any segment, and $\psi(\alpha_0) = 0$.

$x = \ln\left(y + \sqrt{y^2 + 1 - a^2}\right) - \ln(1+a)$; $x'_y = \frac{1}{\sqrt{y^2+1-a^2}}$. $\psi(\alpha_0) = 0$; $\psi(\tilde{\alpha}_0) = \frac{2a}{\sqrt{1-a^2}}$. Thus, $y = \psi(x) \equiv shx + achx$; $x = \phi(y) \equiv \ln\left(y + \sqrt{y^2+1-a^2}\right) - \ln(1+a)$—mutually inverse single-valued functions, both of which are strictly increasing. If $x \in \left[\alpha_0, \tilde{\alpha}_0\right]$, then $y \in \left[0, \frac{2a}{\sqrt{1-a^2}}\right]$ and vice versa. Let $0 < \delta << 1$. If $y = \delta$, then $x = \ln\left(\delta + \sqrt{\delta^2 + 1 - a^2}\right) - \ln(1+a) = \alpha_0 + \gamma = \alpha_0 + \ln\left(\frac{\delta}{\sqrt{1-a^2}} + \sqrt{1 + \left(\frac{\delta}{\sqrt{1-a^2}}\right)^2}\right) = \alpha_0 + \ln\left(\frac{\delta\delta_1}{\sqrt{1-a^2}} + 1\right)$,.$\delta_1 = 1 + \frac{1}{2}\cdot\frac{\delta}{\sqrt{1-a^2}} -$

$\frac{1}{8}\left(\frac{\delta}{\sqrt{1-a^2}}\right)^3 + \ldots$—alternating convergent series. $\gamma = \ln\left(1 + \frac{\delta_1 \cdot \delta}{\sqrt{1-a^2}}\right) = \frac{\delta \cdot \delta_1}{\sqrt{1-a^2}} - \frac{1}{2}\left(\frac{\delta \cdot \delta_1}{\sqrt{1-a^2}}\right)^2 + \frac{1}{3}\left(\frac{\delta \cdot \delta_1}{\sqrt{1-a^2}}\right)^3 - \ldots.$

Let $\delta_2 = 1 - \frac{1}{2} \cdot \frac{\delta\delta_1}{\sqrt{1-a^2}} + \frac{1}{3}\left(\frac{\delta \cdot \delta_1}{\sqrt{1-a^2}}\right)^2 + \ldots$. Then, $\gamma = \frac{\delta \cdot \delta_1 \delta_2}{\sqrt{1-a^2}} = \delta \cdot \tilde{\delta}_0$, where $\tilde{\delta}_0 = \frac{\delta_1 \delta_2}{\sqrt{1-a^2}}$.

In this way, $\gamma = \tilde{\delta}_0 \delta$; $\delta = \tilde{\beta}_0 \gamma$; $\tilde{\beta}_0 = \frac{1}{\tilde{\delta}_0}$, $0 < \tilde{\delta}_0$, $0 < \tilde{\beta}_0$—limited quantities.

It remains to estimate the following integral:

$$I_1^{(3)}(t, \varepsilon) = \int\limits_{l_3} \exp \frac{1}{\varepsilon}[-\cos t_1(cht_2 + asht_2) + \cos t_1(ch\tau_2 + ash\tau_2)]d\tau_2.$$

$$I_1^{(3)}(t_2, \varepsilon) = \int\limits_{\alpha_0}^{t_2} \exp\left[-\frac{1}{\varepsilon}\cos t_1(sh\xi + ach\xi)(t_2 - \tau_2)\right]d\tau_2 \le t_2 - \alpha_0;$$

(1) If $\alpha_0 \le t_2 \le \alpha_0 + \varepsilon^\gamma$, where $0 < \gamma -$ const, then

$$I_1^{(3)}(t_2, \varepsilon) = O(\varepsilon^\gamma).$$

(2) If $t_2 \ge \alpha_0 + \varepsilon^\gamma$ and $\delta_0 -$ constat that $0 < \delta_0 < 1$ then

$I_1^{(3)}(t_2, \varepsilon) = I_1^{(3)}(\alpha_0 + \delta_0\varepsilon^\gamma, \varepsilon) + \breve{I}_1^{(3)}(t_2, \varepsilon)$, where

$$\begin{aligned}
I_1^{(3)}\left(\alpha_0 + \delta_0\varepsilon^\gamma, \varepsilon\right) &= \int\limits_{\alpha_0}^{\alpha_0+\delta_0\varepsilon^\gamma} \exp\left[-\frac{1}{\varepsilon}\cos t_1(cht_2 + asht_2 - ch\tau_2 - ash\tau_2)\right]d\tau_2 \\
&= R(t_2, \varepsilon) \cdot \int\limits_{\alpha_0}^{\alpha_0+\delta_0\varepsilon^\gamma} \exp\Big[-\frac{1}{\varepsilon}\cos t_1\big(ch\left(\alpha_0 + \delta_0\varepsilon^\gamma\right) + ash\left(\alpha_0 + \delta_0\varepsilon^\gamma\right) \\
&\qquad - ch\tau_2 - ash\tau_2)\Big]d\tau_2 \\
&= R(t_2, \varepsilon) \int\limits_{\alpha_0}^{\alpha_0+\delta_0\varepsilon^\gamma} \exp\left[-\frac{1}{\varepsilon}\cos t_1(sh\xi + ach\xi)\left(\alpha_0 + \delta_0\varepsilon^\gamma - \tau_2\right)\right]d\tau_2 \\
&= R(t_2, \varepsilon)O\left(\varepsilon^\gamma\right). \text{Here, } \alpha_0 \le \tau_2 < lt; \xi < lt; \alpha_0 + \delta_0\varepsilon^\gamma;
\end{aligned}$$

$$\begin{aligned}
R(t_2, \varepsilon) &= \exp\left[-\frac{1}{\varepsilon}\cos t_1\left(cht_2 + asht_2 - ch\left(\alpha_0 + \delta_0\varepsilon^\gamma\right) - ash\left(\alpha_0 + \delta_0\varepsilon^\gamma\right)\right)\right] \\
&= \exp\left[-\frac{1}{\varepsilon}\cos t_1(sh\xi + ach\xi)\left(t_2 - \alpha_0 - \delta_0\varepsilon^\gamma\right)\right] \\
&= \begin{cases} O(1) \text{at } \gamma = \frac{1}{2}; \\ O\left(\varepsilon^{1+n}\right) \text{at } 0 < \gamma < \frac{1}{2}; n - \text{ any natural number}, \alpha_0 + \delta_0\varepsilon^\gamma < \xi < t_2. \end{cases}
\end{aligned}$$

Thus, the estimate obtained is as follows:

$$I_1^{(3)}(\alpha_0 + \delta_0\varepsilon^\gamma, \varepsilon) = \begin{cases} O(\sqrt{\varepsilon})\,\text{at}\,\gamma = \frac{1}{2}; \\ O(\varepsilon^{1+\gamma+n})\,\text{at}\,0 < \gamma < \frac{1}{2}. \end{cases}$$

The next estimate is as follows:

$$\breve{I}_1^{(3)}(t_2, \varepsilon) = \int\limits_{\alpha_0+\delta_0\varepsilon^\gamma}^{t_2} \exp\left[-\frac{1}{\varepsilon}\cos t_1(cht_2 + asht_2 - ch\tau_2 - ash\tau_2)\right]\mathrm{d}\tau_2$$

$$= \int\limits_{\alpha_0+\delta_0\varepsilon^\gamma}^{t_2} \exp\left[-\frac{1}{\varepsilon}\cos t_1(sh\xi + ach\xi)(t_2 - \tau_2)\right]\mathrm{d}\tau_2, \text{ where}$$

$$\alpha_0 + \delta_0\varepsilon^\gamma \le \tau_2 < \xi < t_2;\ sh\xi + ach\xi \ge \tilde{\beta}_0\delta_0\varepsilon^\gamma.$$

Therefore, $\breve{I}_1^{(3)}(t_2, \varepsilon) = O(\varepsilon^{1-\gamma})$.
The obtained estimate is as follows:

$$I_1^{(3)}(t_2, \varepsilon) = O(\sqrt{\varepsilon})\,\text{at}\,\alpha_0 \le t_2 \le \alpha_0 + \varepsilon^\gamma\left(\gamma = \frac{1}{2}\right).$$

$$I_1^{(3)}(t_2, \varepsilon) = O(\varepsilon^{1-\gamma})\,\text{at}\,t_2 \ge \alpha_0 + \varepsilon^\gamma\left(0 < \gamma \le \frac{1}{2}\right).$$

Thus, the following estimate is obtained:

$$|I_1(t, \varepsilon)| = O(1)\left[R(t, \varepsilon)\cdot I_1^{(1)}(\varepsilon) + R(t, \varepsilon)I_1^{(2)}(\varepsilon) + I_1^{(3)}(\varepsilon)\right].$$

If $Re\int\limits_{t_0}^{t}\lambda_1(s)\mathrm{d}s \le \varepsilon\ln\varepsilon$, then $R(t, \varepsilon) = \varepsilon$.
Therefore, $|I_1(t, \varepsilon)| = O(1)I_1^{(3)}(t, \varepsilon)$.
Let δ_0, δ − const, where $0 < \delta_0 < 1;\ 0 < \delta \ll 1;\ \alpha_1 = \alpha_0 + \delta_0\delta$.
Then, at $t_2 \ge \alpha_0 + \delta$;
$I_1^{(3)}(t_2, \varepsilon) = \int\limits_{\alpha_0}^{t_2}\exp\left[-\frac{1}{\varepsilon}\text{cost}_1(cht_2 + asht_2 - ch\tau_2 - ash\tau_2)\right]\mathrm{d}\tau_2 = I_{11}^{(3)}(t_2, \varepsilon) + I_{12}^{(3)}(t_2, \varepsilon)$, where

$$I_{11}^{(3)}(t_2, \varepsilon) = \int\limits_{\alpha_0}^{\alpha_1}\exp\left[-\frac{1}{\varepsilon}\text{cost}_1(cht_2 + asht_2 - ch\tau_2 - ash\tau_2)\right]\mathrm{d}\tau_2$$

$$= \tilde{R}(t_2, \varepsilon)\cdot\int\limits_{\alpha_0}^{\alpha_1}\exp\left[-\frac{1}{\varepsilon}\text{cost}_1(ch\alpha_1 + ash\alpha_1 - ch\tau_2 - ash\tau_2)\right]\mathrm{d}\tau_2$$

$$= \tilde{R}(t_2, \varepsilon) \int\limits_{\alpha_0}^{\alpha_1} \exp\left[-\frac{1}{\varepsilon}\mathrm{cos}t_1(sh\xi + ach\xi)(\alpha_0 + \delta_0\delta - \tau_2)\right]\mathrm{d}\tau_2$$
$$= O(1)\tilde{R}(t_2, \varepsilon).$$

Here,

$$\tilde{R}(t_2, \varepsilon) = \exp\left[-\frac{1}{\varepsilon}\mathrm{cos}t_1(cht_2 + asht_2 - ch\alpha_1 - ash\alpha_1)\right]$$
$$= \exp\left[-\frac{1}{\varepsilon}\mathrm{cos}t_1(sh\xi + ach\xi)(t_2 - \alpha_1)\right] = O\left(\varepsilon^{1+n}\right),$$

$\alpha_1 < \xi < t_2$; $t_2 - \alpha_1 \geq (1 - \delta_0)\delta$; n—any natural number.
Thus, there is an estimate:

$$I_{11}^{(3)}(t_2, \varepsilon) = O\left(\varepsilon^{1+n}\right)\text{when}\, t_2 \geq \alpha_0 + \delta. \tag{6.7}$$

Let us consider the magnitudes:

$$\tilde{I}_{12}(t_2, \varepsilon) = \int\limits_{\alpha_1}^{t_2} E_1(t, \tau, \varepsilon)[h_1(\tau) - ih_2(\tau)]\mathrm{d}\tau_2.$$

True

$$\left|\tilde{I}_{12}(t_2, \varepsilon)\right| = \left|\int\limits_{\alpha_1}^{t_2} E_1(t, \tau, \varepsilon)[h_1(\tau) - ih_2(\tau)]\mathrm{d}\tau_2\right| \leq O(1)I_{12}(t_2, \varepsilon),$$

where

$$I_{12}(t_2, \varepsilon) = \int\limits_{\alpha_1}^{t_2} \exp\left[-\frac{1}{\varepsilon}\cos t_1(cht_2 + asht_2 - ch\tau_2 - ash\tau_2)\right]\mathrm{d}\tau_2;$$

$$\tilde{I}_{12}(t_2, \varepsilon) = -\varepsilon\frac{h_1(t_1 + it_2) - ih_2(t_1 + it_2)}{\lambda_1(t_1 + it_2)}$$
$$+ \varepsilon E_1(t, \alpha_1, \varepsilon)\frac{h_1(t_1 + i\alpha_1) - ih_2(t_1 + i\alpha_1)}{\lambda_1(t_1 + i\alpha_1)}$$
$$+ \varepsilon \int\limits_{\alpha_1}^{t} E_1(t, \tau, \varepsilon)\mathrm{d}\,\frac{h_1(t_1 + i\tau_2) - ih_2(t_1 + i\tau_2)}{\lambda_1(t_1 + i\tau_2)};$$

$$\lim_{\varepsilon\to 0} E_1(t,\alpha_1,\varepsilon)=0;\ \lim_{\varepsilon\to 0}\int\limits_{\alpha_1}^{t_2} E_1(t,\tau,\varepsilon)\mathrm{d}\,\frac{h_1(t_1+i\tau_2)-ih_2(t_1+i\tau_2)}{\lambda_1(t_1+i\tau_2)}=0.$$

That is why

$$\begin{aligned}&\lim_{\varepsilon\to 0}\frac{1}{2\varepsilon}\int\limits_{\alpha_0}^{t_2} E_1(t,\tau,\varepsilon)[h_1(\tau)-ih_2(\tau)]\mathrm{d}\tau\\&+\lim_{\varepsilon\to 0}\frac{1}{2\varepsilon}\int\limits_{\alpha_0}^{\alpha_1} E_1(t,\tau,\varepsilon)[h_1(\tau)-ih_2(\tau)]\mathrm{d}\tau\\&+\lim_{\varepsilon\to 0}\frac{1}{2\varepsilon}\int\limits_{\alpha_1}^{t_2} E_1(t,\tau,\varepsilon)[h_1(\tau)-ih_2(\tau)]\mathrm{d}\tau\\&=-\frac{h_1(t_1+it_2)-ih_2(t_1+it_2)}{2\lambda_1(t_1+it_2)}.\end{aligned}$$

This is where the estimate is taken into consideration (7).

6.3 Results

The following is true:

Theorem 1. Let $\delta-$ const, then $0<\delta\ll 1;\ t_2\geq\alpha_0+\delta$.

$$(t_2\leq-\alpha_0-\delta);\ \mathrm{Re}\int\limits_{t_0}^{t}\lambda_k(s)\mathrm{d}s\leq\varepsilon\ln\varepsilon(k=1.2).$$

Then, the tasks (1) and (2) have the only solution on H_0, and at $t_2\geq\alpha_0+\delta(\mathrm{or}t_2\leq-\alpha_0-\delta)$ equality is true

$$\begin{aligned}&\lim_{\varepsilon\to 0}x_1(t,\varepsilon)=\lim_{\varepsilon\to 0}\left[\frac{h_1(t)-ih_2(t)}{2\lambda_1(t)}-\frac{h_1(t_0+i\alpha_0)-ih_2(t_0+i\alpha_0)}{2\lambda_1(t_0+i\alpha_0)}\cdot E_1(t,t_0+i\alpha_0,\varepsilon)\right]\\&-\frac{h_1(t_1+it_2)-ih_2(t_1+it_2)}{2\lambda_1(t_1+it_2)}=0\,\mathrm{at}\,t_2\geq\alpha_0+\delta.\\&\lim_{\varepsilon\to 0}x_2(t,\varepsilon)=-\frac{i}{2}\lim_{\varepsilon\to 0}\left[\frac{h_1(t)+ih_2(t)}{\lambda_2(t)}-\frac{h_1(t_0+i\tilde{\alpha}_0)+ih_2(t_0+i\tilde{\alpha}_0)}{\lambda_2(t_0+i\tilde{\alpha}_0)}\cdot E_2(t,t_0+i\tilde{\alpha}_0,\varepsilon)\right]\\&+\frac{i}{2}\frac{h_1(t_1+it_2)+ih_2(t_1+it_2)}{\lambda_1(t_1+it_2)}=0att_2<-\alpha_0-\delta.\end{aligned}$$

Thus, in the irregular case, the limit transition occurs on the multitude

$$H_c = \left\{ (t_1, t_2) : Re \int_{t_0}^{t} \lambda_k(s)\mathrm{d}s \le \varepsilon \ln \varepsilon (k = 1, 2); \alpha_0 + \delta \le t_2 \le -\alpha_0 - \delta \right\}. \tag{6.8}$$

In the formula (8), magnitude δ—invariable and $0 < \delta \ll 1$. Now, let us prove a stronger result than theorems. 1. To do this, we will proceed as follows.

Let γ, p—invariables, at that $0 < \gamma < \frac{1}{4}$; $0 < p < \frac{1}{2}$ and $2\gamma > p$.

$A_2(-\varepsilon^\gamma, a_0)$; $A_3(-\varepsilon^\gamma, a_0 + \varepsilon^\gamma)$; $A_4(\varepsilon^\gamma, a_0 + \varepsilon^\gamma)$; $A_5(\varepsilon^\gamma, a_0)$; if $|t_1| \ge \varepsilon^\gamma$, then $T_1(t_1, a_0)$; $if\, |t_1| \le \varepsilon^\gamma$, then $T_1^*(t_1, a_0 + \varepsilon^\gamma)$;

$$l_1 = p[A, A_1];\, l_k = p\big[A_{k-1}, A_k\big](k = 2, 3, 4, 5);$$

$$l_6 = p[A_6, T_1];\, l_7 = p[T_1, T].$$

We will estimate the magnitude

$$I_1(t, \varepsilon) = \int_{t_0}^{t} E(t, \tau, \varepsilon) f_1(\tau)\mathrm{d}\tau.$$

Let integration path l be defined as follows:

If $t_1 \le -\varepsilon^\gamma$, то $l = l_1 \cup l_2^* \cup l_3^*$, where $l_2^* = p[A_1, T_1]$; $l_3^* = p[T_1, T]$. If $|t_1| \le \varepsilon^\gamma$, then $l = l_1 \cup l_2 \cup l_3 \cup l_4^* \cup l_5^*$, where $l_4^* = p\big[A_3, T_1^*\big]$; $l_5^* = p\big[T_1^*, T\big]$. If $t_1 \ge \varepsilon^\gamma$, the

$$l = \bigcup_{k=1}^{7} l_k.$$

If now choose γ, p so that the inequality $2\gamma > p$ holds, then it is easy to show the validity of the estimate:

$$|I_1(t, \varepsilon)| \le O(1)\left| \int_l \exp\left[\frac{1}{\varepsilon}\mathrm{Re}\int_{\tau}^{t} \lambda_1(s)\mathrm{d}s\right] \frac{|\mathrm{d}\tau|}{\tau_1^2 + (\tau_2 - a_0)^2} \right| = O\left(\varepsilon^{\frac{1}{2} - 2\gamma}\right)$$

for $(t_1, t_2) \epsilon H_{0\varepsilon}$

$$= \left\{ (t_1, t_2) : \mathrm{Re}\int_{t_0}^{t} \lambda_k(s)\mathrm{d}s \le -\varepsilon^p (k = 1, 2); \text{if } |t_1| \le \varepsilon^\gamma, \text{ then } |t_2| \le -a_0 - \varepsilon^\gamma \right\}.$$

Let

$$H_0^* = \left\{ (t_1, t_2) : \mathrm{Re}\int_{t_0}^{t} \lambda_k(s)\mathrm{d}s < 0 (k = 1, 2) \right\}.$$

Then, $\lim\limits_{\varepsilon \to 0} H_{0\varepsilon} = H_0^*$.

Indeed, let $t = t_1 + it_2, t^* = t_1^* + it_2^*$, where t_1, t_2, t_1^*, t_2^*- valid; $t^* \epsilon H_0^*$; $t \epsilon \Gamma -$ open domain boundary H_0^*;

$$r^* = \min_{t\varepsilon\Gamma} \left| t^* - t \right|; 0 < r < r^*; 0 < p_1 \le p < \frac{1}{2}; 0 < \varepsilon^{p_1} \le r(0 < \varepsilon \le \varepsilon_1 < 1).$$

Then,

$$\mathrm{Re} \int\limits_{t_0}^{t^*} \lambda_k(s)\mathrm{d}s \le -r \le -\varepsilon^p.$$

Now, we choose γ, p so that it takes place $0 < \gamma < \frac{1}{4}, 2\gamma > p$.

Further, taking into account that r does not depend on ε, we can assume that if $|t_1| \le \varepsilon^\gamma$, then $|t_2| \le -a_0 - \varepsilon^\gamma$. Thus, $t^* \epsilon\ H_{0\varepsilon}$.

Theorem 2. For the solution $z(t, \varepsilon) = g(t) + Kx(t, \varepsilon)$ of problems (1) and (2) on H_0, the equality is true.

$$\lim_{\epsilon \to 0} x(t, \varepsilon) = 0 \,\text{at}\, (t_1, t_2)\varepsilon H_0^*.$$

6.4 Conclusion

Thus, it is proved that the solution of the considered problem in the irregular case is bounded. The boundedness of the studied problem in the considered domain is proved. A stronger result than Theorem 2 is proved.

The results of this study of the asymptotic solution of singularly perturbed problems and their applications can be applied in the theory of nonlinear oscillations, in solving stationary and non-stationary problems in the theory of semiconductor devices, in various fields of radio engineering of physical and technical acoustics, in hydro and aerodynamics, etc.

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Chapter 7
MoSER: Sustainable Development Model for the Russian Macroregion

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Abstract The paper provides a brief introduction to the new economic model of the Russian macroregion called the model of sustainable development of the Russian economy. It is a regional sustainable development model that incorporates the main characteristics of the BRICS economy to analyze the impact of monetary policy measures and forecasting. The model of sustainable development is built on the logic of neo-Keynesian models with real and nominal rigidity. It also considers the structure of a small open economy, external (relative to the region) monetary conditions, and other factors necessary to consider the features of the BRICS economy. The model is evaluated using Bayesian methods using the data from the Organization for Economic Co-operation and Development, the Energy Information Administration, the Federal Reserve Economic Data, the Food and Agriculture Organization based on international statistics, information from the Federal State Statistics Service of the Russian Federation (Rosstat), and the Bank of Russia for Q1 2009–Q4 2020. In addition to describing the properties of the model, the authors show the model's potential by decomposing historic and forecast data. The model allows analyzing changes in the indicators of the BRICS economy as a whole and a separate macroregion and therefore, is a valuable tool for macroeconomic analysis.

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7.1 Introduction

Sustainable development has become one of the priorities of interaction between the Brazil, Russia, India, China, and South Africa (BRICS) member countries from the first summit. The BRICS member countries—Brazil, Russia, India, China, and South Africa—are the leading emerging economies of the twenty-first century [1]. To make efficient decisions on monetary policy, the monetary authorities need to consider their consequences not only for the BRICS economy as a whole but also in the context of the sustainable development of individual macroregions (i.e., member states). Member states may be at different stages of the business cycle and have different levels of inflation, budget spending, and stability in global production chains. Therefore, the primary purpose of this paper is to assess the introduction of a new model of the BRICS economy in the context of sustainable development. The paper tests this model and presents it in the Russian macroregion (Russian MR).

The economic policy of BRICS and the implementation of the sustainable development goals are analyzed primarily in the framework of voluntary national reviews provided by the UN member states.

The economy of the Brazil macroregion is one of the largest in the Latin American regions. Moreover, from 2003 to 2010, Brazil demonstrated exponential sustainable economic growth, which caused euphoria among the population and foreign investors [2]; international experts began to talk about Brazil as the most successful and dynamic developing state. However, Brazil's economic growth turned out to be short-lived: as early as 2011, crisis phenomena began that plunged the Brazilian economy into a serious recession that continues to this day [3].

Indian macroregion is one of the most dynamically developing countries in Asia. The average gross domestic product (GDP) growth rate from 2017 to 2021 was 6.9% [4]. Gross national income (GNI) per capita at purchasing power parity is $7680. India is the second-most populous country in the world. The Indian economy has not kept up with rapid population growth. Although about 5.5 million jobs are created annually in the country, the total number of unemployed exceeds 40 million people [5]. Almost 50% of young women do not participate in the labor market: They are not employed and do not receive education [6]. In this regard, social problems remain dominant in the development of national economic policy in the context of sustainable development. The implementation of the tasks set is considered by the Government of the Republic of India through the prism of its innovative development [7].

It is only expected that the leading players in the global economy can overcome the COVID-19 pandemic. However, this, for some reason, categorically does not apply to the analysis of the Chinese economy. Starting this year, the World Bank, the International Monetary Fund, and analytical agencies, such as Bloomberg, have been trumpeting about overcoming the crisis in China [8, 9]. Beijing has once again flooded the country's economy with money. The COVID-19 pandemic has caused irreparable damage to all economies worldwide; it has become not just a black swan but a major global challenge, the consequences of which the world will have to assess and overcome for a long time to come. China is only at the beginning. If we return to the image of a locomotive, then it only cares about itself and still cannot pull out the entire world economy, as it was in 2008 [10].

The South African Republic (SAR) is the southernmost country in Africa. South Africa is a developing middle-income country rich in natural resources, with well-developed financial, legal, communications, energy, and transport sectors, and a stock exchange that is the largest in Africa and one of the 20 largest in the world. The difference between South Africa and many of the world's developing countries is that the shadow economy is not prevalent in South Africa. Compared to Brazil and India, where about half of the working population is in the informal economy, in South Africa, only 15% of jobs are in the informal sector, while in Indonesia, three-quarters of jobs are in the informal economy. South Africa has a well-developed social security system in the context of sustainable development. According to World Bank research, in South Africa, the gap between GDP per capita and its ranking in the Human Development Index is one of the largest in the world [11].

We provide a brief introduction to the new model of the economy of the Russian MR called MoSER (the model of sustainable development of the Russian economy). MoSER is a regional sustainable development model that incorporates the main characteristics of the BRICS economy to analyze the impact of monetary policy measures and forecasting. MoSER is built in the logic of neo-Keynesian models with real and nominal rigidity [12–15].

MoSER is a model of a small open economy that is part of the single currency area. The BRICS national currency, which is planned for implementation, will make the member states financially stable and guarantee protection from pressure from other countries. For example, the trade wars of the USA and the sanctions of the EU harm international payments.

MoSER has a lot of properties of existing macromodels based on dynamic stochastic general equilibrium (DSGE): the US Federal Reserve System, the European Central Bank (ECB), the Bank of Canada, the Bank of Spain, and others. Thus, MoSER is a sustainability model comparable to its analogs. It can use the experience accumulated over many years.

MoSER is evaluated by Bayesian methods, sharing the opinion that it is a powerful, consistent, and flexible promising tool for evaluating dynamic economic models [16, 17]:

1. Bayesian analysis is built on a clear set of axioms directly related to decision theory. The connection is especially relevant for MoSER, as the model has been developed for practical application in the development of economic policy. Many decisions require consideration of uncertainty and estimation of asymmetric losses.
2. The Bayesian approach transparently addresses the problems of misspecification and misidentification that are common in evaluating DSGE models [18, 19].
3. Bayesian estimates are less demanding on sample size and asymptotic properties, even when they are estimated according to classical criteria [20].

4. Priors enable the introduction of pre-sample data and reduce the dimensional problem associated with the number of features.
5. Such a probabilistic method as Bayesian analysis allows restoring all values of characteristics without exception to consider economic policy.
6. Bayesian methods have important computational advantages over maximum likelihood in large models such as MoSER. The conditional distribution of probability parameters is a more common task than maximizing the likelihood of significant dimensionality.

MoSER applies to three key tasks: understanding the trend of fluctuations, economic policy analysis, and forecasting. Even if DSGE models were not specifically designed for this, the forecasting experience using such models was considered satisfactory for models of this class used by the FRS and the ECB [21, 22].

Regional biases have several sources of origin. With a single key rate of the central bank, the rates on issued loans vary significantly from region to region. The smallest regional premium in Russia is observed in the Central Federal District, where most credit institutions are located.

The second source of bias is the regional difference in real interest rates depending on the levels of expected inflation. If expected inflation is high for a particular region compared to others, then the real interest rate is relatively low, and economic agents in that region are more likely to borrow and invest, which stimulates economic activity.

Thus, if economic activity is expected to rise above the countrywide level, then a period of strong economic growth could trigger more price increases, leading to another upsurge of the inflationary spiral. In world practice, this most often translates into unfavorable economic situations such as "bubbles" in the real estate market. The opposite is also true: if regional inflation remains below national inflation for a long time, this may serve as an additional factor contributing to the start of a recession.

An assessment of the trend of the gross regional product (GRP) and its growth by macroregions of the Russian Federation for the period Q1 2010–Q1 2020 (Fig. 7.1, Table 7.1) indicates an imbalance between the structure of total GRP in Russia and the contribution of macroregions to its growth. As part of this research, the results of calculating the GRP leading indicator using the temporal disaggregation method [23] were used.

The main advantage of the proposed approach compared to previously available models is the study of the interaction and mutual influence of the economic characteristics at three different levels: the world economy, the BRICS economy, and the economy of the Russian MR, with the prospect of monitoring and evaluating the contributions of factors for indicators at each level.

Thus, the main goal of the study is to create a sustainable development model that allows studying the trend of the main indicators of the region (using the Russian MR as an example) for various key rate decision scenarios, considering internal and external factors.

1. The research structure is as follows:
2. The regional heterogeneity of Russia in terms of output trend is shown.
3. The discussions are presented.

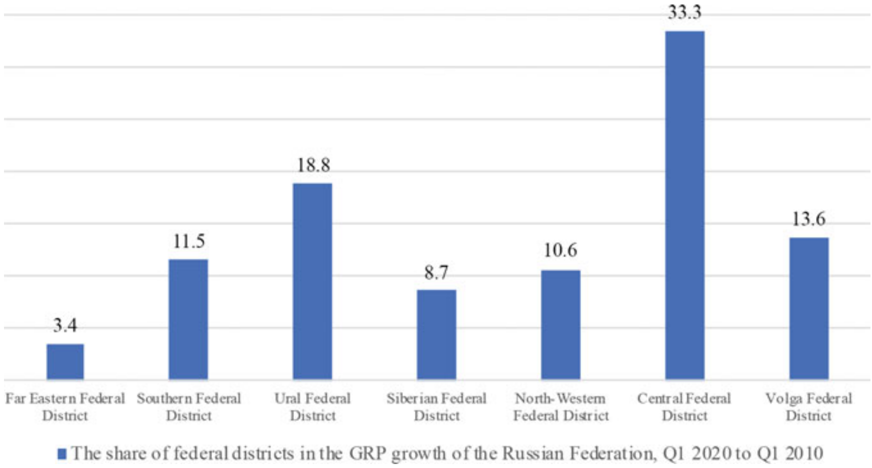

Fig. 7.1 Share of federal districts in the GRP growth of the Russian Federation, Q1 2020–Q1 2010. *Source* Calculated and compiled by the authors

Table 7.1 Average GRP growth rate, per year

Region	Q1 2010–Q1 2020	Q1 2010–Q4 2014	Q1 2015–Q1 2020
Russian Federation	2.06	3.00	1.27
North-Western Federal District	2.19	2.23	1.46
Far Eastern Federal District	1.21	1.74	0.56
Central Federal District	2.01	2.25	1.33
Siberian Federal District	1.95	3.08	1.03
Volga Federal District	2.78	4.54	1.17
Ural Federal District	2.11	2.53	1.87
Southern Federal District	2.76	3.59	1.23

Source Calculated and compiled by the authors

4. The structure of the model in MoSER schemes is explained.
5. The key findings of the research are given in the conclusion.

7.2 Materials and Method

MoSER is a regional sustainable development model that incorporates the main characteristics of the BRICS economy to analyze the impact of monetary policy measures and forecasting. MoSER indicators are applicable quarterly.

Gaps are indicated by $(\hat{\upsilon})$; trend components are indicated by $(\overline{\upsilon})$; growth rates achieved on a sustainable growth trajectory are indicated by $\overline{\upsilon}^{ss}$; shocks are indicated by ε_{υ}. The seasonal component is removed by using υ 13-ARIMA-SEATS. Uppercase symbols (V) designate variables in the initial form and lowercase symbols (υ)—in natural logarithms. Annualized (adjusted to year-on-year growth rates) seasonally-adjusted quarter-on-quarter growth rates are indicated ($V_{\omega,t}^{\text{QoQ SAAR}}$), yearly growth rates—($V_{\omega,t}^{YoY}$). The initial values of the estimated coefficients for indicators are taken from the research literature on this topic [21, 23]—or coefficients for lag (1) are taken from the AR (1) process, then their Bayesian estimation was carried out in the IRIS toolbox.

$$V_{\omega,t}^{\text{QoQ SAAR}} = 4 * \left(\upsilon_{\omega,t} - \upsilon_{\omega,t-1}\right); \tag{S1}$$

$$\upsilon_{\omega,t} = \overline{\upsilon}_{\omega,t} + \hat{\upsilon}_{\omega,t}; \tag{S2}$$

$$\overline{\upsilon}_{\omega,t}^{\text{QoQ SAAR}} = \rho_{\overline{\upsilon}_{\omega,t}^{\text{QoQ SAAR}}} * \overline{\upsilon}_{\omega,t-1}^{\text{QoQ SAAR}} + \left(1 - \rho_{\overline{\upsilon}_{\omega,t}^{\text{QoQ SAAR}}}\right) * \overline{\upsilon}_{\omega,t-1}^{\text{QoQ SAAR}} + \varepsilon_{\overline{\upsilon}_{\omega,t}^{\text{QoQ SAAR}}}; \tag{S3}$$

$$\overline{\upsilon}_{\omega,t}^{\text{QoQ SAAR}} = 4 * \left(\overline{\upsilon}_{\omega,t} - \overline{\upsilon}_{\omega,t-1}\right); \tag{S4}$$

$$\hat{\upsilon}_{\omega,t} = \rho_{\hat{\upsilon}_{\omega,t}} * \hat{\upsilon}_{\omega,t-1} + \varepsilon_{\hat{\upsilon}_{\omega,t}}. \tag{S5}$$

7.3 Results

We compared the analytical properties of this model with other models and models offered in the academic literature. Moreover, to compare the quality of forecast estimation, the authors applied the random walk method (RW) and the autoregressive integrated moving average (ARIMA) model. The RMSE estimates of the nominal interest rate in the Russian MR are presented in Table 7.2.

Let us consider the obtained values for row t1: starting from Q4 2016, for each of the 16 subsequent quarters, forecasts were made for 16 observations ahead by sequentially adding actual data. Thus, 16 projections were derived from data available before the forecast period: the Q1 2017 forecast is derived from the actual data, and so on up to the Q4 2020 forecast, which is derived from the actual data available for Q3 2020. The forecast error was calculated for each forecasted value obtained; the quality of the RMSE forecast was assessed to compare different models with each other. In Table 7.2, in each row, the values of the model that gives the lowest RMSE estimate are in bold, and the values of the second-best model are in italics. It can be concluded that MoSER gives the smallest error in predicting the nominal interest rate for the Russian MR.

Thus, the use of the MoSER model is best suited for forecasting the key macroeconomic indicators of the Russian MR.

Table 7.2 Root-mean-square error (RMSE) of the nominal interest rate in the Russian MR

ω_{RUS}, t	ARIMA	RW	MoSER
t1	0.83	*0.55*	0.35
t2	1.58	*0.95*	0.69
t3	2.13	*1.19*	1.10
t4	2.68	1.45	*1.43*
t5	2.70	1.58	*1.76*
t6	2.75	1.59	*1.86*
t7	2.80	1.54	*1.83*
t8	2.80	1.46	*1.85*
t9	2.79	1.50	*1.77*
t10	2.72	1.64	*1.67*
t11	2.63	*1.80*	1.58
t12	2.51	*1.96*	1.46
t13	2.37	*2.00*	1.29
t14	2.17	*1.95*	1.04
t15	1.96	*1.85*	0.76
t16	1.50	*1.46*	0.42

Source Calculated and compiled by the authors

7.4 Conclusion

The presented implemented MoSER is a modification of the neo-Keynesian model of a small open economy. It is characterized by the following main features that describe the economy of the Russian MR:

1. Stochastic output growth is caused by neutral technological progress.
2. The world economy is not modeled as the result of an equilibrium that goes beyond the behavior of the Taylor rule. The Russian MR is too small to impact the global economy significantly.
3. Accounting for the impact of the public sector in BRICS budgets.
4. Besides the trend of world prices for Brent oil, the trend of oil production is taken into account (according to EIA and OPEC). Regular recording of adjustments to production quotas under the OPEC + agreement allows us to more accurately explain the trend of the physical volume of output and forecast output, considering current and planned restrictions.
5. Accounting for the dynamics of world prices for basic metals mined or processed in Russia: iron, copper, aluminum, zinc, and titanium. We believe that the cycles of changes in world prices for metals should sufficiently correspond to the investment cycles of the largest metal processing companies and influence the trend of physical output.
6. The division of data on Russia on inflation and output into two components (the Russian MR and BRICS without the Russian MR) allows one to consider

regional inflation expectations, regional inflation, and the regional output gap in the Taylor rule.

7. The national currency is in a floating exchange rate mode, the trend for which is determined by uncovered interest rate parity.

The application of the proposed approach allows determining the consequences of planned or unforeseen changes in key macroeconomic indicators for BRICS as a whole and for the Russian MR. Moreover, it allows assessing the contribution of the Russian MR to change in the indicators of the BRICS economy.

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Chapter 8
Analysis of Existing Systems of Indicators Used to Assess the Potential of Economic Growth of Rural Areas in the World Practice

Irina A. Morozova, Olga E. Akimova, and Anna A. Khryseva

Abstract Nowadays, the identification and evaluation of the effectiveness of the economic growth of rural areas are of great interest because they are directly related to important aspects affecting the sustainable development of these territories. Therefore, this paper analyzes the factors affecting the potential of economic growth and its social dimension and presents the main groups of indicators that help assess the socio-economic development of rural areas. It is especially noted that the spatial approach to the development of rural areas should consider demographic, legal, financial, managerial, and administrative aspects, which will have a significant impact on strengthening the potential of these rural areas. The main tools for increasing the competitiveness of rural areas include the development of innovations, improved access to the labor market, and the preparation of projects for the sustainable development of territories. Additionally, the authors study the approaches that give basic ideas about the concepts of effective rural development prevailing at the present stage in world practice.

8.1 Introduction

Economically stable and socially developed rural territories are the basis for preserving and maintaining social control and territorial independence. Therefore, their development should become a priority direction of the state policy in the field of national security of any country.

However, in recent years, the socio-economic gap in the level and quality of life of urban and rural populations has been growing, infrastructural restrictions remain, and access of the population to the services of social organizations, information technologies, and advanced means of mass communication remain challenging, which does not allow rural areas to overcome the main problems of development and ensure sustainable economic growth.

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In this regard, rural territories currently require an integrated approach that considers the territorial aspect and the totality of public relations, including economic, social, cultural, demographic, and other indicators.

This research defines the growth of rural areas as the process of improving the quality of life of the rural population and associated with solving problems faced by local communities in various fields, such as the economy, education, health, and the environment, with the mandatory participation of the local population and the government as the primary agents of change.

To assess the development potential of these territories, it is necessary to have a clear definition of the boundaries of geographical areas to which the concept of "rural territories" is applied, as well as specific cities that define the differences between rural and urban areas. Given that rural areas are often more economically backward than urban areas, the economic revival of rural areas is a priority of national development.

8.2 Theoretical Basis of the Research

The greatest challenge currently facing the analysis of the economic growth potential of rural areas is the need to give research depth to a current approach to development that can consider the main characteristics and original features of rural development of territories, taking into account the diversity that currently characterizes rural areas, as well as their inhabitants and the activities they are engaged in.

Recently, the concepts of economic growth related to intellectual growth and intellectual development of the economy have become the most relevant. One of these concepts is called the "smart growth" strategy. At its core, this strategy asserts that smart growth supports sustainable development, which is achieved by encouraging research, innovation, and knowledge to achieve economic growth in rural areas. The strategy's purpose is based on identifying the comparative advantages of rural areas and their consistent inclusion in the supply chains of the country's economy and innovative development processes.

Usually, smart growth is used in the context of knowledge, which includes policies in the field of innovation, education, and research, or it may concern planning policies aimed at the so-called counteraction to urban sprawl. The common goal of smart growth in different countries is planning and construction policy, especially urban planning. For example, in the EU, smart growth is associated not so much with planning but with policy in innovation, research, and education [7, 8].

This concept is mainly based on two concepts:

1. The so-called "related diversity" [9], which includes cognitive affinity or kinship between firms and relationships between different sectors that are closely related or belong to interrelated fields of activity and technologies;
2. The involvement of firms, for example, there are strong regional or local links with certain industries, in terms of links between production resources and labor,

based on the dissemination of knowledge, personal contacts, and mobility of people [13].

Many authors devoted their works to the interpretation and application of the concept of smart growth in the context of rural development [1, 2]. The key issues discussed in these works relate to the application of the concept of smart growth in the context of regional policy, expected results, and differences in the levels of rural development. These works also indicate a growing understanding that universal models of growth and development of territories should be reoriented to a policy based on the application of knowledge [4, 5].

The logic of the smart growth concept is well suited for rural areas integrated with large urban areas, which, as a rule, have a large population and a developed industrial base [13].

These territories have a significant number of opportunities to stimulate the potential for economic growth because they benefit from the advantage in size and additional resources of nearby urban areas [19].

Many rural areas do not have the same access to resources and markets and differ in socio-economic conditions and social structure. Common characteristics, especially inherent in peripheral and isolated rural areas, include poor accessibility, large migration flows, and a low level of education. Following the conceptual framework underlying, the smart growth strategy will mean that peripheral and isolated rural areas do not have much of their own potential for endogenous development [6]. Nevertheless, there are more and more scientific and research papers that recognize the importance of local business services and entrepreneurial experience for rural development [10, 18].

Additionally, social and economic benefits are also highlighted as important factors for attracting and retaining creative people, who, as a rule, make significant scientific and cultural contributions to the development of rural communities [14].

Thus, there is a certain difficulty in accurately and specifically defining smart growth. Therefore, it is challenging to directly measure smart growth. Similarly, the role played by various types of social and economic benefits is not explicitly indicated as a key factor in achieving rural growth. It rather remains uncertain and is combined into a wide set of characteristics related to the level of development of specific territories.

Currently, there is a wide range of opinions regarding the need to focus on the social, human, and environmental aspects of rural growth, as well as the need for closer attention to rural problems in regional and territorial development theories [21].

These concepts of economic growth of rural areas reflect several main provisions. Over time, the concept of territorial diversity and the specifics of the problems made obsolete any attempts to define a standardized model of rural development that would be relevant under any conditions and in any territories. The weakening influence of agriculture, accompanied by the economic and socio-demographic diversification of rural areas, required the consideration of the multifunctionality of these systems and their interaction with other activities [12].

In the works of Romer [20], Grossman and Helpman [11], the role of innovations and technological achievements as endogenous factors explaining their impact on economic growth and labor productivity is quite well known and analyzed. These papers analyze the increasing economic return on investment in the development of technological innovations, which, in turn, can lead to increased competition between different territories.

The concept of "smart specialization" first appeared in the mid-2000s. The theory of smart specialization was developed by a group of scientists mainly to formulate a logical scheme for determining priorities in the innovation policy of the development of countries. Smart specialization implies the formation of an innovation policy considering the specifics of a particular area based on the opportunities and potential for economic growth of various territories.

The basic idea is that each region or rural area should specialize in activities in which they have competitive advantages based on the principle of differentiation, or in other words, in which they can outperform their competitors based on the specific consumer characteristics of the final product and the entire value chain [17].

From a practical point of view, each rural territory should determine and choose several key activities or technologies that should provide it with a competitive advantage over other territories. These development priorities are based on three criteria [3]:

- Specialization in a specific field of activity;
- General development of rural areas (activities should fit into the value chain);
- Consistent diversification of economic activity.

The recognition of the heterogeneity of rural areas underlines the need to assess the economic growth of agriculture, its impact in terms of external factors, and other aspects of rural development, such as business, services, tourism, or the environment [6].

8.3 Results

Nowadays, there is still no unified approach to the economic assessment of this process due to several reasons.

First, all rural territories differ markedly in terms of socio-economic and technological development [22]. This fact is a considerable obstacle to choosing the best system of indicators for assessing their economic growth potential. These indicators of territorial development are usually selected in direct dependence on the goal set. Second, there is still no consensus on which indicators should be used when measuring rural development.

Most often, economic, environmental, and social subsystems of indicators are distinguished within the framework of general systems of indicators of potential.

The use of an integrated system approach is a prerequisite for starting work on creating an effective system of economic growth indicators. It should be borne in mind that these indicators do not always answer the question of the presence or absence of economic growth. Economic growth is not only about sustainable development but also about improving living conditions and increasing the incomes of the rural population, which, as is known, is theoretically possible by simply redistributing resources between different segments of the population without increasing production [15, 16, 23].

This research identifies and systematizes a number of indicators that represent the main key areas for assessing the potential for economic growth of rural areas (Table 8.1).

In this case, the system of economic indicators for assessing the potential consists of indicators that can measure, among other things, the income of rural residents. Considering the unique features of the rural economy, the income of the rural population can be divided into income from agricultural production and non-agricultural income.

Indicators that reflect the incomes of the population received from agriculture include such components as agricultural production, agricultural distribution of products, and agricultural infrastructure. Indicators affecting non-agricultural income can be represented by technological development, suggesting that this level of development is closely related to the level of non-agricultural income.

Agricultural productivity is related to the scale and mechanization of the economy, the cultivation of crops, the number of production organizations, and the access of residents to agricultural technology centers.

The distribution of agricultural products is currently improving because it becomes easier to exchange information on prices of agricultural products between farms, and transport conditions for the delivery of agricultural products to distributors are simplified. The level of penetration of information and communication technologies is a relatively effective indicator of the ease of access to price information, which allows many farmers and producers to better navigate the needs of the market for food and raw materials.

The incomes of rural farms and the quality of the infrastructure of rural areas for production and the distribution of manufactured products have a positive economic connection because the income received from agricultural activities will increase as the conditions of the infrastructure itself improves. The length and volume of commissioning of public roads can be used as the main indicator of the efficiency of agricultural infrastructure development.

To increase non-agricultural incomes, it is necessary to develop various industries. Non-agricultural incomes are interrelated with industrial development, and the level of industrial development is economically related to the number of enterprises in manufacturing and agro-technical production that process and commercialize agricultural products.

The income received outside of agricultural production is also significantly affected by the scale of the presence of the tourism industry in a particular rural area, the development of production sites, and the complexity and availability of

Table 8.1 Main indicators for assessing the potential of economic growth in rural areas

Subsystem of indicators	Name of the indicator
Indicators of the economic structure	
Competitiveness	Per capita income in the manufacturing industry
	% of gross income in high-tech sectors
	Research and development expenses
	% of newly registered enterprises from their total number
Diversification	% of the rural population's income from non-agricultural activities
	The share of multi-profile rural industries
	% of employed in high- and low-tech sectors of the rural economy
	The share of people employed in agricultural production
	The share of rural enterprises in the total tourist turnover
Effectiveness	The ratio of net profit/loss to the number of enterprises and organizations
	Profitability/unprofitability of goods and services
	Investments in fixed assets per capita
	The share of innovative goods, works, and services in the volume of products produced in this rural area
	Volume and length of highways
Income of the population	% of households receiving social benefits
	Average earnings per capita
	Disposable income of a household in a certain rural area
Indicators of quality and social standard of living	
Quality of employment	% of highly and low-skilled and workers
	% of part-time employees
	% of self-employed workforce
Availability and quality of housing	% of well-maintained residential premises in rural areas
	For the purchase of housing through the provision of social benefits
	% of housing in rural areas, the improvement of which is increased due to preferential loans
Medical services	% of available medical services
	Accessibility of paramedic and obstetric stations in rural areas
	% of provision of rural residents with medical workers
Education	The coverage rate of preschool education for children under six years of age in rural areas

(continued)

Table 8.1 (continued)

Subsystem of indicators	Name of the indicator
	The number of general education organizations in this rural area
	The number of rural residents with higher education
Demographic and migration indicators	
Demographics	The share of the rural population in the total population of the country
	Population density
	% of the population aged 16 and under
	% of the population aged 65 and over
Migration	Average annual population change
	% of rural migration from the total population
Environmental indicators	
	The share of environmental protection expenditures in the total budget of rural areas
	% of neutralized pollutants in this rural area

Source Compiled by the authors

vocational training and retraining programs for job seekers. Thus, the number of enterprises and employment in the non-agricultural sector are used as indicators for assessing the level of development of the production potential of rural areas.

The system of social indicators mainly consists of indicators that assess the level of development of the health care system and social well-being. Life expectancy at birth is used as an indicator of the health and well-being of rural residents.

Indicators reflecting the quality of the rural health system include indicators of the state of medical institutions and medical services available to rural residents, especially the provision of high-tech medical care and the number of medical workers providing medical services, including the number of doctors, nurses, midwives, and pharmacists.

Indicators of the level of education are important for assessing the basic knowledge and literacy of people living in rural areas. In future, these data form the personnel potential of economic growth of a particular rural area directly affect its competitiveness because they can significantly affect increasing labor productivity in local industries. Among other things, the level of education is calculated based on the number of higher and secondary educational institutions present in a given rural area, the number of employees employed in the field of education, and the number of measures to improve the skills and retraining of rural workers.

The average annual expenditure on culture and cultural leisure is used as an indicator to measure the level of dynamism of the cultural and entertainment life of rural residents. The increase in the number of facilities for cultural events, tourism, and sports increases the level of cultural and entertainment events. These include the number of libraries, cinemas, nature and amusement parks, tourist attractions, and local festivals, which are necessary as indicators of the level of condition and development of tourist facilities. It can also be data on the number of stadiums and swimming pools needed as an indicator of the condition of sports facilities in rural areas.

Summing up, the economic growth of rural areas is determined by the availability of opportunities and factors for effective strategic development based on a correct assessment of the growth potential and a competent system for its implementation.

Assessing the potential for economic growth and determining the main directions of rural development form the most important goals of improving efficiency and competitiveness, including the development of advanced forms of rural production, the formation of an optimal management system, and the creation of prerequisites for the common interests of the state, business, and the population to achieve an improvement in the quality of life of rural residents.

8.4 Conclusion

The conducted research demonstrates that the policy in the field of assessing the potential for economic growth of rural areas should meet contemporary development criteria and be focused on achieving the following main goals:

- To promote economic growth, employment, entrepreneurship development, and infrastructure creation in the least developed and structurally weak rural areas;
- To promote the competitiveness of rural territories by promoting innovation, improving access to the labor market, and preparing projects for sustainable development of territories;
- To ensure territorial cooperation based on the principles of encouraging joint projects in the field of integrated territorial development and based on the exchange of experience between different rural territories.

A set of basic measures that could increase the potential for economic growth looks promising. These measures primarily include those measures aimed at forming a socially-oriented direction of economic growth in rural areas, among which one can distinguish the following:

- Maintaining and developing the social potential of the rural population and creating conditions for its self-realization;
- Forming a highly effective system of education, culture, and sports, and ensuring guaranteed access to basic life benefits;
- The creation of a favorable comfortable living environment in rural areas and the development of the tourism sector;
- The development of social partnership and social responsibility of business.

Ensuring socially-oriented economic growth requires a certain concentration of efforts for balanced social development of rural areas in such areas as diversification of the rural economy, expansion of the rural labor market, and the development of industrial infrastructure and social processes.

To determine the effectiveness of assessing the potential for economic growth of rural areas, a system of indicators is needed that could meet the current needs of managing the socio-economic development of the territory. This system of indicators was presented and analyzed in the framework of this research.

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Chapter 9
The Problem of Cross-Border Cooperation and Its Solution Based on a Flexible Application-Oriented Approach

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Abstract The paper aims to develop a mechanism for managing cross-border cooperation based on a flexible application-oriented approach and show the potential of its application using the Republic of Kazakhstan (West Kazakhstan Region) and the Russian Federation (Orenburg and Samara Regions) as an example. The authors identify three major areas that require flexible application-oriented management of cross-border cooperation: political, economic, and socio-cultural contexts. High flexibility and an application-oriented approach are provided by project financing to a wide range of participants. Businesses, universities, and local communities have the opportunity to develop and implement joint projects that contribute to solving major problems for border regions. An important advantage of the proposed mechanism is its consistency with the strategic goals and priorities of the border regions because their support is required to participate in the cross-border cooperation program. The paper shows that border regions need flexible application-oriented management of cross-border cooperation. The problem of insufficient cross-border cooperation resides in outdated methods of vertically constructed management that are currently being used, where the government authorities play the main role. Local communities and businesses are poorly involved in solving common problems. The focus is primarily placed on cost-effective projects. A flexible and application-oriented mechanism is required to solve this problem, including a program of providing grants for financing cross-border projects and a digital platform for seamless interaction between participants and all stakeholders. The developed mechanism includes principles, forms, methods, and tools for flexible and application-oriented management of cross-border cooperation. The potential of such mechanism application was assessed on the example of terms of cross-border cooperation between the West Kazakhstan Region (Kazakhstan) and the Samara and Orenburg Regions (Russia).

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9.1 Introduction

Border regions are at the forefront of the country and are highly susceptible to external economic and political influence. In an open economy, any changes on the border inevitably affect the flows of labor, material, human, and investment resources between neighboring regions. Some changes stimulate the activity of cooperation, having a positive impact on mutual commercial exchange and socio-economic development of neighboring regions. Others, on the contrary, lead to weakening mutual ties, strengthening the separation function of the border. Activities aimed at solving common problems contribute to strengthening relationships and increasing interest in bilateral cooperation. Therefore, flexible management of cross-border cooperation aimed at solving common problems is important for science and practical application.

The problem poses a challenge by the need for flexible management depending on trends, conditions, and current needs of neighboring territories forming a political, economic, and socio-cultural context.

Mutual political relations form the political context. If political leaders express a friendly attitude and mutual interest, this creates a positive environment for mutual cooperation.

The economic context is created by the participation of countries in common trade blocs. If neighboring countries are not members of trade blocs, the barrier is stronger because there are difficulties in the movement. Participation in trade blocs, on the contrary, contributes to the establishment of favorable trade regimes (low or zero duties on goods, visa-free entry, a simplified procedure for processing import–export transaction documents, and general technical regulation of products).

The social and cultural context is established by the social and cultural environment in which cross-border cooperation is performed. The social and cultural environment is developed through a set of values, norms, and rules that are customary for society and used for communication. An important aspect of the socio-cultural environment is the commonality of historical development and mutual cooperation experience. A positive experience of mutual cooperation between the countries lays a good foundation for the further development of relations.

Despite the two contradictory trends that have developed internationally in recent years (globalization and regionalization), the role of cross-border cooperation is increasing. Thus, in April 2022, the sixth generation of the Interreg cross-border cooperation program was launched in the EU. This program is a crucial tool supporting cross-border cooperation through project financing. The Interreg program has updated the key areas of cooperation and is aimed at jointly solving common problems of health care, the environment, research, education, transport, sustainable energy, and so on.

In Russian-Kazakh cross-border cooperation, it is advisable to consider the accumulated positive international experience to strengthen good-neighborly relations and shift the focus to local territories and solving common problems.

Cross-border cooperation is defined in the European Framework Convention and includes bilateral and multilateral coordinated actions to strengthen and develop good-neighborly relations [1].

9.2 Methodology

The research shows the need for flexible application-oriented cross-border cooperation and highlights its advantages [2]. Using the example of the European experience, the authors reveal the key factors and mechanisms for the development of cross-border cooperation [5, 8–10]. However, what stands out is the fact that Russian regions located on the western borders of the country are involved in European programs, while no such mechanisms have been created within the EAEU framework.

The studies of cross-border cooperation extensively use the Paasi model as an analytical structure ("us-them"/"here-there"), which allows constructing of intra- and interregional identity in connection with social differences and forming an understanding of the current socio-cultural context [3].

According to the research literature, effective administrative bodies for managing cross-border movements, physical and functional complementarity between territories, and the absence of cultural and political contradictions [4] facilitate the removal of mental barriers of the borders.

There is no strong evidence that the socio-economic development of the border region is affected by the border length. Studies aiming to find a connection between the border length and the cross-border trade volume mostly failed to do so. Nowadays, it can be considered proven that not the border length but the unique system of relations that have developed around the border can be loaded either with conflict or be free from conflicts and demonstrate openness and trust. The driving force for building a conflict-free and friendly environment can only be cooperative systemic work on solving common problems [5].

The consistency of such work can be achieved through the relevant program adoption at the EAEU level. High flexibility and an application-oriented approach can be provided by the methodology of project management, the consolidation of functions for the implementation of cross-border cooperation projects at the regional management level in Russia and Kazakhstan, and monitoring of the program implementation.

9.3 Results

In international science and practice, cross-border cooperation is understood as the cooperation of adjacent territories [6]. In this paper, cross-border cooperation is viewed as cooperation between regions of neighboring countries, such as Russia and Kazakhstan.

International economic relations are characterized not only by their dynamic character but also by their complexity and multidimensionality. WTO bans and sanctions wars between countries which play the part as well. In this situation, cooperation between countries at the interregional level seems to be an important development trend for Russia and Kazakhstan; it is implemented through cross-border cooperation.

The mechanism of cross-border cooperation based on an application-oriented approach is presented in Fig. 9.1.

To organize systemic work on cross-border cooperation based on a flexible application-oriented approach, it is advisable to develop and adopt an appropriate program.

The purpose of such a program may be to improve the level and quality of life of the population in border regions. The program should be implemented on the principles of equal and mutually beneficial cooperation, respect, sovereignty, support of the exchange and transfer of experience, implementation of innovative approaches, and interaction between authorities, business, and citizens. Such a program should be

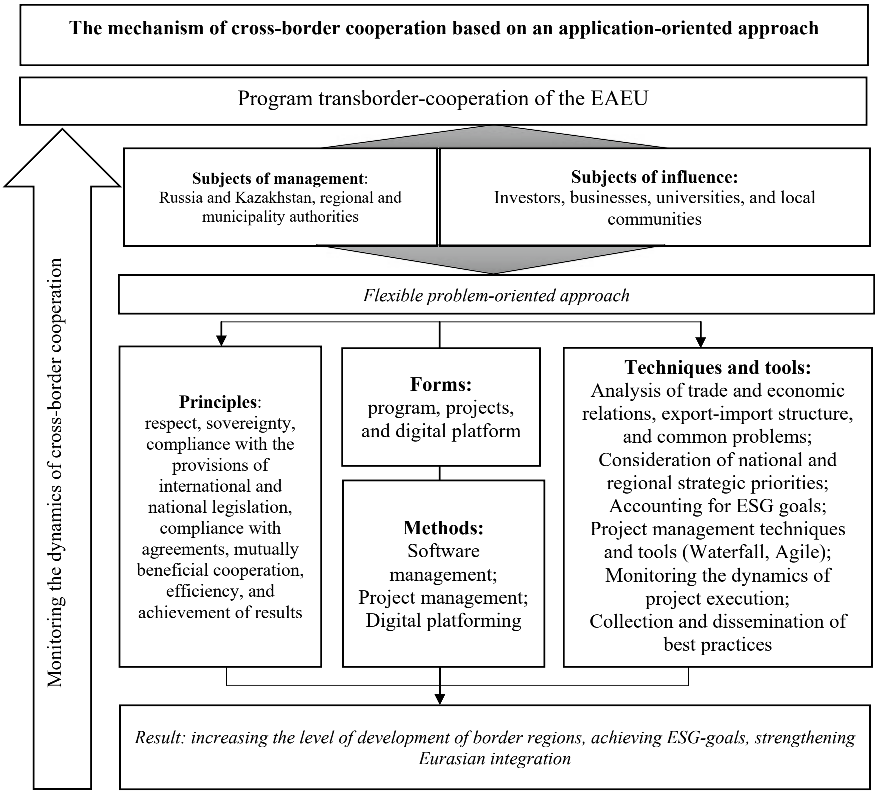

Fig. 9.1 Mechanism of cross-border cooperation based on the application-oriented approach. *Source* Developed and compiled by the authors

financed on a parity basis; the financing operator is the Eurasian Development Bank (EDB). Although the program should be built around a common cross-cutting goal described above, it is advisable to set priorities consistent with the goals and priorities of the EAEU and key strategies and plans of the member countries. This means that beneficiaries can cooperate on any topics of common importance in accordance with their regional needs if this falls within the scope of the Eurasian integration policy.

Thus, the corresponding priorities can be the development of transport infrastructure and logistics, innovations for life and business, and ESG goals.

The program participants can communicate through a digital platform. It can be either a separate website or a section of the EAEU official website. To participate in the program, the applicant submits a project in the due form. Participants can be small, medium, and large commercial enterprises, non-profit organizations, and educational institutions.

Since the program is end-to-end, the program management has a vertical structure. Responsible organizations should be national, regional, and local authorities, as well as organizations in the management and coordination system of the EAEU. Each participating region determines the area of economy, culture, and ecology that needs to be improved through cooperation. To formally consolidate the interest and responsibility of the government authorities, they shall be involved in the program as partners.

As noted above, the application is submitted on the program's website and evaluated by experts. The following criteria may be applied: consistency with program priorities, application quality, partnership quality, budget, successful experience of project completion, and potential effect. Program applications can cover a period of 1–3 years. The cross-border cooperation management should be monitored annually to ensure its effectiveness and flexibility. Based on the findings, the obtained effects are evaluated. It is advisable to conduct a post-project evaluation, which includes information about the long-term project consequences and the use of results after its completion.

Let us test the proposed mechanism through cross-border cooperation of the West Kazakhstan Region (WKR) of the Republic of Kazakhstan and the Orenburg Region and the Samara Region of the Russian Federation.

The WKR is a leading representative of the country's oil (more than 40%) and gas (more than 99%) industry. Although oil refining enterprises, machine building, metallurgy, defense, mining, clothing, and food industries are available in the region, a high level of integration into the global economic space is determined by the petroleum commodities export, amounting to 98.9% [7] (Table 9.1).

The largest trading partners of the region in terms of exports are the EU countries. Among the EAEU countries, the largest trading partner for the WKR is the Russian Federation; exports are increasing year on year.

The main import trading partners for Kazakhstan are the EAEU countries (Table 9.2).

It can be noted that imports from the EAEU countries grow annually. Thus, a solid foundation has been laid for the further development of cooperation between the WKR and the Russian regions.

Table 9.1 Exports of the WKR in the context of regions and countries of the world 2016–2020, $ million

Regions and countries	2016	2017	2018	2019	2020
EAEU countries	84.65	163.79	170.35	165.65	112.47
Including the Russian Federation	69.02	131.57	145.79	136.81	102.71
EU countries	3146.88	4125.55	4923.04	3824.76	3146.52
Asia	118.28	235.49	946.76	1038.06	512.58
America	60.10	88.95	91.91	243.96	76.31
Africa	1.26	2.30	1.37	0.36	3.57

Source Compiled by the authors based on [8]

Table 9.2 Imports of the WKR in the context of regions and countries of the world 2016–2020, million USD

Regions and countries	2016	2017	2018	2019	2020
EAEU countries	391.96	488.05	524.15	523.96	450.40
Including the Russian Federation	380.24	473.63	509.15	512.24	437.13
EU countries	261.03	199.09	122.19	180.38	152.33
Non-EU countries	4.97	4.01	4.55	9.01	23.53
Asia	45.45	39.51	54.65	63.94	55.37
America	147.26	75.97	48.14	47.65	36.63
Africa	1.74	0.99	0.68	1.73	1.80

Source Compiled by the authors based on [8]

The WKR borders five Russian regions; the longest part of the border, amounting to 1876 km, accounts for the Orenburg Region.

Mutually beneficial cooperation of the WKR with the border regions of Russia is performed under the agreements on the development of various fields of cooperation: trade, economy, science, technic, and culture. The priority areas of cooperation are as follows:

- Implementation of joint investment projects and various forms of cooperation in basic industries, including agricultural and energy sectors;
- Development of cross-border trade and entrepreneurship;
- Development of transport, communications, and construction;
- Ensuring the rational use of the entire natural resources spectrum and taking measures to protect the environment;
- Migration and labor market regulation;
- Development of scientific and humanitarian cooperation.

An important task is to preserve the transboundary Ural River basin ecosystem. Since 2018, the exchange of hydrological and hydrochemical information, the interaction of regulatory and supervisory authorities, the water treatment and reforestation work, conservation of the river ecosystem biodiversity, and other measures have been accomplished.

One of the main aspects of cross-border cooperation between the WKR and the Samara Region is transportation and logistics.

Thus, the Samara Region occupies an advantageous geographical position, being located at the intersection of the most important international transport corridors—"West–East" and "North–South."

The region's transportation hub is one of the largest in Russia, with significant potential in terms of logistics and the direction of cargo flows between the main macroeconomic poles—the Asia–Pacific region and the EU countries.

Samara transportation hub is represented in the overall structure of the transport and logistics system of the Russian Federation by all possible means of transport, with the only exception of sea transport. Notably, it has the capacity to serve not only Russian, but also international cargo flows from and to Kazakhstan, Southeast and Central Asia, China, and Europe.

Tourism is another promising area of cross-border cooperation. The Samara Region has a high potential in this area.

A significant disadvantage of the current organization of cross-border cooperation is its purely vertical management system. Traditional management approaches are applied: An agreement is signed, and a joint action plan is developed. Further, the authorities responsible for its performance organize the work and monitor the plan implementation. The most important mechanism is missing—motivation and stimulation of stakeholders, primarily local communities, thus depriving cross-border cooperation of flexibility. Within the framework of the proposed cross-border cooperation mechanism based on a flexible application-oriented approach, the following steps need to be made:

1. Announcement of the cross-border cooperation program commencement and collection of applications;
2. Examination of applications and selection of projects complying with the strategic priorities and tactical objectives of neighboring regions;
3. Implementation of projects, evaluation of results, and monitoring of the program progress.

The most important advantage of the proposed program is the involvement of stakeholders (representatives of business and local communities) based on self-management. The main activities of cross-border cooperation should be shifted to the grassroots level to facilitate the involvement of local communities in solving common problems. Local residents and local authorities better know their strengths and weaknesses, barriers to development, and competitive advantages. It can be expected that local authorities will pay attention to the consistency of projects with the strategic goals and objectives of their administrative territories. Therefore, joint projects will improve the quality of results of achieving development strategies in Russian and Kazakh local territories.

9.4 Conclusion

The conducted research allows the authors to conclude that contemporary cross-border cooperation requires flexible application-oriented approaches in two areas: the use of advanced project management technologies and the involvement of the population of the neighboring region in solving common problems. The problem of providing flexible application-oriented cross-border cooperation lies in the insufficient development of scientific and methodological support for such cooperation management, depending on the regional context and problems.

A promising solution to this problem lies in the use of a cross-border cooperation mechanism based on a flexible application-oriented approach. The developed mechanism includes principles and advanced forms, methods, and tools that constitute the framework set of government authorities' actions at the national, regional, and local levels.

By the example of the WKR, the Samara Region, and the Orenburg Region, the authors showed that current cross-border cooperation has an outdated administrative management structure. The advantage of the proposed cross-border cooperation mechanism based on a flexible application-oriented approach is in creating the basis for the joint work of project teams (representatives of business and local communities) to solve important problems of regions, cities, and towns. Joint work is known for bringing people together. Additionally, the local communities are aware of pressing problems that need to be solved in the first place. Local government authorities formally and virtually act as reliable and responsible partners of projects. Another important advantage of the proposed mechanism is the application of a digital platform because it allows for seamless interaction between all stakeholders: the state, business, and the local community.

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Chapter 10
Information and Communication Technologies in the Digital Economy

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Abstract The paper aims to analyze the factors of the development of the digital economy and assess the current situation in the field of information and communication technologies (ICTs) in the Kyrgyz Republic. The paper discusses the factors of the development of the digital economy and notes that there is little official data on the development of the digital economy, the definition and concept of the digital economy and other components are not legislated, and there are no criteria for assessing the market size. The authors consider the position of Kyrgyzstan in international ratings that characterize the development of digitalization. Moreover, the authors evaluate some indicators of ICT development. In 2011–2015, the share of total costs of enterprises and organizations that use computer technology and ICT to develop and introduce IT and computing facilities averaged 1.13% annually in the GDP of the Kyrgyz Republic. In 2016–2020, this figure decreased by 0.33–0.80%. Based on the analysis of the dynamics of changes in official statistical materials, the authors found that the total costs of enterprises and organizations for the development and application of ICT have an uneven dynamic. Nevertheless, it tends to increase. Over the last five years (2016–2020), the share of these expenditures in GDP decreased by 0.33% relative to 2011–2015. The low volume and decrease in the share of funding and the lack of organizations with advanced production bases based on innovative technologies determine the slow development of ICT in the activities of enterprises.

10.1 Introduction

Under conditions of deepening globalization and increasing competitiveness of the national economy, the issues related to the development of ICT as a separate branch of the economy and issues associated with the use of information technology (IT)

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in other areas of the economy become a priority. Expanding technical capabilities and fully realizing this productive potential in practice will play an important role in enhancing the competitiveness of the national economy and thereby ensure the strategic sustainability of private and public entities.

According to current trends in the global market, the introduction of innovations in the field of ICT and their effective use will create the basis for improving the efficiency of management and technological processes in enterprises, expanding existing markets for goods and services in various sectors of the economy, and thereby improving living standards.

In many developed countries, including Kyrgyzstan, the creation and implementation of digital technology have become the main direction of national development at the state level. The country adopted several policy documents to develop the Kyrgyz Republic's digital economy [1, 2]. The roadmap for the implementation of the digital transformation concept "Digital Kyrgyzstan 2019–2023" (Approved by Order of the Government of the Kyrgyz Republic of February 15, 2019, No. 20-p) [3] is aimed at implementing the main provisions of the Concept of Digital Transformation in the Kyrgyz Republic. The current stage of digitalization of industries and sectors of the economy poses new technological, organizational, and managerial challenges and threats.

To provide practical recommendations for building a competitive digital economy in the Kyrgyz Republic, the experts decided to analyze the characteristics of the digital economy and transformation models of foreign countries, which show a high level of efficiency in extracting "digital dividends" for society. These countries include Ireland, Sweden, Israel, the UK, South Korea, Singapore, and China. Among the post-Soviet countries are Estonia, Belarus, and Kazakhstan.

The government also adopted a program for active cooperation in the widespread introduction of ICT, digital, and Internet technologies in traditional sectors of the economy: energy, agriculture, light and food industry, trade, services, tourism, etc. This program aims to expand the coverage of traditional industries with ICT tools to 60% or more, where ICT becomes a general-purpose tool and contributes to productivity across the economy.

10.2 Materials and Method

The term "digital economy" is one of the most widely used concepts by many economists and other experts, and the economic policy of the state is aimed at the development of this sector. The term "digital economy" was first used by Canadian economist and business consultant Tapscott [4] and Nicholas Negroponte to describe the advantages of the new economy over the traditional economy due to the rapid development of ICT [5].

Theoretical aspects of the definition, formation, and development of the concept of the digital economy are analyzed in many works [6–11], analytical reports of international organizations, and policy documents on the development of the digital economy [12–14]. The state of development of the digital economy in the Kyrgyz Republic is also discussed by several authors [2, 15, 16]. Analytical reviews prepared by the National Statistical Committee of the Kyrgyz Republic [17, 18] assess the level of digital development and the current situation in ICT in the Kyrgyz Republic.

The empirical basis of the analysis was the data of the National Statistical Committee of the Kyrgyz Republic [19, 20]. This study evaluated some indicators of ICT development in the Kyrgyz Republic:

- The total costs of enterprises and organizations for the development and use of IT and computing facilities (CF) and their structure by type of economic activity;
- Financing of ICT implementation costs by forms of ownership;
- The amount of work done to create software packages and services, etc.

10.3 Results and Discussion

A rating system is widely used worldwide to better disclose and evaluate economic activity in the digital sector. This system is a methodological tool for scientific and applied research, making it possible to form vast amounts of data, rank them by one or more attributes, and as a result of ranking, assess the business activity of economic entities by comparing them with each other or with the benchmark, the highest indicator.

There is currently very little official data on the development of the digital economy in the Kyrgyz Republic for several reasons. First, the definition and concept of the digital economy and other components, including e-commerce, are not legally established nor are criteria for assessing the market size. Second, the methodologies for calculating e-commerce shares and sizes vary from country to country. For example, some countries do not include in the analysis the market for online services, and some countries consider the market by the volume of non-cash transactions; other countries assess market turnover by the volume of electronic transactions.

In recent years, Kyrgyzstan has made some progress in the development of IT, which has led to increased digitalization of many sectors of the economy and contributed to an increase in the digital share.

To improve Internet access and reduce its cost, in 2019, the World Bank launched the project "Digital CASA–Kyrgyz Republic"; the project is implemented by the Ministry of Digital Development of the Kyrgyz Republic. To provide at least 60% of the country's population with access to the Internet, the project will lay 600 km of fiber-optic communication lines (FOCL) within the country, while Central Asian countries and some South Asian countries will be connected by an additional 400 km of FOCLs. The construction involves the use of existing FOCLs in partnership with telecom operators based on Indefeasible Rights of Use Agreements (IRUs).

Broadband access in the country is mainly developing in the mobile market, which is shared by three operators—O!, Megacom, and Beeline. Long-term evolution (LTE) networks were first deployed in 2014; these networks are currently dynamically developing. Additionally, the Kyrgyz Republic has good transit potential and tries to develop the capacity and coverage of FOCL networks because most of the Internet traffic in the country is inbound. As of 2018, the length of the country's FOCLs, including cross-border backbones, was 19,500 km.

According to the State Communications Agency of the Kyrgyz Republic, Internet coverage in the Kyrgyz Republic equaled 47.1% in 2020. The mobile platform accounts for the vast majority of Internet connections, with mobile Internet services available to about 99% of the population, of which more than 72% have access to high-quality 4G Internet, while broadband Internet access accounts for only about 10%.

The most common rating systems used globally to assess ICT development are presented in Table 10.1.

In 2017, Kyrgyzstan ranked 109th out of 176 countries on the Global ICT Development Index and one of the last among the Commonwealth of Independent States (CIS). In some indicators, the country's position deteriorates annually. The main problem areas for Kyrgyzstan are as follows:

- The number of individual Internet users is 30.25%, while the average for the CIS countries is 61.70%;
- Access to the Internet for households is 16.5%, compared with 64.40% in the CIS;
- The proportion of households with computers is 19.51%, and in the CIS—64.40%.

Another problem is the low number of broadband Internet subscribers: 3.71 per 100 people in Kyrgyzstan and the CIS average of 14.80; the average speed of active

Table 10.1 Rating of Kyrgyzstan on ICT development

Country	Network readiness rating 2019 121 countries	Global innovation index 2020 131 countries	Development of electronic government 2020 193 countries	ICT development index 2017 176 countries	Population 2020 million people
Ireland	19 place	12 place	27 place	20 place	4.9
Sweden	1 place	2 place	6 place	11 place	10.0
Israel	22 place	13 place	30 place	23 place	9.2
Belarus	61 place	72 place	40 place	32 place	9.4
Kazakhstan	60 place	77 place	29 place	52 place	18.7
UK	10 place	4 place	7 place	5 place	67.8
Estonia	21 place	25 place	3 place	17 place	1.3
PRC	41 place	14 place	45 place	80 place	1400
Singapore	2 place	8 place	11 place	18 place	5.7
South Korea	17 place	10 place	2 place	2 place	51.2
Kyrgyz Republic	No rating	90 place	83 place	109 place	6.5

Source Compiled by the authors based on [17] mobile broadband subscribers is 30.98 per 100 people, the CIS average speed is 51.20, and the external Internet channel speed (per user) is 7356.52 bits/s, while the CIS average speed is 36911 bits/sec. While residents of major cities have access to relatively inexpensive and high-quality Internet access, residents of rural and remote areas do not have such an option. The main reasons for this are the lack of access to the use of advanced information and telecommunications infrastructure and services in rural areas to the Internet, as well as the lack of access to these services and computers, the high price of these services and computers, etc. [2].

The use of ICT in the public sector and business remains low. According to the Digital Adoption Index (DAI) of the World Bank, the dynamics of digital technology adoption are the lowest in business—0.37, in the public sector—0.50, and in the population—0.60. Comparing the indicators of neighboring countries on the DAI for the population, it should be noted that the population of Kyrgyzstan uses digital technology more actively than residents of other Central Asian countries [14].

One of the key components of the digital economy is e-commerce. Kyrgyzstan needs to intensify efforts to create favorable, competitive, and open market relations in a single digital market. Nowadays, the country is included in regional e-commerce trade agreements, and trade corridors are created to stimulate bilateral trade between countries.

In October 2019, the E-Commerce Association conducted a study to investigate the current level of development of the digital economy and its individual components. The research objects were the sites of the e-commerce participants—online stores, logistics companies, commercial banks, etc. The total sample consisted of 769 sites, including 25 commercial banks, 194 logistics companies, and 350 online stores in the Kyrgyz Republic, including 257 full-fledged online stores (Fig. 10.1).

Most (72%) online stores use offline stores and have omnichannel sales: mainly represented on social networks as a virtual storefront. According to Statista Digital

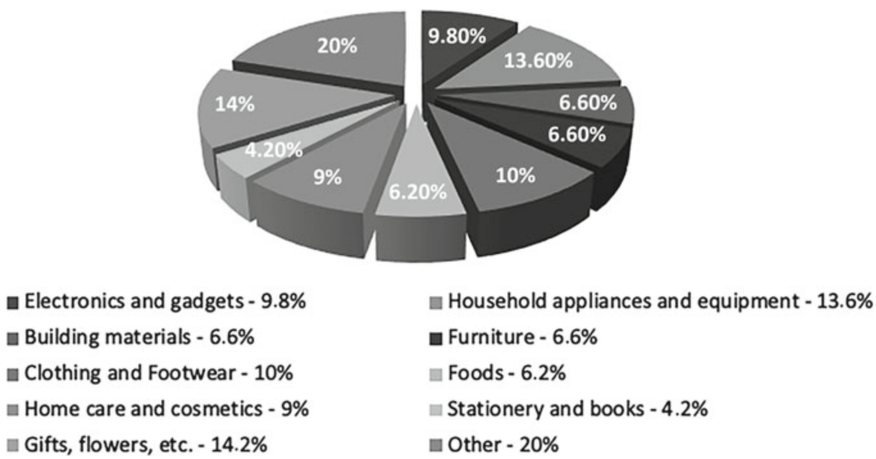

Fig. 10.1 Categories of online stores. *Source* Compiled by the authors

Market Outlook 2019 [21] and International Trade Center [22], the growth rate of e-commerce in the Kyrgyz Republic is projected at 14.1% by 2023, and the revenue from e-commerce will be $185 million.

It is necessary to note the following:

- E-commerce sales in 2019 amounted to $109 million;
- Annual growth of 14.1% is expected, resulting in market size of $184.7 million by 2023;
- The largest market segment is fashion, with market size of $41 million in 2019;
- The average revenue per user in 2019 was $52.

Currently, there are no guidelines or regulations on how e-commerce businesses should register. When companies are registered in the organizational-legal form of a limited liability company, they have the opportunity to choose the type of economic activity—distance selling via the Internet and postal service. However, most companies were registered before this option became available for registration, and they can also sell online and offline. Therefore, there are no strict rules that e-commerce businesses must follow in their activities. Some entrepreneurs use the simplified option of buying a "patent" on a monthly basis; this data cannot be used for further study and analysis. Nevertheless, e-commerce as an activity is not included in the list of activities carried out based on a patent. Thus, mostly retailers use retail patents.

According to the studied official data, the ownership of bank accounts has increased significantly in recent years, from 327 accounts per 1000 adults in 2014 to 684 accounts per 1000 adults in 2020. The percentage of the population with bank accounts in 2020 exceeded 64%, up from 33% in 2014. Measures taken by the National Bank of the Kyrgyz Republic and the Government of the Kyrgyz Republic to develop the banking infrastructure, such as VAT exemption on importation of ATMs and terminals and zero NRS rate on non-cash payments, had an impact on the growth of the number of ATMs and other banking payment equipment. However, despite progressive growth in ATM penetration in terms of geographic coverage and the number of ATMs per 100,000 adults, Kyrgyzstan has not reached the level of ATM penetration in developed countries. Most ATMs and terminals are concentrated in large cities and towns.

The term "digital economy" is often used in policy documents on the development of the digital economy in a number of countries, as well as by researchers, entrepreneurs, experts, and politicians. It should be noted that there is no unified approach to defining the essence and boundaries of this concept. Some researchers speak narrowly of the digital economy in relation to the computer industry and e-business, while others argue that the digital economy is a separate branch of scientific knowledge, the economic theory of the information society. A number of researchers see the digital economy as a distinctive feature of the information society, which gives priority to intellectual and creative labor and information products.

In a seminal paper, Tapscott defined the digital economy as an economy based on the use of ICT [4]. He also noted that the digital economy encompasses two types of economic activity. The first type, information, involves basic tasks such as uploading static information to network resources. Information is a special commodity that takes the form of information processes and services. In the digital economy, information is the most valuable resource that is created, shaped, stored, transmitted, and processed by ICT. The second type, related to communications, includes activities made available through the Internet.

According to the concept proposed by Kozyrev [9], the essence of the digital economy is considered in two meanings:

- In the first case, the digital economy is a scientific direction;
- In the second case, the digital economy is interpreted as a sector of the real economy.

In both senses, digitalization, the properties of digitized information, and their role in the economy are discussed. According to Kozyrev, as a scientific term, the digital economy relies on the conceptual apparatus aimed at studying the results and fundamental causes of the digital transformation of the real economy, as well as on the growth of products and services and the share of new forms of business based on digital technology.

Based on the analysis of the definitions and concepts given to the digital economy in various studies, Bucht and Hicks consider it appropriate to review three main levels of the definition of the digital economy [6]:

- Level 1—the digital sector, which includes information services, components manufacturing, software and IT consulting, and telecommunications;
- Level 2—the digital economy, which includes the digital sector (Level 1) and digital services, the platform economy, the free income economy, and the sharing economy;
- Level 3—digitalized economy, the components of which are Level 2 components, e-commerce, precision agriculture, algorithmic economy, and Industry 4.0.

To study the dynamics and volumes of internal costs of organizations for the dissemination and use of digital technology, the authors analyzed and charted the total costs for these purposes for 2011–2020 and the dynamics of costs for certain types of economic activity, the share of which in total expenditure is quite strong (Fig. 10.2):

- Financial intermediation and insurance—37.8%;
- Information and communication—21.2%;
- Public administration and defense, compulsory social security—10.1%.

As the data shows, total expenditures for ICT development in 2020 amounted to 5404.1 million KGS, corresponding to only 0.90% of the country's GDP. The growth of total expenditure compared to 2015 and 2019 was 132.1% and 127.1%, respectively, i.e., most of the growth corresponded to 2019–2020. From 2016 to 2020, the growth rate of costs for ICT use averaged 0.80%.

Comparing these numbers to 2011–2015, they are down 0.33% over the last five years. Thus, the activities of enterprises, within the cost of ICT development, have a declining trend and small funding, which determines a slow development of ICTs

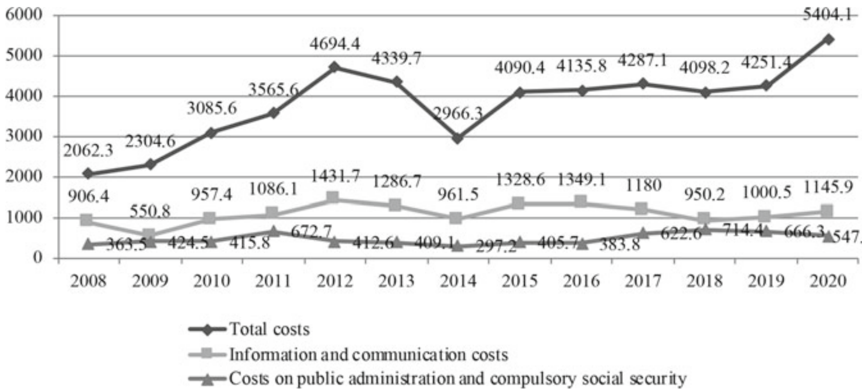

Fig. 10.2 Diagram of costs of enterprises and organizations for the development and use of IT and computing facilities (million KGS). *Source* Compiled by the authors based on the data from the National Statistical Committee of the Kyrgyz Republic [19, 20]

in the Kyrgyz Republic. The amount of domestic spending on ICT development as a percentage of a country's GDP is one of the key indicators of the development of the digital economy.

10.4 Conclusion

For a long time, the practical application of digital technology has led to radical changes in the countries that have implemented it. Nowadays, this trend is a determining factor in the socio-economic development of society. Putting the digital economy into practice is a priority for many countries. The rise of the wave of change in business models and social engagement in recent years is due to the creation of a new generation of digital technologies. Such technologies include artificial intelligence, robotics, the Internet of things, wireless technology, and more. According to experts, introducing digital technology in various sectors and areas of the economy will increase productivity by 40%. In the near future, the effective use of advanced digital technologies will determine the level of international competitiveness of individual companies and countries and create the infrastructure and legal environment of digitalization.

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Chapter 11
Development of the Information-Analytical Base of Accounting and Analysis in SMEs Under the Conditions of Digitalization

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Abstract The paper considers the development of management mechanisms for small and medium businesses. The authors apply the methods of compilation, the concentration of information flows in accounting, proper planning, and principles, and management of information flows. The authors describe the use of the application software package 1C: Accounting by small- and medium-sized companies in their business for accounting work. The main goals of minimizing the costs of the economy are shown. Moreover, the authors show how the digital economy gives all users transparent and accessible information when making various economic decisions. In today's world, where there are plenty of opportunities to prepare financial statements at any time in any situation using information technology, all information users have their own needs in making different, competitive decisions. The paper considers projects created in "DOK" LLC on the implementation and improvement of the application of 1C: Accounting in some operations of the company. In practice, streams of information can appear as an object of accounting, with different types of information located in different places, requiring processing and not having a stable character. The authors develop and propose a recommended version of information flows that can be reflected in the accounts. The sources of information by industry in SMEs are investigated, and the level of application of information flows is reflected. The conducted research clarified and proposed recommendations to improve the quality of accounting and ways to improve the management of SMEs.

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11.1 Introduction

The present age is diverse and prone to change. The study gives the interest of the traditional doctrine of transition research to contemporary methods in studying human society for a particular market environment. The origin of paper money is associated with ancient Chinese merchants. In Europe, paper money first appeared in France in 1716 [19]. Nevertheless, in today's world, the use of paper money is not profitable, and all companies implement digital business to save financial resources.

As stated in the textbook by Drury, company managers need information on which to apply potential solutions and make specific types of monitoring and inspection, price and cost of goods sold, services rendered, etc. [4]. According to Ergeshova, "market laws have different effects on the economies of very developed and developing countries" [18].

Information is the most important resource in the activities of business entities to make any management decisions [2].

11.2 Materials and Methods

Several opinions of foreign and domestic scientists are reflected in the optimal management of SMEs using information flow: Alisheva and Keneshbaeva [1]; Arzybaev [2]; Botobekov [3]; Drury [4]; Ergeshova [5, 6, 14]; Israilov [7, 8]; Kadyrova [9]; Khamzaeva [10]; Khamzaeva et al. [11]; Konyukhovsky [12]; Kurmanbekov and Kurmanbekova [13]; Mamashov [15]; Matkerimova and Kanybekova [16]; Mescon et al. [17]; Omuralieva [19]; Rahman and Sheremet [20]; Sokolov [21]; Taigashinova [22].

According to Ergeshova, "the digital economy is comprehensively changing the production of businesses, as well as cross-border markets for goods and services, expanding productivity and increasing competitiveness" [18].

According to the National Statistics Committee, "Internet digitization adds up to interconnectedness of supply in all areas of the expanded economy, which cost effectively transcends international barriers" [18].

According to Alisheva, the decisions made to develop small- and medium-sized businesses during the economic crisis are divided into three groups:

1. Measures in the tax regulation environment;
2. Reduction of administrative barriers;
3. Staffing support for small businesses [1].

The digital economy of the Kyrgyz Republic could benefit from digital information in an environment between government attraction and obtaining competitive qualities. Considerable work is being done for digitalization in the Kyrgyz Republic, but it is progressing slowly. A new approach to work would give good results with the rational and safe management of information in a particular environment. According to Mescon, “the automation of production processes will allow using uncrewed technologies in mining, which will minimize the risks of human loss in force majeure situations” [17].

The growth of the development and expansion of information and communication technologies in all areas of society is factor-driven elements that should be considered when identifying the most pressing issues in the information base.

11.3 Results

The prospects for developing small- and medium-sized businesses and improving mechanisms for their effective management are particularly relevant. The development of small- and medium-sized businesses is justified by the huge amount of rapidly changing information on the financial market, which necessitates constant monitoring of market conditions and rapid processing of information in making decisions in information management. In a highly competitive market environment, a creative market approach can be considered a more acceptable tool for the qualitative and potential improvement of management in SMEs. This approach requires advanced techniques for collecting and processing the obtained information, analyzing its application, evaluating reliability, and controlling safe information.

Konyukhovsky points out that “economic information is the information that arises in the preparation and during the industrial and economic activity; this information is used to manage this activity” [12].

Israilov reflects the opinions of several scientists who considered the term “information” as an object of research:

- K. Shannon specifies that information is a communication in the process of which uncertainty is eliminated;
- W. R. Ashby highlights that it is possible to convey a variety of thoughts through information;
- N. Wiener indicates that information is the designation of content received from the outside world [8].

The reliability and security of information require a material medium that serves as a source of useful information, an application system, transmitters, communication channels, a receiver, and a repository for the information received. The information received from the source to the user can be transferred through branches of communication channels or mass media (Fig. 11.1).

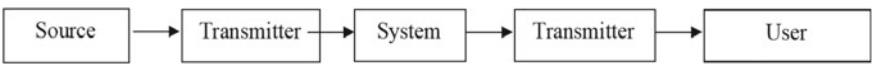

Fig. 11.1 Process of applying the information flow. *Source* Compiled by the authors

Table 11.1 Principles used in assessing information flows

No	Principles	Explanation
1	Intended use	Reflection of real information flow
2	Actual reflection	Justification of operations by the real facts of the information flow
3	Relevance	The analyzed period or volume
4	Timeliness	Timely application of information
5	Value	Valuation of useful information
6	Reliability	Unquestionable characteristic
7	Comparability	Possible comparison in calculations
8	Usefulness	Obtaining the maximum economic benefit when using the information
9	Analytical nature	Use and application in economic analysis

Source Compiled by the authors

"Computer technology allows bringing accounting and economic analysis so close that these two mechanisms of company management merge into one mechanism in terms of its timing and information sources" [5].

The authors systematize the principles of assessing information flows in Table 11.1.

Compilation of information flow in SMEs by industry characteristics makes it possible to reflect the usefulness and importance of the information flow in making alternatives in the management of the company.

Sokolov specifies that "it is apparent that information itself is of substantial value, regardless of the facts it captures" [21].

According to Sheremet's definition: "…a person doing business needs economic information to make an optimal-potential economic decision" with a high probability of usefulness of economic information [20].

In developing and installing accounting applications, it is necessary that these applications cover all distinctive features of the industry and structural units of all companies after installation support, without regard to scale and size, with a quality, and comfortable use of accounting.

Digitalization is very rapidly embracing all areas of society, global business, and even intergovernmental governance at the global level [14].

The correct potential adoption of our management decisions determines how properly this information is used in making decisions [16].

Digital technology should switch all sectors of the economy, social spheres, and policy sectors [11].

We need a creative and integrated approach of the government to the implementation of digitalization of all enterprises, companies, government financial institutions, and the sphere of social direction [10].

It is now proven that there is a specific relationship between the structure and functions of the information system. The next source of information is the contract of sale between the buyers and the seller. Based on the information source in the competitive environment, the economy is expected to receive economic (material and financial) resources, which are the legal justification for the appearance of sources of material and financial resources.

The information is a strategic resource that provides a particular way to make managers aware of the negative and positive factors. Moreover, information can help correct deficiencies and reinforce successes [3].

Information flows can be analyzed in two stages:

1. The first stage—diagnosis of possible places of arrival paths, types, and scale of information flows;
2. The second stage—ranking and analysis of information structure.

The initial source of the scheme of information system is the final result of the study of information flows and document flow of the considered company. Israilov confirms that "the integration of accounting and reporting information implies the creation of a single flow of a minimum of objectively necessary, primary, and consistently aggregated information, direct and reverse communication between managed economic entities and all management bodies" [7].

The primary purpose of automation and computerization of various flows of useful information is the modernization of the process of movement of documents and the used forms, the optimization of document management, and the improvement of information flows, and the structure of the formation of their application and use. The most important tasks of the IT group of the company are the development and implementation of means and methods of the application of information technology for the transfer of paper document flow into electronic form. Nowadays, a considerable amount of accounting work is performed with the introduction of the latest application software packages like 1C: Accounting.

Small- and medium-sized enterprises need to implement elements of the digital economy to develop and run their businesses successfully [9].

Information flows are immersed in the information space, in connection with which it takes considerable time to search and make specific choices. Digital space or "a digital globe" encompasses the entire world in an expanded and almost digital format. Users must have practical skills and be highly skilled when using this digital environment.

According to Israilov, "to be an object of study, information flows must meet the requirements. The information must be used or applied according to the relevance, when economic subjects make potentially justified and economically profitable decisions" [13].

The current picture and improvement of the domestic economy reflect how important small- and medium-sized businesses are to the country's economy, as well as their importance in creating big business in the country.

As Israilov points out, "in recent years, while preserving the control function, the importance of the information function of accounting has increased significantly" [8].

Users of useful information should take a special interest in its application. Taigashinova considers that "correct, optimal, and qualitative application of information flows in checking, analysis, and management, as well as operative and timely acceptance of administrative decisions, can become the result managing companies," "information support of the manager in making management decisions causes the need to create a bank of the data, which are integrated elements of the information system of the company" [22].

Smith says the following about buying and selling: "The tailor does not try to make his own shoes but buys them from the cobbler, and the cobbler does not try to make his own clothes but hires a tailor" [17].

Recently, many small- and medium-sized enterprises have used automated accounting programs in the conduct of accounting work. According to the survey results, among all entities doing business in Kyrgyzstan, individual entrepreneurs are the leaders in the use of accounting software in their accounting work.

Any accounting information is confidential, "the content of accounting registers, internal reporting, and other documents is a trade secret. No one has the right to get acquainted with the content of these documents except by permission of the head (owner of the entity) or by a court and prosecutor's decision, as well as in other cases stipulated by the legislation of the Kyrgyz Republic" [6]. "DOK" LLC created projects for implementing and improving some operations in companies using the program 1C: Accounting.

Information is changing rapidly at a faster rate than one would expect. Therefore, it is necessary to optimize the processing and use of information flows (e.g., currency conversion, prices for goods and services, etc.). From this, we can conclude about the usefulness, effectiveness, and necessary importance of covering this change in the accounting registers.

"The organization of accounting of information flows will improve the methodology of accounting in general and ensure the quality of financial reporting of SMEs in Kyrgyzstan, as well as improve the efficiency of business company management in today's environment" [15].

It is very important to change the stage of the management process—to create a digital manual. In making their own optimal management decisions, external and internal users of economic information refer to the financial statements of the company, which is the final stage of the accounting process. Information analysis is performed to compare the financial result with the previous year. The following types of analysis are applied:

1. Horizontal analysis—changes in the financial statements for the current and previous years;
2. Vertical analysis—the ratio of several items to a single item;
3. Trend analysis—an indicator of the future;
4. Comparative analysis—evaluation of the results of companies;
5. Industry average comparison;
6. Analysis of reporting indicators.

In accordance with contemporary requirements, all changes that have occurred in the process of managing the company, in the methodology of accounting, or in financial reporting affect accounting in general.

11.4 Conclusion

According to the study, small- and medium-sized businesses must overcome barriers to improve the use of information flows. Bureaucracy is unacceptable for the digital economy and technical processes because it can make digital operations of homogeneous processes inapplicable. To eliminate the barrier, it is recommended to develop a process of change in the regulatory framework in all areas of activity. For example, we can use the experience of Germany, which combines the interests of private business and academia.

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Part II
Regulatory Framework for the AI Economy

Chapter 12
The Main Components of the Innovation Audit of the Economy

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Abstract The article discusses the essence, definition and main components of innovation audit, the significance and role of innovation audit in a market economy of an innovative type of development. Methodology: Taking into account this situation, there is a need for the fastest modernization of the industry, improvement of import substitution elements aimed at manufacturing innovative products and introducing fundamentally new technologies into industrial production. The most effective tool in maintaining a high level of competitiveness, organizing production, as well as in introducing and applying innovative technologies, is a technological audit, which, through analysis, will reveal the mistakes and shortcomings of the organization and will also help to correctly use the strengths of the company. Findings: By evaluating the technological system of the enterprise, eliminating losses at individual stages, determining control points, impartial analysis of the production process, technological audit will improve the quality of the products offered by the enterprise, improve and improve production. Originality: For an innovation audit to be useful, it must conduct an in-depth analysis of all components of an enterprise's innovation ecosystem and not be limited to the most obvious ones. An innovation audit is a way to understand how effectively an organization is managing innovation, and to recognize which components are working well, and where additional efforts and adjustments are required.

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12.1 Introduction

An innovation audit examines how effectively an enterprise is able to deliver the level of innovation needed to create new products, new services, and new ways of doing business. Success in this endeavor is likely to depend on a company successfully harnessing the latent creativity of people at all levels of the organization. Innovation audit became widespread at the end of the twentieth century and is aimed at checking the necessary assets and competencies. When conducting an audit of innovative activity, the diagnostic stage seems to be the most important, which should include an assessment of the innovative potential, the environment for functioning and development, innovative activity and the innovative position of the enterprise.

12.2 Methodology

An innovation audit can be defined as a formal audit of an enterprise's accounts, usually by an independent body. It is important to highlight two aspects of this definition: «Checking Accounts»—an understanding of current status versus best practice. «Independent»—by encouraging the third party to complete the evaluation, this ensures that it is not affected by biases and internal politics. With this in mind, an innovation audit can be defined as an independent assessment that provides a better understanding of where the organization in question currently stands relative to innovation best practices and what it needs to do in order to successfully achieve its goals.

Maintaining and developing the potential of the organization, the transition to an innovative development model determines the regular diagnosis of the state of the innovative sphere of the enterprise: strengths and weaknesses, its opportunities and threats. Periodic audit of innovation activities will allow to determine at what level of readiness for the development of innovations is the company.

Every organization is different and should be treated as such. An organization's innovation goals must be clear and defined before evaluation can be effective. Simply put, there are three key areas that should be analyzed in an innovation audit: resources, processes, and values. Their alignment is critical if an organization is to effectively explore breakthrough innovations.

The purpose of the study is to study the concept of innovative audit and its main components, to consider the stages of the process of researching the innovative potential of organizations.

12.3 Results

An innovation audit is an important step for an organization. It allows you to objectively view and analyze from a third-party perspective the situation in the organization before running programs to update innovative capabilities that may not match what is actually happening on a day-to-day basis.

The use of advanced technologies in an audit company should be a basic expectation from the auditor. The data-driven risk assessment offered by analytics tools can improve quality and efficiency, and improved audit efficiency means time savings for your company that could be invested elsewhere.

According to the authors of strategic marketing, innovation audit consists of an audit of the organization's climate, the organization of current activities in the field of innovation, the organization's policies and practices to support innovation and balance the cognitive styles of the management team [8].

The climate of the organization is assessed using an attitude survey and the technique of metaphorical description. The attitude survey examines the current attitudes of employees toward the organizational climate. This review focuses on 8 critical areas:

1) Teamwork, i.e., commitment to work, trust between team members, and willingness to help each other.
2) Resource, access to appropriate resources.
3) Problems related to the work done.
4) Freedom, that is, the degree of control people has over their work and ideas.
5) Supervisor, management support in terms of clear goals, good communication and boosting morale.
6) The infrastructure for creativity, the level of senior management support and encouragement of creativity, and the structures needed to develop creative ideas.
7) Recognition, level of recognition, and type of award for innovative ideas.
8) Unity and cooperation, factors such as the atmosphere of cooperation and cooperation and the degree of common vision in the organization [1–3].

4 constraints are also identified: lack of time, status quo (unwillingness to change the existing system), political issues (battles over areas of responsibility), evaluation pressure (evaluation or feedback systems are perceived as irrelevant, and the environment is focused on criticism).

The second part of this part of the audit is the so-called metaphorical description. The strength of the metaphorical approach is that it can overcome the limitations of literal language and describe much more complex relationships and connections. People are asked to describe their organization in terms of a metaphor. The metaphorical description is analyzed from the point of view of its positive or negative meanings. In such a description, several topics are identified with a particular type of questions. These areas include: management skills, organizational structure, operations, organization life cycle, strategic orientation, people orientation, and power orientation [7, 10].

Tools used in the innovation audit procedure.

There are tools that are used at various stages and in different areas of a business that can also be used for innovation auditing as they provide an overview of business strategy and performance. These tools are as follows:

1) Value chain: the main and supporting activities of an organization and therefore directly related to the definition of organizational capabilities.
2) An analysis that reflects the current performance of the organization and identifies strengths on which a marketing strategy can be built or weaknesses that need to be overcome. Such a portfolio provides valuable information about a product or service. Such models are as follows: growth share matrix.
3) SWOT analysis

    This is an internal analysis of how the organization functions in terms of innovation—one of the best ways to avoid wasting money (and time) and frustrating company employees. No one in the organization is interested in managing change and inaccurate goals that do not actually achieve what they are aiming for [4].

The research development process is tailored to each specific company situation, but typically begins with a quantitative survey that is sent across the organization between departments and business units, with particular emphasis on elements of innovation opportunity. The purpose of this step is to understand how innovations are currently configured and working in the company, in order to further compare them with the findings obtained from semi-structured qualitative interviews with senior employees and senior management, who have a broader understanding of the innovation process in the company.

The next step is to consider whether there is a gap between how top management communicates its strategic innovation intentions and how it works on a day-to-day basis throughout the business. Then, an interview is organized with the authorities and top management of the enterprise and its divisions. As mentioned above, the goal here is to gain a deeper understanding of top management's understanding of the enterprise's innovative capabilities, process, and results.

Each participant is interviewed on four general topics:

1. Current innovation opportunities.
2. Journey through innovative projects.
3. Post-innovation projects.
4. Cultural aspects of innovation [8].

These areas cover a range of organizational activities that underpin the innovation process and allow for a high level of understanding to uncover key messages through open-ended questions. This, in turn, helps to better understand and uncover the hidden causes that create potential barriers to innovation.

In this way, causal mechanisms are identified and emerging themes explaining why and how innovations function the way they do. When completed, the innovation audit provides grounds for answering the key question: "Where is the enterprise now located?" After that, the next steps are proposed to solve specific problems from the strategic level to the level of the project team in the field of innovation.

One of the main goals of audit innovation is to improve the efficiency of the entire audit process, including for all employees of the organization. Some efficiencies will be quickly realized and become more obvious. And an auditor's risk assessment can provide valuable information about excessive risk in certain financial reporting processes or transaction flows.

Audit firms must continually reinvest in their innovations, and many innovations require an entry-level effort to implement, so be wary of claims that every innovation brings immediate cost savings.

Also, the stages of the innovation audit process can be considered in a different way. The first step to implementing a successful audit is the communication stage, when clients send an optional request and their code to the audit company. She then evaluates the project and sends an individual proposal to the client.

The audit team then gets to work, reviewing the code for vulnerabilities that could make the project vulnerable to hacking and other attacks. This process includes quality tests that identify and classify vulnerabilities by severity.

The audit firm categorizes the issues found as «Critical», «Medium», or «Low» before sending a report including recommended fixes back to the project development team [5].

The audit firm works with the client to make sure that all vulnerabilities are closed, after which the final audit is carried out. Once the code review is complete, the team provides an audit certificate with all the details of the meticulous process.

The Code of Ethics and Auditors' Conduct includes five fundamental principles. They are outlined below:

1. Honesty.
2. Objectivity.
3. Professional competence and due care.
4. Privacy.
5. Professional behavior [6].

Companies that used to feel unstoppable are failing, as evidenced by a significant reduction in the average life expectancy of companies. Innovation will not thrive in organizations that lack alignment across processes, values, and systems. Many organizations are not set up to explore and implement revolutionary innovations. The recommendations from an innovation audit will encourage organizations to create an environment that truly supports innovation through tangible and measurable results.

Both financial and innovation audits share the same basic goal of protecting shareholder value and corporate reputation. Just like financial audits, annual innovation audits should be conducted in small, medium, and large companies. More progressive and innovative countries will soon promote annual innovation audits as a highly recommended requirement for businesses. It is time for organizations to take a proactive stance in preparing for the future rather than living in the past. This is an audit of the new time, and soon all organizations will have to join this.

The audit should look at the company's portfolio, its human resources and organizational capabilities. A good innovation audit should lead to a final gap analysis followed by a clear action plan.

When it comes to the capabilities part, things get complicated because of the intricacies of human resource capabilities, organizational capabilities, tangible and intangible elements. Before auditing the innovative capabilities of an enterprise, it is necessary to start by dividing them into human resources and organizational ones. The separation of ecosystem elements is important because it will determine the audit method and the tools that will be used later. While it is fair to assume that interviews, along with scorecards, will be the most commonly used tools, they are not sufficient for some elements.

Another way to analyze the innovation ecosystem of an enterprise is at a higher level, but it consists of looking at some basic indicators, such as:

1) failure/learning cost per unit of time (basically, how many failed products were launched in a pre-specified unit of time),
2) average time to market across the company, time to market in individual departments,
3) the average time required to respond to market shifts (changing customer preferences or introducing new technologies),
4) the percentage of ideas implemented (or accepted by various business units) of the total number of ideas generated,
5) other KPIs for innovation accounting [9].

Although these indicators can paint a clear picture of the past and present state of an enterprise's innovation ecosystem, they cannot explain what caused this situation to arise, so in-depth study is needed.

12.4 Conclusion

The conducted research allowed us to draw the following conclusions: an innovative audit is an important step for an enterprise. It allows you to objectively consider and analyze from the point of view of a third, disinterested person the situation in the enterprise before executing programs to update innovative capabilities that may not correspond to what is actually happening in the company.

Innovation audit involves auditing the enterprise climate, studying the organization's current activities in the field of innovation, the organization's policies and practices to support innovation and balance the cognitive styles of the management team.

An innovation audit consists of the following stages: preparation, diagnostics (actual assessment of the state of innovation processes in a company), action planning, implementation of proposals and recommendations, and completion of the audit. The results of the innovation audit conducted allow answering the key question: «Where is the enterprise located now?», and also, based on this data, certain steps are proposed to solve specific problems.

It is also necessary to note five fundamental principles that must be observed when conducting an innovation audit: honesty, objectivity, professional competence and due care, confidentiality, and professional behavior.

An innovation audit allows you to understand how effectively an enterprise manages innovation, and to recognize which components are working successfully, and where additional efforts and adjustments are required.

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Chapter 13
Application of the Mechanism of Public–private Partnership by Industrial Parks in the Context of the Sustainable Development Paradigm

Svetlana N. Kuznetsova, Victor P. Kuznetsov, Elena V. Romanovskaya, Tatyana E. Lebedeva, and Elena P. Kozlova

Abstract In the article, the authors analyze the relevance of the application of the mechanism of public–private partnership. In most Russian regions, the level of development of private industrial parks is not realized without state support, so it is advisable to use public–private partnership (PPP). Purpose: The authors of the article point out that the industrial park is a professionally managed site for the location of production, which allows you to reduce the risks of non-core activities, reduce the time for launching enterprises, and benefit from cooperation. Methodology: It is possible to receive state support measures using the following mechanisms: for management companies—№ 831, № 1325, for residents—№ 1119, № 316, 1704. The authors determine that by 2021, about 25% of all management companies have used federal subsidies. Findings: It is necessary to apply a new measure to support private industrial parks by compensating up to 50% of the costs of creating or upgrading infrastructure, the amount of support will be 15 million rubles per 1 ha. Originality: According to 2021 statistics, the number of private industrial parks (IP) is twice that of public ones (229 out of 334). Private industrial parks form a financial model based on market payback within a few years. State institutions plan long-term projects and take into account the socio-economic effect. There is a need for industrial parks to use public–private partnerships in the context of the sustainable development paradigm. The mechanism assumes that the initial investment will attract more investment capital into production facilities.

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13.1 Introduction

The purpose of the study is to analyze the economic efficiency of attracting investments in industrial parks using the mechanism of public–private partnership.

Research objectives:

- economic justification for the need to create industrial parks using the PPP mechanism;
- choice of state support measures in the context of the sustainable development paradigm;
- calculation of the economic efficiency of investments in industrial parks.

PPP is one of the important tools for the implementation of key investment projects.

Sustainable development involves taking into account the temporal factors of socio-economic development in order to improve the quality of life through the joint efforts of the state and industrial sites.

Industrial parks are complicating the structure of their activities, moving to support the current production activities of anchor residents. The need for such interaction is formed in a number of areas: the supply of components and components, the performance of individual technological operations, contract manufacturing, a consolidated offer of standard products to large buyers, the joint promotion of products to foreign markets, and the exchange of experience [1].

The number of industrial sites using the PPP mechanism has increased and amounts to 3562. The increase in investment, 4.7 trillion rubles, of which 3.4 trillion rubles from private industrial sites, is positively correlated with an increase in state support for projects, which indicates the important role that plays state support. The total investment in the creation of new industrial sites using the PPP mechanism in the form of concession agreements amounted to 120 billion rubles, of which 105 billion rubles are private investments [2].

13.2 Methodology

The necessary PPP mechanisms have not been developed; there is no vision and strategy for the overall operation of industrial parks and the state, industrial sites underestimate the advantages and possible benefits, including in the context of promoting interests in the regions.

To do this, it is necessary to draw up a program for obtaining state support [3].

For management companies (MC):

Mechanism—RF GD № 831. Compensation for part of the cost of servicing % on loans until 2030: in the amount of the value of the base indicator 6.0–6.5% (up to 2/3 of the cost of servicing loans, but not more than the base indicator); the term for obtaining a loan is 2020–2022 (1.3 billion rubles of subsidies were provided to industrial parks in 2014–2020, of which: 2021—193 million rubles; 2022—298 million rubles; 2023—337 million rubles); the purpose of the loan is the creation of a new park, an increase in the existing one, modernization without increasing the area (15 investment projects for the creation of parks were supported).

Mechanism—PP RF № 1325 (since 2022). Compensation of a part of the expenses of the management company for the creation and development of the BCP infrastructure—15 million rubles per 1 ha/industrial technology parks (IT)—60 thousand rubles per 1 m^2; due to the return of the federal part of taxes and customs duties paid by residents (100% VAT, 50% import customs duties, 100% federal part of income tax, 100% excise taxes on the production of cars and motorcycles).

New mechanism (from 2022). Direct subsidy from 300 to 900 million rubles for the creation and development of industrial technology park infrastructure: the project implementation period is up to 2030; obligations for the revenue of residents, the occupancy of the site, the release of products. For the subject of the Russian Federation (residents of the PP):

Mechanism—RF GD № 1119. Compensation of part of the costs of the management company for the creation and development of the infrastructure of the BCP—15 million rubles per 1 ha/PT—60 thousand rubles per 1 m^2 (15 billion rubles of state support was provided to industrial parks in 2016–2020, of which: 2021—9164.7 million rubles; 2022—9634.0 million rubles; 2023—5835.6 million rubles); due to the return of the federal part of taxes and customs duties paid by residents (13 investment projects for the creation of industrial parks were supported).

Mechanism—RF GD № 316. Interbudgetary transfers of up to 500 million rubles to co-finance the expenditure obligations of the constituent entities of the Russian Federation for the creation of PP/PT, for subjects of the Russian Federation with a low level of socio-economic development new mechanism (from 2022).

Mechanism—PP RF № 1704—at the expense of a preferential budget loan.

The effect of providing support (2021–2023): off-budget investments (25.8 billion rubles); new jobs (5.2 thousand); tax revenues to the budgets of all levels (4.8 billion rubles).

The amount of funding for the period from 2021–2023—3.0 billion rubles.

The authors analyze the total amount of additional demand for the implementation of the regional industrial policy in 2021–2023, million rubles [4].

1. Support for the regional industrial infrastructure of industrial parks and technology parks.

   The launch of a mechanism for compensating part of private investors' investments in park infrastructure (analogous to PPRF № 1119) is linked to tax and customs payments by park resident enterprises to the federal budget.

   - extension of subsidizing interest rates on loans from private investors for loans received for the creation and development of parks in 2020–2025. (PPRF № 831) budget allocations in the amount of 828.8 million rubles. for 2021–2023 redistributed by the Ministry of Industry and Trade of Russia within the limits adjusted by the Ministry of Finance of Russia (2021—193.5 million rubles, 2022—298.1 million rubles, 2023—337.2 million rubles).

- refinement of the mechanism for compensating part of the regions' investments in park infrastructure (PRRF № 1119), the mechanism is linked to tax and customs payments by park resident enterprises to the federal budget.

2. Stimulation of industrial cooperation and suppliers of the component base of the 2nd and 3rd levels. Resumption of support for industrial clusters (PRRF № 41): total for 2021–2023—RUB 1588.0 million); 2021—588.0 million rubles, 2022—500.0 million rubles; 2023—500.0 million rubles
3. Coordination of regional industrial policy. Launch of the mechanism of the Unified Regional Subsidy (PRRF № 194) in total for 2021–2023—3000.0 million rubles); 2021—1000.0, 2022—1000.0 million rubles; 2023—RUB 1000.0 million [5].

13.3 Results

In the context of the sustainable development paradigm, it is necessary to apply the mechanism of public–private partnership, which is determined by the availability of infrastructure.

The authors propose to use the PPP tool based on the project approach: start with the formation of the PPP concept and policy development.

A significant advantage of the sustainable development paradigm is that the implementation of these requirements is not the task of each resident, who use various forms of cooperation [6].

But, if the anchor residents independently overcome problems with environmental and social tasks, then the concept brings completely new opportunities to small and medium-sized residents.

The authors considered the mechanism for developing support for regional industrial infrastructure in 2020–2023.

The proposed measure of state support for a group of regions of total parks % of the Russian Federation:

Launching a mechanism to compensate for part of the investments of private investors in the infrastructure of parks through the return of part of federal taxes and customs duties of resident enterprises (Analog of PPRF № 1119, from 2021) [7].

Launch of a specialized loan product within the framework of the FRP line for concessional loan financing (at 0%) for park residents (under development).

- 10 regions with a low level of socio-economic development—5 sites (1.6%);
- 27 priority geostrategic regions—30 sites (9.5%);
- 63 regions with single-industry towns (321 single-industry towns)—30 sites (9.5%). Refinement of the mechanism for compensating part of the regions' investments in park infrastructure through the return of part of federal taxes and customs duties of resident enterprises (PRRF № 1119, from 2021)—reducing target indicators and simplifying the selection mechanism.

Since 2014, PPRF No. 1119 has been able to benefit from 12 projects from 10 regions, mostly with a budget surplus, which received more than 88% of all subsidies (13.0 billion rubles out of 14.7 billion rubles).

Extension of subsidizing interest rates on loans from private investors for loans received for the creation and development of parks in 2020–2023 (PPRF № 831). 2021—193.5 million rubles, 2022—298.1 million rubles, 2023—337.2 million rubles—85 regions, 316 sites (100%).

Provision of infrastructure for industrial parks includes an increase in construction volumes, an integrated approach to the development of industrial parks.

Planning for the development of industrial parks is carried out taking into account the development strategy, the number and location of organized jobs. It is necessary to define the role of the state in financing industrial parks.

The authors highlight the promotion of the use of public–private partnership mechanisms in the development of the infrastructure of industrial parks and the launch of projects for the integrated formation of industrial territories (Fig. 13.1).

As a result of the emergence of state support instruments, there is a tendency to equalize regional disparities in the number of industrial parks. Let us give an example of the operating industrial parks of the Nizhny Novgorod region: ZMZ, Oka-Polymer, Real-Invest, Investprom [8].

According to the dynamics of the emergence of new industrial parks (an increase of more than 20% annually), the percentage of their occupancy by residents is increasing.

The authors systematized the rating of regions in terms of PPP 2019 (Table 13.1) and cities in 2020 (Table 13.2), among which the Nizhny Novgorod region is among the top five results.

Industrial parks give preference to universal specialization, industry specialization, or industry clusters are formed in the process of activity, which depends on the

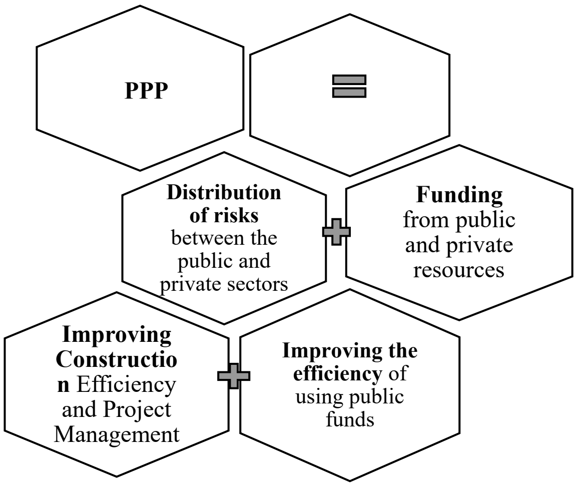

Fig. 13.1 Comprehensive development of territories in the development of PPP. *Source* Compiled by the authors

Table 13.1 Ranking of regions by PPP in 2019

Place	Region	Points, total	Place
1	Samara region	98.7	+2
2	Moscow	98.6	+1
3	Moscow region	98.0	–
4	Nizhny Novgorod region	96.9	+6
5	Perm region	95.8	+3

Source Compiled by the authors

Table 13.2 Ranking of cities by PPP 2020

Place	City	Points, total, %	Number of projects	Amount, billion rubles
1	Surgut	67.3	6	8.6
2	Novosibirsk	59.6	18	2.4
3	Nizhnevartovsk	53.2	4	15.3
4	Volgograd	49.4	5	88.9
5	Nizhny Novgorod	39.6	5	8.9

Source Compiled by the authors

first anchor residents who are located on the territory. For example, the concept of ecotechnoparks is introduced, which use the PPP model.

Some industrial parks use a cluster approach at the design stage of the territory, which enhances the effect of residents' cooperation.

Cooperation schemes arise within industry clusters filled with residents of the same vertical chain, for example, automotive (KIP Master, Grabtsevo, Rosva) and aircraft manufacturing clusters (SEZ Titanium Valley).

13.4 Conclusions

In the constituent entities of the Russian Federation, there is no common approach to determining measures to stimulate the activity of industrial parks. In the subjects of the Russian Federation, regional laws have been adopted, within the framework of which a list of incentive measures is fixed.

However, in practice, the regions are limited to supporting management companies and residents of industrial parks and industrial technology parks in the form of subsidies and tax incentives. Opaque from the point of view of the possibility of monitoring are the measures of regional support actually provided to the subjects of activity in the field of industry.

The PPP model allows you to create complex objects of ecotechnoparks. Through the PPP model, a number of advantages are formed: the creation of complex facilities, including a wide range of state support measures; it is possible to carry out both regulated and unregulated activities—recycling; the ownership of the facility belongs to a private industrial park [9].

The decision to create ecotechnoparks through the PPP model is fraught with risks. More than 3.5 thousand residents have located production facilities in industrial parks, having invested almost 1.5 trillion rubles of private investments in their creation. The total volume of investments attracted by residents exceeds the costs of creating industrial parks (10% are localized in industrial parks). The share of industrial parks is multiplied annually; for every ruble invested in the creation of industrial parks, there are 10 rubles of attracted investments [10].

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Chapter 14
Artificial Intelligence as an Object of Civil Law Regulation

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Abstract The paper focuses on the category of "artificial intelligence" as an object of civil law regulation. In an age of rapid technological change, digital technologies (DT) have firmly entered various areas of socio-economic relations. The development of DT in the field of artificial intelligence (AI) required the creation of legal regulations for their use. Simultaneously, an important area of legal transformation is civil legislation, which mediates a wide range of property-value and personal non-property relations. To achieve the goals outlined in the work, the authors applied a dialectical approach and formal-logical, comparative-legal, systemic, and structural–functional research methods. Due to the development of high technologies and the creation of AI, there is a need for amendments to the legislation, for example, on the recognition of copyright for intellectual property objects created by artificial intelligence. The norms of the current civil legislation in the field of intellectual property do not make it possible to determine the legal regime of such objects. That is why the current socio-economic realities require the transformation of the norms of civil law regulation in the field of intellectual property. The authors also note that it is necessary to regulate civil law norms of relations to ensure workflow using AI technologies and establish the procedure for concluding contracts in electronic form, particularly smart contracts. The proposed changes to the civil legislation of Russia will improve the legal framework for the successful application of AI technologies in socio-economic relations.

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14.1 Introduction

The emerging digital socio-economic relations in the field of entrepreneurship [1, 2], in the innovation sphere [3, 4], and in other areas require the consolidation of adequate legal concepts and institutions that ensure contemporary digital civil circulation and define, among other things, the principles of paperless interaction and the use of electronic documents, determine the procedure for concluding the so-called "smart" contracts [5], identify the regime of intellectual property objects created using information technologies [6], etc.

One of these concepts is AI. Scientific literature has not yet found a uniform understanding and interpretation of the concept of AI.

According to one of the definitions, AI is a science and technology that includes a set of tools that allow a computer, based on accumulated knowledge, to answer questions and draw expert conclusions on this basis, i.e., to gain knowledge that was not put into it by the developers [7].

Other authors define AI as a technology of creating intelligent machines and the science in this field, especially intelligent computer programs [8]. This characteristic reflects the challenge of using computers to understand human intelligence. John McCarthy believes that intelligence is the computational part of the ability to achieve goals.

In connection with the application and use of AI technologies in socio-economic relations, it becomes necessary to create a legal framework, primarily in the field of civil legal regulation of public relations. Such a need has arisen in many legal orders, including the Russian one.

14.2 Methodology

The dialectical approach to the cognition of socio-economic and legal phenomena, allowing us to analyze these phenomena in the context of a set of objective and subjective factors, determined the choice of the following research methods: formal-logical, comparative-legal, systemic, and structural–functional, which allowed the authors to ensure the reliability and validity of the conclusions.

14.3 Results

In foreign legal order and in Russia, various normative documents and program acts in the area of AI technologies have been adopted, which are of a general nature.

In Russia, the concept of AI is enshrined in the National Development Strategy until 2030. According to this document, AI is "a set of technological solutions that simulates human cognitive functions (including self-learning and search for solutions without a predetermined algorithm) and obtain, when performing specific tasks, results comparable at least to the results of human intellectual activity." "The complex of technological solutions includes information and communication infrastructure, software (including those that use machine learning methods), and processes and services for data processing and finding solutions" [9].

A passport for the Federal project "Artificial Intelligence" was developed as part of the implementation of the Presidential Decree No. 490 of October 10, 2019 [10]. The passport was approved at a meeting of the Presidium of the Government Commission on digital development and the use of information technologies to improve the quality of life and conditions for doing business on August 27, 2020. In this case, the date of entry into force of the Federal project is the date of approval of the amended national program "Digital economy of the Russian Federation," in which the Federal project is included.

In 2021–2024, financing of the Federal project "Artificial Intelligence" will amount to 31.5 billion rubles, of which 24.6 billion rubles will be allocated from the Federal budget, and 6.9 billion rubles will be attracted from extra-budgetary sources. It is also expected to provide additional funding for the introduction of AI in the public sector at the expense of public funds provided for the digital transformation of departments. This amount of funding has significantly decreased compared to originally planned due to the economic crisis caused by the COVID-19 pandemic, which, in our opinion, may somewhat slow down the implementation of this Federal project.

For comparison, in February 2020, the European Commission adopted a new Digital Strategy of the European Union. It includes the principles of developing legal norms for the development and implementation of AI, which is aimed at ensuring the global leadership of the EU in the field of AI. According to the head of the EU Commission, Ursula von der Leyen, the EU "will invest at least €20 billion in the development of AI until 2030" [11].

We believe that Russia should also direct a more significant amount of funding to the development of AI technologies because the country will fail to enter the number of countries leading in the production of breakthrough AI technologies without the introduction of these technologies in various sectors of the national economy.

According to the European Commission [12], firms in various areas of the European economy are currently involved in the production of IT technologies using AI (Fig. 14.1). These are mainly the areas of electronics and telecommunications. However, a significant number of organizations produce AI technologies in the automotive sector, the production of agri-food products, medical devices, and others.

Russia developed a roadmap for the development of "end-to-end" digital technology "Neurotechnology and artificial intelligence" [13]. This document identifies seven sub-technologies of "end-to-end" digital technology: computer vision, natural language processing, speech recognition and synthesis, recommendation systems and intelligent decision support systems, advanced methods and technologies in artificial intelligence, neuroprosthetics, neurointerfaces, neurostimulation, and neurosensing.

For each sub-technology, the current level of readiness is determined. The most promising potential tasks or technologies and the most promising potential scientific,

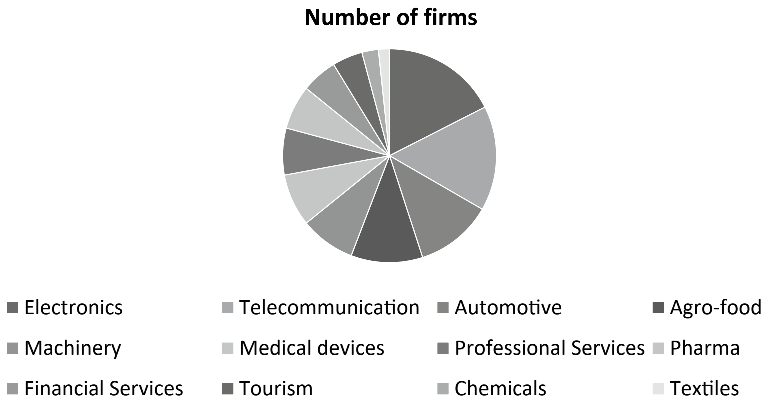

Fig. 14.1 Number of firms in the EU engaged in the production of advanced technologies in various sectors of the economy. *Source* Compiled by the authors

technical, and technological solutions (target use-cases) are highlighted. They are as follows:

1. Computer vision. Compared with the world level, for a number of technological solutions, the SRL in Russia reaches 6, which corresponds to the world level;
2. Natural language processing. The SRL for a number of technological solutions in Russia reaches 6, which corresponds to the world level;
3. Speech recognition and synthesis. The SRL for a number of technological solutions in Russia reaches 5, which corresponds to the world level;
4. Recommender systems and intelligent decision support systems. For a number of technological solutions, the SRL in Russia reaches 7, which corresponds to the world level.
5. Advanced methods and technologies in artificial intelligence. For a number of technological solutions, the SRL in Russia reaches 2, which corresponds to the world level.
6. Neuroprosthetics. For a number of technological solutions, the SRL in Russia reaches 5, which corresponds to the world level.
7. Neurointerfaces, neurostimulation, and neurosensing. For a number of technological solutions, the SRL in Russia reaches 3, which corresponds to the world level.

For the purpose of integrated development of "end-to-end" digital technology, directions to support the implementation of technologies by application sectors (market and infrastructure sectors, social sectors, and public administration and security) were proposed. It also proposed directions of support for seven driving factors for the development of such technologies: software, hardware, algorithms and mathematical methods, human resources, data, and regulations. The list of groups of activities by area is as follows:

1. Support for the implementation of AI technologies in all areas of application:

- Stimulating the adoption of AI technologies;
- Formation of an industry data platform;
- Updating industry standards labor market adaptation.

2. Support for the market for artificial intelligence solutions:
   - Development of R&D of AI in companies;
   - Supporting the commercialization and acceleration of AI companies;
   - Stimulating demand for AI solutions and supporting exports.
3. Software:
   - Development of technological and software solutions in AI;
   - Development of open ecosystem and specialized libraries of AI implementations;
   - Creation of uniform standards and comparison criteria for systems and solutions in AI.
4. Hardware:
   - Development of domestic high-speed and energy-efficient processors that are optimal for solving problems related to AI;
   - Creation of high-density hardware and software systems that are optimal for solving problems in the area of AI;
   - Support for the development of special data centers for collective and individual use.
5. Algorithms and Mathematical Methods:
   - Support for fundamental and applied research in the field algorithms and mathematical methods.
6. Neurotechnology:
   - Development of research and technology in the "Neurotechnology" sector.
7. Personnel:
   - Building a multi-level education system in the field of data analysis and AI;
   - Building a system for attracting and retaining specialists in the field of data analysis and AI;
   - Informing citizens and organizations about the benefits of using AI in various fields.
8. Data:
   - Implementation of uniform methodologies for collecting and marking data;
   - Providing infrastructure for accessing datasets for educational, research, and other purposes.
9. Regulatory regulation:
   - Providing a regulatory environment for data access;

- Creation of a simplified administrative-legal and regulatory-technical procedure for testing and implementation of developments in the field of AI;
- Development of a special investment regime for financial and legal incentives for investments;
- Maintaining an effective balance between the interests of companies developing and implementing artificial intelligence and the interests of society.

Thus, the program documents of the Russian Federation determine the directions for the development of AI technologies that determine the vectors of legal regulation in this area. In our opinion, these measures are insufficient. It is necessary to develop sectoral (in particular civil) legislation that regulates specific problematic points in the use of AI technologies.

In recent years, a discussion about the independence of those results that arise as the consequences of the action of AI has become extremely relevant. As the researchers note, there are suggestions that the use of AI can considerably change the copyright system because it is unclear how to qualify works of literature and art created by robots or programs based on AI [14].

Currently, Russian legislation in the field of intellectual property establishes that "the objects of copyright are works of science, literature, and art, regardless of the merits and purpose of the work, as well as the way of its expression" (clause 1 of Article 1259 of the Civil Code of the Russian Federation). Performances, phonograms, and databases, which have rights related to copyright, are also recognized as protected objects. In this regard, in our opinion, a work or database created by a robot or using AI may well be recognized as an object of intellectual property.

In this case, there arises a natural question. Who will be the author of such a work? In accordance with Article 1257 of the Civil Code of the Russian Federation, "the author of a work of science, literature, or art is a citizen by whose creative labor it was created." The same position is enshrined in Article 2 (6) of the Charter of Rights of Authors. "Since copyright ownership arises from an act of intellectual creation, this right can only arise from a creator who is a natural person. A legal entity can never be considered as the original owner of the copyright to the result of intellectual activity."

Thus, copyright can be recognized only for an individual—a subject of civil rights, which directly created a work of science, literature, or art. In light of the norms of the current legislation, a robot acts as an object of law belonging to a specific person (physical, legal, public law). In this regard, it is difficult to recognize the copyright or exclusive rights to a work for the person—the owner of the robot or other AI technology that created the corresponding work. In our opinion, AI cannot be recognized as the author of work because it acts as an object of rights, and its recognition as an object of law will generate additional problems [15].

This issue requires a revision of the norms of the current civil legislation in the field of intellectual property. The legal regime of intellectual property objects created by a robot or AI should be determined. For this purpose, it is necessary to recognize the exclusive rights to works created by artificial intelligence for the persons—its owners (right holders).

The issues of concluding contracts and other transactions in electronic form using various digital technologies, including AI, remain unresolved.

In Russian civil law literature, it is rightly noted that the terms of the definition of electronic transactions should be changed in the Civil Code of the Russian Federation. The purpose of these changes must be to ensure effective electronic civil circulation, maintain the balance of rights and obligations of the parties to the contract, and protect the weaker party [16].

The definition of "transaction in electronic form" needs to be developed and introduced into legislation. It is also necessary to develop a normative regulation of the procedure for making such transactions, in particular, criteria by which it is possible to determine the moment of the conclusion of an electronic transaction, the possibility of recognizing the actions of the parties as an offer and acceptance, etc.

The improvement of legislation leads to the identification of other new legal institutions, their formulation and consolidation, and then the creation of requirements for these institutions in the electronic civil circulation [17].

The automated contracts should be secured by the Civil Code of the Russian Federation as a form of fulfillment of an obligation. For example, the digital market cannot provide algorithmic trading without such contracts. The concept of "smart" contracts should be enshrined in Article 327.1 of the Civil Code of the Russian Federation to ensure that obligations can be performed without the additional will of the debtor.

14.4 Conclusion

The areas of development in the field of AI and the digitalization of the Russian economy are a priority. In Russia, a number of policy documents have been adopted that determine the directions for the development of technologies using AI. Nevertheless, in our opinion, the state funding for these purposes is not enough to achieve the goals of Russia's entry into the number of countries leading in the production of breakthrough AI technologies.

Policy documents adopted in foreign countries and Russia are general and do not contain industry regulation of relations with the use of AI. It is necessary to develop sectoral legislation that considers today's socio-economic realities, primarily the area of civil law regulation.

It is recommended to determine the legal regime of objects of copyright and related rights created by a robot or using AI. For this transformation, the norms defining the right holders of the objects of intellectual activity must be subjected to transformation. It should be noted that the personal non-property rights of the author cannot be recognized for works of AI. In this case, the exclusive rights to these works can be recognized for the subjects—the owners (right holders) of the robot or AI technology.

The norms of civil legislation in the field of law of obligations should be transformed. It is necessary to regulate the procedure for concluding contracts in electronic form, as well as with the use of various automated systems. It is recommended to consolidate the concept of "smart" contracts in Article 327.1 of the Civil Code of the Russian Federation.

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Chapter 15
Principles of Legal Liability of Owners (Proprietors) of Vehicles Equipped with Components of Artificial Intelligence

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Abstract Nowadays, the development of robotics, particularly cyber-physical systems, in the area of functioning of various types of transport necessitates the creation of the principal bases of the further development of legal regulation aimed at implementing legal liability for infringements committed using robotic vehicles. The purpose of the present research is to draw up the principal provisions grounded upon the system approach that, in the opinion of the authors, can form the basis for further improvement of the legal regulation of legal responsibility in the functioning of robotic vehicles in the Russian Federation. To achieve the research purposes, the authors have applied various scientific methods, such as system analysis, content analysis, synthesis, comparative legal studies, and legal modeling. This allowed us to come to the following conclusions and suggestions, which consist of proposals for the need for the further legal regulation of the development of legal responsibility, based on the following principles: differentiation of legal liability for infringements committed with the participation of an uncrewed robotic vehicle; occurrence of legal liability for committing an unlawful and guilty act using a robotic vehicle; delictual dispositive capacity of an individual or a legal entity (including individual entrepreneurs) for an infringement committed using a robotic vehicle; special liability for unlawful interference into activities of a robotic vehicle; presumption of guilt of an owner (a proprietor) of a robotic vehicle; legal liability insurance for a robotic vehicle.

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15.1 Introduction

The process of applying artificial intelligence (AI) to handling vehicles is actively underway, thereby building up a cyber-physical system or, in other words, a robotic vehicle. Such systems are being built up in the area of maritime, railway, airborne, pipeline, and even road automobile transportation systems handling. Meanwhile, the current Russian and foreign legal systems lack a conceptual approach to solve practical issues in the area of the functioning of robotic vehicles. The attempt undertaken in the Resolution of the European Parliament "Civil law regulations on robotics" (February 16, 2017) [1] to articulate general approaches toward legal regulation of the application of AI does not allow us to identify the principal concept concerning legal liability issues, which the authors of the instrument tried to deliver. Contemporary Russian and foreign scientific sources lack doctrinal approaches aimed at solving issues of legal liability for unlawful activities committed using AI.

We have to assert that it is necessary, under the current development of robotics, to solve a package of legal and regulatory enforcement issues which, according to the current legal sciences, include the following:

- Issues concerning the range of subjects assigned with delictual dispositive capacity for committing an infringement with the participation of an uncrewed vehicle;
- Grounds for legal liability occurrence;
- Other relevant issues of its implementation.

The necessity to make up the fundamental bases of legal liability implementation for the functioning of a robotic vehicle is an urgent need for further development of legal regulation of the aforesaid new social and technical phenomenon. This will allow generating scientific, theoretical, and law enforcement principles and benchmarks of the implementation of criminal, administrative, and civil legal liability for violations committed with the participation of a robotic vehicle.

15.2 Methodology

The issues related to the legal personality of AI have already been sufficiently studied, as well as the possibility to generate a "digital personality" as an independent subject of jural relations. Nevertheless, they still do not allow solving practical issues of the current state of legal regulations related to the application of AI in the transportation segment. This circumstance allows the authors to articulate the system of fundamental principles of legal liability of an owner (a proprietor) of an uncrewed vehicle applying methods of system analysis, content analysis, synthesis, jural comparative studies, and legal modeling. The methods described above allowed us to formulate a system of scientific principles related to legal liability and substantiate their content and need of their implementation in legal instruments, which regulate social relations in the segment of robotic vehicles functioning.

15.3 Results and Discussion

As per the classification proposed by English scientists, a vehicle equipped with AI components (a robotic vehicle) or, in other words, an uncrewed vehicle is a cyber-physical system acting on a rational basis [2, pp. 1–21], which allows to define it as a functional robot performing human functions and thinking like a human while operating. Foreign authors propose to comprehend an uncrewed vehicle "as a mechanical vehicle equipped with an automated control system that can handle the vehicle without the participation of a human driver" [3, p. 742]. Skyrocketing development of uncrewed vehicles at various types of transport generates a complex of legal issues stipulated by the necessity to identify legal liability for committing an infringement using a vehicle equipped with AI components. Meanwhile, we should recognize that, unlike other infringement cases, an unlawful act committed using an uncrewed vehicle entails more severe consequences than, for example, an AI system error (fault) that occurred while managing an organization or providing some specific public services. The abovementioned circumstance actualizes the need to articulate the system of legal liability principles for unlawful acts committed with the participation of an uncrewed vehicle. Moreover, foreign [4, pp. 1–6; 5, p. 383; 6] and Russian science pay much attention to the issues of legal responsibility for offenses committed with the participation of AI, which is especially typical for Russian civil science [7, pp. 30–36; 8, p. 45; 9, pp. 128–133]. Meanwhile, the generation of legal responsibility principles for violations committed by an uncrewed vehicle is related to solving a set of scientific and theoretical conceptual issues and, first and foremost, the issue of the delictual dispositive capacity of the subject to bear such liability. These circumstances allow us to formulate a set of fundamental principles on which, as we see the matter, the legal liability of such types of cyber-physical systems is to be grounded.

15.3.1 The Principle of Differentiation of Legal Liability for Infringements Committed with the Participation of an Uncrewed Vehicle

Contemporary scientific legal approaches focus primarily on the research of issues related to reimbursement of damage caused by a robot and resulting from its activities [10, pp. 21–32; 11, pp. 79–102]. For example, Laptev assumes that the damage rooted in the robot's activity that caused such damage is to be reimbursed by the seller or the manufacturer, regardless of their guilt and whether the victim had any contractual relationship with them or not [11, p. 92]. In the meantime, it should be recognized that unlawfulness of the activity of a robotic vehicle might comprise not only civil (non-contractual) but also criminal and administrative law. The necessity to differentiate legal liability for an infringement committed by a robotic vehicle is stipulated by several circumstances:

- By the specifics of legal liability within the frameworks of the national legal system, in which administrative and civil law liability exist along with criminal liability.
- By doctrinal, statutory, and regulatory codification of legal liability occurrence that comes into force only in case of an unlawful and guilty act (infringement) has been committed.

This circumstance requires the formulation of the following principle of legal liability of a robotic vehicle.

15.3.2 The Principle of Occurrence of Legal Liability Only for Committing an Unlawful and Guilty Act While Operating a Robotic Vehicle

This principle develops the previous one because an infringement is a basis for the occurrence of the legal liability, and the nature of unlawfulness allows discussing the type of legal liability for an act committed while operating a robotic vehicle. In the meantime, the aforesaid principle conveys dialectical, particularly cause-and-effect relationships, between an unlawful act, guilt, and the occurred consequences reflecting interrelations of objective and subjective attributes of a delict. Meanwhile, the nature of the objective and subjective attributes stipulated in the legislation allows distinguishing between criminal, administrative, and civil law liability for an offense committed while operating a robotic vehicle. The presence of guilt as one of the attributes of an infringement that is the basis of legal liability is, in our opinion, an incontrovertible circumstance that entails liability for an infringement committed while operating a robotic vehicle. Herein, it is appropriate to consider that the guilty liability of a person for using a robotic vehicle is typical for "punitive" types of legal liability. In contrast, the "compensatory" of civil law liability might be both guilty based and without guilt. The principle described above logically generates the third legal liability principle for unlawful operating of the robotic vehicle.

15.3.3 The Delictual Dispositive Capacity Principle Including the One for an Individual Entrepreneur for an Infringement Committed while Operating a Robotic Vehicle

The issues of the legal capacity of AI have been vigorously discussed in contemporary foreign and Russian legal sciences. Meanwhile, it should be outlined that there is no consensus on the matter. The concepts proposed by certain researches [12, pp. 1–8;

13, pp. 73–81; 14, p. 358] that reveal AI as a subject of law or as a "digital personality," as a legal fiction paralleled with a legal entity, do not seem to be consistent. According to a fair observation of N. Nilson, a widely recognized English researcher of AI issues, AI is an activity intended for generating an intelligent machine (a robot), while intelligence is just a quality that allows the abovementioned robot to function considering the empirical environmental factors [15, p. 476]. Meanwhile, we should emphasize that this quality is derived from human beings, transferred to a robot by human beings. Even if AI can generate activity algorithms, it is still based on the data that the originator has incorporated into it [16]. It is also appropriate to mention Gödel's theorem on the imperfection of formal systems [13]. At the same time, the opposed approaches are articulated in the science narrative. Thus, Zaplatina assumes that "AI might be delictual while effecting activities without permanent control of people" [9, p. 130]. A similar point of view is articulated by Philipova, who assumes that AI is to be voluntarily registered in a special register. Otherwise, the AI activity coincides with its owner's activity [17, p. 81]. Morkhat considers that solution to the issue of AI units lies in the necessity to generate "specific legal capacity" of a "digital personality" [18, p. 276]. The third approach is that an inventor (an originator as a natural person), or a programmer (an engineer, an employee of a legal entity), or a corporation—a software developer (as a legal entity), or a manufacturer plant (as a legal entity), or a user/owner (as a legal entity or an individual), or a third party are to be assigned with delictual dispositive capacity in case a robot is unlawfully misappropriated or is re-programmed to cause harm. Herein, we should also mention provisions of the European Parliament Resolution "Civil law regulations on robotics" (February 16, 2017 P8_TA-PROV(2017)0051) [1], where it is emphasized that robotics technologies should be developed exclusively to complement human abilities but not to replace human beings. Byers assumes that the AI unit should be evaluated as a fundamentally non-guilty agent acting as an instrument of the real perpetrator of an unlawful act [4, p. 6]. The arguments developing in favor of the third approach toward identification of delictual dispositive capacity of a subject committed an infringement while operating a robotic vehicle, from our point of view, are the following:

- Inadmissibility of assigning a delictual dispositive capacity to a robotic vehicle, since it is a root of a heightened danger that is, according to our conviction, an attribute of a subject of legal relationships;
- Being a root of heightened danger, a robotic vehicle is to be controlled by a human using "black box" and "red button" technologies [19, pp. 386–393], i.e., it is required stronger control over its functioning by an owner (proprietor).

It should be emphasized that it is appropriate to talk not only about the criminal, administrative, and civil tort of an owner (a proprietor) of a robotic vehicle but also about the specified tort of the software developers, the manufacturer of the robotic vehicle, and, in particular, the tort of a third person who effects unauthorized interference into operation of an AI unit. Regarding this fact, it is appropriate to talk about a subject—an owner (a proprietor) of the robotic vehicle and a subject interacting with such a robot in various variants. Meanwhile, the variety of liability subjects allows us to articulate the next principle.

15.3.4 The Special Liability for Unauthorized Interference into Activities of a Robotic Vehicle Principle

The unauthorized interference into activities of a robotic vehicle acquires a special, heightened danger to its operation and poses threats to people around. Up to the date, the Russian legislation has implemented legal means of criminal liability for unlawful access that entails damage or re-modification of AI functionality, as a result of which the crime has been committed, or in case such act causes elimination, blocking, modification, or copying of computer information, generating and distribution of malware aimed at unauthorized eliminating, blocking, modification, copying of the computer information, or neutralizing of the computer information protective tools, in case it causes elimination, blocking, modification, or copying of the aforesaid information (Art. 272 and 273 of the Criminal Code of the Russian Federation) [20, pp. 564–574]. Meanwhile, the unauthorized interference with the activities of a robotic vehicle, resulting in a violation of the rules of its operation, currently does not entail administrative or other legal liability, in case no damage to life, health, or environmental objects has been caused. Additionally, it has remained a disputable issue concerning the liability of a person who took a robotic vehicle under his or her control which caused violations of its operational regulations, for instance, traffic regulations for cars driven by AI. Considering the above provisions, it is apparent that the existing criminal legal means are not sufficient to oppose the abovementioned manifestations of interference into a robotic vehicle operation. As we see it, it is necessary to generate corpus delicti of administrative offenses for unauthorized interference into a vehicle operation that did not entail harmful consequences to the life and health of citizens and other negative consequences.

15.3.5 The Principle of Presumption of Guilt of an Owner (a Proprietor) of a Robotic Vehicle

The principle mentioned above is stipulated not only by the necessity to impose the increased liability of the owner (a proprietor) of a strengthened damage source, but also the necessity to allocate the robotic vehicle into a special group of subjects, the operation of which requires significant attention to ensure the safety of functioning a country, a personality, and a society. Art. 2.6.1 of the Administrative Offenses Code of the Russian Federation contains similar provisions. In our view, the presumed guilt of an owner (a proprietor) of a robotic vehicle shall relate to any type of legal liability. At the same time, disproving the guilt of the owner (proprietor) of a robotic vehicle or a subject interacting with such robot in different formats shall be borne by the aforesaid owner (by the subject interacting with such robots in different formats) and by the persons performing proceedings to bring the abovementioned person to legal liability.

15.3.6 The Principle of the Risk of Legal Liability Insurance of a Robotic Vehicle

The Resolution of the European Parliament "Civil law regulations on robotics" (February 16, 2017 P8_TA-PROV (2017) 0051) outlines the necessity to ensure liability of an owner (a proprietor) of a robotic vehicle. The need for insurance of this liability is also recognized in legal science [3, p. 742; 21, pp. 25–50; 22, pp. 516–523]. Meanwhile, according to scientists' opinion, the existing provisions of this institution related to the development of robotics require further improvement [23, p. 187]. The cited authors recognize the validity of the English approach stipulated by the necessity to differentiate liability insurance depending on the technological level of a robotic vehicle [24]. It appears to be appropriate to insure not only the risk of causing harm by an uncrewed vehicle but also by other types of uncrewed robotic vehicles (robots).

15.4 Conclusion

Generating a system of fundamental principles of applying legal liability to an owner (a proprietor) of a robotic vehicle and to other persons developing, implementing, operating, or effecting non-authorized interference into operation of a robotic vehicle is regarded as a prerequisite for its further formation and improvement of the legal regulation process. It will contribute to the formation of legal regulation of criminal, administrative, and civil liability of persons involved in the operation of a robotic vehicle, ensuring its safe use. The proposed system of principles of legal liability arising from the procedure of using a robotic vehicle allows substantiating the up-to-date status of legal regulation of the operation of robotic vehicles in the Russian Federation. It might underlie the process of further improvement of the aforesaid legal regulation, proceeding from the current state of development of robotics and AI units in the country.

Acknowledgements The study of issues concerning the legal liability of an owner (a proprietor) and other persons developing, implementing, or performing non-authorized interference into a robotic vehicle operation confirms the firmly established trend related to the necessity of working out national legal mechanisms of legal liability for unlawful acts committed while operating AI units. Simultaneously, as a matter of fact, there is no systematized restatement of fundamental principles of the aforesaid mechanism based not only upon the current level of robotic vehicles development but also upon the legal regulation of social relations, the subject of which they are, in

the Russian Federation. The present research reveals that the system approach of prospective legal regulation of protective legal relations stems from the robotic vehicles functioning process typical for the Russian Federation.

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Chapter 16
Legal Problems in the Application of Distance Technology at General Meetings of Members of Corporations

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Abstract The paper aims to determine the legal conditions for the use of remote access information and communication technologies in decision-making at general meetings of shareholders of corporations, ensuring the implementation of the rights of the participants of the corporation and impeccable will element of decisions. The methodological apparatus of the research includes methods of classification, expert evaluation, comparative analysis, formal–legal method, and the analysis of scientific publications and court and arbitration practice. The authors formulated conclusions on the legal conditions for the application of information and communication technologies of remote access in the decision-making at general meetings. The paper determined legal meaning of regulatory requirements for information and communication technologies of remote access as procedural requirements, the implementation of which ensures the implementation of the right to manage and impeccable will element of decisions by the participants of the corporation. The consequences of violations of the regulatory requirements for information and communication technologies of remote access for the validity of the decision made at the general meeting of members of the corporation were determined. Moreover, the authors substantiated the admissibility of application of identification/authentication of persons during remote general meetings based on the use of human biometric data and AI technologies. The research novelty lies in the approach to the legal conditions of application of information and communication technologies as procedural elements of the legal forms of decision-making at general meetings of shareholders of corporations,

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ensuring the implementation of the right to management and impeccable will element of the decision by the participants of the corporation. The proposed conclusions are of practical value for optimizing the rule-making and law enforcement activities in the field of corporate governance in the context of digital transformation.

16.1 Introduction

The current level of development of information technology allows using information technology in corporate management in various forms. Primarily, such technology can be used to automate management processes related to fixing and storing information about certain facts of reality. Digitization of relevant data using blockchain technology ensures openness and immutability of data, traceability, fixation of results, and resistance to unauthorized changes [1]. However, it does not mean the digitalization of management itself: the difference between the latter and automation is found in the presence of analytical mechanisms that allow using data collected by the system to make management decisions without human intervention [2]. Despite this fact, the use of artificial neural networks, fuzzy systems, evolutionary computations, etc., recognized as artificial intelligence technologies [3, 4], when automating processes, such as the collection and counting of votes when making decisions of assemblies, is not decisive. Nevertheless, the use of these technologies allows significantly increasing the efficiency of management, primarily in terms of the reliability of the information obtained by the system. This issue has become particularly relevant due to the fact that general norms governing the use of remote technologies in the conduct of meetings of participants of civil law communities were introduced in Chapter 9.1 of the Civil Code of the Russian Federation in June, 2021.

The paper aims to determine the legal conditions for the application of information and communication technologies of remote access in making decisions at general meetings of shareholders of corporations, as well as to identify their importance in the legal mechanism of exercising the rights of participants of the corporation and ensure the impeccability of the volitional element of decisions.

The research tasks are as follows:

- To assess the legal forms of decision-making at meetings of civil law communities in terms of the permissibility of using information and communication technologies of remote access;
- To determine the legal meaning of the regulatory requirements for information and communication technologies of remote access in the system of conditions providing the volitional element of the decision of the general meeting of shareholders of the corporation;
- To analyze the impact of violations of the regulatory requirements for information and communication technologies of remote access on the validity of the decision of the general meeting of shareholders of the corporation;

- To assess existing technologies of identification/authentication of persons in the electronic environment in terms of normatively established criteria of admissibility of their application in making decisions at general meetings of members of corporations, as well as to assess the potential of artificial intelligence to ensure reliability of identification of persons participating in the meeting.

16.2 Methodology

During the research, the authors applied various methods of scientific research to ensure the achievement of the stated goal and solve the tasks set, including the following methods:

(1) The method of classification was applied to differentiate the legal forms of decision-making at general meetings and classify the existing systems of identification/authentication of meeting participants to identify their potential application in the field of corporate governance;
(2) The method of expert evaluation was used to determine the current state and trends in the use of information and communication technologies of remote access using artificial intelligence in the corporate sector, as well as to determine the consequences of violations of regulatory requirements for such technologies;
(3) The comparative method was used to identify the features of legal forms of decision-making at meetings, as well as legal models for the use of remote technologies in decision-making at meetings of participants in corporations;
(4) The formal–legal method was applied to clarify the content of the rules of law enshrined in the current legislation.

As part of the research methodology, the authors analyzed scientific sources, including those devoted to the general issues of legal regulation of meetings of participants of corporations [5, 6], the use of advanced information and communication technologies in economic turnover and corporate governance [1, 2, 7], and the problems of artificial intelligence [3, 4]. Additionally, the authors analyzed judicial acts of the Supreme Court of the Russian Federation and arbitration courts on corporate disputes.

16.3 Results

No information system related to social processes can initially be closed by computational processes themselves because the basis for their implementation is the facts of reality; the system interacts with the social environment, receiving information about such facts from the outside as a result of human actions. Thus, according to clause 1 of Article 60 of Federal law "On joint-stock companies" (December 26, 1995 No. 208-FZ) (Law on JSC) [8], shareholders take part in voting on agenda items by means of ballots; clause 1 of Article 58 of this law provides for the use of an electronic form of bulletins posted on a Web site on the Internet. This provision is correctly regarded in the literature as a regulatory prerequisite for the application of distributed registry technology in decision-making of general meetings of shareholders. For limited liability companies, the regulatory basis is provided in clause 1 of Article 38 of Federal law "On limited liability companies" (February 8, 1998 No. 14-FZ) (Law on LLC) [9]. This law allows absentee voting by exchange of documents by mail, telegraph, teletype, telephone, electronic, or other communication ensuring authenticity of transmitted and received messages and their documentary confirmation. These regulations do not solve the problem of the use of digital technology in decision-making by the highest bodies of other corporate entities. Thus, in 2019, the legislative body has supplemented paragraph 2 of clause 1 of Article 181.2 of the Civil Code of the Russian Federation (CC RF) [10] with a reference to the possibility of voting by absentee voting at meetings of any civil law communities by electronic or other technical means. These norms provided for the use of electronic means of voting only for absentee decisions, which created obstacles to the use of advanced information and communication technologies to make decisions on issues that could only be resolved in the form of a face-to-face meeting; the only exceptions were joint-stock companies, for which clause 11 of Article 49 of the Law on JSC provided for remote participation of shareholders in meetings of the general meetings. However, for other corporations, a meeting was recognized only as a form of meeting that required the direct (physical) presence of the participants of the civil law community (their representatives) in a particular place. However, the Law on JSC also left open the question of the possibility of holding completely virtual meetings in the electronic environment, which, in particular, followed from the compulsory indication of the place of the meeting in the minutes of the general meeting.

The situation has considerably changed with the enactment of the Federal law "On amendments to the first part of the Civil Code of the Russian Federation" (June 28, 2021 No. 225-FZ) [11]. This law enshrined a general norm on holding meetings with the use of remote technologies, the use of which does not transform them into absentee voting: as an organizational form, meeting mediates the participation of members of the civil-law community in the discussion of the agenda, thereby creating the possibility of forming their will by verbal communication (posing questions, clarifying information, providing other information, voicing objections, etc.). With this approach, the distinction between the two forms of decision-making is based not on how each participant expresses his or her will through voting (direct or mediated by technical means) but on the formation of will: the meeting allows participants to form their position on agenda items as consciously and objectively as possible. This seems to be the purpose of the statutory separation of several issues that are particularly important to the existence of the corporation, which cannot be decided by absentee voting; the method by which a participant participates in voting (raising his hand or filling out an electronic form) is irrelevant for this purpose. In the digital age, the way an individual (community member or representative) attends and participates in a meeting can be either physical (corporeal) or virtual. In the latter case, we are talking about remote participation in the meeting, which is provided through advanced information and communication technologies, in particular remote access technologies, the use of which will allow corporations to reduce organizational costs and increase the engagement of shareholders [7]. The provisions of Chapter 9.1 of the CC RF are common to all types of meetings, including general meetings of participants in corporations. Therefore, these provisions form the regulatory basis for the use of remote technology in making decisions on any issues, not limited to those for which special laws on corporations allow for absentee voting.

In contrast to the previous rule, paragraph 2 of clause 1 of Article 181.2 of the CC RF indicates the possibility of using electronic and other technical means in making decisions of assemblies, defines the grounds for the use of remote technologies at meetings, and sets forth the requirements for such technologies. The law, the unanimous decision of the participants of the civil law community, and the charter of the legal entity are specified as the grounds for the application of remote access technologies. The requirements derive from the essence of the meeting as a means of collective expression of the will of authorized persons and include three elements:

- Reliable identification of the person taking part in the meeting;
- Ensuring that everyone has the opportunity to participate in the discussion of issues on the agenda (the process of will formation);
- The provision of an opportunity to vote (the process of expression of will).

Thus, the meaning of the specified norm is not limited only to a new approach to the concept of the form of assembly: the general parameters of the legal regime of application of remote technologies in the course of their conduct have received normative consolidation.

In assessing the legal significance of the above requirements, we must proceed from the following. Ensuring a real opportunity for each participant of a corporation to exercise the right to participate in management in the context of confrontation between minority and majority shareholders, corporate property participants, and managers requires legal protection of the “weak” from the “strong,” which, to a certain extent, is resolved through a detailed and strict regulation of the general meetings [5]. The requirements for the procedure for meetings must be combined to ensure that each participant freely forms his or her will and that the cumulative will of the community is consistent with its will as expressed in the decision adopted; the compliance with these requirements is thus intended to ensure that the will element of the decision is impeccable. From this point of view, it is easy to see that the requirements set forth in paragraph 2 of clause 1 of Article 181.2 of the CC RF for remote technologies for holding meetings are, in fact, the requirements for the procedure of their (meetings) holding, actually filling the gap existing at the level of general provisions in the legal regulation. Chapter 9 of the CC RF lacks general requirements to the procedure for holding meetings of civil associations. This lack is partially compensated by the regulation of the procedure for convening and holding general meetings of participants in special laws on certain types of corporations. However, a systematic solution of this problem requires the introduction of appropriate additions to the CC RF. Non-compliance of the technology with the requirements creates prerequisites for recognition of the meeting procedure as violated. According to subclause 1 of clause 1 of Article 181.4 of the CC RF, substantial violation of the procedure for holding a general meeting or absentee voting of the company participants, as well as the procedure for passing resolutions of the general meeting, which affects the expression of will of the meeting participants, is a ground for invalidity (in the form of voidability) of the resolution.

Thus, non-compliance of the remote technology used at the meeting with the requirements established by the CC RF may lead to the invalidity of the decision taken by the meeting. The main factor to assess the corresponding violation as a ground for invalidity of the decision is its (violation's) substantial nature because, based on the essential meaning of procedural requirements, violation of any of them to a certain extent affects the will of the participants.

Non-compliance of the used remote technology with the requirement of reliable identification of the person participating in the meeting implies the probability of expression of the will in the voting process by an unauthorized person, which, in turn, may be associated with the failure to express the will of the authorized person. The category of materiality of violation means that this defect of technology can lead to the invalidity of a decision in two cases: if the unauthorized person who participated in the meeting has expressed the decisive will to make a decision (if the vote of a person who is not a member of the company did not affect the result of the vote, the corresponding violation is not a ground for voiding the decision of the general meeting) [12] or if the authorized person has been deprived of the opportunity to participate in the meeting. The second reason is ambiguously assessed in court and arbitration practice, primarily from the point of view of the norm of clause 4 of Article 181.4 of the CC RF, which literally allows "saving" the decision of the general meeting adopted in violation of the rights of a minority participant, without regard to the materiality of procedural violations [13–15]. Simultaneously, regarding business companies, the Supreme Court of the Russian Federation has formulated a different position: depriving a shareholder of the opportunity to participate in a meeting is, in itself, a significant procedural violation because it prevents them from exercising their right to participate in decision-making, which belongs to all shareholders of the company, regardless of how many shares they own [16]. Apparently, the deprivation of a shareholder's opportunity to participate in a meeting may be a result of his or her unawareness of the meeting and the result of his or her inability to participate in the meeting due to deficiencies in the mechanisms of identification/authentication by the electronic service with which the meeting is held.

The participation of a person in an assembly meeting requires his or her legitimation as a subject of the right to participate in the decision-making of the assembly, which includes two aspects: the establishment of the existence of such a right of a certain person and person's authentication. At first glance, the technological solution of the first problem presents no special problems in terms of formalizing the subjects of such rights. Clause 1 of Article 51 of the Law on LLC provides for compiling a list of persons entitled to participate in the general meeting of shareholders. However, any deviation of the composition of authorized participants of the meeting from the formalized (by the register, list) composition of the subjects of law can lead to incorrect results. Normal reasons for such deviation may be participation in the meeting through a representative, including in the case of alienation of shares after the list of persons entitled to participate in the general meeting of shareholders. Thus, participation in a meeting of a corporate participant through a representative implies the need to assess whether the latter has the appropriate authority. In "classic" meetings of shareholders (held in person), such verification is the responsibility of certain persons (registrar, civil law notary) [17]. As rightly noted in the literature, in the absence of a general requirement for a notarial form of power of attorney, it is impossible to provide reliable identification of the participants in the meeting [6]. Clause 1 of Article 57 of the Law on JSC [8] and clause 2 of Article 37 of the Law on LLC [9] establish a notarial form as one of the options for the form of power of attorney, allowing its execution in simple written form, while the power of attorney issued by a citizen should be certified by the organization in which the principal works or studies, or the administration of hospital care facility where he or she is being treated. When holding a meeting using remote technology, verification of authority will consist of viewing by an authorized person not even the power of attorney itself but its electronic image, which will further increase the existing risks. Currently, the way out of the existing situation is the use of powers of attorney signed with an electronic digital signature, which are placed and stored in a registry integrated with the information system through which the meeting is held. According to Federal law "On the experiment to establish special regulation to create the necessary conditions for the development and implementation of artificial intelligence technologies in the subject of the Russian Federation—the city of federal significance of Moscow and amending Articles 6 and 10 of the Federal law 'On personal data'" (April 24, 2020 No. 123-FZ) [18], AI technologies include computer vision and natural language processing. Thus, the development of artificial intelligence technologies in conjunction with a distributed data storage registry will, in the near future, allow drawing up an electronic power of attorney based on the verbal expression of the principal's will, perceived, recognized, and recorded in the corresponding information system. We believe that such a possibility will create the preconditions for systemic changes in the institute of the written form of the transaction as a whole.

The authentication of a person in an electronic environment is possible in various ways that provide varying degrees of authenticity; the literature classifies them into three types [2]:

- "Something you know" (provides for the use of secret information known to the person—codes, passwords, etc.);
- "Something you have" (individualization of a person by the ownership of certain material media—payment cards, electronic keys, etc.);
- "Something you are" (use of human biometrics).

Nowadays, electronic services in the field of corporate governance provide for authentication of the participant mainly through authorization in the relevant information system (e.g., in a personal account) using an individual login and password. This method is used by such electronic services in the area of corporate governance as the "Meetings Portal" system created by VTB Registrar JSC [19], and the "Shareholder 24/7" system created by Independent Registrar Company JSC [20]. This method provides identification not of the participant himself, but of the person who has information about the username and password (for "something you have"—a kind of tangible medium) [21]. Regarding remote bank account management systems, the Supreme Court of the Russian Federation has formulated the approach that the use of such a method (SMS code) does not allow identifying the owner of the account or his principal who possesses the relevant code or password because the operation of entering such a password is available to any person using a phone at the relevant time. It is necessary to distinguish situations in which information for the identification of a participant in an information system has become available to an unauthorized person due to illegal actions of the latter, from the provision of such information by the participant himself. In the first case, there is no expression of the participant's will to authorize another person to participate in the meeting. In the second case, the corresponding actions may be evidence of such an expression of will. The absence of a written power of attorney does not in itself mean the absence of authority because the consequence of defects in the simple written form of power of attorney by virtue of the general rule of clause 1 of Article 162 of the CC RF is not its invalidity. In any case, if a person has an appropriate identifier (a password or some kind of tangible medium), it does not allow identifying him or her with the subject of the right (authority) to participate in the assembly outside of the circumstances related to the receipt of the identifier, the verification of which is impossible during authentication of a participant of the meeting. The uncertainty on this issue is exacerbated by the approach found in jurisprudence based on the distinction between the power of representation to participate in an assembly and to vote: the latter is considered a special power, which must be expressly stated in the power of attorney; in its absence, voting will have no legal value and, under certain conditions, may lead to the invalidity of the decision made by the assembly [22]. The current jurisprudence tries to overcome the shortcomings of "something you know"/ "something you have" identification systems by applying the theory of reliance on external facts based on the recognition that a reasonable appearance of law in relations with third parties creates the effect of law [23], but the resulting priority of volition over will actually shifts all risks associated with the shortcomings of these identification methods to the participants and the corporation itself. In any case, in the conditions of normative enshrining in relation to remote technology of holding a meeting, the requirement of reliability of identification of the person participating in the meeting raises doubts about the admissibility of the "something you know"/"something you have" methods of identification for the reasons stated above. In today's conditions, only, an identification system based on the use of biometric data can be recognized as meeting this requirement. In contrast to the previously described systems, this system allows authenticating a person by the directly inherent physical properties. The regulatory framework for the application of this technology has already been established. Article 14.1 of the Federal law "On information, information technology, and information protection" (July 27, 2006 No. 149-FZ) [24] provides for the functioning of a unified biometric system, which is a unified information system of personal data that ensures the processing, including the collection and storage of biometric personal data, its verification, and the transfer of information on the degree of matching the biometric personal data provided by an individual. The federal state information system "Unified System of Identification and Authentication" (USIA) currently operates in Russia. This system is operated by the Ministry of Digital Development, Communications, and Mass Communications of the Russian Federation. There is also the unified biometric system (UBS), which is operated by Rostelecom. These systems successfully operate in the areas of public administration and financial services. The use of artificial intelligence technologies (e.g., computer vision and natural language processing) allows authenticating people with a high degree of reliability based on their biometric data (face image and voice data). Integration of these systems with electronic services in the field of corporate governance will allow successfully solving the problem of compliance with regulatory standards for holding general meetings using remote technologies.

16.4 Conclusion

The research allowed us to formulate the following conclusions on the legal problems of the use of distant technologies in conducting general meetings of shareholders of corporations.

1. The distinction between the two forms of decision-making at meetings provided for in the civil law—meeting and absentee voting—is based not on the way used by each participant to expresses his or her will (direct or mediated by technical means) but on the process of will formation: unlike absentee voting, meeting provides an opportunity for each participant to form the will on the agenda of the meeting in the process of direct communication with other participants.
2. Advanced information and communication technologies allow for direct communication of meeting participants without their physical presence in a certain place (virtual presence). Therefore, the form of the meeting allows using remote technologies for holding a meeting, given that such technologies provide reliable identification of the persons participating in the meeting, the possibility of voting, and the possibility of verbal interaction between meeting participants.
3. In their functional meaning, the requirements for remote technologies of meetings, enshrined in the CC RF, are the requirements for the procedure of their (meetings) holding, actually filling the gap existing at the level of general provisions in the legal regulation. Failure of the technology to meet these requirements creates prerequisites for the recognition of the meeting procedure as violated, which, if such a violation is qualified as significant, is the basis for voiding the decision.
4. The deprivation of a member of the corporation of the opportunity to participate in the general meeting as a result of his or her non-participation in the meeting due to defects in the identification or authentication mechanisms of the electronic service with which the meeting is held is a material violation of the meeting procedure, regardless of whether the participant's vote could have affected the voting result.

5. Legitimization of a representative as an authorized participant of a meeting held with the use of remote technologies implies the use of powers of attorney signed with a qualified electronic digital signature; the application of artificial intelligence technologies (computer vision and natural language processing) in conjunction with a distributed data storage registry will allow implementing the drafting of an electronic power of attorney based on the verbal expression of will of the principal, perceived, recognized, and recorded in the appropriate information system.
6. Systems of identification/authentication of a person in the electronic environment, based on the use of secret information known to the person (codes and passwords) or the possession of certain material media (e.g., electronic keys, etc.) do not allow identifying such person with the subject of the right (authority) to participate in the meeting beyond the assessment of circumstances related to the receipt of the identifier, the verification of which is impossible during the authentication of the meeting participant. Therefore, it does not meet the normatively established in relation to remote technology check. In today's conditions, this requirement is met only by identification systems based on the use of human biometric data (using such artificial intelligence technologies as computer vision and natural language processing).

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Chapter 17
Artificial Intelligence Technology as a Complex Object of Intellectual Rights

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Abstract The paper aims to identify the legal essence of artificial intelligence technologies. The research relevance is confirmed by its compliance with the goals of national strategies for the development of artificial intelligence adopted by more than 30 countries. The development of the regulatory framework outlined in the strategies is impossible without determining the legal essence of artificial intelligence. During the research, the authors applied the comparative legal method, the method of classification, and systematization. The authors summarized the opinions of foreign and Russian lawyers and identified four main scientific approaches. Using their scientific and critical analysis, the authors formulated the provisions, which, in turn, became the theoretical basis of this research. The authors prove that the recognition of artificial intelligence as an object of law follows from the system of its features and requirements developed by the world community during the formation of a regulatory framework for "end-to-end technologies." Artificial intelligence is a product of human intellectual activity; it meets the conditions of intellectual property protection. The authors conclude that this technology has signs of complex objects of intellectual rights. The research substantiates the need to abandon the development of ethical rules of interaction between humans and artificial intelligence and revise the one-sided utilitarian approach to the development of artificial intelligence. The

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authors provide suggestions on ways to consolidate the status of artificial intelligence in legislation.

17.1 Introduction

As a new stage of the scientific and technological revolution, digital transformation lasted for more than four centuries. It changed the technological order and questioned the exclusivity of human intelligence, the inexhaustible possibilities of the human mind, and the uniqueness of the human essence.

In the pursuit of efficiency, maximum productivity, and high competitiveness, countries have entered a race for technological achievements. This primarily concerns "end-to-end technologies," which have become a key national priority in the strategic development of the "golden billion" countries.

Artificial intelligence is the technology of the greatest interest in the list of "end-to-end technologies." On the one hand, this technology is designed to get rid of routine and monotonous work (processing a large amount of homogeneous data at high speed), unprofitable in terms of labor costs and mental stress, as well as operations that are dangerous to human life and health (e.g., sapper robots, police robots, robots for underground work [1]). On the other hand, the "strong" artificial intelligence threatens to displace a reasonable person with more technological and perfect human-made physical entities. Minimizing the human factor is very effective in many areas of life [2]. As a result, the number of jobs is reduced. Bank and financial workers, managers, doctors, drivers, and lawyers enter into competition with technology and often lose to it in terms of productivity, clarity, and pace of task completion.

Expectations of positive changes in people's living standards due to the use of artificial intelligence turned out to be overstated. The reverse side of the new lifestyle is the interference of technology developers in the structure of life and the essence of people, the manipulation of their consciousness and actions. Thus, lawyers discuss the legal personality of artificial intelligence [3], create the conceptions of the "multimodal legal personality of artificial intelligence units" [4], and propose to give it rights for the results of creative activity. This violates the basic provisions of jurisprudence that only a human being—a living person—can be a subject endowed with rights and obligations.

Based on the above, this research aims to substantiate the objective essence of artificial intelligence, regardless of its type, form, and learning ability. The relevance of this research is confirmed by its compliance with the national "Strategy for the development of artificial intelligence in the Russian Federation" [5].

The development of the regulatory framework and the choice of optimal means of its creation, outlined in paragraphs 48–51 of the Strategy, are impossible without determining the legal essence of artificial intelligence.

This becomes apparent when referring to the strategy text. As a task, sub-item Zh. of paragraph 49 specifies the development of ethical rules for the interaction between artificial intelligence and human. Thus, the legislator introduces technologies into the number of subjects to which social norms apply. However, developers, manufacturers, and users of artificial intelligence must comply with ethical and other social norms. Artificial intelligence is only an object about which people enter into legal relations. This provision should become imperative in the field of legal regulation of "end-to-end technologies."

Given that most of the countries that lead in economic development are solving similar tasks (more than 30 national strategies for the development of artificial intelligence have been adopted), the research is not limited to the region. Moreover, a number of model conventions and draft laws, called "robotlaw," contain articles on the legal personality of robots. The research proves that artificial intelligence should be considered complex objects of intellectual rights.

17.2 Scientific and Methodological Approaches to Determining the Legal Essence of Artificial Intelligence

The definition of artificial intelligence and its impact on law have been discussed almost for a century in the scientific literature. However, the first serious studies appeared only in the 1970s in the USA [6, 7]. The analysis of the results obtained by the researchers allows dividing them into overview works that consider the areas and consequences of the mutual influence of jurisprudence and artificial intelligence [8] and studies on the possibilities of using "end-to-end technologies" in the implementation of legal actions and operations [9].

Regarding the legal essence of artificial intelligence, foreign researchers mostly agree that it is an object about which people enter into relationships [10]. Therefore, responsibility for illegal actions of artificial intelligence should be borne by people that improperly fulfilled or failed to fulfill their legal obligations. For example, criminal liability for crimes committed by a robot is proposed to be distributed between the programmer, the user, and the manufacturer if they are guilty and if there is a causal relationship between the actions of the robot and the illegal consequences [11]. This position (some researchers express alternative opinions [12]) is considered stable.

In Russian science, the study of the legal essence of artificial intelligence is at an early stage. The positions expressed are contradictory, ambiguous, and generally fit into four groups (Fig. 17.1).

In our opinion, the most radical position is the recognition of artificial intelligence as a subject of law. Proponents of the legal personality of the carriers of artificial intelligence, above all, proceed from the autonomy of robots, the ability to perform actions similar to human behavior, learn, and simulate algorithms, images, and situations. In their opinion, these abilities serve as the basis of the emergence of subjective rights and legal obligations for robots [13]. This is especially true for decisions made

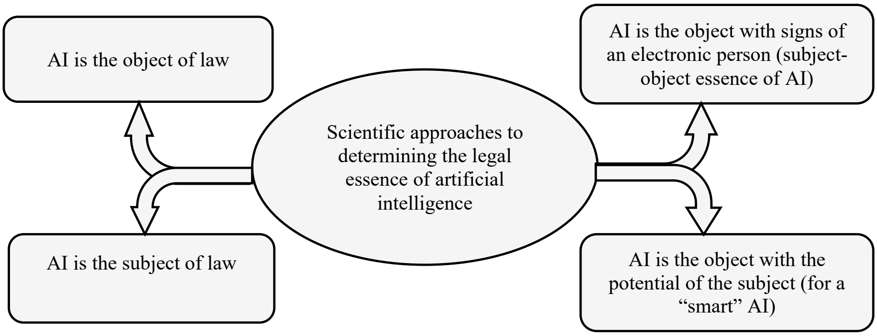

Fig. 17.1 Scientific approaches to determining the legal essence of artificial intelligence. *Source* Developed and compiled by the authors

by the works themselves [14], e.g., the work of the counterparty at the conclusion of the contract [15].

There is also no unanimity regarding the choice of the face model to which robots can be assigned. Some equate them with humans and even propose to include the rights and duties of robots in the Declaration of Human Rights. Several articles review works as legal entities as a kind of derivative subject of law. Arkhipov calls artificial intelligence a property with legal personality, which, in his opinion, does not distinguish it from a legal entity in any way [16].

Other studies substantiate the subject-object essence of artificial intelligence. Their authors believe that it acts as an object of legal regulation and, at the same time, has the characteristics of an electronic person endowed with legal personality [4].

Many lawyers do not consider artificial intelligence as a subject of law, but they do not exclude the possibility that when moving to intelligent systems with artificial self-awareness, the problem of its legal personality will be resolved positively. Simultaneously, legal constructions of the subject are proposed: a legal entity (electronic person) or a quasi-legal entity [17].

According to researchers such as E. V. Ponomareva, it is unscientific to consider robots as law subjects. The socio-legal value of an object and the significance of its actions resembling human actions are not a basis for the emergence of subjective rights for it. Artificial intelligence is not a subject because it is not a person and has no signs of a subject of law. With the help of robots, it is possible only to mediate relations between people [18].

The multiplicity of diverse positions on the legal essence of artificial intelligence does not prevent the development of general provisions forming the basis of this study.

First, there are no fully autonomous and self-learning automatic systems operating without human participation at this stage of technological development. Artificial intelligence is a technological product of the human activity, a means for the realization of will, interests, needs, and the acquisitions and the implementations of subjective rights by a certain circle of persons.

Second, artificial intelligence is a complex result of intellectual activity (RIA) of a person, possessing the properties of systemic unity, learnability, and autonomy of actions, as well as a number of skills, laid down by the developers, in searching, processing, and systematization of a large amount of data, modeling, etc.

Third, artificial intelligence has become an objective reality and affects the virtual and the material world, generating legal consequences. Artificial intelligence exists in a virtual (software) or cyber-physical (robots, cyborgs, and other human-made objects) form.

Fourth, the functioning of complex software-automatic systems called “artificial intelligence” should be carried out under human control because, in addition to high efficiency, effectiveness, and productivity, they can be a source of high danger for humans and the environment.

17.3 The Concept of Artificial Intelligence and Its Legal Essence

To identify the legal essence of artificial intelligence, it is necessary to form a priori proposition that should not be ignored or changed for solving momentary problems. Relativism in the understanding of basic legal categories hinders the provision of legal certainty, the fulfillment of legal obligations of legal entities, and the protection of their subjective rights. Thus, a clear understanding that the subject of law is the legal personality of a living person possessing the qualities of legal personality, including responsibility, will give clarity, precision, and certainty to legal structures.

Assigning the status of a subject at the will of the legislator, which is proposed by lawyers, to transfer responsibility from the developers and manufacturers of artificial intelligence to a virtual or physical entity (the product of their activity) resembles medieval punishments of the bell or granting the status of a citizen to the beloved animal of the Roman emperor.

Such approaches are unscientific and, in the conditions of digitalization, dangerous for the loss of social value of a person and their replacement by digital counterparts as more accessible, productive, and economically profitable workers. Investments in the market of technological solutions related to artificial intelligence are growing rapidly and currently exceed $20 billion. In the nearest future, they will overcome the milestone of $100 billion [19].

The objective essence of artificial intelligence coincides with its origin and the legislative definitions of the concept. Thus, in the national strategies of digital transformation in Russia, artificial intelligence is understood as “a set of technological solutions that allows simulating human cognitive functions (including self-learning and finding solutions without a predetermined algorithm) and obtaining results comparable at least to the results of human intellectual activity when performing specific tasks" [20]. Similar definitions are found in EU projects [21].

If certain provisions of this definition are controversial (e.g., the situation where artificial intelligence with the mechanic and realistic logic can get a creative result), in general, it can be stated that artificial intelligence in it is an object of the law. It is a system technological complex aimed at solving certain tasks and obtaining specific results.

Article 1 of the draft of the French Charter of Artificial Intelligence and Algorithms fairly states that automated systems do not have a legal personality. Therefore, legal duties and responsibilities are assigned to the person who uses the system and becomes its legal representative [22].

In answering the question of what kind of object artificial intelligence should be recognized as, lawyers also express different opinions. Some authors investigate artificial intelligence as a special kind of property and propose to develop a special legal regime for it. Others find that it has common features with intellectual property, which seems to be true.

Artificial intelligence technologies have signs of immateriality, novelty, originality, individuality, independence, and the ability to reproduce. They can have an objective form (virtual or cyber-physical). Moreover, it is possible to argue that artificial intelligence was created to qualitatively improve the creative activity of people and provide technological opportunities for creative additions and constructing reality through tools inaccessible to humans.

Thus, it should be admitted that artificial intelligence technologies are an object of law, through which human cognitive abilities are imitated to improve their qualitative and quantitative parameters. These technological solutions are a product of people's intellectual activity. They meet the conditions of intellectual property protection.

17.4 Results

The definition of artificial intelligence as a result of intellectual activity does not solve the problem of its legal regulation because the list of objects protected under this name is very wide.

From the scientific literature and legal acts, we identified such signs of artificial intelligence as a complex system structure, including other RIA, united by the common design and purpose. Additionally, artificial intelligence has inseparable integrity and a single focus on imitating a person's cognitive abilities to fulfill their needs.

Unlike other complex RIAs, the unity becomes a legislative and a real condition for their existence and their use in civil law. This object is a specially created inseparable integral system formation, consisting of objects of intellectual rights and other unprotected elements.

As a result, there is a multi-personality of copyright holders, which can be divided into original and derivative ones. The original copyright holders are the authors of the RIA, which are part of artificial intelligence. In our opinion, the transfer of the exclusive right to the result from the author to the person who organized the creation of artificial intelligence is an indispensable condition for the emergence of intellectual property rights to this complex object.

Thus, artificial intelligence meets the requirements for complex objects of intellectual property rights, which are enshrined in legislation in Article 1240 of the Civil Code of the Russian Federation. Under this name, the RIA is protected, which includes protected objects of intellectual rights on the terms of inseparable integrity, functional and structural unity, created with the participation of the organizer who acquires the exclusive right to this object based on agreements concluded with the authors of these objects on the transfer of the exclusive right to the RIA included in the complex object.

Artificial intelligence cannot be attributed to any of the varieties of a complex object enshrined in Russian legislation. However, it has all characteristics of these objects, such as:

- Creative personal contribution of the author (co-authors) to the creation of this object, as well as the organizer who initiated its emergence;
- It is created, reproduced, transmitted, and stored on a single medium in electronic (digital) form, which is due to the computer program in the complex composition of this object or implementation corresponding to the topology of an integrated circuit, and a database as mandatory elements;
- It has the property of universal or full interactivity, ensuring the active participation of the user in the process of reproduction of the artificial intelligence carrier. Digital form, interactivity, mobility, combinatorial nature, and intelligent automation of the elements of the artificial intelligence system allow users to interact with it and use it at their free will and in their own interest within limits set by the developers.

Individual varieties of artificial intelligence should be determined only considering its selected features. The qualification of artificial intelligence as a complex object is carried out based on the proposed set of features, the list of which should be improved and detailed in further research.

17.5 Conclusion

The regulatory and legal fixation of artificial intelligence and other end-to-end technologies as an object of law will allow establishing legal restrictions on the use of technological solutions that are beyond human control. However, it will pose a threat to public and environmental safety. Nevertheless, it will balance the existing system of legal regulation ("human rights") and legal norms ensuring the development, implementation, and use of robotics. The development of end-to-end digital technologies transforms law and order but should not change its anthropocentricity.

Artificial intelligence does not replace a person but helps them be more creative, accurate, and productive.

As a result of the research and based on the obtained conclusions, the following is proposed:

- It is necessary to abandon the development of ethical rules for the interaction of humans and artificial intelligence. This technology is aimed at data analysis. Its safety is ensured by technical rules. Social standards and legal limits should be set by developers and manufacturers of end-to-end technologies to prevent threats to the life, health, and safety of people and the environment;
- It is necessary to revise the one-sided utilitarian approach to the development of "end-to-end technologies," pay attention to the cultural and civilizational threats entailed by digitalization and informatization, including the loss of significance of national legal and cultural values, ideals, principles, and other civilizational achievements [23];
- It is necessary to normatively define artificial intelligence as a complex RIA (an automated complex created by the unity of technological design and aimed at solving specific problems mechanically and mathematically), having the characteristics such as novelty, reproducibility, expression in an objective form, learnability to automatic selection and processing of big data to solve the goal, interactivity;
- Normative consolidation of the object essence of artificial intelligence can be carried out in two ways, depending on the model of legal regulation of intellectual property in national legislation. In legal systems, where intellectual property rights are codified, it is proposed to separate a complex object of intellectual rights into a separate institution and fix it in a separate chapter of the corresponding part of the civil code. In states that regulate intellectual property rights by separate laws, it will be necessary to adopt a law on complex objects of intellectual property rights, including artificial intelligence.

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Chapter 18
Regional Perspective of the Development of Digitalization of the Economic and Legal Areas of Public Relations in Russia

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Abstract The paper analyzes the features of the development of the use of digital technologies in the regional economy, assessing the level of digitalization of regions and ensuring state cybersecurity. Moreover, it actualizes the need to expand the use of new energy-saving and environmentally-friendly technologies, expand state support for enterprises that actively use these technologies in their production, as well as support the practice of using information technologies to ensure greater accessibility of state power to the population, considering the rights of the population, employees, and officials of public authorities at the state and municipal levels. The authors propose ways to improve the legal regulation and practice of using information technologies in the activities of all branches of public authorities at the state and municipal levels. To achieve this goal, the authors use various methods of a systemic approach, statistical and logical analysis methods, comparison, observation, expert assessments, and the sociological method. The authors identify the most effective ways to improve the digitalization procedure of the regional economic and legal areas, including the creation of regional commissions on the digitalization of the economy of the subject, the activation and expansion of the practice of using videoconferencing in courts, the creation of a special information system for transferring trials (especially in appellate and cassation instances) to a remote format, the expansion of the list of judicial acts required for posting on the portal of the electronic court filing system "Justice," and the introduction of remote mechanisms of discussion and collective decision-making into the activities of state and local self-government bodies, economic entities, political parties, and public organizations.

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18.1 Introduction

The development of a digital model for the development of the regional economy has been updated in connection with the emerging threats of a global scale, which allows us to formulate proposals concerning the transformation of the existing mechanisms of economic interaction, the adjustment of the current legislation regulating various aspects of the analyzed problem, and the identification of possible areas for improving the legal mechanism for the implementation of new technologies, communication formats, control, management, and other aspects of the proposed reform, ensuring cybersecurity at the federal and regional levels. Previously, the term "remote" was mainly used in the educational environment. However, the active expansion of the use of information technologies in all areas of the life of the state, society, and citizens, which allow carrying out professional activities in the absence of personal interaction, entails the question of extending the remote factor to other social relations, which actualizes the need to create an effective mechanism for legal guarantee of all aspects of the manifestation of the analyzed phenomena.

Currently, the market of services has changed significantly. The format of remote sales and payments is expanding. Public authorities switch to new rules for communication and provision of services, which entails the need to change legislation and strengthen state control to prevent possible violations of individual rights, freedoms, and various aspects of cybersecurity that are related to the leap in the development of information technologies.

The vast majority of the subjects of the Russian Federation are characterized by a steadily dynamic expansion of the use of digital technologies in various areas of life. In this regard, it is possible to identify certain trends in fluctuations in the volume of digitalization on a regional scale and build a linear trend according to the most stable patterns in the implementation of various manifestations of digitalization of the regional economy [3].

18.2 Methodology

In identifying current problems and directions of developing the regional aspect of digitalization of the economic and legal areas of public relations in Russia, the authors used the methods of a systematic approach (its functional and structural aspects), categorical and structural–logical analysis, and processing of legal and practical information at the federal and regional levels.

The methods of statistical and logical analysis were applied to process, analyze, and generalize data materials from various regions of the country in accordance with the set goal and formulated tasks. The methods of comparison, observation, and expert assessments were also applied at different stages of this research. The sociological method allowed the authors to trace the real effectiveness of the regional perspective on the digitalization of the economic and legal areas of public relations in Russia.

18.3 Results

The development of the remote economy of the region and the expansion of its digitalization implies an increase in the use of new technologies related, among other things, to the use of energy-saving and environmentally-friendly industries, which will undoubtedly have a beneficial effect on natural capital. Within the framework of this direction, it is necessary to develop state support for economic entities belonging to the category of producers seeking to preserve the ecology of the region, simplify the procedure for providing it, and expand the list of grounds for state financing and co-financing of business projects. Without the state participation, which is also interested in protecting the natural environment, many interesting ideas in this area will not find their way into the real production cycle.

According to the results of the study of information of Russian crop industry, it should be concluded that digital innovations in the management of all levels of the production cycle have a uniquely positive impact on the growth of productivity and product quality, increase the properties of soil fertility, and allow saving financial costs, optimally using seed material, protecting plants, and choosing and using optimal types of fertilizers and fuel. Accordingly, similar conclusions regarding the use of IT technologies can be made not only for crop production but also for the livestock sector of agriculture [1].

The remote economy assumes the most active development and application of information capital and, as a result, the expansion of its influence on all other subsystems, which entails the expediency of analysis, identification of current problems, and ways to improve the current legislation regulating the legal mechanism of its implementation. There is an issue of strengthening responsibility for disseminating false information through information resources, which is the most urgent problem in connection with numerous cases of the dissemination of the so-called fake messages, which entail the possibility of adverse consequences and violations of individual rights and freedoms. It is necessary to strengthen the state control over the content of the information activity of the population while not violating their rights and freedoms, without restricting them.

It is necessary to develop and support, including at the legislative level, the use of Internet resources in the activities of state authorities because, in accordance with the Constitution of the Russian Federation, all power in the country belongs to the people, and state authorities and local self-government in their activities should not forget about the priority of individual rights and freedoms. Accordingly, the executive, legislative, and judicial authorities should expand the use of information technologies to ensure greater accessibility of state power to the population. Simultaneously, it is necessary to find a balance that will allow us to observe the golden mean and prevent violations of the rights and freedoms of individuals, not only ordinary citizens but also employees and officials of state authorities and local self-government.

The judicial authorities quite actively use information resources (e.g., the electronic court filing system of the Russian Federation "Justice,"). Nevertheless, in the context of the transition to a remote format, it seems advisable to expand the grounds for the use of information resources, for example, to activate and expand the practice of using videoconferencing in courts. This form of trial is provided for in part 2 of Article 401.13 of the Criminal Procedure Code of the Russian Federation and guarantees the principle of immediacy and oral proceedings while significantly reducing labor costs and deadlines, saving budget money and time for staging to the place of consideration of the case (especially for persons in detention facilities). Despite its high potential and functionality, such a system is not installed in all courts, and judges in practice often refuse a request to organize a videoconference. A variation of this form of judicial proceedings in connection with the global expansion of the Internet network may be the inclusion in the practice of using Internet resources of programs that involve the possibility of video conferencing (e.g., Skype, Google Hangouts, etc.) or the creation of a special Russian program for the implementation of the functions of the judiciary, assuming the possibility of exercising the function of justice using video conferencing. Simultaneously, to establish the identity of all participants in the process (criminal, civil, and arbitration), it is possible to offer the use of the resources of the portal of state services of the Russian Federation, so that the entrance is performed through the personal account. To ensure the principle of publicity of the trial, it is additionally necessary to allow all interested persons to participate remotely as a listener, by analogy with the presentation of such an opportunity in a real format, when anyone, if the court session is not closed, has the right to attend it.

Currently, the portal of the electronic court filing system of the Russian Federation "Justice" contains only sentences placed by courts. It is necessary to expand the list of acts that are mandatory for posting to simplify the procedure for protecting the rights and freedoms of citizens and ensuring the principles of transparency and accessibility of justice.

Court proceedings in the courts of appeal and cassation instances especially need to be transferred to a remote mode, including with the help of the scheme proposed above, because these judicial bodies are not located in every city or even in every subject, which significantly complicates the personal presence of all participants in the process.

The legislative power also actively uses information resources in its activities. Special attention should be paid to the functioning of the Internet resource "Russian Public Initiative," the activities of which are regulated by Presidential Decree "On consideration of public initiatives sent by citizens of the Russian Federation using the Internet resource "Russian Public Initiative" (March 4, 2013 No. 183). Using this resource, citizens can put forward legislative proposals and vote for initiatives posted on the website. This mechanism of participation of Russian citizens in implementing legislative activities at the federal, regional, and local levels is aimed at organizing the remote implementation of the constitutionally established right to public participation in the management of state affairs. However, it demonstrates low-efficiency indicators, which implies the expediency of improving the legal framework and the mechanism of its work. Currently, more than 15,000 initiatives have been put forward on the website, while only 34 have been considered.

The problems of this platform that need to be solved, including by improving legal regulation in this area, include the low level of legal literacy of the population (legal nihilism, lack of faith in the effectiveness of this legal instrument, etc.), an opaque voting system that assumes the possibility of cheating votes, the lack of mandatory acceptance of public initiatives, a control mechanism, and excessive involvement of executive authorities in this process. It is necessary to work out this process in more detail, up to the adoption of a legislative initiative by a regional or federal legislative authority, a representative body of local self-government, including providing for the obligation of these structures to adopt a draft law for consideration, which was the result of the functioning of the "Russian Public Initiative" and ensuring transparency of all stages. Thus, the effectiveness of this resource and the confidence of the population in it will significantly increase.

Social capital is of particular concern when introducing a remote economy because remoteness implies the absence of personal interaction, which can be psychologically uncomfortable for the Russian population, including when carrying out professional activities. Various collective events are held using Internet resources and information resources, or are canceled altogether, which can lead to a decrease in the involvement in decision-making of all participants in these public relations, including economic, social, political, cultural, and other relations. To prevent the restriction of individual rights and freedoms, it seems necessary to integrate (into the activities of state and local self-government bodies, economic entities, political parties, and public organizations) the mechanisms that involve the organization of participation of all employees and officials in making decisions that have been previously taken at congresses, conferences, and similar events; the possibility of voting.

The current situation of significant restrictions on the rights and freedoms of subjects of all areas of public relations can be viewed not only from a negative point of view. It will help us gain new experience in remote communication and implement various forms of interaction. Moreover, it will expand the grounds for performing various functional duties of public authorities, subjects of economic relations, and ordinary citizens of the Russian Federation, which will allow us to actively continue using the mechanisms developed now. Undoubtedly, the positive aspects of remoteness are saving time and money and a significant reduction in the negative impact on the environment (e.g., as a result of reducing the use of vehicles).

The discussion points of the stated topic are various aspects of the active use of digital technologies at the regional level. The question is raised about the degree of readiness of the overwhelming number of subjects of various sectors of economic activity for such a global application of innovations. Simultaneously, it is worth noting the problem of ensuring national security and cybersecurity in light of the development of the use of information technologies, including in the work of public authorities and their officials. Improvement of the system of constitutional and legal mechanisms to ensure the national security of the current state is a new promising scientific direction [2], the development of which should be given attention, including the creation of a regional concept of the use of information technologies in the legal and economic areas, ensuring cybersecurity, protecting the rights and freedoms of the individual at all stages of participation in this type of public relations.

Increased economic growth under the influence of intensive factors, among which the introduction of digital technologies and an increase in the digital competence of employees are highlighted, entails an increase in the level of structural unemployment and faster growth in the wages of IT workers, which determines an increase in inequality in the distribution of income [11]. Accordingly, the authors conclude that Piketty's judgment on the form of reducing social inequality by introducing a capital tax [10] should be supplemented with an initiative to introduce a tax on excess income from digitalization on beneficiaries represented by employers and employees, namely, the inclusion of "digital rent" in the tax turnover. Simultaneously, the expansion of the use of digital technologies in the exercise of public power at the level of the subject and local self-government should entail the creation of innovative management structures that will be based on the principles of horizontal network interaction [6].

The problem of assessing the readiness of employees of various subjects of economic activity and the subjects of the Russian Federation in general to expand the use of digital technologies is of considerable interest to representatives of the scientific community. In this regard, it is worth paying attention to the position of Lapidus and Leontieva, professors of Lomonosov Moscow State University. In 2019, they put forward the thesis about the need to introduce the term "minimum digital basket of Russian regions" into scientific and practical use to further consider its data during the formation of the Russian national rating of digitalization of Russian regions [4]. The formation of this digital basket serves as a basis for accelerating the development of the subjects of the Russian Federation within the digital field and leveling their inequality in the digital sphere.

The minimum digital basket of the subject of the Russian Federation includes the basic composition of indicators of the state of the digital economy, which characterizes the following points [5]. Using this minimal digital basket of Russian regions, it is advisable to analyze the degree of digitalization of regions when compiling ratings.

Due to the fact that the subjects of the Russian Federation consist of municipalities, according to the degree of their digitalization, it has a direct impact on the level of the use of digital technologies in the region. The creation of an effective municipal management system using digital technologies involves a set of technical, technological, software, and methodological tools and solutions, the implementation of which should be carried out systematically, in a logical sequence, and considering the analysis of the initial state of the municipality.

An urgent problem is the increasing use of digital technologies in the activities of the entire system of public power at the federal, regional, and local levels, the formation of a digital environment of trust of citizens in the country, for which a set of measures related to the introduction of digitalization is being implemented, including in the area of public services to simplify the procedure for their provision.

This problem is also actualized in light of ensuring the legal sovereignty of the Russian Federation as a federal state, which is understood as the exclusive property of state power at the expense of the power of the multinational Russian people, by virtue of which the Russian Federation has the right to carry out legal regulation throughout its territory [7].

From the point of view of the law, the primary and basic task is the formation of a system of legal regulation and development based on a flexible approach to each sphere of the digital economy and the expansion of the use of various digital technologies in civil law turnover, and, as the final desired result, the formation of a unified digital environment of trust [8].

It is planned to base the so-called service state on this digital platform, one of the main characteristics of which is the provision of public services exclusively in electronic format, which will allow making decisions on various life situations of citizens at the same time, significantly increasing the efficiency of public administration. The participation of officials will be reduced; paper documents will be excluded from circulation; the state itself will remind of the need to carry out certain actions in the interests of a citizen. Simultaneously, a single identifier will also make it easier to receive documents and services from the authorities [9]. On the one hand, the development and implementation of these technologies will facilitate various procedures for obtaining public services and the realization of citizens' rights and freedoms. On the other hand, it will allow the state to exercise almost total control over citizens in all areas of public relations, which can undoubtedly serve to provide certain categories of people with resistance to these innovations from the position of the lack of a clear mechanism for ensuring personal rights and freedoms related to privacy, and so on. Accordingly, before their widespread introduction into practice, these technologies require a detailed study of all areas of their application to ensure the protection of constitutional rights and freedoms of the individual.

Thus, the complete replacement of all principles and stages of legal proceedings with a digital platform will affect the level of justice, which allows us to assume that this particular branch of state power should be digitalized on a fairly moderate scale, applied only to those moments that cannot have a significant impact on the final decision but only contribute, from a procedural point of view, to speeding up and facilitating the commission of individual procedural actions.

18.4 Conclusion

Based on the research results of the regional perspective of the development of digitalization of the economic and legal areas of public relations in Russia, several conclusions can be drawn about the need for further measures in this area.

To improve the procedure for digitalization of regional economic and legal areas, including in light of ensuring the national security of the country, it seems appropriate to create commissions on the digitalization of the economy of the subject (supervisory board) at the level of the subject of the Russian Federation. These commissions may include representatives of public authorities responsible for the economic policy of the region, representatives of industrial enterprises, developers and suppliers of digital equipment and technologies, and scientific and educational institutions of the subject of the Russian Federation.

The following is necessary to improve and facilitate the procedure for conducting legal proceedings:

- To activate and expand the practice of using videoconferencing in courts;
- To create a special information system that, with the help of Internet resources, would make it possible to transfer trials (especially in appellate and cassation instances) to a remote format, using a videoconference, in which all subjects of the process and everyone who has previously notified the secretary of the court session, could take part. The entrance is carried out using the portal of state services of the Russian Federation;
- To expand the list of judicial acts that are mandatory for posting on the portal of the electronic court filing system of the Russian Federation "Justice."

Digitalization of the implementation of regional management involves the following decisions:

- The establishment, at the level of the law, of the obligation of state authorities and local self-government bodies to adopt a draft law for consideration, which was the result of the functioning of the "Russian Public Initiative";
- Introduction of remote mechanisms into the activities of state and local self-government bodies, economic entities, political parties, and public organizations, involving the organization of participation of all employees and officials in making decisions that were previously taken at congresses, conferences, and similar events; the possibility of voting (e.g., videoconferences, etc.).

Digitalization of the regional economy should solve various tasks, including the correct implementation of the rights and freedoms of individuals, ensuring the accessibility and transparency of the activities of public authorities, expanding the opportunities for citizens of the Russian Federation to participate in the management of the country, simplifying the mechanism of financial participation of the state in the activities of economic entities, and the development of environmentally-friendly industries, energy- and resource-saving technologies, and the latest information technologies.

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Chapter 19
Directions for Improving the Legal Regulation of the Use of Digital Technologies and Ensuring Cybersecurity in the Economy of the Russian Federation

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Abstract The paper analyzes some problems of legal regulation of the use of digital technologies and cybersecurity in the economy of the Russian Federation, in particular, the lack of clear legal regulation of several innovative tools that are already used in practice in economic relations, as well as the lag of regulatory and legal regulation from the existing public relations. The authors put forward proposals to adjust the norms of various legal acts. The paper substantiates the need for an early consistent systemic reform of the Russian legislation regulating all aspects of the use of digital technologies in the Russian economy to create a more effective mechanism for ensuring cybersecurity in the country's information field. The paper aims to identify urgent problems and directions for improving the regulatory framework for the use of digital technologies in the economy of the Russian Federation. The authors carried out a comprehensive analysis of the stated problems. The authors conclude that it is necessary to consolidate a separate category of temporary work and the criteria for switching to a similar schedule of professional activity in the norms of the Civil Code of the Russian Federation and the Labor Code of the Russian Federation. Moreover, it is necessary to expand the use of Internet resources in the development of budget funds and public procurement, increase state support for economic entities seeking to preserve the environment, and adopt a federal law that will clearly fix new terms, which already exist in practice in economic turnover but are not disclosed in detail by legislation (e.g., digitalization, digital law, digital money, token, cryptocurrency, and blockchain). Additionally, it is necessary to fix the basic principles of taxation and transactions with these elements.

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19.1 Introduction

The theoretical study and identification of the most acceptable ways to improve the normative regulation of the use of digital technologies in the economic sector of public relations and interaction in the Russian Federation was updated by the adoption of the "Strategy for the development of the information society in the Russian Federation for 2017–2030," approved by the Decree of the President of the Russian Federation of May 9, 2017 No. 203 [1]. This document established the main goals, objectives, and measures for the implementation of the domestic and foreign policy of the Russian Federation in the field of application of information and communication technologies, which are aimed at developing all aspects of the information society, structuring the national digital economy, guaranteeing national interests, and ensuring implementation strategic national priorities.

The need for a clear legal regulation of the digital aspects of the development of economic relations is unconditional for avoiding the lag of the current legislation from the existing economic relations, which are increasingly exposed to the digital factor, but with the indisputable recognition and provision of human and civil rights and freedoms [2]. Simultaneously, it is necessary to systematize the activities on legislative registration of active digitalization of all areas of society's life to prevent the harmful impact of digital technologies on the country, society, and citizens. In the context of the study of this problem, it is worth noting the opinion of S. A. Avakian, who believes that "the problems of ensuring national security and the personal security of an individual become inevitable." The author wishes that the digital world would not create new platforms for long-standing dishonest relationships [3]. For example, according to Mukhina, about 85% of the volume of the Internet is structured from trade in counterfeit, prohibited goods, and dubious services, considering the fact that the income of these operations within the free market can be huge and reach thousands of percent of profit [4]. Accordingly, when developing a theoretical concept of legal regulation of digital technologies and all related legal institutions, it seems appropriate to consider positive and negative aspects and manifestations of the global practice of their application.

The COVID-19 pandemic made adjustments in all areas of the country's life; it significantly intensified the expansion of the sectors, methods, and areas of application of information technologies and the use of Internet platforms and websites in the implementation of various types of economic activities, the provision of public services related to the regulation of economic legal relations, and so on. The sharp jump in the influence of the infosphere on the economic infrastructure was determined by an objective necessity, while the legislative framework was not fully ready for such a total use of digital technologies, which, in some cases, caused significant difficulties in the realization by subjects of civil and other legal relations in the economy of their rights and freedoms, as well as the performance of obligations. We must pay tribute to the state authorities, who have done a lot to support small and medium businesses and the most vulnerable categories of the population, providing financial assistance and tax benefits and suspending inspections by authorized regulatory authorities. Nevertheless, those subjects of economic relations that were urgently unable to switch to the online format suffered losses because trade and other economic activities mostly switched to the digital area. In this case, the practice was significantly ahead of the legislation, which also had to be transformed under new realities, which determines the theoretical and practical relevance of the research topic.

19.2 Methodology

When identifying current problems and directions for improving the regulatory framework of the use of digital technologies in the economy of the Russian Federation, the authors applied general methods of cognition, namely, analogy, analysis, synthesis, and deduction. The authors also applied special methods of cognition, in particular formal-legal, system-structural, and comparative methods that allowed achieving the goal and solving the tasks set. The complexity of the use of the claimed methods allowed the authors to analyze the stated problems of legal regulation of digital aspects of economic legal relations and ensuring cybersecurity in the economy of the Russian Federation.

19.3 Results

Due to the widespread introduction of restrictive measures, employers are required to transfer employees to remote work whenever possible, which causes certain difficulties, since there is no such a concept in Russian legislation, neither in the Labor Code of the Russian Federation nor in the Civil Code of the Russian Federation. The norms of Chapter 49 of the Labor Code define the concept of homeworkers; chapter 49.1 defines the concept of remote work. However, it is illegal to apply these terms in the current situation because these types of employment assume a permanent nature of work with their own conditions. Particularly, homeworkers carry out their activities exclusively at home, have the right to use the help of family members, and, in most cases, they produce certain products. Remote work consists of working with the help of using Internet resources outside the office. Thus, in connection with the current situation, it seems appropriate to separate temporary work into a separate category, accordingly prescribing the criteria for transition to such a schedule of professional activity in the current Russian legislation.

Such a situation implies the expansion of the practice of using contractual relations, within the framework of which all conditions and circumstances and the legal mechanism for implementing this type of work will be prescribed. It is possible to conclude additional civil contracts for the period of the restrictive measures, the terms of which should not lead to a deterioration in the situation of employees.

At the end of the restrictive measures, the possibility of using this form of organization of labor relations does not lose its relevance, especially given the fact that the pandemic passes through wave-like stages, and the practice of the regions clearly demonstrates different approaches to the organization of economic activity during the deterioration or improvement of the overall epidemic situation. Considering the hypothetical but probable possibility that the world will now always exist in the conditions of a pandemic, it seems necessary to create a clearly structured regulatory framework, including for regulating remote labor relations.

The use of Internet resources in the exercise of the powers of public authorities is aimed not only at simplifying procedures but also at ensuring their transparency to combat corruption. In particular, the state order, the implementation of which has almost completely passed into the information environment, is an area that is associated with a high level of corruption in all states. Companies that are fully or partially owned by the state are required to hold tenders to purchase goods, works, and services, the money for which is budgeted.

All state and municipal organizations whose activities are financed by the budget (e.g., schools, kindergartens, hospitals, city administrations, etc.) conduct purchases in accordance with the provisions of Federal Law No. 44-FZ [5], necessarily publishing them on the website zakupki.gov.ru, in the Unified Procurement Information System (UIS), and duplicating all electronic procedures on eight federal electronic platforms: Sberbank-AST, RTS-tender, Roseltorg, NEP, Gazprombank's ETP (GPB), TEK-torg, ZakazRF, and Lot-online.

Companies with a share of state property of 50% or more, their controlled structures, natural monopolies (Russian Railways, oil and gas companies), organizations carrying out regulated activities (energy and water supply), and budget institutions that carry out purchases with the help of grants, subcontracting funds, and their own money conduct them based on the norms of Federal Law No. 223-FZ [6], which assumes that these subjects have more freedom, the ability to determine their own criteria for selecting winners, etc.

It seems appropriate to expand the use of Internet resources, especially when carrying out activities related to budget financing, tighten control over the implementation of public procurement and other actions in this area, and create additional information opportunities for the population to receive information about spending from the state budget. This information is currently available but is located on various websites, which does not imply the possibility for the population to get a complete picture and entails the presence of corruption risks.

The introduction and total expansion of digital technologies in economic activity imply distancing in various areas of the application of human capital, including in communication and socialization, which, undoubtedly, can decrease the efficiency of labor activity for the majority of participants in economic relations. To improve the mental component of the employee's personality, it seems advisable to intensify the use of various forms of online communication within the framework of working interaction and hold events more often, including those involving the adoption of important decisions, in which not only the management staff of an enterprise, institution, or other subjects of economic relations but also all its employees are involved.

The creation of an effective mechanism for guaranteeing cybersecurity is one of the main directions of ensuring the national security of the Russian Federation. Theoretical and methodological aspects of the organization and activity of public authorities ensuring national security, as well as possible ways to solve emerging problems in this area of public relations, are extremely important in today's legal science, and their new theoretical understanding, embodied in the author's concept of constitutional and legal research on ensuring the national security of the state, develops the science of constitutional law [7]. In this area, including within the framework of organizing activities to form the legislative framework for ensuring the national security of the Russian Federation, special attention should be paid to the information sector and Internet resources in terms of guaranteeing the cybersecurity of all subjects of public relations that are possible in this environment. These measures are particularly relevant considering the fact that the growth of economic activity in the Internet sector is quite significant, especially against the background of the COVID-19 pandemic, which by and large has transformed many aspects of our life, transferring them to a remote format, the implementation of which is provided, including with the help of various Internet platforms.

In the Internet sector, ensuring the security of realizing state, public, and personal interests is one of the most important manifestations of the mechanism for ensuring the legal sovereignty of Russia, which is understood as the exclusive property of state power at the expense of the power of the multinational Russian people, by virtue of which the Russian Federation has the right to exercise legal regulation throughout their territory [8]. We believe that all aspects of the use of digital technologies and ensuring cybersecurity in the economy of the Russian Federation should be regulated in detail by the norms of Russian legislation, considering national characteristics and national mentality, as well as provided with protection from interference of foreign countries in the Russian economic system.

International studies on the impact of information technologies and digitalization on the economic sector of public life using various examples in the form of installing cameras in working rooms [9] and transport movement sensors [10], monitoring by insurance companies of risky behavior of drivers [11], forming an equilibrium market price, minimizing opportunistic behavior, and improving the quality of taxi drivers' services based on the Uber platform [12–15] have demonstrated positive experience in using digital technologies in various markets.

The study of the experience of foreign countries conducted by N. Bloom allowed us to conclude that the introduction of digital technologies directly affects the increase in labor productivity, considering the presence of an additional factor, which can include organizational capital, which provides an opportunity to optimally and effectively implement information technologies in the structure of business processes [16]. Russian analysts note that the company's corporate culture significantly affects the process of digitalization [17].

An interesting problem of legal practice in the economy of the Russian Federation is the use of cryptocurrency in Russia and, accordingly, the specifics of the legal regulation of this activity, the clear absence of which creates a situation where this type of economic interaction is applied but not legally regulated on a sufficient scale. Cryptocurrencies are not prohibited, their turnover is not limited, but there is no legal mechanism for carrying out the economic activity when using this type of settlement. Additionally, as noted by Smirnov and Botasheva, blockchain technology is actively introduced in the economic sector, which determines the need to create a correct mechanism of legal regulation that guarantees the realization of rights and freedoms by subjects of legal relations [18].

It is possible to divide the position expressed by M. V. Kostennikova, A. V. Kurakina, and D. V. Karpukhin. They believe that the law enforcement practice of legal regulation of cryptocurrency in Russia is intended to neutralize the law "On digital financial assets" [19].

As a debatable problem, it is necessary to note the question of the expediency of forming a legal mechanism for the functioning of electronic civil turnover.

Digital innovations, such as self-executing contracts and blockchain technology, also need additional and detailed theoretical analysis based on the existing practice of their application to improve the legal mechanism for their implementation [20].

The discussion of the problems of digitalization of the economy, agriculture, and other important areas of the life of the country, society, and citizens of the country involves the actualization of questions about the possibility of intervention of innovative technologies in nature in its global understanding, because, despite the undeniable benefits of their implementation, the factor remains the impossibility of influencing all natural phenomena, the question arises about the ratio of benefits and harmful effects on the environment. When implementing regulatory and practical or digital innovations, primary, it is worth considering the indisputable fact that humanity, at whatever stage of its development it is, completely depends on the natural environment, and, despite all attempts to control its various manifestations, nature and natural phenomena play a decisive role in our life. Accordingly, innovative technologies should be introduced only if there is no harm to the environment, which should be confirmed by reliable research and evidence.

In general, it is necessary to support the opinion that to adopt the scientific concept of digitalization of integration law; it is necessary to synthesize scientific approaches to develop a new generation of regulatory and legal structure for ensuring digital transformation, focused on international standards and the search for flexible legal regulators in the field of digitalization in the virtual space [21]. Accordingly, the legal regulation of the use of digital technologies in the area of the analyzed economic legal relations should be carried out subject to the total guarantee of the interests of all subjects of public relations, both economic and other, the mandatory protection of the rights and freedoms of the individual, acting as participants in the analyzed legal relations, maintaining an optimal balance between the impact of economic interaction on the environmental situation.

19.4 Conclusion

Based on the results of the conducted scientific research on ways to improve the legal regulation of the use of digital technologies in the implementation of economic interaction in Russia, it seems appropriate to outline a fairly large volume of public relations that are affected by the implementation of a legal mechanism for regulating the specifics of the use of such technologies, which necessitates the implementation of a consistent and systemic reform of legal norms associated with this phenomenon of society. Simultaneously, the volume of the research allows us to identify only several areas, which, from our point of view, are the most relevant given the current economic situation, including the following:

1. To fix a separate category of temporary work and the criteria for switching to a similar schedule of professional activity in the norms of the Civil Code of the Russian Federation and the Labor Code of the Russian Federation;
2. To expand the use of Internet resources, especially in the implementation of activities related to budget financing, tighten control over the implementation of public procurement and other actions in this area, and create additional information opportunities for the population to receive information about spending from the state budget;
3. To develop state support for economic entities belonging to the category of producers seeking to preserve the ecology of the region, simplify the procedure for its provision, and expand the list of grounds for state financing and co-financing of business projects;
4. To introduce remote mechanisms into the activities of state and local self-government bodies, economic entities, political parties, and public organizations, involving the organization of participation of all employees and officials in making decisions that were previously taken at congresses, conferences, and similar events; the possibility of voting (e.g., videoconferences, etc.);
5. To initiate the creation and ensure the adoption by the Russian legislative body of a new federal law that clearly fixes new terms, which already exist in practice in economic circulation but are not disclosed in detail by legislation (e.g., digitalization, digital law, digital money, token, cryptocurrency, and blockchain), and establishes the basic principles of taxation and the implementation of transactions with these elements;
6. To develop legal norms and ensure their inclusion in the text of the Civil Code of the Russian Federation and the Tax Code of the Russian Federation; these norms should carry out detailed legal regulation of the interaction of subjects of the digital economy, in particular, clearly define the essence of a permanent digital establishment in relation to business entities.

The creation of a clearly structured digital law, including ensuring cybersecurity, is one of the manifestations of the legal sovereignty of the Russian Federation because it regulates the most important areas of public relations, which almost all citizens of the state enter, even without knowing it themselves. Nevertheless, the most important task of the state is to structure an effective legal mechanism for ensuring and guaranteeing the realization by citizens of the state, as well as by all other persons legally located on its territory and having the opportunity to exercise their rights, of all rights and freedoms within the established restrictions, including in the field of using digital technologies in the implementation of economic relations.

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Part III
State Regulation of the AI Economy

Chapter 20
Artificial Intellect in Criminal Law: Issues of Governance, Regulation, and Prospect of Use

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Abstract Due to the rapid advancement of digital technologies and their widespread introduction in all areas of human life, it becomes necessary to raise the question of their proper legal regulation. Like other branches of law, criminal law faced problems of protecting and regulating relations arising from the use of artificial intelligence systems. The problems of specifying the legal status of artificial intelligence and possible criminal liability become increasingly urgent. The authors analyzed the criminal law problems of regulating the social relationships associated with the use of artificial intelligence. It is noted that the legal doctrine currently fails to respond to the question on the place of artificial intelligence in the corpus delicti. In this connection, the need is stressed for a more responsive development of criminal law norms regulating legal relations in this area of activity. The importance of timely improvement of criminal law derives from the fact that the cases of committing illegal acts using artificial intelligence are already taking place. The authors of the work made attempts to formulate recommendations to improve the criminal law to bring it to a state corresponding to the development of the achievements of science and technology.

20.1 Introduction

The twenty-first century is the century of technology and innovation, thus marking the transition from the traditional industrial era to the era of information technologies. Scientific and technological progress, the widespread digitization of human life, and total informatization and computerization of social relationships opened new horizons for people and expanded international ties.

So far, one of the most pressing issues in the area of innovation is large-scale robotization and the possibility of using artificial intelligence in various areas of

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human activity. Artificial intelligence is applied in healthcare, machinery, industrial, military, trade, and other industries.

However, any progress, in addition to positive aspects, carries many new risks as well, which poses a threat of harm to legally protected interests.

Even though advanced digital technologies open up significant opportunities for the development of individual countries and the entire world community, they also increase incentives for cybercrime. According to some scholars, cybercrime in the current environment is one of the most serious threats to the country's information security and its economic development [3, pp. 46–62]. The use of artificial intelligence as a means for committing a criminal act causes the beginning of a new stage in the threat to information security.

The legal assessment of the nature of artificial intelligence and the regulation of the procedure for its use became the most urgent task of contemporary legal science.

Studies on criminal law and criminology contain intensive discussions on the use of an artificial brain, the legal regulation of social relations arising from modeling, creation, and use of artificial intelligence.

The Russian criminal doctrine faces questions on whether social relationships associated with the use of artificial intelligence require separate protection, whether it can act as a means of committing a crime, and whether it is possible to consider artificial intelligence as a subject of a criminal act, etc. To answer these questions, it is primarily necessary to specify the essence of the addressed concept, correlate it with the elements of the corpus delicti, and find a solution for the issue of responsibility for harm caused by artificial intelligence.

20.2 Methodology

The general scientific dialectical method of cognition was taken as a methodological basis of this research. Besides, the authors engaged such approaches as formal legal, comparative-legal, and statistical methods, system analysis, synthesis, and other methods.

20.3 Results

The increasing pace of automation of human life has admitted a wider application of artificial intelligence in criminal activities, which, in its turn, determines the relevance of the problem of specifying the significance of artificial intelligence in criminal law.

Currently, the Russian criminal law does not contain any special provisions on artificial intelligence.

To understand the nature of artificial intelligence, it is necessary to draw attention to the presence or absence of definitions within a legal framework.

In Russian law, an informative definition of the concept of artificial intelligence appeared only in 2019 with the approval of the National Strategy for the development of artificial intelligence for the period up to 2030 [2]. Earlier, at the departmental level, there was only the Order of the Federal Agency for Technical Regulation and Metrology No. 959-st dated December 15, 2009, which, in accordance with GOST R 43.0.5–2009, clause 3.17, disclosed the concept of "artificial intelligence" [1].

Analyzing the criminal-legal nature of artificial intelligence and the justified need for this definition in the criminal legislation of the Russian Federation, we consider that the blanket nature of the provisions of criminal law allows not to overload them, and it will be sufficient to anchor the definition of "artificial intelligence" in a special normative legal act regulating general issues of its creation, acquisition, and use. Additionally, the concept of artificial intelligence does not apply to criminal law, but, having a comprehensive nature, it is also used by other branches of law.

To specify the place of artificial intelligence in criminal law, it is primarily necessary to scrutinize this phenomenon as applicable to certain elements of the corpus delicti.

Regardless of the vast number of interpretations of the corpus delicti, in the science of criminal law, there is a well-established concept, under which it is a set of objective and subjective elements that allow recognizing a certain socially dangerous act as matching its description in the article of the criminal law [17, p. 956].

The scientific literature has repeatedly raised the issue of whether the social relationships arising from the use of artificial intelligence should be separately highlighted as an object of crime. In this regard, we share the viewpoint of I. N. Mosechkin, who notes that the extent of social relationships arising from the use of artificial intelligence is not yet comparable to the number of generic or specific objects of crime, despite their growing influence. Accordingly, it is not appropriate to separate such an object at the level of generic or specific, as well as to create a special section or chapter in criminal law [14, p. 25].

Once we consider certain corpora delicti recorded in the Criminal Code of the Russian Federation, we can conclude that the legislator is already protecting social relationships, which can be harmed by means of artificial intelligence systems (norms of Chaps. 22 and 28 of the Criminal Code of the Russian Federation and general norms protecting inalienable human and civil rights and the foundations of the constitutional system of the Russian Federation, etc.).

Considering the elements of the objective side of the crime, we can confidently assert that artificial intelligence can act as a means of committing a crime.

The Next Web has published the results of a study conducted by University College London (UK), in the course of which artificial intelligence skills that can be used in criminal activities were specified:

- Driving electric cars;
- Engaging in phishing;
- Collecting any personal data;
- Manipulating robots;
- Creating deepfakes, etc. [6].

The use of self-trained programs significantly expands the possibilities of crime while simultaneously simplifying the implementation of their activities. For example, instead of independently creating and disseminating deliberately false information, it becomes possible to transfer such a function to a program that would generate fake news faster and in greater volume and will also allow governing the mindset of a great number of people.

Artificial intelligence can be used to conduct fraudulent negotiations, commit theft of non-cash funds, illegally acquire information constituting a secret protected by law, and commit other socially dangerous acts.

Statistically, in 2021, the number of registered crimes in the area of high technologies increased by 780% to the indicator of 2019.

In the opinion of Andrey Nekrasov, the scale of cybercrimes allows us to speak of them "as a threat to national security, especially with attention to their low clearance rate, recorded at the level of no more than 25%."

Global statistics also confirm the ever-increasing level of cybercrime. According to the X-Force Threat Intelligence Index report, in 2020, the number of cyberattacks in the healthcare, manufacturing, and energy sectors has doubled worldwide [23].

The mentioned method could be called high-tech, which, for its part, significantly increases its social danger given that the guilty person gets the opportunity to commit a criminal act remotely. Simultaneously, the probability of avoiding criminal liability is significantly increased compared with that of a person who commits the same act in a traditional "physical" way.

One of the main objectives for leading experts in the area of criminal law is to respond to the question of who should be held criminally liable for harm caused by artificial intelligence.

Even though unlawful acts committed through the use of artificial intelligence mostly do not enjoy impunity. The analysis of Russian criminal legislation indicates the absence of provisions purposed to protect social relationships from encroachments committed through the use of artificial intelligence, which might have reduced the social danger of crimes committed in this way. Therefore, there is a need to record "committing a crime using artificial intelligence" as an aggravating circumstance.

It is not only Russian legislation that faced a gap in the legal regulation of the analyzed relations but also the entire international community. Foreign experts affirm that "the development of artificial intelligence systems entails the need to restructure the legal system" [4, p. 376].

Gabriel Halevi, professor of criminal law at Ono Academic College Law School, in his book "When robots kill: Artificial Intelligence under criminal law" points out that the increasing use of artificial intelligence in commercial, industrial, military, medical, and other areas provoked a wide-ranging discussion on resolving the issue of legal consequences of causing harm to human life or health by artificial intelligence. The scholar suggests that the outlined problem can be solved by developing a special theory of criminal liability for the actions of artificial intelligence and robots, which would cover "the manufacturer, programmer, user, and other persons involved" [7, pp. 177–178].

According to scientists, the objective side of the committed act matters within the frames of such an approach. It is necessary to establish a causal link between non-compliance or improper performance of duties by a person involved in the activities with the use of artificial intelligence and the resulting consequences [8, p. 174].

Foreign authors elaborated three models for the distribution of criminal responsibility in committing crimes with the use of artificial intelligence, the gradation of which is based on subjective and objective elements of a crime.

The first model—"Committing via another person": artificial intelligence is not the person of a criminal act, and it is not required to have a simultaneous combination of mens rea and actus reus (will and action) to commit an act. In this case, the person is a priori considered innocent. According to this model, the subjects of crime can be programmers or system users.

The second model—"Natural probable consequence": in the given case, we refer to the absence of a guilty will and guilty action on the part of an individual, which shows the careful use of artificial intelligence systems to commit a crime.

The third model—"Direct responsibility": artificial intelligence acts as an independent subject of a criminal act, which can be held criminally liable. It is a matter of the direct responsibility of artificial intelligence without linking an intention of offensive consequences on the part of the programmer or user to its actions [18, pp. 552–556].

Russian lawyers also diverge on the issue of legal personality and delinquency of artificial intelligence. For instance, P. M. Morkhat supposes artificial intelligence to necessarily have a multimodal legal personality, depending on the functional purpose of the unit's capabilities, with the introduction of the appropriate subject of law, namely an electronic person [12, p. 21].

Other authors point out that for artificial intelligence to acquire the status of a subject of law, it should possess such a quality as will [22, p. 39].

In the scientific community, the most supported point of view is the impossibility of considering artificial intelligence as a subject of crime. For example, Inger Marie Sunde, a professor at the University of Bergen, finds that even once a robot is trained to select from the available alternatives, it may turn out that the decision made by a program is created by humans. Therefore, people should be held accountable for their actions. It would also be an important factor in this case whether the wrongdoer had realized that the results of their actions might be illegal and yet decided to continue. A robot should be considered a tool, regardless of how much its actions are out of the control of a person [20, p. 62].

As Ponkin and Redkina rightly note, another feature of artificial intelligence is that its "legal status depends on the measure and nature of the autonomy of artificial intelligence from humans" [15, p. 93].

In this regard, the question of responsibility for the actions of artificial intelligence, endowed with a certain autonomy and capable of self-learning, remains relevant. It means that the system may autonomously modify the behavior algorithms, which can lead to expected and unpredictable activities, even in the presence of basic limitations on decision making. Such a "robot" significantly distincts from other phenomena and objects, so the situation with the responsibility of artificial intelligence, which independently decided to commit actions that qualify as a crime, seems much more complicated.

In this case, the decisive factor will be the lack of self-consciousness of the robot. Until the most "intelligent" machine is only capable of "cold reasoning," it can hardly be recognized as a subject of criminal responsibility because it is deprived of the ability to feel, experience, etc., and can only simulate human intelligence [9, p. 1231].

Let us examine several particular examples from practice: in 2018, a self-driving car under the mobile app created by an American international company Uber Technologies Inc. hit a girl in Arizona, USA, due to a software error [21, p. 273]. In Vienna, in 2019, a self-driving Navya bus hit a pedestrian [11]. In 2018, the first self-driving vehicle of the Russian Post failed to complete the task and crashed, colliding with a residential building [16]. In 2019, the Russian self-driving aerial vehicle Orion crashed within 70 m from residential buildings [5].

To recognize artificial intelligence as a subject of criminal liability from the point of view of Russian criminal law, the presence of guilt in the form of intent or negligence is required.

In the examples given, the explanation for the erroneous activity of artificial intelligence systems, having led to the violation of protected social relationships, is most likely the imperfection of algorithms, but not "the realization of the social danger of its own actions (inaction)."

The application of artificial intelligence in healthcare is becoming increasingly popular. There is singled out the great potential and efficiency of the use of neural networks in medicine: the possibility of identifying rare diseases, reducing the time for examining a patient, offering several treatment options, lowering the workload of a human doctor. Unfortunately, despite the positive trend of robotization, statistics also display the reverse side of the implementation of artificial intelligence into medicine: over eight years of operation of surgical robots, 144 deaths of patients and 1391 injuries caused by technical difficulties or device malfunctions were recorded [10].

As another negative example, the situation should serve when the Watson Health program appeared to be imperfect and made medical errors, suggesting incorrect treatment methods that lead to the death of patients [13].

According to Mosechkin, in this case, it is the matter of an error in the program, of shortcomings of the system provided that the human person is responsible for its development and application [13, p. 463].

From the aforesaid, it could be concluded that so far, the legislation is not ready to consider artificial intelligence as a subject of criminal liability. A significant amount of work is needed not only to alter the foundations of criminal law but also to create a base that would constitute the basis for assessing the actions (inaction) of the artificial intelligence system in order to establish the presence of objective and subjective signs of a criminal act. For the time being, the study of subjective signs permits limiting the range of subjects of crimes committed with the use of artificial intelligence by the producer of the program and the user of products equipped with artificial intelligence.

20.4 Conclusion

On the grounds of the conducted research, it can be concluded that to date, there is no common understanding of the significance of artificial intelligence in the theory of criminal law and law enforcement practice. Primarily, it is conditioned by the lack of statistical data ensuring a comprehensive assessment of the criminological risks related to the use of artificial intelligence. Besides, the analysis of the mentioned socially dangerous acts committed using artificial intelligence demonstrates that they are derived from the "error" of the system caused by imperfect algorithms or improper use of the equipment itself. In that way, the main essence of the blame should still be shifted to the creators of the program, as well as to their users.

Given the pace of development of information technologies and the possibilities of science, the issue of regulating criminal liability for committing socially dangerous acts using artificial intelligence will change depending on the development of the latter and the level of possessing of self-consciousness by it.

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Chapter 21
The Use of Artificial Intelligence in the Activities of the Preliminary Investigation Bodies: Questionable Merits and Apparent Disadvantages

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Abstract The pace of technological advancement in society is speeding up. Accordingly, digital informatization and artificial intelligence programs are being constantly improved, which, in general, is likely to lead to the transformation of all business and management activities of the country. The performance of all state institutions, including law enforcement agencies, aimed at the fight against crime is enhanced. This paper studies the performance of preliminary investigation bodies and the possibility of using artificial intelligence in investigative work. The authors reviewed the definition of artificial intelligence and its significance in the life of society and in investigative law enforcement practice. Possible courses of the development of information technologies that would accelerate the procedure for uncovering and investigating a criminal case were also examined. The problem of transferring the procedure for investigating a criminal case into an electronic format remains a relevant issue, which would not only shorten the time for investigation but also make it possible to collect and verify evidence more effectively.

21.1 Introduction

In the era of active development of the digital environment and information technologies, there is a need for scientific research on the practical application of artificial intelligence by investigators during investigative actions in criminal cases. A significant number of theorists and practitioners recognize the potential benefit of research in this area because such a necessity is associated not only with the development of digital technologies in various areas of social activity but also with a considerable increase in crimes committed online.

The investigators and inquiry officers have a constant and compelling need for a more responsive and rational use of artificial intelligence to accelerate the process of uncovering crimes and improve the quality of investigative work. The use of

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information technologies would facilitate the effective recording of evidence in a criminal case and provide an opportunity for participants in criminal proceedings to exercise their legal rights and interests.

The paper aims to analyze the uses of artificial intelligence in solving crimes, methodology of criminal investigation, tactics of conducting investigative actions, as well as in gaining an appropriate level of recording evidence in a criminal case that would comply with the requirements of criminal procedure legislation. Even though this research area is esteemed quite "young," it seems necessary and promising for its possibility to significantly increase the level of uncovering and, accordingly, the quality of criminal investigation, which would certainly contribute to stability and security in society and ensure the legal rights and freedoms of citizens.

Certain areas of the implementation of information technologies into the procedure for investigating criminal cases have become a subject of a series of fundamental studies, for example, those on methods of preventing and detecting crimes based on the best international practices, on carriers of artificial intelligence as subjects of law, on electronic documents and the possibility of their use as evidence in a criminal case, on the administration of justice, and others. These issues are analyzed in the works of Bakhteev, Voronina, Gavrilov, Kovalev, Malina, Popova, Khoroshevsky, Yu. Fesik, and others [6, 8-11, 13, 14].

21.2 Methodology

From a research perspective and the available theoretical and practical material, the authors used the methods of cognition, analysis, and synthesis. The juridical subject matter of the study predetermined the use of formal-logical, comparative-legal, systemic, hermeneutic, and other general scientific research methods.

21.3 Results

Scientific and technological progress enters into the life of society by leaps and bounds. The sequence of events related to the COVID-19 pandemic accelerated the development of more advanced technologies and, accordingly, accelerated absorbing these technologies by people.

Simultaneously with the growth of information technologies in society, the online crime rate is increasing. Its indicators are not comforting. The statistics of the so-called IT crimes are swelling; so far, there are no tendencies to decrease it. Every fourth crime in the country is committed through gadgets and the Internet (Fig. 21.1).

Since the beginning of the year (compared to last year), the number of online crimes has increased by 51.3%; the number of crimes committed through mobile communications has increased by 39%. A more detailed analysis of crimes committed

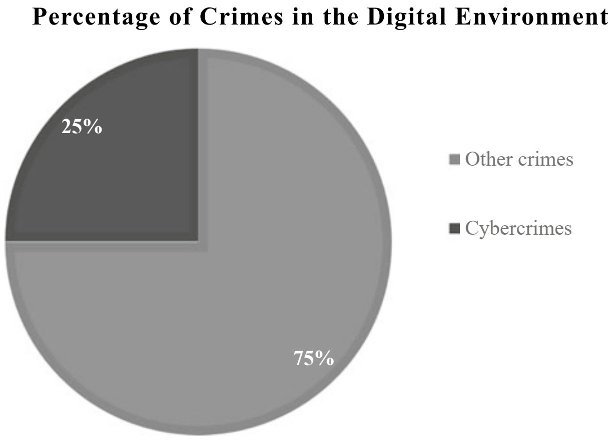

Fig. 21.1 The proportion of crimes committed with the use of information and telecommunication technologies in the total number of reported crimes in percent. *Source* Compiled by the authors

using information and telecommunication technologies on the territory of the Russian Federation is displayed in Fig. 21.2.

As the law enforcement practice shows, offline types of crimes, such as contract killings, also "flow" into the digital space. Scientists calculated that if the situation does not change, the proportion of such crimes could increase to 30–32% of the total number of registered criminal cases by 2023 [1].

At the state level, great attention is paid to the implementation of information technologies and the development of artificial intelligence. According to the Decree of the President of the Russian Federation "On the strategy for the development of

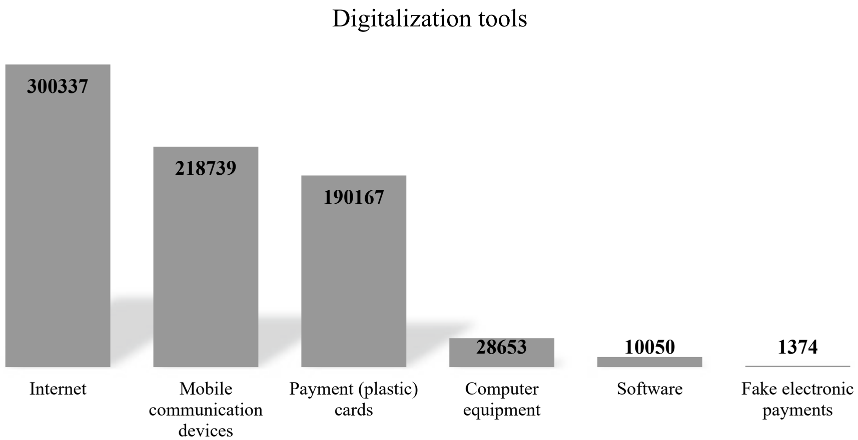

Fig. 21.2 Crimes committed with using or applying information and telecommunication technologies. *Source* Compiled by the authors

the information society in the Russian Federation for 2017–2030" (May 9, 2017 No. 203) [2] and the Decree of the President of the Russian Federation "On the development of artificial intelligence in the Russian Federation" [3], one of the main focuses of the development of Russian information and communication technologies is the development of artificial intelligence technologies.

Information technologies of the near future will be complemented by new methods, which will result in the development of new knowledge in industrial processes and the social sphere. As the head of the state V. V. Putin noted at the conference dedicated to artificial intelligence, "In just a few months, our country and the whole world have made a transition that could have taken years and maybe even decades. Before our eyes, artificial intelligence technologies and big data analysis modify daily habits and the entire way of life. The present pandemic spurred us to develop these technologies. What was generated in previous years turned out to be in demand" [4]. The area of artificial intelligence and modeling of cognitive processes will lead to the creation of a fundamentally new generation and intelligent technologies.

It is generally accepted that the concept of "artificial intelligence" was first formulated by the American scientist John McCarthy, who was a computer analyst and cognitive scientist. He first used this concept in a report at a conference at Dartmouth University (New Hampshire, USA) in 1956, which addressed the technology of creating "intelligent" machines, in particular, "intelligent" computer programs [12].

Nowadays, there is no explicit legislative enshrinement of the term "artificial intelligence" in the digital space. Therefore, each author interprets it in his own way.

Gavrilova and Khoroshevsky propose to use the following concept of artificial intelligence: "one of the areas of computer science aimed at the development of hardware and software tools that allows a non-programmer user to set and solve his or her own tasks, traditionally considered intellectual, while communicating with a computer in a limited subset of natural language" [9, p. 89]. For their part, V. N. Sinelnikova and O. V. Revinsky note that "from the point of view of the law, artificial intelligence is a computer program created by a human and capable of producing new data (information) or objectively expressed results of its activities due to the commands embedded in it" [15, p. 17].

"The national strategy for the development of artificial intelligence for the period up to 2030" contains the following specification: "artificial intelligence is a set of technological solutions that allows simulating human cognitive functions (including self-learning and search for solutions without a predetermined algorithm) and obtaining, while performing specific tasks, results at least comparable with those of human intellectual activity. The complex of technological solutions includes information and communication infrastructure, software (including the one using machine learning methods), and processes and services for data processing and search for solutions" [3].

In light of the foregoing, we can conclude that the basis of artificial intelligence is computer programs or software embedded in a computer to obtain the results of intellectual activity. A human should certainly monitor such intellectual activity.

Such a "highly developed intellect" can give enormous assistance to a human in any area and industry, provided that it is aimed at performing good deeds.

Information technology has also affected the activities of law enforcement bodies. There are databases "Palantir," "Osiris," "Sherlock," and "Pskov," which allow uncovering crimes in cyberspace. The active use of information technologies is expressed in the emergence of such information systems as the Centers for the automated photo fixation of administrative road traffic offenses (TSAFAP ODD GIBDD), the operational reference card file (OSK) of the Ministry of Internal Affairs of Russia, the Information Database (IBD) "Region," maintaining e-registry books of reports of crimes (CRSP), the State Automated System (GAS) "Justice," and other internal resources in government agencies, which simplify the search for information for officials and ordinary citizens.

The activities of the preliminary investigation bodies are aimed at the responsive, high-quality collection and recording of evidence in a criminal case. Therefore, it has its own specificity. Certainly, artificial intelligence could be of great help to investigators in this area as well. The use of the cognitive function of artificial intelligence could be demonstrated through a vivid example—the feature film "Trace." In the film, the members of the investigative-operational group receive various kinds of information within the framework of the investigation of a criminal case with impressive promptness. Assisted by various computer systems, all kinds of databases, and banks of information storage, they get access to the information they are interested in. This significantly accelerates the receipt and processing of data, the construction and verification of versions, and the search and identification of suspects (accused) persons.

Besides, the investigation of a criminal case involves the collection of evidence in strict accordance with the norms of criminal procedure legislation. For these reasons, the investigator needs to apply information technologies in the fixation and study of evidence, where there is a possibility of digitalizing investigative actions. Therefore, the implementation of digital technologies in investigative work should be carried out in several aspects: technical, procedural, and forensic.

The first of these is technical work with procedural documentation. It has long been drawn up by computers in investigative practice, from about the mid-1990s. This significantly saves the investigator's time and improves the quality of drawing up protocols of investigative actions and orders. Simultaneously, artificial intelligence can enhance the procedure for filling them out, e.g., by using the mechanism for autofilling procedural forms (as for place, time, and other data), correcting errors and inaccuracies in writing, and transcribing the oral speech of an investigator or another participant in criminal proceedings. These capabilities of artificial intelligence are specified in the work of P. Yu. Fesik. He proposes using a computer program called FORVER in investigative work [8, p. 18].

L. V. Golovko and M. A. Malina suggest that the information system can monitor the time frame of interrogation and verify the mandatory requirements for drawing up the protocols of investigative activities (such as the signatures of the participants, warning notes for criminal liability, etc.) [11, p. 18; 14, p. 23).

In our opinion, the possibilities of using digital technologies described above in such technical activities are quite feasible. For example, computer programs “Situational Designer: Virtual inspection of the crime scene (educational and methodical complex)” and “Virtual search” are implemented in law enforcement practice. Novice investigators can conduct training in the form of an inspection of the crime scene or a search using 3D modeling on personal computers. Simultaneously, they have more than 20 various virtual crime scenes with the ability to change the situation at their disposal. Such a program supports novice practitioners in mastering their skills and can facilitate the recording of the necessary actions in the course of the most complex investigative actions at a specific crime scene, thereby easing the investigator’s work and preventing procedural errors [7, p. 7].

The procedural aspect of the development of investigative practice based on information technologies is the second aspect greatly important for collecting and recording evidence in a criminal case. This is of the greatest importance in investigative law enforcement practice because it requires strict observance of the criminal procedure legislation while obtaining evidence that should comply with the requirements of relevance, admissibility, and sufficiency.

For the time being, the socialization rate of human relations through digital space is very high. According to a recent study by a team of authors [13], the age gap of registered online users ranges from 18 to 65 years. The category under 18, as minors, and over 65, who are assisted in using gadgets by the younger generation, is officially unaccounted for. Namely, this category is of the greatest interest to criminals and is the most vulnerable to them.

Since many crimes are committed using various gadgets (ICQ, Skype, Viber, WhatsApp, etc.) and social networks, while the criminal actions can be recorded on various video cameras, the investigator should procedurally record this information in a competent way and evaluate it further within the frames of the investigation of a criminal case. Numerous “electronic documents” in the form of e-mails, electronic messages, “screenshots,” subscriber connections, videos, and other data recorded on special media carriers have long been attached to the materials of criminal cases. In legal enforcement practice, investigators and courts regard such electronic evidence as other documents, in accordance with p. 6 of Part. 2 Art. 74 of the Criminal Procedure Code of the Russian Federation [5]. Thus, it is important to ensure their admissibility as evidence while investigating a criminal case. In such a situation, the use of information technology is desirable. For these cases, M. A. Malina proposes to set up “procedural filters” designed to screen out substandard and, therefore, potentially inaccurate information. “By that, artificial intelligence is quite capable of taking on the role of such a filter. While collecting evidence, the investigator would always be signaled by the virtual system once the information was not obtained by conducting investigative actions or in violation of the rules for their conducting” [14, p. 23].

In studying this issue, we would like to draw attention to the appropriateness of the implementation of an electronic form of the criminal investigation into criminal proceedings. The authors stated their point of view on this matter in a separate article. “There is a need to create relevant technical conditions allowing not only to lay a basis for creating electronic criminal cases and their investigation but also to ensure the security of confidential information constituting an "investigative secret" [10]. We still suggest that this form of legal proceedings would correspond to current realities since the possibility of using artificial intelligence is increasing, which will improve the investigation of a criminal case.

The forensic aspect of the application of information technology can be multifaceted. It can address both orienting information and specific accounting and private forensic methods. The accounting and databases created by artificial intelligence would allow, in a short time, to obtain the data of interest to the investigation regarding the participants in criminal proceedings, for example, the ownership and registration of the vehicle, the ownership of the property and the cadastral number, recording the departure outside the region (territory) or abroad by rail or air, etc. This information has been accumulated and stored in the relevant databases of the entities and agencies, being, however, not available to the investigator. The investigator can obtain it only on written request. This kind of interaction between government agencies is reminiscent of yesterday. At the conference mentioned above, the President of the Russian Federation, Putin, pointed out that in the near future, obtaining information from government agencies should be transferred to digital space and available for every citizen to receive [4]. Officials of the preliminary investigation bodies should have such access first and foremost because it is a matter of the investigation of criminal cases and imposing criminal liability. Certainly, such an attitude toward obtaining information in the context of the development of digital technologies urgently needs to be modified.

The contribution of forensic records to the uncovering and investigation of crimes is invaluable. For example, the "Papillon" system is designed to collect fingerprints and allows identifying a criminal by fingerprints. This system has existed for more than a dozen years in the law enforcement system, and a considerable number of crimes have been disclosed with its support. Nevertheless, bearing in mind the "transition" of crimes to a digital format, there is a need to create a fundamentally new system of forensic accounting, which could identify the electronic digital footprint of various technical devices and specify them with particular accuracy, which would, in fact, make it possible to establish the identity of the device user.

Under the proposal of Bakhteev, the investigation of criminal cases should be qualitatively improved by the use of information technology in the course of fixing and collecting into an assembly of individual elements of the crime mechanism, starting with active actions on a specific crime, and ending with the detection of the persons who committed it (e.g., the movement of individual criminals in the location, time fixing, communication with members of a criminal group, etc.). "In this case, artificial intelligence systems act as a tool for carrying out a versioned process or as a component of decision-making or decision support systems" [6, p. 7]. Thus, artificial intelligence will take over part of the operational work, carrying out operational and search activities, for example, in the form of surveillance.

Along with the development of the areas outlined in the article, it is necessary to solve the problem of providing technical capabilities and personnel potential needs. The high-quality functioning of computer systems that ensure the activities of investigative units requires the work of various aggregates and programs, as well as employees (programmers, technicians, analysts), which would inevitably lead to colossal monetary costs. This issue should be resolved at the state level.

An important issue requiring mandatory solutions is the issue of the security of information systems. These systems are directly related to the personal data of citizens, along with various official information and classified investigative data. Therefore, having recourse to creating such powerful information systems in law enforcement practice, legislators and practitioners should protect the system from information "leakage" in the first turn.

21.4 Conclusion

The effectiveness of using artificial intelligence in investigative activities is obvious. Information technologies may appear both as a source of information, a means of processing and filtering, and have more significant capabilities, realizable in recording the evidence base and investigating criminal cases in electronic format.

Currently, there is no clear legislative definition of the term "artificial intelligence" in cyberspace. The lack of normative fixation of such initiatives hinders their actual implementation. Accordingly, there is a need to fix the concept of "artificial intelligence," as well as the categories and concepts associated with it in the procedural activities of officials conducting a criminal investigation.

Considering many promising areas, there are also apparent complexities with the development and implementation of such information systems in the activities of the preliminary investigation bodies requiring the mutual work of several departments and services. Only the consolidated work of investigators, forensic scientists, and computer scientists can create such "smart" systems for investigative work that may effectively influence accelerating the process in this area.

We are convinced that in the near future, the bodies of a preliminary investigation will have information technologies allowing them to qualitatively improve the investigative work, increase the crime detection rate, and, in general, improve the results of the fight against crime.

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Chapter 22
Modernization of Judicial Activity in the Context of a New Strategy of Social Development

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Abstract Based on the descriptions developed by Russian and Western sociologists and legal scholars of the methodologies for studying such objects of social and legal systems as a person, personality, human behavior, society, social life, conflicts, social management, people management, and conflict management, the authors of this research proposed to use the methodology of constructivism as a scientific basis for the modernization of the Russian justice system. In the twenty-first century, legal conflicts have moved from a negative connotation to the category of positive ones and are assessed as sources of development and improvement of society. Sociology has identified the features of the present reality of social development, where the motives of the behavior of participants in communicative relations depend on their living environment, which generates certain attitudes, ideas, and views, as a result of which it became possible to manage conflicts and change the social life of society. In the era of digitalization of the legal protection system, Russian legal science, relying on the concept of sociological constructivism, can preserve the social values of law and prevent the embodiment of destructive ideas in social development.

22.1 Introduction

The events of the last decade (i.e., globalization and the rapid development of digital technologies) have changed the policy of Russia in matters of public administration and legal regulation. These events have also presented completely new requirements for legal science. By historical standards, in the twenty-first century, human ideas about the world order are rapidly changing, regarding primarily the rule of law that has developed over the centuries. Legal theorists began to think about hybrid law as its current state, program codes as the basis of legal regulation, and, on this basis, about the convergence of the content and forms of law. In recent years, the

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process of rethinking legal values has been occurring in a stormy stream; there is a return of discussions about the commensuration of the ideas of individualism and collectivism, about the relationship between the concepts of forms and sources of law, principles and rules of behavior. Legal science is in a state of searching for models of digitalization of legislation and justice [2].

What changes will occur in the relationship between the government, society, and an individual? What is the nature of power in the new conditions of development? Will the traditional understanding of law remain unchanged? Will the process of hybridization of regulatory legal regulation entail the cooperation of regulatory legal acts of public authorities with the regulations of digital corporations? In what direction will the institution of judicial protection of the individual develop in the information society? What is the likelihood of problems of limited and ineffective means of legal protection, rights, and interests of citizens in the digital world?

The Davos Economic Forum 2020 (the declared topic "Formation of capitalism for all interested parties") cited the following main risks of the development of international institutions: the weakening of state institutions and the state as a whole, aggravation of interethnic relations, the fourth industrial revolution and robotization, natural anomalies, and human-made disasters [5].

Held in January 2021, an online session of the Davos Forum stated the consequences of the COVID-19 pandemic and outlined the tendencies of the "Great Reset" based on the rethinking of world politics. For more than 50 years, the Club of Rome has been developing scenarios for regional and world development based on the universality of development processes and the convergence of economic, social, and state-legal phenomena and institutions. Economic and financial crises, the COVID-19 pandemic, aggravation of the problems of climate change, and social and political upheavals are the narratives of the twenty-first century.

22.2 Methodology

From ancient times to the present, the best minds of humanity have attempted to describe the processes of cognition of law, developed a variety of theories, concepts, and teachings about law, and described various models of the regulatory impact of human rights, civil society, public institutions, and the economy. Legal science has been searching for a regulation formula for centuries.

However, the current understanding of law without analyzing actual reality based on scientific concepts and ideas of sociological science is meaningless and unscientific. The potential of sociological science is evidenced by the following:

- New interpretations of the problems of social development;
- Rejection of the chronological description of events, philosophical postulates, and worldview ideas;
- The transition to the conclusions of natural sciences and the analysis of real facts and events;

- The transition from the paradigm of sociological realism (the object of research is society), the paradigm of sociological nominalism (the object of research is a person and personality) to the constructivist paradigm (the object of research is social life in all its diversity) [10].

In the sociology of the twentieth century, the basic idea was the social order based on maintaining the system's equilibrium, coordinating its structural elements, and striving for agreement between them, which was reflected in the legal science of this period. At the beginning of the twentieth century, the French scientist L. Dugi developed the theory of solidarity**,** when members of society voluntarily and consciously perform any part of social functions.

The ideas of neo-evolutionism were born within the framework of structural functionalism. These ideas are based on the differentiation of functions performed by individuals, giving culture the role of an independent magnitude. R. Merton's theory of social changes predetermined the need for a scientific search for cause-and-effect relationships, which was reflected in legal science on the idea of the German professor Savigny (a representative of the historical school of law) to consider law as a natural process of development based on the traditional folk spirit, customs, traditions, and a sustainable way of life. French sociologists (Foucault, Levy-Strauss) developed concepts related to identifying the content of the dominant ideology and the reasons for the radicalization of human behavior, the conditions for the formation of social movements and protest actions, which continued the development of neo-Marxism and was reflected in law in the theory of dominance of interests in the form of law. The theory of domination of interests in the form of law is based on the definition of law by the classics of Marxism as the will of the ruling class, elevated to law. It indicates the social principle in law and its provision by the state, including the coercive mechanism. Plekhanov recognized the benefits of parliamentarism. Nevertheless, he believed that the main thing was not the rule of law but the supremacy of the dictatorship of the proletariat.

Russian sociologist Sorokin viewed society as a living social organism in which people are carriers of economic, political, and professional status. Their movement in the horizontal (migration, change of profession) and vertical (change in social status) directions depends on the type of society.

The most popular concept in jurisprudence was the concept of the rule of law and the priority of law (positivist legal thinking). The interpretation of law "base-superstructure" (materialistic approach to law) was continued in the concept of the American professor R. Posner on the economic analysis of law.

However, the approaches outlined in the late twentieth and early twenty-first centuries lost their relevance; the classical concept of the social structure of society no longer reflects the reality of contemporary processes, since many elements have lost their meaning (the concept of classes has lost its essential basis), have changed, or new elements have appeared. According to contemporary sociology, a real uniting social force is not professional groups but bearers of the same worldview with the same or similar ideas, views, attitudes, and the desire to realize them [10].

Since the end of the twentieth century, in the works of Western sociologists, a globalist characterization of the ongoing changes in society and the world has been formed, based on geopolitical, geo-economic, and transcultural positions (Wallerstein's concept). In science, the terminology of modernity, the general history of humankind, and the balance of systems began to prevail. Studies have appeared in which wars and economies are considered as determinants of long waves and cycles of hegemony (the concepts of Modelsky). The theory of new institutionalism appeared in sociology and law, which was reflected in the works of Russian legal scholars (Maltsev) [3].

22.3 Results

With the advent of computers and the Internet, sociologists began to describe in detail the network society and the state based on the processes of capital globalization and global networks, including financial markets, transnational production, the Internet with interactive and multipurpose communication, and international institutions that govern the global economy and interstate relations. The German scientist J. Habermas and his supporters developed a theory of network law. In a networked society, communication between different cultures is carried out not based on shared common values but on the basis of communication processes. Power in a networked society is not identical to the concept of the state. The state traditionally includes the institutions of social management, legislative, executive, and judicial branches of government, government, armed forces, law enforcement agencies, oversight bodies, and political parties at four levels—national, regional, local, and international. In turn, the political decision-making process takes place in networks through interaction between national, supranational, international, transnational, regional, and local institutions.

In sociology and jurisprudence, the so-called objectively human-oriented theories have emerged, including the theory of interactive and ritual goals, the theory of the phenomenologization of social and legal reality, and the sociology of knowledge. According to these theories, the motives of the behavior of participants in communicative relations depend on how much the semantic fields of participants in such relations intersect, in connection with which science has proposed to legitimize the symbolic universals of society to create a stable living environment.

The regulatory impact assessment (RIA) mechanism applied in the European Union has been used by Russia in the legislative process. Theories of the mutual influence of international and national law received a powerful development in the late twentieth and early twenty-first centuries, which gave rise to several problems in the dynamics of the relationship between legal sovereignty and global regulation [7].

Digitalization of society requires a new coding of law because legal decisions and actions lag behind the real pace of development of society [8]. Within the framework of the concept of sociological constructivism, which considers social life in all its diversity, the theory of social conflict has taken a fundamental place. This theory is based on the statement that society is constantly in a state of instability, a constant struggle between various social groups pursuing certain interests [9]. Conflictologists define social conflict as a struggle for power, a change in social status, a redistribution of income, and a reassessment of values. Most sociologists assess conflicts as a source of development and improvement of society, reject their spontaneity, and advocate the possibility and necessity of regulation. Leading legal scholars of Russia note that in Russia, as in the whole world, conflict is recognized as a dominant development, which is of great importance in law enforcement, embodying the results of the implementation of scientific concepts and establishing feedback between legal creators and society [6].

The analysis of the use of concepts such as conflicts and protests in the Russian-language (Fig. 22.1) literature [4] shows that the notion of protests prevailed in pre-revolutionary Russia (the highest rate in the year of 1913 and recession since 1920), while the concept of conflicts was most widespread in 1998 and 2013. The comparison of these indicators with political events in the UK, the USA, and Russia indicates that the widespread use of the topic of conflicts in the literature is associated with political events. Thus, in 1989, the Thatcher government introduced a poll tax, which provoked the outrage of the British. The USA invaded Panama the same year. In Russia, the year of 1998 was full of economic failures—the lack of funds from the military budget for the payment of wages to military members, the default of GKOs, the liquidity crisis, and the resignation of the Kiriyenko government.

Being a type of social conflict, legal conflicts are identified within the framework of this research as legal disputes. Therefore, the study of the current model of their consideration and resolution has methodological significance for the formation of the concept of digital justice.

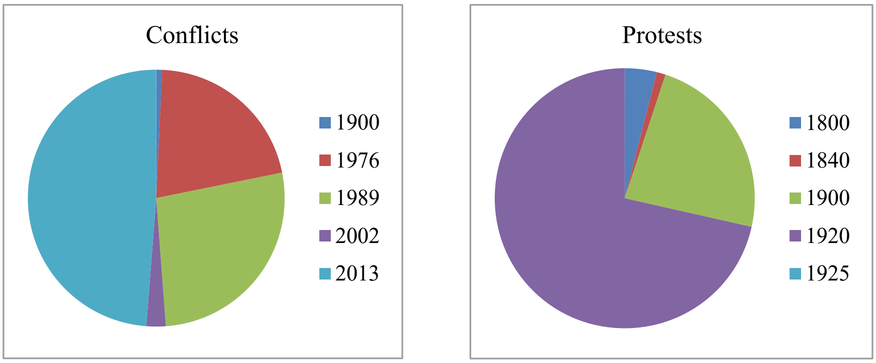

Fig. 22.1 Use of the concepts of "conflicts and protests" in the Russian language. *Source* Compiled by the authors

The function of power-coercive dispute resolution is carried out by the government, represented by bodies vested with jurisdictional powers, based on a jurisdictional process, within the framework of a certain culture of dispute resolution activities. In the scientific literature, the concept of a system for resolving legal disputes is used. In normative acts and acts of judicial practice, the terminology is used—the resolution of disputes (economic disputes, tax disputes, disputes from family relations, disputes from property relations, etc.). The dispute resolution system is part of the legal system. The structural components of the dispute settlement system are courts that carry out their activities in accordance with the rules established in the procedural codes, based on the cultural values prevailing in the state that accompany such activities. Consequently, the words—law, court, and justice reflect society's need for a protective mechanism.

Through litigation, legal conditions and regimes are created for the orderly, rhythmic, and effective activity of all subjects of law, for the consideration and resolution of disagreements and disputes over the recognition of law and its protection from offenders. The analysis of the parabola of the frequency of using the concepts of law, court, and justice (Fig. 22.2) [1] indicates the interconnection of the bursts of mention in Russia with the demand for a judicial form of protection of rights based on the principles of justice (Table 22.1).

Related concepts of conflict management and schools of activism are based on the analysis of the problems of human behavior in a particular environment. Under

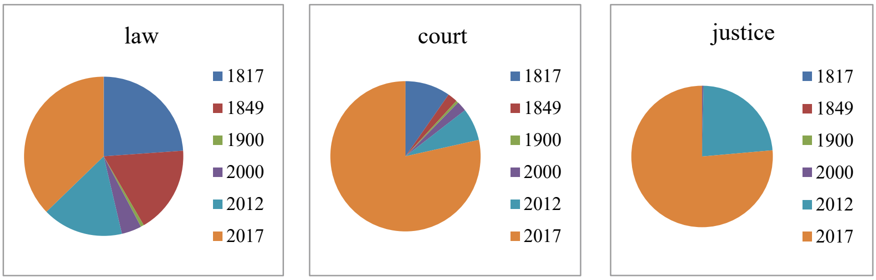

Fig. 22.2 Frequency of using the concepts of law, court, and justice. *Source* Compiled by the authors

Table 22.1 Analysis of the frequency of using the concepts of law, court, and justice

Russian-language literature	*English literature*
Law, court, and justice	**Law, court, and justice**
The maximum value of using the theme of court falls on 1867 and 2019; the theme of justice falls on 2019 The right, respectively, for 1817–1820 and 2019	The theme of court and justice peaked in 1997. The theme of law peaked in 1829 and 1909

Source Compiled by the authors

their influence, theories of scientific management, the construction of the present and future reality appeared. Legal scholars propose a theory of the evaluative and measuring direction of the development of legal thought when the evidence of legal influences is used along with statistical, sociological, quantitative, and other methods of regulation. Tikhomirov [6] believes that until now, scientists have underestimated the transition from goals to regulators, from regulators to actions, and from actions to results.

In our opinion, the theory of conflict has acquired particular relevance in the framework of the processes of informatization and digitalization of judicial activity, the controversial ideas of humane justice.

The theory of legal dispute, developed by Russian lawyers, can become the basis for developing software codes for judicial protection of law [11].

According to the named theory, any legal dispute includes the parties, the subject, and the disagreements of the parties regarding the subject, the existence (absence) of the right, and its violation. The models of a legal dispute are differentiated into theoretical legal and regulatory legal. The construction of the normative structure of a legal dispute is based on the current legislation, in which the legal experience of its knowledge and legal regulation of the forms of its solution is embodied. Substantive claims and objections (mutual claims) constitute the legal expression of the parties' disagreements, their legally significant form. A legal dispute is characterized by the stage of its development, legal means of its declaration, implementation and completion, and legal forms (methods) of resolution. Jurists distinguish three stages of a legal conflict: (1) a conflict situation, (2) conflict interaction, and (3) the end of the conflict.

The design of software products for the judicial system can go in the following directions:

- The introduction of the practice of holding remote court sessions through the use of the Internet and messengers (software applications of smartphones that allow the exchange of information with WhatsApp, Viber, etc.); holding court sessions in the mode of video conferencing, audio (video) recording, and replacement of court clerks and assistant judges with robots;
- The introduction of digital technologies in management processes—resource support for judicial activity;
- Transfer to software for preparation of standard statements of claim; automation of the processes of registration of applications in courts; automatic verification of the jurisdiction of the case; selection of normative acts necessary to resolve the case (it is even possible to predict options for the outcome of the case based on the analysis of judicial practice); preparation of judicial acts or their separate parts;
- The use of blockchain technologies at the stage of preliminary investigation and preparation of cases for trial.

22.4 Conclusion

1. A new role of law in a changing world is in demand: legal reflection and targeted impacts on current reality should be based on the choice of objects of legal impact, analysis of the dynamic correlation of objective laws and legal laws.
2. There is a need for a scientific analysis of the dynamics of legal consciousness and behavior according to the formula "man—cognition—intellectual and moral decision—technology" (since the ways to stimulate civic activity in society have been lost, the human factor in lawmaking and law enforcement is underestimated).
3. It is necessary to modernize approaches to assessing the role of the public and other social institutions in society.
4. Continuing to explore the issues of legal thinking, lawmaking, and law enforcement, one should study target-oriented and project management, legal, and other models for forecasting and evaluating management results.
5. It is necessary to expand the range of research of objects of legal influence based on the balance of state and legal regulation and self-regulation with strict observance of laws and technical rules.
6. It is necessary to find the right balance of measures on a national and international scale.
7. It is necessary to use the potential of contemporary concepts of sociology and jurisprudence to manage processes in society and regulate digital transformations, including in judicial activity.
8. The methodology of constructivism, including normative, organizational, informational, and procedural constructions and the theory of legal dispute, combining substantive and procedural aspects, should be offered as a scientific basis for the modernization of the Russian dispute resolution system.

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Chapter 23 The Use of Artificial Intelligence in Considering a Criminal Case on Its Merits as One of the Safeguards of Legal and Reasonable Sentencing by a Judge

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Abstract In view of the rapidly developing digital technologies and artificial intelligence software in various areas of human activity, there emerges a necessity to study the possibility of implementing the artificial intelligence technologies in criminal proceedings, with identifying the possibility of transferring justice to artificial intelligence. During the research, the authors applied basic scientific methods of inquiry. The conclusions set forth below were made as a result of the conducted study. The implementation of artificial intelligence software into administering justice in criminal cases is currently impossible. However, it is possible to implement these technologies into criminal proceedings in the area of monitoring compliance by the participants in the process, including the judge, with the requirements of criminal procedure legislation. It is also possible to use artificial intelligence software to record all procedural actions in legal proceedings and draw up a trial transcript. As we suggest, the application of artificial intelligence software in this way would increase the legality and reasonability of the imposed sentences.

23.1 Introduction

The importance of studying the mechanisms and ways of using AI in court proceedings is justified by several factors. First, there is an improvement of European legislative practices in this area, an example of which is the adoption of the "European ethical Charter on the use of artificial intelligence in judicial systems and their environment" (the Charter) by the European Commission on the Efficiency of Justice (CEPEJ) [1]. Second, the interest in this topic is driven by the necessity of implementing the National Strategy for the Development of Artificial Intelligence 2030, approved by the Presidential Decree "On development of artificial intelligence in the

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Russian Federation" [7]. Currently, the Russian criminal proceedings use artificial intelligence as an automated system of allocation of cases. Electronic justice is used in cases of undisputed claims where the evidence presented by the party is apparent and supported by the defendant. Alongside that, there is still concern on to what degree could artificial intelligence be used in legal proceedings, whether artificial intelligence neural networks are capable of replacing a judge in the decision on the merits of a case, and whether there is a possibility of using AI in criminal proceedings to increase the safeguards of legality and reasonability of a judicial decision.

To get a response to these questions, it is necessary to find out what is meant by artificial intelligence, which of its modalities are applied in Russian justice, and what are the possibilities of promoting new directions for applying artificial intelligence neural networks in legal proceedings.

23.2 Methodology

During the research, the authors applied basic scientific methods of analysis to essentialize artificial intelligence. The research was carried out involving the works by Ponkin [23], Zakirov [26], Haenlein and Kaplan [17], and Morkhat [22]. When investigating the essence of the internal conviction of a judge, the authors analyzed the works of Kudryavtseva [19] and Yatsishina [25]. The statistical method was used when handling the data of judicial statistics of the Judicial Department at the Supreme Court of the Russian Federation [4].

23.3 Results

Proper administration of justice is indispensable to long-term national development, a safeguard against civil rights violations. This implies not only the constant improvement and development of material and procedural legislation that contributes to increasing its legitimacy and reasonability but also the implementation of achievements in the area of digital technologies, software, and artificial intelligence into criminal, civil, and arbitration proceedings [16]. Pursuant to the report submitted to the CEPEJ, the Russian judicial system is technologically advanced as compared with the courts of Western states. The major strength of the Russian judicial system is the use of digital technologies, assessed by the European Commission at 8.81 points. For comparison, this indicator equals 8.3 points in Germany, 5.19 points in France, 6.42 points in Italy, and 5.55 in Switzerland. The level of the implementation of digital technologies in Russian courts in dealing with participants in criminal proceedings is more than twice as high as the average European level: 8.6 points compared to 4.1. As for electronic interaction with participants in the proceedings, a score of 9.09 points was assigned to Russia (the European average being 5.04 points), where the application of digital technologies in the distribution of cases and

Table 23.1 Use of video conferencing during legal proceedings

Type of proceedings	Period			
	2017	2018	2019	2020
1	2	3	4	5
Criminal cases	5732	6421	7321	15,805
Disposition of the motion for remand in custody and extension of the custodial period	816	604	688	9635
Other materials of judicial review	3041	3074	3433	6339
Materials in the sentence enforcement procedure	72,905	83,085	87,500	84,152
Total videoconferencing assigned	82,494	93,184	98,942	115,931

Source Compiled by the authors

the court administration is also 9.09 points (the European average is 7.11 points), and the application of advanced technologies in the preparation of judicial acts is 8.24 points (the European average is 6.15 points) [11].

According to the "Report on the work of courts of general jurisdiction in criminal cases in the first instance," the measures of the Supreme Court of the Russian Federation in 2020 aimed at preventing the spread of COVID-19 [8, 9] contributed to an increase in the use of videoconferencing in various court proceedings in criminal cases. Thus, in 2020, the use of videoconferencing increased by 14.65% compared to 2019, by 19.62% compared to 2018, and by 28.8% compared to 2017 [4] (Table 23.1).

The positive results of the application of videoconferencing in the course of court hearings during the period of restrictions displayed its relevance by the participants in legal proceedings and the possibility of administering justice without affecting the legality principle. Consequently, in 2021, a bill "On amendments to certain legislative acts of the Russian Federation regarding the regulation of remote participation in legal proceedings" was submitted to the State Duma of the Russian Federation [3]. The bill provides for amending the Arbitration Procedure Code of the Russian Federation, the Civil Procedure Code of the Russian Federation, the Code of Administrative Procedure of the Russian Federation, and other legislative acts of the Russian Federation to improve the procedure for applying electronic documents in legal proceedings and ensure the possibility of remote participation in court hearings using personal means of communication by the users [6].

Nowadays, artificial intelligence is applied in Russian legal proceedings in the form of implementing an automated system for the distribution of cases and the application of electronic justice in cases of undisputed claims.

In determining a judge or composition of a court, the automated system for the distribution of cases takes into consideration the judge's specialization and his or her lowest load factor.

The application of artificial intelligence in dispute resolution in the presence of irrefutable evidence and the absence of the defendant's objections allows reducing the time of proceedings, reducing the workload of judges, and making justice more accessible. Currently, these technologies are used to prepare the necessary documents for making a decision.

The Charter interprets artificial intelligence as a set of science, theory, and techniques to reproduce the cognitive capabilities of a person by a machine. Current development aims to transfer complex tasks previously assigned to a person to a machine [1].

The National strategy for the development of artificial intelligence 2030 [7] defines artificial intelligence as a system of technological solutions made in a computer environment, which allows one to perform specific tasks and obtain results based on the work of algorithms, which are based on a historical volume of data, through computing technologies using predetermined formulas and models. AI includes hardware and software parts that provide collection, processing, analysis of data, searching for relationships between data elements, and forming solutions through machine learning methods [18, p. 64].

The definition of artificial intelligence is currently receiving special attention in the scientific literature. In general, the authors consider it as complex cybernetic computer software and hardware system capable of recognizing and analyzing the situation and making a decision while being able to adjust its actions [17, p. 9; 23, p. 93; 26, p. 214]. Morhat proposes the most comprehensive definition reflecting the whole essence of AI, according to which artificial intelligence is regarded as fully or partially autonomous self-organizing (and self-organized) computer hardware and software virtual or cyber-physical (including bio-cybernetic) unit, which is not living in the biological sense of this concept, with the appropriate software, endowed/possessing software-synthesized (emulated) abilities and capabilities for recognition, interpretation, modeling, accumulation of information and experience, training and self-learning, etc. [22], pp. 151–152].

In the IT industry, the definition of artificial intelligence is based on the capabilities of the software to solve specific tasks. In this context, weak and strong artificial intelligence is distinguished. Weak artificial intelligence refers to software complexes applying machine learning, neural networks, multivariate statistical analysis for pattern recognition, programs for communication with a computer in natural language, and software allowing integrating streams of numerical, text, audio, video, and signal data into a single information processing system [20]. Weak artificial intelligence includes a certain set of computer programs purposed to solve a small range of problems. Strong artificial intelligence refers to machines capable of self-learning with no human intervention, improving software, and increasing the amount of memory and storage options.

Under the present conditions, artificial intelligence, on the one hand, acts as a computer setting out a logical consistency of the given task with data previously entered by a human person based on the application of complex statistical algorithms, being, on the other hand, a software product with its own developer.

The fact that the bank of decisions of courts of general jurisdiction, which is part of the existing in Russia database of Justice state information system, contains more than fifty million judicial acts could be taken as a basis for creating large databases used by artificial intelligence. Nevertheless, a problem may arise regarding the sufficiency of the information contained there for use by a software product. Another problem is protecting this information from unauthorized access. Simultaneously, according to the first principle of the Charter, an artificial intelligence processing judicial decisions should comply with the fundamental rights guaranteed by the European Convention on Human Rights and the Convention on the Protection of Personal Data (Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data, ETS No. 108c as amended by Protocol CETS No. 223) [2].

To prevent the deployment of a software product that would violate human rights when making a decision, following the principle of non-discrimination formulated in the Charter [1], the state corporations specializing in software development are required to assume its implementation or to exercise expert control over it, taking an obligation to develop artificial intelligence standards in Russia. In 2020, the CEPEJ prepared a feasibility study to certify tools and services based on artificial intelligence [2], which would precede their implementation in legal proceedings.

Artificial intelligence can also correctly qualify a criminal law act that raises doubts because the principle of justice and humanism in sentencing is not proper to it, as well as emotions; it cannot comprehend the nature of the human psyche. Artificial intelligence neural networks cannot make decisions as a judge does, using not only the norms of the law but also his or her internal conviction formed by the presented evidence and professional legal consciousness, which Bondar defines as “a necessary structural element of the model of the modern lawyer, while, due to its specificity, its normative principle is the constitutional worldview (legal consciousness)” [12, p. 48]. As rightly noted by Kudryavtseva and Yatsishina [19, p. 45; 25, pp. 10–11], internal conviction is a set of elements providing new knowledge on the studied phenomenon.

In this connection, we share the position of the representatives of the judicial community [14], as well as the proceduralists having studied this topic [10, p. 136], that artificial intelligence cannot replace a qualified judge in the administration of justice in criminal cases and can only be used as an instrument, a sort of mechanical controller over procedural actions by the judge in the administration of justice during a trial.

This circumstance is also enshrined in the fifth principle of the Charter [1]. According to this principle, the “user” (i.e., the judge) is independent in making a decision, and, therefore, he or she cannot be made dependent on the use of artificial intelligence tools. Simultaneously, the participants in the trial must be informed that the decisions elaborated by artificial intelligence are not binding for the court.

Taking this into consideration, it appears that artificial intelligence can be used for procedural control over the course of the trial and, while considering the case on the merits, for recording procedural violations committed by the participants in the trial, which may affect the legality and reasonability of the sentence.

Article 237 of the Criminal Procedure Code of the Russian Federation sets out the requirements for a sentence and determines the circumstances under which it will be legal, reasonable, and fair. Hence, any breach of the requirements of the criminal procedural legislation during court proceedings affects its reasonability because,

Table 23.2 Data on the grounds for canceling or commuting the sentence by the court of criminal appeal

Grounds for canceling or commuting the sentence	Periods			
	2017	2018	2019	2020
1	2	3	4	5
The discrepancy between the court's conclusions stated in the verdict and the actual circumstances of the criminal case (Art. 389.16 of the Criminal Procedure Code of the Russian Federation)	1840	1975	1799	1732
Substantial breaches of the law of criminal proceedings (Art. 389.17 of the Criminal Procedure Code of the Russian Federation; Clause 5 of Art. 389.15 of the Criminal Procedure Code of the Russian Federation)	4991	6656	6188	7960
Injustice of the sentence (p. 2 of Art. 389.18 of the Criminal Procedure Code of the Russian Federation)	1777	1992	1593	1497

Source Compiled by the authors

in this case, all possible legal methods of collecting evidence are not fulfilled [21, pp. 192–193] or the constitutional rights of the participants in the process are violated.

The analysis of reports of the Judicial Department at the Supreme Court of the Russian Federation on the work of courts of general jurisdiction on the consideration of criminal cases on appeal for the period from 2017 to 2020 indicated that the total number of sentences canceled by the court of appeal on grounds for canceling or commuting the sentence under Art. 389.16 of the Criminal Procedure Code of the Russian Federation and Art. 389.17 of the Criminal Procedure Code of the Russian Federation increased by 20.4% [4] (Table 23.2).

The study of judicial practice allowed us to provide several examples of violations of procedural legislation having influenced the verdict's legality. In considering a criminal case in the court of the first instance against an employee of the body for abuse of official powers, which consisted in forging the signature of the accused in the decision on imposing a preventive measure against him, the court ignored the arguments of the defense on violation of the methods in conducting handwriting examinations in the course the preliminary investigation. Also, in violation of the requirements of p. 4 of Art. 271 of the Code of Criminal Procedure of the Russian Federation, the court rejected to grant the petition submitted by the defense to interrogate the handwriting specialists who came to the opposite conclusions in conducting a study of free samples of signatures submitted by the defendant and signatures in a copy of the decision on the imposing a preventive measure, wherein, according to the prosecution, the signature was present, made by the defendant on behalf of the accused against whom the measure was imposed [5, 13, p. 56].

In another case, by the appeal decision of the Judicial Collegium for Criminal Cases of the Rostov Regional Court, the sentence of the Zheleznodorozhny District Court of Rostov-on-Don against K. was canceled. The case was sent back for retrial to the court of the first instance from the trial stage in a different composition of the court.

The basis for this decision was a significant violation by the court of the first instance of the requirements of the criminal procedure legislation, which influenced the adoption of a legal and reasonable court decision. In violation of the requirements of the criminal procedure legislation, the court, on its initiative, examined numerous protocols of investigative actions and documents used by it to prove the circumstances relevant for the case. Also, the court deliberately entered knowingly false information into the trial transcript that the public prosecutor announced the indictment in this court hearing. The court sought the defendant's opinion on the charge and brought up the issue of establishing the procedure for examining the evidence for discussion by the parties, while, in fact, the indictment was not announced in the hearing, the opinion of the defendant on the charge was not sought, and the issue of establishing the procedure for the examination of evidence by the court was not brought up for discussion by the parties.

Thus, the court significantly violated the criminal procedure law, in particular the principle of adversarial proceedings, independently determined which evidence was subject to investigation, and examined them in the court session, which is a breach of the norms of the criminal procedure law regulating the procedure for drawing up the trial transcript [24, p. 9].

As can be seen from the given examples and statistical reporting data of the Judicial Department at the Supreme Court of the Russian Federation, a fairly large number of sentences are canceled by the appeal instance on grounds related to violation of procedural legislation. These circumstances impact the attitude of society toward the judicial community and justice. The reasons may vary. However, it seems to be more related to the high case-load of judges. According to a study conducted by the Higher School of Economics, 68% of the 449 judges who participated in the study had an excess of the standard working hours by 20% or more, including 38% of judges who worked beyond the established limit two times or more, 19%—three times or more, and 5%—five times or more. A total of 54 h of working time of judges (which is seven working days) are spent on the consideration of a typical criminal case, whereof 15 h are allotted for the resolution of the case at first instance in the district and equivalent courts. The rest of the time is occupied by the revision of court decisions in the appeal and cassation instances [15, pp. 7–8].

An increase in the load entails a reduction in the time for the consideration of a criminal case while leading to an unhealthy routine and affecting the quality of the conduct of the actions provided for by the Criminal Procedure Code of the Russian Federation in each part of the legal proceedings. Given that the legal proceedings are of a procedural nature determined by legislation, the reduction or failure of the judge to perform procedural actions entails a violation of the rights of the participants in the legal proceedings. It negatively affects the principles of legality and adversariality. It appears that the technical capabilities of artificial intelligence can be used for the procedural control of the judge's actions, and once the actions do not comply with procedural legislation, the software would draw the attention of the participants in the process to this fact in order to be recorded in the trial transcript. If the identified procedural violations are found to be well-grounded, they will be rectified. Otherwise, if the judge disagrees with the conclusions made by artificial intelligence, he or she would have to justify his or her actions by issuing a relevant decision.

Besides, artificial intelligence software could record the entire course of the legal proceedings, digitizing the speeches of the participants in the trial, and drawing up the trial transcript.

23.4 Conclusion

The research revealed that software is being actively implemented in Russian legal proceedings, aimed at administering justice in simple proceedings with an indisputable demand and converting the entire document flow into digital format. Alongside, the implementation of artificial intelligence software into administering justice in criminal cases is currently impossible. However, in our opinion, there is a possibility of implementing these technologies in criminal proceedings in terms of monitoring compliance by the participants in the process (including the judge) with the requirements of criminal procedure legislation. Artificial intelligence can also be applied to record all procedural actions during legal proceedings and draw up a trial transcript. We suggest that the application of artificial intelligence software in this way will increase the legality and reasonability of the sentence imposed.

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Chapter 24
The Use of Artificial Intelligence in the System of State Regulation of Entrepreneurship

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Abstract The introduction of artificial intelligence is just beginning. Nevertheless, this issue is important for the development of entrepreneurship in the current conditions and it is necessary to give scientific understanding and adequate legal regulation for it. The paper attempts to determine the areas and directions of the use of artificial intelligence in the entrepreneurship regulation, comprehend the term "artificial intelligence," develop the principles of introducing artificial intelligence in the entrepreneurship regulation, substantiate the positive aspects of the introduction of artificial intelligence in the state regulation of entrepreneurship, and identify the main threats of such introduction.

24.1 Introduction

Nowadays, Russia is in an economic crisis caused by various reasons, including the restrictive measures to counteract COVID-19 [12]. The situation is further aggravated by sanctions from the EU and the USA, resulting in foreign policy and economic isolation.

According to Table 24.1, there are many "fading" enterprises in Russia (in 2020, their number exceeded 83 thousand).

These factors led to the fact that the government of the Russian Federation began to take active measures to develop and support entrepreneurship.

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Table 24.1 Indicators of entrepreneurial activity of enterprises in the Russian Federation in 2020, units

The number of active enterprises		2,821,827
The number of growing enterprises:		
Estimation of growth in the number of	the staff of fast-growing enterprises	14,070
	the staff of fast-growing enterprises, including enterprises- “mice”	32,126
	enterprises with high growth potential	28,609
	enterprises with high growth potential, including enterprises- “mice”	61,048
	enterprises-gazelles	2788
Estimation of turnover growth of	fast-growing enterprises	66,441
	fast-growing enterprises including enterprises- “mice”	108,595
	enterprises with high growth potential	115,581
	enterprises with high growth potential, including enterprises- “mice”	176,061
	enterprises-gazelles	8522
The number of “fading” enterprises		83,295

Source Compiled by the authors

It is necessary to develop effective mechanisms for interaction between business and government structures and state regulation of the economy to implement the progressive development of entrepreneurial relations.

In accordance with the Decree of the President of the Russian Federation “On the strategy of economic security of the Russian Federation for the period up to 2030” (May, 13, 2017 No. 208), an important aspect of ensuring national economic security is the formation of a strategic management system of the national economy and the Russian state, in which corporate and private interests would have a dominant and integral influence [9].

The advanced direction in the development of relations on state regulation of business is the use of artificial intelligence in the system of state regulation and control of entrepreneurship, as well as in the system of state support for entrepreneurs.

Technological solutions based on artificial intelligence in various sectors of the economy and areas of public relations are currently being implemented at an accelerated pace [8, 10, 15]. Such technologies seem to be successfully applied in the system of state influence on business.

The concept of artificial intelligence is becoming more widespread. Nevertheless, there is still no legal definition of this term [7].

There are several types of artificial intelligence in the scientific literature, some of which can be applied in the field of government regulation of entrepreneurship.

Artificial intelligence that performs very clear tasks in various applications, for example, virtual assistants such as bots responding to typical user requests, systems detecting credit card and Internet fraud, facial recognition applications, machine learning, automation, and robotics are also related to artificial intelligence technologies. These are examples of weak artificial intelligence.

This type of artificial intelligence can be successfully used in the registration of individual entrepreneurs and legal entities, as well as for the effective distribution of state support, training of entrepreneurs, and implementation of entrepreneurial activities to increase productivity and efficiency.

Artificial general intelligence (AGI, or strong artificial intelligence) can support multitasking. It is also considered to be an intelligence that can surpass or even replace human intelligence [14]. The use of this type of artificial intelligence is not permissible until adequate legal regulation and restrictions of its use have been developed.

24.2 Methodology

The research is based on general scientific (system, historical, and logical methods) and special legal methods of cognition (formal-legal and comparative-legal methods).

The comparative-legal method was used to identify the features of world experience in the field of state regulation of entrepreneurship using information technologies and artificial intelligence.

Logical and formal-legal methods were used to analyze the forms of legal support of state influence on the business area.

The system method was used to analyze various regulatory legal documents comprehensively.

The historical method allowed the authors to reflect the trends in the development of state regulation of entrepreneurship.

24.3 Results

The National Strategy for the Development of Artificial Intelligence for the period up to 203, approved by Decree of the President of the Russian Federation "On the development of artificial intelligence in the Russian Federation" (October 10, 2019 No. 490), provides the following definition of the concept of "artificial intelligence": these are "technologies based on the use of artificial intelligence, including computer vision, natural language processing, speech recognition and synthesis, intelligent decision support, and promising methods of artificial intelligence." In the area of state regulation and support of business entities, these technologies can be successfully used to monitor the business environment and facilitate access to state support by business entities.

Currently, a number of federal executive authorities have developed projects to introduce artificial intelligence into their work. Thus, the Ministry of Industry and

Trade of the Russian Federation has prepared the project to introduce a self-learning system for recognizing an unstructured text for a convenient provision of public services.

Based on the analysis of intelligent systems for industrial production, equipment loading, and production logistics, it will be possible to transfer the state support to a proactive format. Based on the state information system of industry (GIS), the Ministry also plans to create industry data sets, which will allow analyzing the actual level of industrial production correctly [3]. The Ministry of Industry and Trade plans to implement these solutions by the end of 2022.

Let us take a closer look at the problem connected with registering and running a business. For the modernization of the business entities registration system, it is necessary to implement a set of measures commensurate with the level of law enforcement development, the state apparatus capabilities, and the available material and financial resources [11].

In today's conditions, the main goal lies in the introduction of information technologies using artificial intelligence into the system of state registration and maintaining the business entities register. Currently, the Federal Tax Service of the Russian Federation runs the Unified State Register of Legal Entities, the Unified State Register of Individual Entrepreneurs, and the Unified Register of Small and Medium-sized Businesses.

Additionally, Article 7.1 of Federal Law "On state registration of legal entities and individual entrepreneurs" (August 8, 2001 No. 129-FZ) provides for the maintenance of the Unified Federal Register of Legally Significant Information on the activities of legal entities, individual entrepreneurs, and other economic entities. Its formation and running are carried out by the operator of the Unified Federal Register. It is a legal entity, determined by the results of the competition by the executive authority of the Russian Federation. Thus, Russia provides for the maintenance of a significant number of state registers containing a large array of constantly changing data on business entities. In this regard, the introduction of information technologies using artificial intelligence for their running seems to be a promising process.

International recommendations can contribute to this process. Many legal systems attempt to simplify and improve the efficiency of the registration system of entrepreneurs through the widespread use of artificial intelligence [2]. It is reasonable to use their experience in the Russian legal order, primarily in legislative support of information systems [4] and solving applied issues, such as the use of new technologies for the identification of the person [5].

These issues are especially urgent in connection with the implementation of the state policy of support for small- and medium-sized businesses [13]. The documents of the profile working group of the UN Commission on International Trade Law (UNCTAD), which contain a number of recommendations, can significantly help [1]. These recommendations are as follows:

(1) The formation of a unified service system, in which all necessary actions can be performed by subjects at the same institution, accelerates the registration of entrepreneurs. This implies the creation of a so-called "one window" system.

(2) If numbers are assigned to entities subject to registration, if their use is limited to one body, each body must keep track of the numbers used by others to ensure the exchange of information.
(3) It is recommended not to establish fees for the registration of business entities, the proceeds from which would exceed capital and operating costs, and, if possible, to link them only with the reimbursement of capital costs. Forming a registry based on information technology in partnership with a private entity, it is important to give an opportunity to such an entity to get a percentage of the proceeds.
(4) If it is possible for infrastructure development, information technologies should be used in the registration system, but their implementation may be expensive. It is recommended to start with the use of simple databases and programs for basic operations, develop a website informing about the registration procedure, and create the forms of necessary documents. Then, it is necessary to automate the operations of departments, establish a connection with branches, and convert previously made records into digital form. At the final stage, it is recommended to combine the submission of an electronic application for registration or updating of information with the payment of fees, registration for tax and other types of accounting, and the provision of related services within special platforms.
(5) Modernization should be made at the same time with amendments to regulatory legal acts so that they contribute to an increase in the number of legally operating business entities, especially small businesses.

Thus, international recommendations to improve the system of registration of business entities suggest a systematic approach to the automation of the register of entrepreneurs. It is advisable to use them in the Russian system of state registration of entrepreneurs, as well as in running state registers, including the small businesses register.

The introduction of an electronic (digital) residency regime for legal entities is also very promising. This implies a transition from the registration of organizations in an electronic notification form through the portal "Public Services" to an alternative format of electronic (digital) residency for organizations, including the possibility of remote formation and control of a legal entity.

Thus, some scientists propose to identify cases in which it is possible to replace the "physical" address of an organization with a virtual one (the so-called digital office) [6]. These measures seem to be quite justified in the future. Nevertheless, to introduce these measures, it is necessary to change the legislative framework, primarily the provisions of Article 54 of the Civil Code of the Russian Federation on the legal entity location, as well as the norms of Federal Law "On state registration of legal entities and individual entrepreneurs" (August 8, 2001 No. 129-FZ).

A promising area of applying information technologies using artificial intelligence is the distribution of state support among business entities. The use of artificial intelligence can simplify the distribution of support among business entities, making

Table 24.2 Principles of the use of artificial intelligence in the state regulation of entrepreneurship

Principles	Principle implementation
Guarantee of the personal data safety	Blockchain technology, a user identification
Effective management	No subjective interference, transparent reporting, automated and objective decision-making in public services providing
Caring for entrepreneurs	Regular monitoring of needs and rapid adjustment of government regulation
System stability	Regular auditing by the developer of the artificial intelligence platform and maintenance by the artificial intelligence platform, as well as monitoring the financial stability of entrepreneurs and timely submission of tax reports when making a decision on the provision of state financial support
Risk insurance	Insurance and reinsurance contracts with “chains” of insurers
Data protection from hacker attacks	Security software and distributed cloud servers for data security
Staff support	Staff training, technical and educational support
Responsibility	Legal and technical responsibility of the developer
Legal support	The development of the regulatory support for the activity of artificial intelligence in the entrepreneurship state regulation

Source Compiled by the authors

the procedure more transparent, economically reasonable, efficient, and fair, emphasizing priority types of economic activity. This will allow us to bring new types of state support to business entities quickly. If the legislative framework and infrastructure for applying information technologies using artificial intelligence and related material resources are functioning stably, all interested parties should feel the effect of the phased implementation of the measures. These measures are necessary for challenges facing the current legal order in entrepreneurship.

Let us attempt to formulate the main principles of the use of artificial intelligence in the state regulation of entrepreneurship (Table 24.2).

24.4 Conclusion

1. The introduction of artificial intelligence is just starting. Nevertheless, this issue is important for the development of entrepreneurship in today’s conditions. It is necessary to give scientific understanding and adequate legal regulation.
2. The use of artificial intelligence in the state regulation of entrepreneurship will reduce the level of corruption in the distribution of state support.

3. The use of artificial intelligence optimizes the state support system and reduces the costs for its maintenance.
4. The use of artificial intelligence in the regulation of entrepreneurship will reduce the time for registration and the bureaucratic burden on small businesses.

It is necessary to comprehend the following problematic points scientifically:

1. The lack of regulatory framework for the safe introduction of artificial intelligence into the system of entrepreneurship state regulation;
2. Expensive implementation procedure, the lack of technical capabilities in the regions of Russia, and staff problems;
3. Possible ethical problems connected with the replacement of real workers with artificial intelligence technologies.

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Chapter 25
Artificial Intelligence Systems in Criminal Procedure

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Abstract The paper aims to solve problematic issues related to the determination of the place of artificial intelligence in criminal proceedings, the potential of scientific developments in this field, and the capabilities of certain types of artificial intelligence systems. To achieve the goal, the authors applied universal (dialectical), general scientific (analysis, synthesis, induction, deduction, comparison, forecasting, generalization, abstraction, etc.), and private scientific (sociological, statistical, mathematical, etc.) methods. The research results showed that artificial intelligence is only an attribute of advanced and effective criminal procedure. For the criminal procedure, the most optimal case is the development of application areas of artificial intelligence systems, not the systems themselves. The direction of creating standard algorithms for proof and decision-making in criminal proceedings for artificial intelligence systems is promising. The research novelty lies in the proposed approach to the application of artificial intelligence in criminal proceedings and the results obtained in the aggregate.

25.1 Introduction

None of the areas of human activity can exist in isolation. Mutual influence and interpenetration are characteristic of individual activities and entire systems. It is natural. However, there are cases of artificial conjugation of practically unrelated processes, phenomena, and objects. Such attempts are often not crowned with success, which

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is due to the fact that such interference and interpenetration should occur by default; otherwise, side effects and rejection are expected.

In recent years, there has been a tendency in the scientific field to conduct research, scientific, representative, cultural, educational, and organizational activities dedicated to informatization and the introduction of computer and information technology and artificial intelligence in various government and social processes. Similar developments have affected the criminal justice system.

With knowledge of the case and without procedural scientists, law enforcement officers actively discuss the potential of artificial intelligence in criminal proceedings, the electronic criminal case, and electronic evidence, as well as the newly rebuilt high-tech format of criminal proceedings. This fact is confirmed by numerous works, including fundamental ones, conferences, and seminars. However, not all researchers, following emerging trends, come to any worthy conclusions based on the results of their own developments. More often, the output is semi-finished products that demonstrate either a weak orientation in the topic or the conjunctural aspirations of the authors. However, the problematic nature of equipping real practical activities with artificial intelligence systems can come not only from the level of doctrine but also from the readiness of the criminal procedure for corresponding changes. Our survey of law enforcement officers (investigators and interrogators) yielded the following results:

- 75% of the survey participants believe that the current state of criminal proceedings indicates that it is not ready for the introduction of artificial intelligence systems, and such prospects are not expected soon;
- 22% of the survey participants noted that the introduction of artificial intelligence is possible only after reforming the criminal process and conducting scientific research;
- 3% agreed that it is impossible in the Russian criminal process.

It is unlikely that such results could indicate that the mass of publications in this area is known to law enforcement officers. Moreover, such data can show how much the subjects of crime detection, disclosure, and investigation trust artificial intelligence and allow its use in criminal proceedings. This probability is negligible.

To understand the reasons for this situation, it is necessary to determine the following central points:

1. What place should artificial intelligence systems take in criminal proceedings, and to what extent can they replace subjects of criminal proceedings?
2. How and to what extent can procedural scientists develop problems of using artificial intelligence in criminal procedure in their research?
3. Can artificial intelligence systems be potentially implemented in criminal proceedings, and in what format?

25.2 Methodology

Within the research framework, the authors used universal, general scientific, and private scientific methods. Universal methods are represented by dialectical methods, which serve as the basis for building the scientific knowledge of the research object and subject. General scientific include analysis, synthesis, induction, deduction, comparison, forecasting, generalization, abstraction, etc. These methods were used when presenting all material, formulating conclusions, and basic provisions on the text of the work. Private scientific included the following methods:

- Sociological methods were applied for conducting a survey of investigators, interrogators, investigators, and subsequent interpretation of the results of the questionnaire;
- Statistical methods were applied during the study of statistics on crime detection rates, crime rates, and other information obtained from official sources;
- Mathematical methods were applied when calculating the results of the questionnaire.

To update the identified problem, attention was drawn to the existing developments in this area [1, 2, 4, 5, 10], general provisions of the criminal procedure [6], and statistical data [9]. To reveal the main research part of the work, in addition to copyright data, the authors analyzed the provisions on artificial intelligence problems, including the justice system [2, 4, 10]. In the process of arguing the position on the functional essence of the criminal process, particularly on its biofunctionality, with the author's interpretation, central ideas from individual works in the field of the criminal process were cited [3, 7, 8].

25.3 Results

The scientific literature often presents publications that provide statistics from various official sources indicating problems in detecting, disclosing, and investigating crimes. We are mainly talking about low disclosure rates. For example, it contains information that less than half of thefts committed using advanced information technologies are disclosed [9]. This circumstance is used as an argument for the need to find new means and tools to counter crime. This is also guided by an increased level of crime, the use by criminals of new ways of committing crimes, and the eternal problems of the criminal process. The eternal problems of the criminal process are as follows:

- Contradictions of the criminal procedure law and real criminal procedure;
- The increased workload of the subjects involved in the detection, disclosure, and investigation of crimes and the court;
- The prosecutorial nature of criminal procedure;
- The dependent position of the subjects involved in the detection and investigation of crimes;

- Poor training of law enforcement officers;
- Investigative and judicial red tape;
- Corruption risks of criminal procedure and criminal procedure law [1, 2].

For a radical transformation in this situation, the intellectual capabilities of individual investigators, interrogators, heads of investigative bodies, etc., become extremely insufficient. In this regard, the need for a qualitatively new system of intellectual support for operational-search and criminal-procedure activities, including based on the capabilities of artificial intelligence, is being updated. To what extent can artificial intelligence replace officials? We turned to the law enforcement officers with this question. Even though the majority of respondents (40%) indicate that the advantages of artificial intelligence can be successfully used in criminal proceedings, and 26% note that artificial intelligence systems can perform separate functions of subjects of criminal proceedings, it is noteworthy that 34% indicate that artificial intelligence will never replace subjects of criminal procedure.

It is apparent that, first, most law enforcement officers do not fully understand the capabilities of artificial intelligence systems in criminal proceedings; second, law enforcement officers allow a reduction in the number of posts of investigators, interrogators, and other subjects of the criminal process with the strengthened introduction of artificial intelligence systems, which is a significant risk of losing their jobs.

Fears are partly justified because artificial intelligence systems are actively used in a wide variety of areas, replacing the person, including the sectors of services, trade, industry, finance, banking, etc. These developments also affected the legal area. The examples are as follows:

- Sberbank PJSC introduced a "robot lawyer," conducting a legal examination of a credit transaction and issuing conclusions;
- PJSC MegaFon introduced a program that performs the functions of creating model contracts, generating feedback on standard claims, and translating scan copies of accounts into the format of the copied text;
- Interfax-LAB Research Center introduced SPARK service that calculates the risk load;
- PJSC SIBUR Holding introduced a digital expert on contracts on the PolyAnalyst platform, saving lawyers from routine operations.

Nevertheless, there is no question of criminal proceedings due to the complexity of legal relations arising from the facts of the crimes committed and the equally complex criminal procedure. Even if artificial intelligence systems are introduced in the criminal process, they will be able to replace officials only on routine, similar operations that do not require creativity, the thinking activity of a living person. In this regard, artificial intelligence is only an attribute of modern and effective operational-search and criminal-procedure activities; it is not a basis for abandoning officials. Simultaneously, the prospects for the successful development of criminal proceedings lie in artificial intelligence systems, which will facilitate and accelerate the activities of subjects of the criminal process [4].

The current research on the problems of using artificial intelligence in criminal proceedings serves only as an attempt to approach the solution of relevant problems; it is not a solution. No matter how surprising, there is an explanation for this: a full-fledged independent study of artificial intelligence and its capabilities in jurisprudence and criminal proceedings is beyond the control of lawyers. Special knowledge in the field of mathematics, engineering, linguistics, management, psychology, and information technology is required to create algorithms for solving problem situations and special legal knowledge to adapt the developed algorithms to a specific subject area. The success of exploring the possibilities of artificial intelligence in criminal proceedings will depend solely on the simultaneous use of both pieces of knowledge.

Thus, the conclusions of procedural scientists who are trying to offer some solutions for the introduction of artificial intelligence systems in criminal proceedings without appropriate information and technological basis may look unconvincing. In these conditions, it is best for the subject (i.e., the processual scientist) to develop only the areas of application of artificial intelligence systems, not the systems themselves. Apparently, the second is impossible without the first, as well as the first meaningless without the second.

During the survey, officials of the criminal process named artificial intelligence systems that can potentially be implemented in criminal proceedings. Among such systems, they identified expert systems (27%), decision support systems (21%), neural networks (15%), and automated databases (37%).

The results of the survey show some interesting moments. In particular, the reference of artificial intelligence to the automated databases by most of the respondents suggests that law enforcement officials do not know the types of artificial intelligence and have no complete idea of the device of the automated databases. In such conditions, it is too early to speak about the readiness of the system of criminal proceedings for equipment of this sort of technology.

To this day, scientists and practitioners are offered many options for implementing such systems. It is fairly possible to speak about such forms of the application of artificial intelligence as the systems of support of decision-making, expert systems, neuronets, intelligent manufacturing systems, etc. Such systems help improve management efficiency by automating the activity and functioning of law enforcement agencies, allow considerably reducing time expenditures on decision-making within the specific situation related to the law, and improve the quality and development of the made decision [10]. This is made possible by the fact that any intelligent system is the result of the accumulation of all available knowledge in a certain area. For example, in expert systems, human intelligence is used in the concentrated look for the solution of standard situations in various fields of knowledge. Simultaneously, the recommendations issued by the machine have advisory character; decision-making remains for the person though these decisions represent qualitatively new, higher level [6, pp. 29–30].

Regarding the area of criminal proceedings, it is proposed to perceive artificial intelligence (1) as a means of reducing the burden of subjects of criminal procedure, (2) as a means of reducing paperwork and the transition to an electronic criminal case,

(3) as assistants at criminal proceedings, (4) as a condition for refusal of traditional functions of the investigation and inquiry, etc. [2]. Without getting into an argument with the authors of the offered positions, we will point to their key omission: they did not consider the functional essence of criminal proceedings.

The problems specified earlier do not form a crisis state of criminal proceedings; they are not initial and do not act as backbone factors. By and large, they act as a consequence of the improperly constructed criminal procedural system of implementation of the functions of criminal proceedings. The traditional form of representation of the functional side of the criminal proceedings in the form of prosecution, defense, and resolution of a criminal case is long outdated. We believe it does not demonstrate the existence of competitiveness and is the cornerstone of all related problems. This is due to the fact that the ability to exercise any of these functions depends primarily on access to evidence and decision-making in criminal proceedings rather than on the specific authority to prosecute, defend, and resolve a criminal case. From this point of view, there is no need to talk about the equivalence of functions.

We are not talking about the classic version of the representation of the functions of the criminal process, where the functions are the same as those of the parties to criminal proceedings. We offer to develop the bifunctional essence of criminal proceedings, which we have previously proposed and supported and that have already received the corresponding justification [3, 7, 8]. The function of providing and the function of decision-making, having genetic interrelation (proof for decision-making, decision-making for proof), predetermine a form and content of criminal-procedure activity. In criminal proceedings, everything is directed to proof and decision-making.

This can be seen by analyzing the text of the Criminal Procedure Code of the Russian Federation regarding the identification of norms that do not regulate (realize, will organize) proof and decision-making. It is practically not present. It was explained by us earlier rather in detail [3].

Thus, our position is that artificial intelligence systems, in general, should prove themselves in the implementation of given functions. Therefore, they have to be directed to the proof on criminal cases and adoption of criminal procedure decisions. Identification, disclosure, and investigation of crimes provide a set of criminal procedure and organizational decisions, the adoption of which assumes optimization of all cash forces and means, including consulting, help, and advisory nature. We consider that expert systems can be quite successfully used, for example, in the course of proof and decision-making. The knowledge, contained in expert systems and expressed in the form of rules like “If there is such fact, then probably such action took place, or there was such motive of this action,” is suitable for the automated processing and allow imitating the process of assessment by the investigator of a situation and providing consulting support of the adoption of decisions in the dialogue mode. They can act as the key tasks carried out by means of such systems: definition of the possible directions of investigation (formation of versions about the occurring events, whenever possible, and various sources of obtaining information), the choice of the most probable directions; providing recommendations regarding further actions to the user (purpose of examinations, holding operational-search actions, test, and investigative actions, etc.).

It is also necessary to mention that the solution of these tasks is impossible without the following additional elements:

- Standard models of investigative actions;
- The system of the policy strokes providing optimality of carrying out investigative action;
- The system of the logical methods optimizing the solution of standard investigative tasks in traditional forms;
- The system of heuristic methods of the solution of investigative tasks.

In fact, it is necessary to develop standard algorithms of proof and decision-making in criminal proceedings, which will be put, for example, in an expert system. Depending on a particular input, based on its characteristics, the expert system will select the corresponding algorithm of actions of the subject of activities for identification, disclosure, and investigation of crimes. For example, on the message about the burglary which came to a control room of law enforcement agency, the expert system based on criminal, criminal procedure, and criminalistic characteristics of burglaries will carry out the criminalistic analysis of information and offer the algorithm consisting of standard actions for proof and standard proceeding decisions of the subject of investigation. Respectively, such a system will help the subject of investigation of crimes to distinguish and truly assess a criminal situation, select and carry out an algorithm of actions, and prove and make decisions.

However, there are several vital issues of basic property:

1. So far, neither criminal, nor criminal procedure, nor criminalistic characteristic of crimes is presented in an appropriate form; everything is either outdated, unreasonably integrated, or written vaguely;
2. Algorithms of proof and decision-making in criminal proceedings are unknown; they do not exist. It is difficult to register such algorithms for each crime. In this case, we believe that it is possible to be limited to standard algorithms;
3. There are no interdisciplinary developments that allow, on the one hand, procedural scientists to see in what legal knowledge there is a primary requirement for the introduction of a system of artificial intelligence in criminal proceedings, and, on the other hand, to experts in the area of computer and information technologies and artificial intelligence to understand in what embodiment the procedural scientists and law enforcement officials see the possibilities of artificial intelligence for their purposes.

In these conditions, it becomes impossible to speak about any introduction of artificial intelligence systems in criminal proceedings. Working in this direction will allow further optimizing all procedures in criminal proceedings. However, it is apparent that this is a task for the future. At the very least, it will require the systemic efforts of a considerable number of scholars and practitioners, but not certain researchers. Given all difficulties of such developments, it is easier for most people to abandon such initiatives. In this case, we believe that there is no way around the designated difficulties without the appeal to areas that promote the law in matters of the introduction of artificial intelligence systems.

25.4 Conclusion

If artificial intelligence systems are introduced into the criminal process, they will be able to replace officials only on routine operations that do not require a creative approach and the mental activity of a person. In this regard, artificial intelligence is only an attribute of modern and effective operational-search and criminal-procedure activities, not a basis for abandoning officials.

The conclusions of procedural scientists, who try to offer some solutions for the introduction of artificial intelligence systems in criminal proceedings, look unconvincing. For the subject, that is, a procedural scientist, the most optimal is the development of only areas of application of artificial intelligence systems, not the systems themselves.

Our position is that artificial intelligence systems must prove themselves in implementing the functions of proof and decision-making—the central and only possible functions of the criminal process.

It is required to develop standard algorithms for proof and decision-making in criminal proceedings, which will be embedded, for example, in the expert system. Their condition is negligible. Under these circumstances, it becomes impossible to talk about any introduction of artificial intelligence systems into criminal proceedings. Work in this direction is likely to optimize all procedures in criminal proceedings further. This will require the systemic efforts of many scientists and practitioners, not individual researchers.

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Chapter 26
Countering Cybercrime as the Main Area of State Criminal Policy

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Abstract The paper analyzes the provisions of the current legislation providing for criminal liability for cybercrime. The main directions to improve the effectiveness of the fight against cybercrime are determined. The issues of the effectiveness of the state criminal policy in combating crime at the national and international levels are raised.

26.1 Introduction

In the current world, most countries move from industrial to information type of society, which leads to an active transformation of public relations.

Nowadays, cyber technologies are the basis of information structures. The importance of it, as the main productive force of society, will only increase in the future.

With active digital development, national legislation lags behind the pace of technological progress. The emergence of new technologies, in addition to socio-positive processes, has also led to the use of scientific and technological advances to commit illegal actions, which requires additional criminal law protection of public relations developing in cyberspace, since with the transition to the post-industrial type of state, the connection of information technology and society becomes inextricable and increasingly interdependent.

The development of information technologies has created a virtual environment for new social relations, and traditional criminal law methods of combating crime are not effective against it. As a result, the phenomenon of cybercrime has emerged

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and is developing fast. Currently, the methods of cybercrime implementation are not fully known.

The spread of cybercrime is an objective and inevitable process because this type of crime allows committing socially dangerous acts with access to the information structure and personal data of Internet users in a short time with minimal resources spent.

F. A. Vestov and P. P. Shmelev draw attention to the fact that the growth of cybercrime is currently not the only problem; there is also a cybercrime spread in all areas of society.

Up until recently, crimes involving information and telecommunication technologies were committed primarily with the aim of embezzlement of cashless and electronic funds of citizens. However, computer technology is currently used to legitimize the financing of drug crimes, terrorism, and extremism, create and carry out illegal banking activities that affect the main state institutions [4, p. 73].

The anonymity and limitlessness of the information space allow the subjects of cybercrime to create and implement any illegal activity and legalize the proceeds.

Thus, when moving to the informational type of society, the main focus of state criminal policy is counteracting cybercrime and legal regulation of the creation, receipt, processing, storage, transfer, and usage of information.

26.2 Methodology

The methodology of cybercrime investigation is based on a comparative analysis of Russian criminal legislation with international legal regulation of activities to implement cybersecurity.

26.3 Result

The emergence and development of cybercrime have primarily led to a significant increase in economic crime. This is a great threat to government institutions and the private business sector. However, it also leads to a decrease in the level of traditional crime.

Simultaneously, the scientific community agrees that the main hallmark of cybercrime is its pronounced international character because cybercrime is committed outside state borders and uses a considerable number of information resources worldwide.

The primary target of developing the current criminal policy of the country is to work out effective criminal-legal measures against cybercrime. In the context of the scientific and technological revolution, information technologies do not always allow the state to implement criminal-legal regulation of public relations and develop new methods to combat cybercrime quickly and effectively. Therefore, it is necessary to create the opportunity for others in the information society to counter cybercrime.

One of the main drawbacks of criminal-legal counteraction to cybercrime is the lack of legislation, which additionally makes cybercrime latent and does not allow us to trace the quantitative and qualitative indicators and establish a relationship with socio-political and economic phenomena occurring in society.

Despite the long-standing recognition of this negative social phenomenon, the legislator and the scientific community have not yet formulated a clear definition of the cybercrime concept. This type of crime includes socially dangerous acts, where information resources are a way and a means of committing a crime. This concept also includes actions in the information space aimed at creating and maintaining conditions conducive to the commission of crimes.

The most common definition of cybercrime was developed by A. V. Nomokonov, who described cybercrime as a set of crimes committed in cyberspace using computer systems, computer networks, and other means of access to cyberspace, within the framework of computer networks and computer data [1, p. 48].

Another definition was formed by T. L. Tropina, who defined cybercrime as a set of committed in cyberspace unlawful and culpable interventions in the work of computers, computer programs, computer networks, unauthorized modification of computer data, and other illegal socially dangerous actions committed using computers, computer networks, and programs [2, p. 15].

Such a broad interpretation of cybercrime is due to its atypical nature. That is why it is difficult to form and implement any measures to counter this type of crime. Each crime involving the use of information and telecommunication technologies has exceptional specific characteristics, the probability of repetition of which when trying to commit a similar attack is very small. The accessibility of information and telecommunication networks and means of communication allows criminals to freely choose any social and legal environment of the state, which has the most criminal purpose and minimizes the risk of criminal consequences.

Despite abovesaid, it is impossible to legislate an exhaustive list of criminal acts constituting cybercrime in the criminal code because there is currently no uniform approach to the definition of the concept and signs of cybercrime in the international community [3, p. 139].

Russian criminalization of cybercrime is limited mainly to special articles of the Criminal Code providing for ordinary and terrorist offenses aggravation involving information technology. Chapter 28 of the Criminal Code of the Russian Federation, which provides for criminal liability for the commission of crimes in the field of computer information, currently contains some of the most ineffective articles of the Criminal Code.

As the main driver of the information society, information has a cross-border nature. Therefore, the protection of social relations of the post-industrial state cannot be effectively carried out exclusively at the domestic level. International institutions for countering cybercrime are crucial to the formulation and implementation of the criminal policy of the country against cybercrime.

It seems necessary to harmonize existing legislation in the field of combating cybercrime and regulating the use of information and telecommunication technologies with the legal standards of international organizations after the creation of a specialized regulatory act with the main directions of the criminal policy of the country.

As previously noted, the main sign of cybercrime is its cross-border nature, which, like any other cross-border crime, requires participation in international specialized organizations whose activities are aimed at countering cybercrime, since the introduction of the best practices of international organizations is one of the main methods of countering cybercrime.

The importance of international cooperation in countering cybercrime is determined, among other things, by the lack of separation of state borders in the information space.

In this regard, most countries recognized the need to develop international legal instruments that enshrine the main supranational provisions of the criminal policy on countering crime. The effectiveness of international cooperation in the fight against cybercrime requires, above all, political will and political compromises, which most countries are not currently ready to make because of the geopolitical situation.

Simultaneously, the national strategy to combat cybercrime should be an integral part of the overall international cybersecurity strategy and not exist separately.

To effectively counter cybercrime, the ones involved in the formation and implementation of criminal policy do not have sufficient criminological data and strategically and tactically verified plans to improve criminal legislation because current criminal statistics do not reflect the real scale of cybercrime, which will begin to develop rapidly as a result of the untimely development of criminal-legal mechanisms to combat it.

In the context of digitalization of the economy, the strategy of the criminal-legal fight against crime in the field of high technology developed based on reliable criminological research should become the basis of the criminal-legal protection of the post-industrial state.

The country's criminal policy against cybercrime cannot be effective using only criminal law methods because the necessary information resources and infrastructure must be created for the timely implementation of criminal policy.

One of the most effective ways to counter the commission of crimes is to create an automated system for exchanging information about emerging cyber threats between state authorities of the Russian Federation, state bodies of the Russian Federation, international organizations, governments of other countries, and the business community.

Despite the existence of automated electronic systems and electronic document management systems in state bodies, when cyber-attacks are committed, state bodies do not receive information about the presence of such a threat, which does not allow using timely and prompt preventive measures. Simultaneously, electronic systems for warning and exchanging information about the presence of cyber threats were the first stage in the creation of a system to counter cybercrime in most countries of Europe and were introduced back in the eighties and nineties years of the last century.

The creation of an automated system that transmits threats to information and telecommunications resources is possible now, even before the formation of the legal framework of criminal policy regarding cybercrime. It is assumed that for the normative consolidation of the procedure and rules for the exchange of information between state bodies on the presence of cyber threats, it is enough to adopt a by-law regulatory act of the Government of the Russian Federation, which will lay the foundation for the development of future criminal policy even before the adoption of the main array of federal laws.

Another important challenge to countering cybercrime is the lack of a clear delineation of the power to adopt and implement cybercrime measures among public authorities. It is impossible to solve this problem by adopting a substatutory decree. Therefore, the regulation of this group of legal relations will require the adoption of several federal laws because the current legislation provides for the security of only the critical information infrastructure of the state, ignoring other manifestations of information crime and the procedure for implementing the security of other actors in the information society.

Simultaneously, the effective implementation of these legal instruments also requires the creation of a verified strategy to combat cybercrime based on forecasting the situation, considering potential risks to society and the country. The constant change in public relations and the dynamism and variability of cybercrime do not allow the state apparatus to be endowed with exhaustive measures that will allow the country to ensure security against cyber threats independently. The criminal policy of the country should be comprehensive, integrate and involve the private sector in countering cybercrime. These measures will allow coordinating the actions of all participants in the information society and timely criminalize the developing cybercrime.

26.4 Conclusion

The main task in the formation and implementation of criminal policy is not only to reduce the number of crimes in the field of high technology but also to rationally use measures of state intervention in public relations of the information society and create conditions that contribute to technical progress, ensuring the protection of the main production forces in the digital economy.

In the context of the post-industrial type of state transition, the main direction of criminal policy in the country is the creation of the legal and organizational basis of the information security system. It refers to the entire state's information infrastructure and each participant in information relations.

To address the challenges posed by the effectiveness of the criminal policy against cybercrime, it is envisaged that the above-mentioned legislative changes will be implemented initially:

1. To enact a regulatory act that provides for the creation and commissioning of an automated information system for exchanging data on the presence of cyber threats between government agencies and the business community, which determines the procedure and conditions for exchanging these data.
2. To develop a legal act providing for the main directions, the strategy of criminal policy to ensure the information security of the country, delineating the competence of state bodies in the field of combating cybercrime, defining a list of subjects for the formation and implementation of the criminal policy of the country.

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Chapter 27
Artificial Intelligence in the Control and Supervisory Activities of the State: Current Trends

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Abstract The paper aims to determine the place and role of artificial intelligence (AI) in state control and supervisory activities, highlighting current trends in its use in this area of public administration. The methodological apparatus of the research includes traditional quantitative and qualitative methods, particularly the method of classification, expert assessment, comparative method, functional analysis, and analysis of scientific publications and other sources. The research reveals the following trends in the processes of using AI in the implementation of state control and supervision: uneven use of AI for different areas of public administration, as well as certain types of state control and supervision; the need to consider the scope of control and supervision of AI technologies applicable to the discussed areas, the criteria for the functioning of which can be formalized; recognition of the supporting and instrumental role of AI in the implementation of state control and supervision; differentiation of the use of AI at different stages or areas of control and supervisory interaction; and a combination of advantages and risks in using AI in state control and supervisory activities. The research novelty lies in substantiating the place and value of using AI in state control and supervisory activities, which seems to be a poorly studied aspect of research related to the use of information technology to optimize management activities. The proposed conclusions are of practical value for optimizing government control and supervision with artificial intelligence.

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27.1 Introduction

The active introduction of information technologies in all areas of public life puts on the agenda the issues of legal and scientific substantiation of such implementation. Artificial intelligence (AI) is one of the topical aspects of information technology in the current time. Its use in economic relations, the financial sector, and public administration is intended to increase the efficiency of the functioning of these areas. In the context of the state control and supervision reform occurring in Russia since 2016, the issues of using AI in the implementation of inspections and other control activities by state bodies are becoming in demand.

Scientists rightly note the lack of a unified view of the term "artificial intelligence" [1, 2]. The current Russian legislation does not provide a legal definition of artificial intelligence. Despite the active use of AI in public administration and in the implementation of control and supervision in the field of public administration, there is no understanding of the purpose and forms of such use, justification of its advantages and threats, highlighting problems and trends. Scientific publications devoted to the use of AI in state control and supervision are single and fragmentary.

The paper aims to determine the place and role of AI in state control and supervisory activities, highlight current trends and problems in the use of AI in this area, and propose solutions.

Research objectives are as follows:

- To review the definitions of AI;
- To explore and generalize approaches to the definition of AI in public administration;
- To highlight the traditional and priority areas of the use of AI in public administration;
- To characterize the trends in the use of AI in the control and supervisory activities of state bodies;
- To identify the advantages and problems of using AI in state control and supervision and suggest ways to solve the problems;
- To highlight the prospects for developing AI technologies around state control and supervision.

27.2 Methodology

The methodological apparatus of the research includes a set of quantitative and qualitative methods and approaches designed to achieve the goals and solve the research problems. These include the following:

(1) Method of classification. Given the variety of types of state control and supervision, as well as areas of control and supervisory activities (e.g., preventive), the use of AI can be differentiated. In the proposed research, the classification

was used to classify the features of the use of AI in various types of control and supervision, as well as to classify the problems of such use.

(2) Expert judgment. Through an expert assessment, the current trends in the use of AI in state control and supervisory activities were highlighted.
(3) The comparative method was used to highlight the national characteristics of the use of AI in the implementation of state control and supervision.
(4) Functional analysis was used to highlight the functions of state bodies in the implementation of various types of state control and supervision.

Scientific and other sources were used as part of the research methodology. Among them, we should highlight the works of scientists devoted to the study of the use of AI in the public administration system as a whole [1–5], as well as specifically in the control and supervisory activities of government bodies [6, 7], in the system of public services [8] and justice [9]. Additionally, we used documents of a programmatic and strategic nature related to the use of AI in today's Russia [10, 11].

27.3 Results

The concept of artificial intelligence is understood ambiguously by scientists. This is due to the fact that, first, the term is interdisciplinary, and, second, international normative sources for its definition are absent or are in the process of development. Representatives of technical, social, natural, and other sciences interpret AI in different ways. What they have in common is the conclusion that the use of AI implies the use of neural networks as a type of machine learning capable of identifying patterns between primary and final data and giving the correct answer even for data that was not in the original sample [2].

Scientists acknowledge the emergence of AI as a result of the use of machine learning [8].

Along with neurotechnologies, scientists refer AI to "end-to-end" digital technologies [6]. Policy documents also contain such a position that using AI in public administration, including control and supervisory activities [10]. Strategic documents name AI among the main directions of the development of Russian information and communication technologies [11].

Scientists also pay attention to the interdisciplinarity of this concept [3], dividing AI into general and specialized (industry), which determines the specifics of its use in various fields.

It should also be noted that instead of the term AI, other terms are often used: information and communication technologies, digital technologies, "smart technologies," digital technologies, robotization, and others. Moreover, in some cases, they are used as synonyms.

It is necessary to highlight the following approaches to AI:

- AI as a subject of control;
- AI as a control object;
- AI as a means (a mechanism) of control.

Scientists also substantiate the concept of the state as a single digital platform [7].

Kim believes that the study of AI management should be multi-level: The first level is technical management, the others are social and economic management, and the highest level is global governance [4].

The effective use of AI in public administration is of concern to scientists and practitioners today. This, the highest judicial bodies of European countries, the EU as a whole, and the USA try to develop universal principles that allow using AI in the exercise of power [5].

All approaches to justifying the use of AI in public administration should be divided into positions that investigate the use of AI in the public administration system as a whole and positions that reveal the specifics of AI mechanisms in various industries. In this regard, it becomes relevant to highlight the industries where AI has been used for a long time and has its own traditions and patterns (traditional industries) and industries where such use is only indicated. It is believed that the maximum spread of AI takes place in the field of medical care of citizens and in the field of public services in general.

Henman recognizes that AI is actively used by the authorities primarily in such areas of public administration as public services, compliance, and the security sector [8].

Nowadays, scientists identify areas of public administration where AI is actually used: economic relations, socio-cultural area, and administrative and political area (or management) [2].

Scientists also divide these areas into those in which decisions were previously made only by humans and those in which the automation of managerial actions was traditional.

In general, scientists recognize that AI can be used at a wide variety of stages of government:

- Collection and analysis of data;
- Forecasting;
- Planning;
- Management organization;
- Coordination and interaction of participants;
- Control and accounting [6].

Despite the earlier cautious attitude of scientists to the use of AI in the field of security, in law enforcement, such studies are now carried out and confirm the effectiveness of using AI in this area of public administration. Thus, Rademacher claims that AI can "autonomously detect suspicious activity"; in certain law enforcement segments, the effectiveness of such detection is much higher than that of police officers [5].

In certain areas of public administration, AI is introduced more selectively, only in provisional blocks, and is at the initial stages of use, for example, in legal proceedings [9].

Understanding the risks of the use of AI leads scientists to recognize that because AI is a technology that is still under development, preventive regulation is impossible [4].

While publications on the use of AI in public administration and the provision of public services have been quite widespread in recent years, scientists are still only exploring the potential of AI in relation to state control and supervision.

Scientists believe that digital control technologies in public administration are information technology processes [7].

Simultaneously, scientists investigate the use of AI in relation to preventive activities, which are now considered the core of state control and supervision [6].

We must agree with the position of scientists that, in general, digital technologies are related to supporting technologies that do not change the very essence of control and supervision in the field of public administration [7].

The study of the use of AI in state control and supervision activities leads to the identification of the advantages and problems of such use.

Scientists acknowledge that AI is a double-edged sword. On the one hand, AI can bring a person as close as possible to a dream, an ideal, to a state of general happiness and prosperity. On the other hand, AI carries serious risks, comparable even to the creation of nuclear weapons [4].

Characterizing the introduction of digital technologies in the preventive activities of public bodies, A. V. Martynov distinguishes two areas in it: automation and digitalization of control, recognizing the domination of the verification component in the latter. The scientist speaks about the one-sidedness of digitalization of state control and supervision, which can lead to a significant lag of Russia from other countries [6].

Nowadays, the scientific community is also concerned with issues related to the integrity of researchers, technologists, and manufacturers of AI mechanisms. Increasingly, the question arises about the moral aspects of robotization and the relationship between social, moral, and legal values when using AI [1].

Henman names the following problems of using AI in public administration:

- Accuracy and legality;
- Proper process and administrative justice;
- Responsibility, accountability, transparency, and explainability;
- Compliance and control.

The scientist proposes technological and managerial innovations developed to solve them [8].

We have identified four main categories of problems arising from the use of AI in state control and supervision activities (Fig. 27.1).

To use AI for the benefit of people without harming them, scientists pay attention primarily to the regulation of relations with the intervention of AI [4].

Tasks are planned in the field of justice for AI, primarily, the creation of tools to support judicial activities, including programs for the intelligent assembly of documents, search for cases, support for making discretionary decisions, and drafting

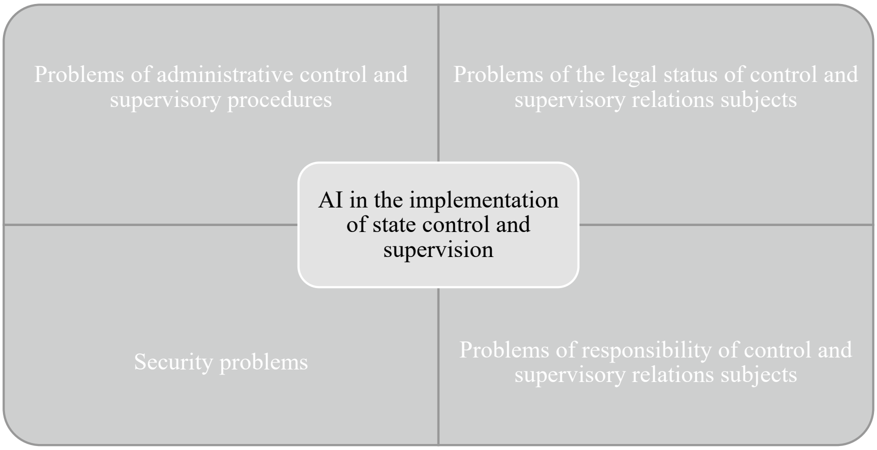

Fig. 27.1 Problems of using AI in the implementation of state control and supervision. *Source* Compiled by the authors

formalized court documents [9]. Scientists are confident that AI will contribute to the uniformity and efficiency of judicial practice [9].

Scientists also call for moderate AI regulation to enhance its positive potential [3].

Rademacher proposes to use two aspects of optimizing the use of AI in public administration: the legal regulation of social responsibility when using AI and suppression by AI of negative properties in the work of authorities with people [5].

In relation to controlling and supervisory activities, scientists propose to use AI to select objects in respect of which preventive measures are possible, analyze the perception of mandatory requirements by controlled persons, and assess the results of the activities of the authorities [6].

Scientists highlight the prospects for using digital control in public administration, associated with increasing the efficiency of transmission, processing of information, enhancing its reliability, ensuring the rights and legitimate interests of controlled persons, and the development of remote control [7].

AI can be used to simulate certain control and supervisory situations and improve the qualifications of state controllers and employees of controlled enterprises and organizations. Martynov also considers the introduction of AI to be relevant to creating digital twins of controlled persons [6].

In our opinion, AI can be used in the following directions or stages of the control and supervisory activities of the country:

- Selection of objects of control and supervision, including based on risk management;
- Scheduling inspections in terms of the danger level of controlled activities;

- Making decisions based on the results of control and supervision, the criteria for passing which can be formalized (automation of control and supervision);
- Control and supervision without interfering with controlled activities (remote control and supervision);
- Other directions of control and supervision that do not require a creative attitude capable of being formalized according to one or several criteria.

27.4 Conclusion

The analysis of scientific research and Russian program-strategic regulation of the use of AI in state control and supervisory activities reveals the following trends in this process.

First, it is necessary to highlight universal approaches when the use of AI is considered in relation to the entire system of public administration, and it is possible to compare it with the use of such mechanisms in business processes.

Second, the active introduction of AI in various areas of public life allows targeting the tools for its use in various sectors of public administration: public services, law enforcement, legal proceedings, and state control and supervision. The introduction of AI into the area of state control and supervisory activities occurs later and more cautiously (compared, e.g., with state services). This allows us to highlight the trend of uneven use of AI for different government areas.

Third, in the development of the above classification, it is necessary to highlight separate areas of control and supervision in public administration, in which the use of AI has already become traditional and proven (fixing violations in the field of traffic through smart systems and others), and areas in which AI systems just get used to it. Thus, the specifics of the area of control and supervision by the government are also essential. Simultaneously, it should be recognized that AI can be used only in those areas, the criteria for the functioning of which can be formalized.

Fourth, we share the position of scientists regarding providing instrumental role of AI in the implementation of state control and supervision. We believe that the decisive word should remain with people, their legal position, and the creative attitude to their official duties, especially in the field of public administration.

Fifth, the use of AI can be used at different stages of control and supervisory interaction, as well as in its different directions (e.g., in preventive measures).

Sixth, the use of AI in state control and supervision activities carries new opportunities and risks for the public sphere. We have identified four blocks of problems of such use, which are associated with the regulation of administrative procedures for such control and supervision, the legal status of participants in the control and supervisory interaction, and issues of safety and social responsibility. Their solution should be comprehensive, systematic, and based on the legal regulation of the use of AI in the contemporary system of state control and supervision.

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Chapter 28
Issues of Unification of Certain Evidentiary Provisions

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Abstract The paper focuses on the problems of unification of procedural legislation on evidence and proof, including provisions on artificial intelligence in the context of the adoption of new procedural codes and the delimitation of procedural forms. The authors argue in favor of developing a unified framework for the legislative regulation of the process of proof and the fundamental impossibility of certain unifying legal provisions.

28.1 Introduction

Considering (comparative aspects of the institute of proof in various procedural forms) the institute of proof in various procedural forms using the comparative method, it should be taken into account that the presentation of evidence by the parties in support of their claims is a guarantee and the main condition for the judiciary to make a legal, reasonable, and fair decision. That is why the task of the court to establish the totality of the circumstances is significant for the competent consideration of the case. Common to all procedural forms is the action of dispositive methodological principle at the stage of gathering evidence to confirm the vast set of facts that constitute the subject of proof in a particular dispute.

Based on the established views in the doctrine, the paper aims to develop and substantiate a system of theoretical provisions on the order of proof in various procedural forms arising from civil and other legal relations.

The research objectives are as follows:

- To improve legislative regulation of the process of proof;
- To assess the effectiveness of the existing procedural order;
- To develop specific areas to improve evidentiary mechanisms;

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- To assess the prospects for harmonization and unification of legislative regulation of the process of proof.

28.2 Methodology

The research methods used during this research are determined by the goal set and the research objectives arising from it. Due to the need to work through a number of issues of legal dogma relevant to the institute of proof, it was considered appropriate to make a small comparison with foreign experience, for which the study of C. H. van Rhee and A. Uzelac was very useful [1]. Along with the legal and dogmatic method, the authors applied the comparative legal method, which allowed them to emphasize the issue of the difference in the purposes of proof in different legal systems. This distinction is confirmed by foreign works, the authors of which, in particular, reflect on the place of the adversarial principle in the different types of process inherent in the Anglo-Saxon and Roman traditions [2–4]. Determining the place of the Russian system in the discussed diversity required an analysis of judicial practice materials [5–7], as well as the use of the inductive method and methods of classification and systematization. This led to the conclusion about the different nature of the procedures of proof in Russian practice, depending on the procedural form. The principles of evidence range from unconditional adversarial to the introduction of the active role of the court.

28.3 Results

Since the beginning of the new millennium, many contemporary jurisdictions have been reconsidering fundamental principles. Even the basic tools of the process, including the ways of collecting and presenting evidence in court, have not been neglected. In recent decades, slow and ineffective litigation has been one of the generators of evidence collection reforms. In Europe and around the world, striking a balance between the demands of factual accuracy and the need to resolve disputes in a fast, cost-effective, and efficient manner remains a key challenge [8].

It is apparent that there are certain differences between various types of proceedings in some evidential matters, primarily due to the peculiarities of the legislative regulation of a particular procedural branch, that is, having their origin in the will of the lawmaker and the legislator. Such differences are often fundamental.

The rules of civil procedure reflect the stability of the rule of law in society, including the extent to which the judiciary can set an example in upholding the rule of law. Courts in civil law countries embody this tradition according to the measure in which judges are authorized to seek the truth according to the principle "the truth and nothing but the truth." In legal systems of the civil law tradition, the rules of civil procedure are procedural frameworks that assist judges in discovering objective truth [6].

The whole process of administration of justice is conditioned by the special procedure established by the legislative regime for certain judiciary actions in resolving certain disputes. It is quite natural that the differences in principle between the order of legal proceedings in different countries can also explain the existing differences between the legal nature of the types of proceedings.

The natural tendency of the reform of today's civil procedure is the introduction of some mechanisms into the procedure, which are becoming an important basis of the dispute resolution system. This includes the reduction of the judge's role in examining evidence, establishing special procedures for small claims, public interest litigation, disclosure of civil judgments on the Internet, and an increased evidential burden [6].

In those countries that historically belong to the Roman (civil) legal family, the investigative type of proceedings is more common. In the Anglo-Saxon legal family, adversarial proceedings are more common. Historically, civil law countries have required written statements and disclosure of relevant documents in court proceedings, and evidence—usually oral—was given in court [7]. The convergence of different types of legal cultures led to the emergence of a mixed type of proceeding along with inquisitorial and adversarial proceedings.

The decisive factor determining the outcome of many cases is the procedures—the rules of the judicial game—that govern the order of proceedings in the court of the first instance. The rules of procedure also apply at the appellate court level. Nevertheless, these rules are largely limited by the time limit within which the losing party must file a written appeal, as well as by the form and structure of the document itself. Unlike orality, a principle that determines most of the proceedings in the first instance, in the appeal, it is mostly a matter of writing [9].

The Russian judicial system is undoubtedly of the mixed type. On the one hand, in various types of legal proceedings, there is a direct effect of the principle of adversarial and equal rights of the parties. On the other hand, all forms allow for a more or less active role of the court (especially expressed in the administrative procedural form), which assists in the implementation of legal claims and legally protected interests of the subjects involved in the case. The court sets a certain vector guiding specific procedural actions of the parties in the process of proving certain circumstances of a disputed legal relationship. Such a complex nature of the process is optimal because it unambiguously ensures the optimal realization of the tasks of legal proceedings through the activities of a particular judicial body and the realization of the right to judicial protection of violated rights and legitimate interests of the subjects.

Thus, it is apparent that the institution of evidence and proof is the fundamental institution through which the principles of adversariality and dispositiveness, which are key to procedural form, are implemented.

As applied to the evidentiary process, on the one hand, the adversarial principle in Russian legal reality generally boils down to the right of persons involved in a case to present evidentiary means in support of their claims and objections. On the other hand, it boils down to the obligation of the court to create all necessary conditions for this. Simultaneously, the legislator does not hurry to unify the adversarial principle in different procedural codes and discloses it differently. Each procedural code contains unique formulations, the peculiarity of which, among other things, is the volume of disclosure of the legal essence of the most important procedural principle of adversarial proceedings and equality of the parties. Only the basic content of the principle and its direct effect in all forms of the process are common. The aforementioned normative acts contain a legal establishment, according to which, one of the fundamental principles is the requirements of the adversarial and equal rights of the parties in the procedural aspect. However, there are certain differences even in this formulation. It is interesting that the Arbitration Procedure Code of the Russian Federation identifies only the adversariality (Article 9).

Thus, Article 9 of the Arbitration Procedure Code of the Russian Federation (APC RF) contains a statement that a natural claim of each party is the right to see each other's arguments in a particular process. The guarantee of presentation of evidence, statements of motions, statements of one's legal position, and other significant procedural actions based on the adversarial principle is deduced from this postulate. Simultaneously, the risks of failure to perform a procedural action (especially in the area of direct evidence) are borne by each of the parties.

This statutory provision was introduced solely to ensure the direct effect of the principle of equality of the parties in the evidentiary process and the correct resolution of the dispute. An important means of ensuring equality of arms is the rule that all persons involved in a case are given the right to become acquainted with the arguments of the opposing party before the actual start of the trial. This right corresponds to the obligation to disclose evidence to other participants in the process within the time limits strictly regulated by law.

In this case, participants in the process are entitled to refer only to evidence with which other persons involved in the case have been acquainted in advance (part 4 of Article 65 APC RF). This statutory provision in no way precludes the possibility of providing additional means of proof directly at trial. Apparently, the scope of the factual basis of a particular dispute (the subject of proof) often changes significantly in the course of the case.

It seems reasonable to introduce a corresponding provision in the Civil Procedure Code of the Russian Federation (CPC RF) and the Administrative Procedure Code of the Russian Federation. Although the arbitration form of the process is traditionally considered by researchers and citizens as the area of action of professional subjects of economic activity, while civil and administrative procedural forms mainly cover the area of rights of individuals, such a guarantee would be an additional basis for ensuring the operation of the adversarial principle in all procedural areas and would contribute to a unified approach to this problem.

In turn, the Administrative Procedure Code of the Russian Federation also contains legislative formulation, the inclusion of which in related normative acts would also be desirable. We are talking about part 3 of Article 14, which also indicates the absolute equality of the parties in procedural matters of petitions and recusal, presentation of evidence and joint study of it, and in such procedural aspects as participation in the judicial debate and presentation of certain arguments, objections, and explanations to the judge. This list is an open one. According to the principle of the leading role of the court acting in administrative proceedings, this set of rights is provided to the parties. Apparently, there is no such meaningful characterization in either the CPC RF or the APC RF.

Finalizing the study of the effect of the principle of the process of proof in various procedural forms, it should be noted that certain aspects are absolutely impossible to unify. Thus, the specifics of the principle of dispositiveness in administrative proceedings lead to the fact that the legislator is forced to include in the Administrative Procedure Code of the Russian Federation the provision, according to which "the court, while maintaining independence, objectivity, and impartiality, directs the judicial process, explains rights and obligations to each party, warns of the consequences of the parties or failure to perform procedural actions, assists them in exercising their rights, and creates conditions and takes the measures provided for by this Code for a comprehensive and complete establishment of all factual circumstances of an administrative case, including for the identification and reclamation on its own initiative of evidence and the correct application of laws and other normative legal acts in the consideration and resolution of an administrative case" (part 3 of Article 14). Simultaneously, in civil and arbitration forms, the court only "assists persons involved in a case in exercising their rights and creates conditions for a comprehensive and complete examination of evidence and establishment of factual circumstances and correct application of the law when considering and resolving civil cases."

This distinction is due to the public-law nature of administrative proceedings and the need to protect the weak procedural side with the power resources of the judiciary. It is quite natural that the effect of the principle of equality of parties does not allow the inclusion of such a norm in the CPC RF and the APC RF, even in theory. With absolute adversarial proceedings, a court of general jurisdiction or an arbitration court is not empowered to collect evidence solely on its initiative in the process of considering a case. It has the right only to invite persons involved in the case to submit additional evidence in the manner prescribed by law.

An exception to this rule is aspects related to the production of judicial support for cases arising out of public-law relations. Considering this specific category of judicial constructions, arbitration courts can proactively request various evidentiary materials if these materials were not independently submitted by subjects with state-authoritative powers (part 5 of Article 66 of the APC RF).

Another aspect of the evidentiary process that requires a unified approach in the legislative regulation is the principle of the loss of the subjective right to object in bad faith or contradictory behavior, the so-called estoppel. This legal institute was originally developed in the science of substantive law to assess the prospective good faith of participants in civil legal relations. However, in recent years, it has found extensive application in procedural relations between persons involved in a case.

The application of this principle is possible in various situations that arise during the consideration of a particular case, including the following:

- When a party changes its position in the court of the first instance. In this case, the contradictory behavior of one of the parties could potentially lead to the annulment of legal claims in situations involving an obvious and unargumented fundamental change in the legal views of the party or the presence of contradictory arguments and explanations in the direct consideration of the case [3, 4].

- In case of non-contradiction of the facts and their subsequent refutation. This statement is especially relevant to the appeal body. A change in a particular position on the factual basis of a case is a potential ground for a ruling not in favor of the party in question [1, 3].
- In the concealment of facts related to the need for the court to take certain procedural actions [5]. For example, the failure to mention the existence of an arbitration clause.

In any case, the inevitable consequence of bad faith or abuse of a procedural right will be the loss of the opportunity to exercise a certain procedural right of a participant in the process. The considered legal structure was borrowed from the Anglo-Saxon legal system [2].

The principle of estoppel is contained in part 3.1 of Article 70 of the APC RF and part 3 of Article 70 of the Administrative Procedure Code of the Russian Federation. However, there are significant discrepancies in the construction of the estoppel in these normative acts. Thus, the APC RF stipulates that "the circumstances invoked by a party in support of its claims or objections shall be deemed recognized by the other party unless they are directly challenged by it or the disagreement with such circumstances does not arise from other evidence justifying the submitted objections to the substance of the claims." In other words, the procedural arbitration law prescribes the parties to take an active procedural position and, accordingly, obligates them to timely present the entire set of evidentiary means already at the stage of consideration of the case in the court of the first instance.

The Administrative Procedure Code of the Russian Federation contains a provision according to which "a party's admission of circumstances may be stated orally or in writing. The fact of the parties reaching an agreement on the circumstances or a party's admission of the circumstances, as well as the content of a party's oral admission of the circumstances, shall be entered in the record of the court session and certified by the signatures of the parties or the signature of a party. Statements on reaching an agreement by the parties on the circumstances, as well as a written acknowledgment by a party of the circumstances, shall be attached to the materials of the administrative case. This construct does not require the "tacit consent" of a party but the proactive actions of a person involved in the case, from which it can be clearly concluded that certain circumstances do not need to be proven because they are recognized.

This difference is due to the differences in the level of legal culture and the type of legal consciousness of potential participants in the proceedings in the arbitration and administrative form. As stated above, it is presumed that the arbitral process is "professional," and hence, additional constructions for the recognition of circumstances and measures for their legalization are not necessary.

It should be noted that the CPC RF does not contain a separate legislative provision enshrining the institute of estoppel. The construction of estoppel as a principle of forfeiture of the right to object in bad faith or inconsistent conduct in the civil procedural form can be derived solely from the rules of substantive law. Thus, such norms are contained in:

- For the invalidity of the transaction—subparagraph 4 of paragraph 2 of Article 166 and paragraph 5 of Article 166 of the Civil Code of the Russian Federation (CC RF);
- For inconclusiveness—paragraph 3 of Article 432 of the CC RF;
- For refusing to perform—paragraph 5 of Article 450.1 of the CC RF.

Simultaneously, it is apparent that a similar norm, on the model of the Administrative Procedure Code of the Russian Federation, should be included in the CPC RF as well. In turn, the APC RF will contain a corresponding norm in the current version due to the specific legal nature of the arbitration procedural form.

In the process of unifying legislation, it is necessary to develop in detail the mechanisms and potential scenarios of participation in the process of proving artificial intelligence, including in determining the reliability of evidence and conducting various expert examinations. Apparently, professional lawyers and technical experts are needed to develop such solutions. Undoubtedly, the justification for the use of the latest technological developments such as artificial intelligence in administrative proceedings is questionable, including in terms of ethics.

The next issue that also needs harmonization and unification is related to the list of means of proof contained in the current versions of the procedural codes.

In the current legal reality, only the APC RF contains an open list of means of proof. The considered act contains a separate rule that other documents and materials (not listed or referred to in separate articles of the Code) are admissible as evidence if they contain information about the circumstances relevant to a proper examination of the case (part 1 of Article 89). This wording is aimed primarily at legalizing the technically new means of recording information. Given the revolutionary and rapid nature of technological development, this position of the legislator is justified.

Similar provisions should be included in the CPC RF and the Administrative Procedure Code of the Russian Federation. Otherwise, certain carriers of information may in practice be deemed inadmissible evidence, eventually leading to forced amendments to these codified acts.

28.4 Conclusion

Summarizing the above, we note that despite the high level of development of the institute of proof in various procedural forms in theory and practice, certain aspects require further development and unification. The level of legal technique of a particular codified act, which is taken as a reference, should be considered.

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Chapter 29
Family Policy as an Integral Component of State Social Policy: Contemporary Challenges and Responses Through Innovation

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Abstract The paper studies family policy as a multicomponent category, one of the multi-structural social policy components. In the context of transformation processes affecting all areas of human activity, many countries focus on the issues of preservation and protection of the family as the primary unit of society, as well as the issues of ensuring the safe and full functioning of the family for the successful performance of its basic functions. The analysis of the constitutional provisions of the Kyrgyz Republic after the last constitutional reform revealed the expansion of social norms, including the country's family policy constitutionalized as a social state. Based on the use of systemic, comparative-legal, and statistical methods, the authors identified certain gaps and shortcomings of national legislation in the field of protection and defense of the family and developed recommendations for its improvement through regulatory and legal innovations. The results can be used in law-making activities in the field of protection and defense of the family, the development and implementation of national family policy, and conducting further research on the institution of family policy.

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29.1 Introduction

One of the integral components of the country's social policy is the family policy. The family is the primary cell of society that forms a person, who then becomes a member of society and, entering various social relations, participates in the country's functioning. The need for innovation in the national social policy is noted in numerous works of various authors, including Cho and Yi [1], Meister Broekema et al. [2], Arampatzi [3], Bragaglia [4], and Fonseca et al. [5].

The issues of family policy become extremely relevant and topical under the conditions of transformation processes affecting all areas of human activity, which occur in many post-Soviet countries, including the Kyrgyz Republic. According to the report of the Ministry of Foreign Affairs of the Russian Federation "On the promotion and protection of family values in the CIS," "an important task for the CIS countries is to develop effective organizational, legal, economic, informational, and educational measures to create favorable conditions for family formation, maternal and child health protection, development of adoption, support for young parents, and care for the older generations" [6].

Scholars consider the family policy as "the activity of the country, political parties, public organizations, interest groups, etc., aimed at reviving the family, the family way of life, the family culture lost in the long historical course of society, and the return of the family to its organic social functions aimed at strengthening the family as a social institution" [7, p. 34].

Because of the importance of family policy to the successful functioning and development of the country, the legal foundations of family policy are laid in the basic law of the country. As a rule, these foundations are enshrined in the constitutional provisions on protecting the family, motherhood, childhood, and fatherhood, which is the case in most constitutions of today's countries. We discussed this in our previous work [8].

29.2 Methodology

To study family policy as a multicomponent category, which is one of the components of multi-structural social policy, we used the method of system analysis to study the formation, development, and functioning of the institution of family policy in the Kyrgyz Republic as well as its relationship with other legal institutions in the study area.

The use of the comparative-legal method allowed us to study the problems in a synchronous aspect when considering the experience of foreign countries, traditions, and innovations in the regulation of this legal institution.

The statistical research method was used to analyze statistical data, which is the evidence base for certain factual data. The use of methods in combination and interrelation allowed us to identify certain gaps and some shortcomings of national legislation in the area of protection and defense of the family and develop recommendations for its improvement by means of normative-legal innovations.

29.3 Results

In the Kyrgyz Republic, which suffered repeated social cataclysms in 2005, 2010, and 2020 during the period of sovereign development, the issues of social policy of the country, particularly family policy, are very important and relevant. In this regard, at the highest level, the Constitution of the Kyrgyz Republic introduced a separate independent chapter "Socio-economic foundations of the constitutional order," which suggests the need to pay attention to the social block of state-legal relations. In this chapter, Article 20 enshrines provisions aimed at protecting and preserving the institution of the family. The legislator has clearly and precisely defined the importance of the institution of the family, stating that the family is the foundation of society [9]. This statement is an axiom. However, its reflection in the constitution demonstrates the country's priorities in social policy. The next provision of this research is that "the family, fatherhood, motherhood, and childhood are under the protection of society and the country [9]. This provision reveals the country's policy in the area of family and legal relations, enshrining the main institutions of the multicomponent institution of the family. In fact, this provision enshrines the objects of the country's family policy.

The following provision is reflected in part two of Article 20 of the Constitution of the Kyrgyz Republic, "Respect and care for father and mother is a sacred duty of children" [9]. On the one hand, this provision strengthens the moral foundations of family policy, which is extremely important because, in society, it is impossible to achieve success by coercion alone: Spiritual principles must be laid down so that a certain behavior becomes the norm, coming from the inner state and the inner conviction of the individual. On the other hand, it reinforces the duty of children to take care of their parents, which is not simply a consolidation of a duty that can be enforced by state coercion but is elevated to the rank of sanctity and must be built into the minds of children during education and upbringing.

The next provision is found in the third part of Article 20 "Children are the most important value of the Kyrgyz Republic. By creating conditions conducive to the full spiritual, moral, intellectual, and physical development of children, the country fosters patriotism and citizenship in them" [9]. This provision is a novelty of the constitutional legislation of the Kyrgyz Republic, most fully corresponding to the norms and provisions of international law regarding the rights of children to special care and assistance. By proclaiming children as the most important value, the country actualizes the special place of children in public policy. It lays the foundation for the formation of future builders of the country, guaranteeing the full spiritual, moral, intellectual, and physical development of children who are not indifferent to the fatherland.

The chapter "Personal rights and freedoms" reflects the basic principles of national family policy: the principles of voluntary marriage, reciprocity of marriage between a man and a woman, equality of spouses, and the principle of mutual responsibility of parents and children. Simultaneously, the recognition of marriage solely registered by the country is enshrined, which allows the country to protect the rights and freedoms of family members. It should be noted that with the expanding influence of religion on public institutions, this provision is an important guarantee of protection of human rights and freedoms, especially for women, who are most often subjected to domestic violence.

Article 27 of the Constitution of the Kyrgyz Republic enshrines the principle of the best interests of the child, the right of the child to a decent life, parental responsibility, and state guarantees for orphans and children left without parental care. We agree with S. M. Muratbekova that "a clear definition of this term seems important because the success and effectiveness of the further development and implementation of state family policy in the Kyrgyz Republic largely depends on how unambiguous this concept will be interpreted by representatives of the state public authorities" [10, p. 83].

In the Family Code of the Kyrgyz Republic, the basic principles of family policy, which are the fundamental ideas and provisions that define the content and directions of legal regulation in the field of protection and defense of the family, are unreasonably and very vaguely placed in Article 1, called "Main tasks of family legislation" [11], which introduces some ambiguity to this issue. For example, the Code "On marriage and family" of the Republic of Kazakhstan clearly and distinctly outlines the principles in Article 2 "Fundamentals of marriage and family law of the Republic of Kazakhstan" [12], which is quite logical and reasonable. The Kyrgyz national legislator substituted the concept of "foundations" or "basic principles of family law" for the concept of "tasks," which disorganizes family policy to some extent. For example, the Family Code of the Republic of Belarus clearly defines the tasks of the legislation on marriage and family [13], the solution of which involves the need for an appropriate family policy by the country.

In our opinion, Article 1 should be designated "Basic provisions" because it contains provisions defining the state policy in the area of protection and defense of the family, derived from the constitutional provisions defining the state priorities in this area. It contains the basic principles of family law and lays its foundation.

In this article, in part three of the normative-legal innovation, it is necessary to emphasize the principles of regulation of family relations by allocating each of them in a separate paragraph. The concept of "family policy" should also be reflected, which will contribute to the formation of comprehensive system activity in the protection and defense of the family because, as fairly noted by S. M. Muratbekova, "Relationships between family and country function mostly spontaneously, which significantly limits the rights of the family, often leading to the country's monopoly. Moreover, there is no clear position of the government on this issue" [14]. It is possible to enshrine the following innovative areas of family policy:

- Reducing poverty and strengthening targeted social protection for vulnerable segments of the population;
- Providing employees with children with favorable conditions for combining work and family responsibilities;
- Improving the quality of family health care;
- Strengthening assistance to the family in the education and upbringing of children;
- Improving family safety by reducing family violence.

By and large, the Family Code of the Kyrgyz Republic regulates marriage and family relations. The issues of protection and defense of the family and family members are also reflected in other normative acts, including the Children's Code of the Kyrgyz Republic, the Civil Code of the Kyrgyz Republic, the Labor Code of the Kyrgyz Republic, the Criminal Code of the Kyrgyz Republic, the Code of the Kyrgyz Republic "On offenses," and others. However, the Family Code must contain the basic principles and objectives of national family policy and, based on constitutional provisions, define the guidelines of family policy, which determines the general course of the government's activities and its main directions in this area.

Additionally, as our recommended innovation, Article 1 should be moved to Article 2; Article 2, which contains the basic concepts used in the code, should be designated as Article 1 because an appropriate glossary should precede the transition to the consideration of family law to provide a definition of the terms and concepts used. The Russian legislator designated a similar article in the Family Code of the Russian Federation as "Basic principles of family law" [15] and reflected in it the basic provisions that define the national priorities in this area.

As indicated earlier, family policy is related to education policy, which is due to the proclamation of compulsory basic general education in Kyrgyzstan at the constitutional level (part 2 of Article 46 of the Constitution of the Kyrgyz Republic). Part 3 of Article 27 of the Constitution of the Kyrgyz Republic establishes the responsibility of each parent, guardian, and custodian to provide the living conditions necessary for the child's development. These provisions should be specified and provided with a mechanism for implementation. Currently, a draft of the new Law of the Kyrgyz Republic "On education" is being discussed [16], in which part 3 of Article 37 provides for the administrative responsibility of parents (legal representatives) for the lack of appropriate conditions for a child, for failure to fulfill the obligations to provide a child with basic general education in accordance with the legislation of the Kyrgyz Republic.

Part 3 of Article 40 of the draft law of the Kyrgyz Republic "On education" indicates that "Trainees of orphanages and boarding schools for orphans and children left without parental care, after receiving basic general (secondary general) education, have the right to receive free primary vocational education," which limits the constitutional right to education of orphans and children left without parental care because part 4 of Article 27 of the Constitution of the Kyrgyz Republic states that "the state cares, raises, and educates orphans and children left without parental care until they are 18. Conditions are created for them to receive free primary, secondary, and higher vocational education. They are provided with social security" [9]. In this regard, it is necessary to supplement the proposed provision in the draft law "On education" with the words "and on a competitive basis of free secondary and higher vocational education" to expand the right to education of this category of persons and bring the educational legislation in accordance with the Constitution of the Kyrgyz Republic.

The full implementation of a family's reproductive and life-sustaining function depends on the population's health. Unfortunately, the current health policy of the Kyrgyz Republic is focused on treatment rather than prevention. Thus, in the first years of independence, the number of institutions providing primary health care was 618, gradually decreasing to 163 in 2010 and to 102 in 2019 [17–20]. Simultaneously, the number of hospitals is increasing. Although their number fell from 331 in 1991 to 184 in 2010, over the past decade, the number of hospitals has increased to 193 [17–20]. In our opinion, it is necessary to strengthen the preventive component of health policy and increase the number of medical organizations providing primary health care. Simultaneously, it is necessary to improve the quality of medical care by improving infrastructure, providing medical personnel, and improving the organization of the healthcare system.

Preventive work to protect the health of expectant mothers and children will play an important role in implementing family policy because healthy family members are healthy and full-fledged members of society. Maternal mortality in Kyrgyzstan is gradually decreasing: According to official statistics, it was 43 in 2019, compared to 66 in 2005 [17]. "Between 2000 and 2018, the maternal mortality rate decreased by 37%: from 45.5 per 100,000 in 2000 to 24.5–28.6 in 2018" [20]. Despite this, maternal mortality "remains high compared to levels in the European region of WHO" [21]. That said, these numbers are probably a bit low, as "WHO/UNICEF estimated that there were 76 maternal deaths per 100,000 births in 2015, while the Institute for Health Measurement and Evaluation (IHME) estimated a rate of 39.4 per 100,000 births in 2017" [21].

There has been a downward trend in infant mortality since 2000. "The mortality rate of children under five years of age has decreased from 65 per 1000 live births in 1990" [21] to 15 cases in 2019. Simultaneously, child mortality continues to be one of the most pressing problems. The greatest number of diseases in infants is individual conditions occurring in the perinatal period, which indicates the need for increased attention to the health of expectant mothers. Despite the proclamation of guidelines for national family policy at the level of the Constitution of the Kyrgyz Republic, its content depends directly on the socio-economic situation in the country. However, their constitutional enshrinement implies an active family policy, especially because the socio-economic and demographic data of today's Kyrgyzstan require urgent measures in this area. Thus, according to the analytical classification of the World Bank, according to the World Development Indicators database of the World Bank (World Development Indicators), the Kyrgyz Republic belongs to the countries with low income per capita (from $1035 and below) [22].

Population growth has decreased significantly. While in 1991 it was 21.9 per 1000 people, it decreased to 17.9 in 2020 [19]. The lowest rate of natural population growth during the years of sovereign development is found in 2000—12.8. Although there has been an increase of 20.2 since 2010, the statistics show a sharp decline in growth in 2020.

There is a significant gradual decline in marriages. Thus, in 1991, their number reached 10.6 per 1000 people; in 2010, the number of marriages was 9.2; and in 2020, their number equaled 6.0. It is necessary to note the greatest decline in marriages in 1995–2000 when the statistics showed 5.9–5.0. As indicated above, the natural increase in the population also showed the lowest rate in 2000—12.8. It is likely that these figures are indirectly related to the catastrophic decline in living standards of the population after the collapse of the USSR, stagnation of the economy, and Kyrgyzstan's transition period. The National Statistical Committee of the Kyrgyz Republic indicates that "from 1991 to 1995, the volume of GDP decreased by 45%" [23].

If we pay attention to the number of divorces, we can state a sharp decline in 1995–2000 and a gradual increase since 2005. According to statistics, the number of divorces equaled 1.3 in 1995, 1.1 in 2000, 1.2 in 2005, 1.5 in 2010, 1.7 in 2018 and 2019, and 1.4 in 2020 [18, 22]. The highest number of divorces (2.0 per 1000 people) was recorded in 1991 [22], which is probably due to the collapse of the USSR and the decline in living standards caused by the stagnant economy.

To ensure social protection of the family from the negative factors of socio-economic shocks, a government oriented toward building a social state must build a system of social protection that provides support for those exposed to social risks due to illness, old age, etc., including support for women with children, multiple children families, children, etc. Having experienced a deep crisis at the beginning of its sovereign development, Kyrgyzstan's social protection system is gradually building its paradigm based on the provision of targeted social assistance. However, there are certain imperfections in the existing system related to insufficient coverage of the population due to the costs of internal and external migration, budget deficit, and insufficient elaboration of the actual need for social assistance for families with children, etc.

Moreover, there is a need to improve labor and employment policy, ensure the right to work for women with children and citizens of socially vulnerable groups, and eliminate the employment of children and minors.

29.4 Conclusion

The following can be summarized as a result of the conducted research:

1. The family policy implies a comprehensive systemic approach because it is closely connected with education, health care, demographic policy, labor and employment policy, social protection policy, and economic policy. It is one of the important components of the national social policy. Because of its importance to the individual, society, and the country, its foundations are enshrined in the basic law of the country. The recent constitutional reform undertaken in the Kyrgyz Republic has updated and expanded social norms, including those that enshrine the principles and guidelines of state family policy, which reflects the social character of the country.
2. Current legislation generally develops, details, and specifies constitutional norms and provisions. In the national legislation of the Kyrgyz Republic, which contains family and legal norms and is aimed at the protection and defense of the family and family members, there are some gaps and shortcomings that have a significant impact on the state-legal regulation of the family sphere. This paper develops proposals for improving family law in the Kyrgyz Republic to define the concepts and principles of the family policy.
3. Given the close connection between family policy and educational policy, the paper argues for the need—as an innovation—to enshrine in current legislation sanctions for failure to fulfill the constitutional obligation to provide children with basic general education, as well as to reflect in current legislation constitutional guarantees for orphans and children left without parental care to receive free secondary and higher professional education.
4. The authors noted the expediency of strengthening the preventive component of the health policy of the Kyrgyz Republic as an innovation that should contribute to a further reduction in maternal and infant mortality.
5. A certain dependence of marriage and family relations on the socio-economic situation in the country was found. The divorce rate increases in periods of economic stagnation or in conditions of low development. As a recommended innovation, social protection and labor and employment policies should be aimed at reducing the negative factors of the socio-economic functioning of the country and increasing the responsibility of the country and the citizens for the family's well-being.

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Chapter 30
Measurement of Customs Performance in Conditions of Customs Institute Intellectualization

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Abstract Measuring performance is one of the most effective management tools. In this research, the authors continue mapping the problem of measuring the customs authorities' results by key areas of activity in the context of the qualitological systemic transformation of the customs institute caused by its intellectualization in the digital economy. The research is based on a cognitive approach that allows describing the intellectual environment of the activities of customs authorities and evaluating and managing models based on artificial intelligence. The implementation of the technology of representing the knowledge of experts in the subject field is carried out through the construction of production models based on fuzzy logic. These models allow presenting knowledge in the form of implicative statements using fuzzy formulations in antecedents and consequents and use generalized modus ponens as a logical inference. Computer-based implementation of mathematical models is performed on the MatLab software system platform by using the Fuzzy Logic Toolbox software package. The research results may be applicable in administering national customs authorities (the Russian Federation and Eurasian Economic Union) and form the basis for developing measurement models of the activity of customs authorities.

30.1 Introduction

One of the most important targets for the development of customs authorities as governmental bodies is aimed at achieving a high quality of customs administration and the implementation at a high level of state policy to ensure economic and other types of security by controlling foreign trade. The implementation of this benchmark

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is impossible without an appropriate system and tools to measure the results of the activities of customs authorities [1] that meet the current conditions of their development.

Since the main function of customs authorities is to provide economic security, control, and supervision, on the one hand, and create a favorable environment for doing business in a foreign trade zone, on the other hand, measuring the results of their activity may occur in various ways.

A strategic goal of developing the Federal Customs Service of the Russian Federation (FCS of Russia) is to create a brand new "smart" customs service, full of "artificial intelligence," rapidly reconfigurable, having information access to internal and foreign partners, invisible to law-abiding business, and efficient for the government [2]. It predetermines the way of measuring the results of the activity in the near term.

The issue of measuring the results of the activity of customs authorities in terms of efficiency and efficacy has not been thoroughly researched as an economic concept until now. It becomes apparent that these assessment areas should be distinguished.

Given that customs bodies are government agencies with limited state budget funds appropriated, it is hardly possible to compute an accurate amount of their economic benefit as an outcome. Thus, it is necessary to assess the efficiency of the activities of customs authorities.

Contemporary approaches to measuring the activity of customs authorities, based on intelligent modeling methods and advanced economic-mathematical tools, make it possible to monitor customs development indicators and create a database for future decision-making.

30.2 Methodology

Measurement of customs performance in Russia has been evolving for a particular period; its genesis is shown in Fig. 30.1.

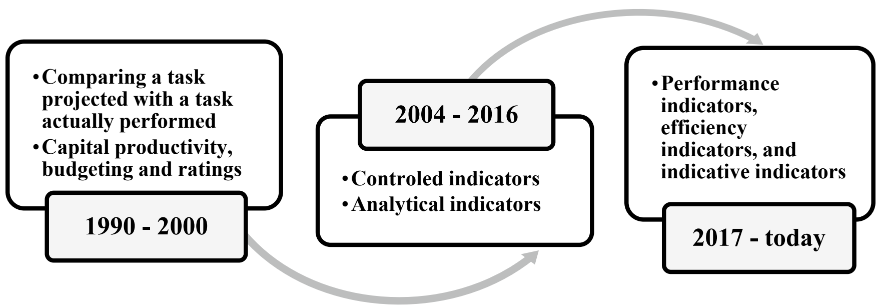

Fig. 30.1 Evolution of the approaches to measuring the results of customs authorities' activity in Russia. *Source* Developed by authors

Originally, the efficiency of the activity of customs authorities was measured by comparing actual data on customs duties paid with a projected task for a particular accounting period.

Figure 30.1 shows that the system of measuring the results of customs authorities' activity has gone through several development stages. Nowadays, the efficiency of the customs authorities' activity is assessed by a complex of efficiency indicators, performance indicators, and indicative indicators. On the one hand, it allows keeping track of evolving results carefully (due to a comprehensive list of indicators) and revealing the resources for improving the overall quality of the activity.

However, this system has several drawbacks. First, it essentially remained intradepartmental, failing to reflect consumer estimates and overall results of the whole system of customs authorities (indicators are computed for distinct links/levels of the system). Second, complex methods of calculation and a huge number of numbers to calculate are preserved. Finally, there is a failure to account for the contribution to the goals by the individual level of the customs system.

The analysis of a foreign experience in quantity indicators showed that the assessment system, being an integral part of results-based management, contains such areas as intelligent data analysis, consumer estimates (perceptions index), and data monitoring mechanisms [3].

Measurement approaches vary from country to country due to the national specificity of customs operations and the level of development of customs services, and the country in general.

Having analyzed the available approaches to measuring customs authorities' activity worldwide [4–6], we conclude that they can be conventionally divided into quantitative (time, cost, etc.) and qualitative (expert) models, involving combined assessments of various types of government bodies' activities.

It is worth noting that the Russian Federation has successfully implemented the first approach, though it is not informative enough to assess managerial decisions. Hence, it is advisable to develop this methodology by applying qualitative (expert) modeling for assessing customs authorities' activity concerning key assessment areas and the strategic perspective of the customs service development. Contemporary digital transformations of socio-economic and financial relations induce the revision of methodology to apply quantitative methods in economy and finance [7]. Considering the metrics of the digital economy, R. Bukht and R. Heeks point out that data collection is left behind technological progress in the context of dialectic innovations [8]. This leads to the need to perform calculations in the presence of inexactly specified parameters. The use of average and weighted average values can be the reason for obtaining significantly shifted point estimates of parameters. Replacing inexactly given values with deterministic ones leads to a complication of the calculation procedure and forces them to be iteratively selected to obtain acceptable results, thereby making it difficult to assess the error of the obtained result. It is also worth noting that the parameters can simultaneously include values with different nature of uncertainty, such as interval, fuzzy, and stochastic. As a result, it becomes necessary to present all information in a single formal logical language.

In this research, economic and financial indicators of the results of the customs authorities' activity were calculated based on the evaluations of subject matter experts. This led to the need to solve the problem of knowledge presentation with its subsequent formalization and imitation on the computer. This problem is one of the central problems in artificial intelligence research [3]. In this research, this problem is solved based on a cognitive approach to creating mathematical models, which is based on the methodology of intellectual modeling using fuzzy logic. Formalization of knowledge in the language of fuzzy logic allowed reproducing the human way of thinking and building actual schemes of reasoning used by experts, followed by their computer implementation. The approach used in this research reflects the general trend of digital transformation of measurement methods and models into an innovative methodology of intelligent measurement. "Traditional control methods cannot effectively solve this problem. Artificial intelligence provides new ideas" [9, p. 783].

A technique to implement a combined assessment of customs authorities' activity as a whole, subject to consumer preferences, is to apply the methods used in accordance with the key standards of customs authorities' activity adopted under the federal law "On customs regulation in the Russian Federation and on amendments to separate legislative acts of the Russian Federation" (August 3, 2018 No. 289-FZ) [10]. These approaches seem to be rather significant from the standpoint of assessing comprehensive results and need further development. As has been proven above [9], a system of balanced indicators may be applied as a comprehensive approach that allows creating a system of indicators concerning the key goals and areas of the customs service development.

Thus, consolidating these approaches to assess the activities of customs authorities allowed classifying these approaches according to the assessment areas proposed earlier [11]—economic security, finance, clients, training, and development. These areas will enable customs authorities to assess the efficiency of their key functions, namely their share of economic security, the volume and completeness of the federal budget revenues, the terms of foreign economic activity (FEA), and the level of the development of customs authorities based on technology innovations in their activity. Moreover, the methodology proposed [9] allows solving the problem of assessing the share of a particular segment of the customs system to achieve the goal set.

30.3 Results

For modeling, we will choose the area of "Finance," which shows the efficiency of customs authorities in performing their fiscal function. The indicators in this area have been specified in accordance with the Regulation of the Government of the Russian Federation "On the system of performance indicators of Customs Authorities of the Russian Federation, the order and methodology of their monitoring" (September 29, 2012 No. 994) [12]. There are three indicators represented further.

Table 30.1 Dynamics of other fiscal indicators in 2013–2021

Years	Indicator "The level of exceeding the projected revenues to be contributed to the federal budget by the customs authorities when collected from the income administered" (indicator 4)	Indicator "The share of customs payments refunded to the payors in order to satisfy the complaints of FEA participants against the decision of customs authorities, its act or omission, in the total amount of customs payments," % (indicator 5)	Indicator "The share of customs payments refunded to the payors and set off as future payments to execute a court order, which set aside the invalid decisions taken by the customs officers, in the total amount of customs payments," % (indicator 6)
2013	1.6	0.0075	0.25
2014	0.0	0.0040	0.17
2015	1.1	0.0200	0.15
2016	1.1	0.0100	0.10
2017	2.8	0.0200	0.10
2018	2.1	0.0030	0.06
2019	1.6	0.0002	0.05
2020	13.3	0.0000	0.04
2021	43.5	0.0000	0.13

Source Compiled by the authors based on the report on the performance of the main performance indicators of the customs authorities of the Russian Federation [13]

The level of exceeding the projected revenues to be contributed to the federal budget by the customs authorities when collected from the income administered (indicator 4) was calculated during the formation of the system of evaluation of customs authorities. Therefore, the empirical basis for this indicator is quite broad (Table 30.1).

The dynamics of customs revenues to the federal budget within the last 20 years demonstrate a steady growing trend with some fluctuations in some years caused by intervening factors, including consequences of the 2008 crisis, tax maneuver in 2014 involving the reduction in export duty, changes in the structure and volume of the flow of goods, policy of sanctions of the recent years, and others. Simultaneously, the projected revenues collected by the customs authorities for transfer to the federal budget exceeded the target by 0–10% until 2020. This fact indicates a high quality of projecting these indicators, on the one hand, and efficient fiscal function performed by the customs authorities, on the other.

In 2020, due to the COVID-19 pandemic, for the first time in a long time, there was an underperformance of the indicator from its initial level (when revaluing the initial planned value by the end of the year, the excess percentage was 7.7%). However, when the situation stabilized in 2021, a peak excess of 43.5% was reached. The influence of these factors is out of the general trend over the past 22 years; for the purpose of correct modeling, these numerical values were not considered in the simulation.

Empirical data on two other fiscal indicators (Table 30.1) are uniform and generally provide a positive assessment of the collection of customs payments. These indicators have been calculated since 2013.

The level of achieving the goal in the area of "Finance" shall be called Y and modeled by means of a knowledge-based technique in the fuzzy logic format, which is a modified class of many-valued logic. Experts verbalize the algorithm as fuzzy reasoning. Since modeling is based on expert knowledge such as "If 'CONDITION,' then 'EVENT,'" rules of production are defined by the experts, and E. Mamdani's algorithm is used as a modeling one.

Mathematical modeling of value Y is considered as a search for the thing described by means of a logical conclusion under the rules using the fuzzy implication operator as follows:

$$Y : \{(x_1; x_2)\} \to [0; 1], \tag{30.1}$$

where

x_1—the value of deviation from the projected revenues to be contributed to the federal budget by the customs authorities when collected from the income administered;

x_2—the aggregate share of customs payments refunded to the payors to satisfy the complaints of FEA participants against the decision of customs authorities, its act or omission, in the total amount of customs payments or set off as future payments to execute a court order, which set aside the invalid decisions taken by the customs officers, in the total amount of customs payments;

$(x_1; x_2)$—the vector of the key efficiency indicators.

When modeling the assessment, the authors conducted experiments in which such parameters as the type of the membership function (triangular, trapezoidal, and Gaussian) and the number of terms in the linguistic variables x_1 and Y were changed. As a result, the authors obtained triangular, trapezoidal, and Gaussian-fuzzy values of the input and output variables. This research describes the results obtained for the case when the formalization of fuzzy sets used the Gaussian membership function:

$$\mu(x) = \exp\left(-\left(\frac{x-b}{a}\right)^2\right), \tag{30.2}$$

where

a—the coefficient of concentration of the membership function;

b—the core of a fuzzy set.

To formalize the first model input as a fuzzy set, the authors analyzed the dynamics of the deviation value from the projected revenues to be contributed to the federal budget by the customs authorities when collected from the income administered in 2000–2021, % (Fig. 30.2). Given the definitive empirical database, knowledge, and practical experience, the range of values [0; 10%] has been set for a variable x_1

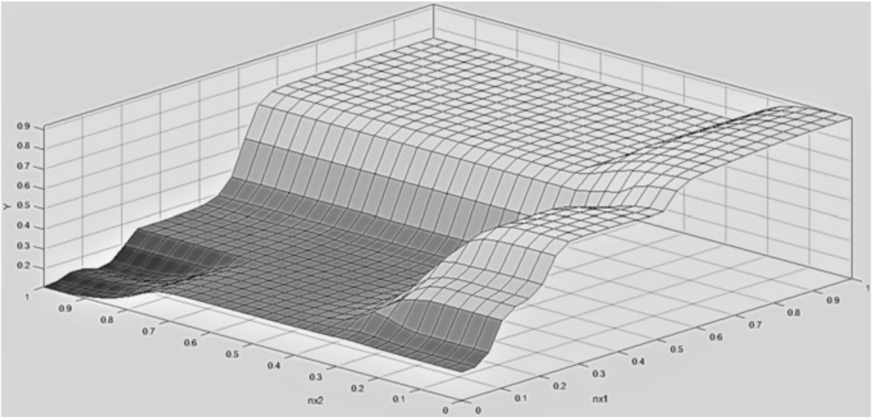

Fig. 30.2 3D model of assessing the level of achieving the goal in the area "Finance" (computer image). *Source* Developed by authors

by the experts; there are four linguistic intervals conventionally named zero (AZ), small positive (PS), medium positive (PM), and big positive (BP). Additionally, the experts set the linguistic values using the names containing Gaussian-fuzzy values: approximately 0%, approximately 1.55%, approximately 3.4%, and approximately 10%, respectively. It should be noted that the range of values does not contain negative values because in the case of failure to achieve the plan for indicator 4, the level of achievement of the goal in the area of "Finance" is automatically assessed as unacceptably low, and the goal—as unachieved.

To formalize the second model input as a fuzzy set, the authors analyzed the data from Table 30.1. The experts have introduced a variable x_2 with a universal set [0; 0.2575] (a unit of measurement—%). Term set of a variable x_2 was specified as follows: {low (L), medium (M), and high (H)}; parameter Gaussian-fuzzy values, respectively: approximately 0%, approximately 0.135%, and approximately 0.2575%.

The range of change in the output variable was divided by experts into five intervals corresponding to the following linguistic terms: below the planned value (L), planned value (NI), slightly above the planned value (SH), above the planned value (A), and much higher than the planned value (MH).

Display (1) will be described by means of expert-stated production rules based on a fuzzy generalized modus ponens [14]. The relationship between the preceding events and the consequences is presented in the following form:

Rule 1: If $x_1 \in$ AZ $\wedge$ $x_2 \in$ L, then $Y \in$ NI.
Rule 2: If $x_1 \in$ AZ $\wedge$ $x_2 \in$ M, then $Y \in$ NI.
Rule 3: If $x_1 \in$ AZ $\wedge$ $x_2 \in$ H, then $Y \in$ SH.
Rule 4: If $x_1 \in$ PS $\wedge$ $x_2 \in$ L, then $Y \in$ SH.
Rule 5: If $x_1 \in$ PS $\wedge$ $x_2 \in$ M, then $Y \in$ NI.
Rule 6: If $x_1 \in$ PS $\wedge$ $x_2 \in$ H, then $Y \in$ L.
Rule 7: If $x_1 \in$ PM $\wedge$ $x_2 \in$ L, then $Y \in$ A.
Rule 8: If $x_1 \in$ PM $\wedge$ $x_2 \in$ M, then $Y \in$ NI.
Rule 9: If $x_1 \in$ PM $\wedge$ $x_2 \in$ H, then $Y \in$ NI.
Rule 10: If $x_1 \in$ PL $\wedge$ $x_2 \in$ L, then $Y \in$ MH.
Rule 11: If $x_1 \in$ PL $\wedge$ $x_2 \in$ M, then $Y \in$ A.
Rule 12: If $x_1 \in$ PL $\wedge$ $x_2 \in$ H, then $Y \in$ A.

Having found actual values of input variables, the authors scaled them to fit the normalized range [0; 1]. The following ration method is applied:

$$nx = \frac{x - x_{\min}}{x_{\max} - x_{\min}} \tag{30.3}$$

where

x—the value with the interval for modifying $[x_{\min}; x_{\max}]$,

nx—the normalized value x.

Table 30.2 shows the normalized values of the parameters of Gaussian membership functions.

A computerized prescriptive logical production model (1) was designed on the MatLab software system platform with the help of the Fuzzy Logic Toolbox software package and interactive module fuzzy.

Verifying a fuzzy model designed based on an expert knowledge base implies the analysis of the results of testing the model to establish the relevance of fuzzy logic conclusions to objective reality. Let us model the parameters of the level of achieving the goal in the area "Finance" and assess the value of the output variable with the help of a fuzzy logic conclusion system. We use retrospective input data of

Table 30.2 Normalized values of the parameters of Gaussian membership functions

Parameters of Gaussian function (2)	Normalized variable						
	nx_1				nx_2		
	AZ	PS	PM	PL	L	M	H
a	0.05	0.040	0.07	0.2	0.131	0.13	0.16
b	0.00	0.155	0.34	1.0	0.000	0.53	1.00

Source Developed by authors

Table 30.3 Verifying a fuzzy model based on retrospective data

Year	x_1	x_2	nx_1	nx_2	Y	Term	Compliance with expert opinion
2013	1.60	0.2575	0.160	1.000	0.120	L	In compliance
2014	0.00	0.1740	0.000	0.676	0.251	NI	In compliance
2015	1.10	0.1700	0.110	0.660	0.252	NI	In compliance
2016	1.10	0.1100	0.110	0.427	0.258	NI	In compliance
2017	2.80	0.1200	0.280	0.466	0.254	NI	In compliance
2018	2.10	0.0630	0.210	0.245	0.548	SH	In compliance
2019	1.59	0.0502	0.159	0.195	0.500	SH	In compliance

Source Developed by authors

2013–2019 as test examples to test the modal. Table 30.3 shows the results of the practical application of this part of the program.

A sample check established a test situation and thereby proved the adequacy of the tools used.

To have the final analysis of a designed fuzzy model made and verification of a knowledge base terminated, we display the whole range of model scenarios (1) (Fig. 30.2).

30.4 Conclusion

The research allows us to make the following conclusions:

(1) The suggested methodology of modeling efficiency assessment of customs authorities by means of fuzzy logic allows us to make a comprehensive performance measurement of the key areas of customs authorities' activity and obtain the database for taking reasonable managerial decisions;
(2) In the conditions of non-stochastic uncertainty, the intellectual measurement methodology allows us to model the assessment in other areas of customs authorities' activities specified by the authors (economic security, clients, training, and development), thereby making an integral assessment of areas of the activity of customs authorities;
(3) The research results may be applicable in the activity of national customs authorities as an important tool in managerial decision-making and serve as the basis for reforming the system of measuring customs authorities' activity.

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Part IV
Current Problems of Financing the AI Economy and Ways to Solve Them

Chapter 31
Artificial Intelligence in the Implementation of Monetary Policy in Russia: Directions and Application Limits

Olga G. Semenyuta, Elena V. Dobrolezha, Oleg V. Basko, Vladimir M. Maznyak, and Inna G. Vorobyova

Abstract The chapter aims to study the possibilities of applying the potential of artificial intelligence in the implementation of monetary policy. The authors highlight the main areas of the application of artificial intelligence for implementing two strategically important tasks in the course of the monetary policy of the Bank of Russia: protecting and ensuring the national currency stability and ensuring the stability of the financial market in the Russian Federation. During the research, the authors formulated the advantages of artificial intelligence, allowing us to quickly obtain the necessary factual information with minimal costs and maximum accuracy, analyze it, and signal the identified facts of unfair practices and deviations from standard situations. This allows the state bodies to make emergency decisions in the field of monetary regulation, increase the reliability of corporate governance control mechanisms and transactions in the financial market, and improve the speed of customer service in compliance with the principles of the company's financial stability. It is shown that such advantages provide a high-quality implementation of monetary policy and the solution of tasks assigned to it.

31.1 Introduction

The introduction of artificial intelligence in all areas of our life and its benefits and risks are the subjects of vivid discussions. Insufficient attention is paid to the existing research in the field of analyzing the possibilities of using AI, given the huge potential benefits in the conduct of monetary policy to ensure the protection and stability of the national currency and the stability of the financial market. Accordingly, this fact causes serious scientific interest and determines the relevance and need to discuss a new vector of existing discussions.

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The effectiveness of the implementation of monetary policy depends on the ability, with minimum costs and maximum accuracy, to promptly receive and analyze the necessary factual information, identify the signals about deviations from the generated standards and standard situations in relation to unfair practices, which allows state agencies to increase the reliability of the control mechanisms of corporate governance and transactions in the financial market, increase the speed of decisions, and develop guidelines for the financial stability of the companies.

31.2 Methodology

The widespread introduction of artificial intelligence technologies, in accordance with the universal recognition of its potential to revolutionize production, contributes to solving major global problems and transforming business models by using aggregated huge amounts of data to make effective management decisions.

The financial sector is a leader in applying the capabilities of artificial intelligence due to its high cost-effectiveness in customer service, risk management, and efficiency improvement.

As a scientific direction, artificial intelligence was born and reflected in the research of human nature by ancient Greek philosophers and the process of cognition of the world. It was further developed in the mechanically constructed logical machine of the philosopher and mathematician of the thirteenth century R. Lulli and arithmetic machines of E. B. Pascal in 1642. Further, it was strengthened by the study of neurophysiologists and psychologists in the analysis of the work of the human brain and thinking, getting its foundation based on the theory of algorithms and the creation of computers.

In the 1930s, Alan Turing, an English mathematician, logician, and cryptographer, made a minor contribution to the development of computer science and the formalized algorithms (the Turing test) to determine in a test mode whether a computer on the machine can perform the following:

1. Treatment from the natural language for basic shared control with the computer;
2. The means of knowledge representation, by which the computer can write to the memory of what it knew or read;
3. The formation of logical outputs based on the stored information and in the construction of answers to questions and conclusions;
4. To adapt quickly to new circumstances, identify, and extrapolate, using machine learning and the signs of standard situations [1].

To fully pass the Turing test, a computer machine must have machine vision to perceive objects and robotics tools to manipulate objects and move in space.

The term "artificial intelligence" was introduced in 1956 by John McCarthy (a well-known American mathematician, the founder of OM functional programming, winner of the OM award for his huge contribution to the field of artificial intelligence research) at the Dartmouth Conference on Artificial Intelligence, with the participation of leading experts at the time in modeling the functions of the human mind and natural intelligence. Further development of artificial intelligence as a scientific direction was carried out by two parallel currents, which differ in methodology and technology. The first direction is neurocybernetics, which is based on mathematical modeling. The second direction is cybernetics "black box," the creation of which is associated with the creation of algorithms and software to existing computing machines with the ability to solve intellectual tasks no worse than people would do it. Unification of these trends unified into a single whole only in recent years.

In science, the term "artificial intelligence" is sometimes replaced by its semantic synonym "artificial cognitive system," which is a computer algorithm that can act independently and rationally, including taking into account information coming from the external environment [2].

Further, it would be possible to analyze the current approaches to understanding the contents of artificial intelligence. Nevertheless, given the scale of the tasks in this research, we believe that the disclosed general ideas about the nature of artificial intelligence are enough to determine the possibilities of its application. We understand this concept as information technology contributing to the development of machine learning systems equipped with the basic capabilities of the human intellect and aimed at solving problems of high complexity class, including management and calculating.

Despite the widespread discussion of the potential of artificial intelligence in various areas of our lives, very little attention has been paid to its use in the implementation of monetary policy to ensure the protection of the national currency and its stability, as well as stability of the financial market. This approach determines the need for this research.

31.3 Results

In cooperation with the Government of the Russian Federation, the Bank of Russia develops and implements a single state monetary policy, within the framework of which it ensures the achievement of the following goals of its activities [3]:

- Protecting and ensuring the stability of the ruble;
- Development and strengthening of the banking system of the Russian Federation;
- Ensuring the stability and development of the national payment system;
- Development of the financial market of the Russian Federation;
- Ensuring the stability of the financial market of the Russian Federation.

As part of the state economic policy, monetary policy is aimed at increasing the welfare of Russians and ensuring financial stability in the financial market. To achieve these goals, the Bank of Russia has a holistic view of the current state of the economy, financial markets, and banking sector and relies on a macroeconomic forecast.

The efficiency of obtaining the necessary information in compliance with reliable qualitative and quantitative characteristics is essential when forming a situational picture for the country as a whole, for the regions characterized by their heterogeneity, and for each financial market institution.

Advanced information and communication technologies can be of great help in solving this problem.

In the Russian Federation, the Federal law "On experimental legal regimes in the field of digital innovation in the Russian Federation" (July 31, 2020 258-FZ) entered into force on January 28, 2021 [4]. This law determines the goals and principles of the experimental legal regimes of digital innovation, defines the range of participants in experiments with digital innovation, and regulates relations arising in the course of establishing, suspending, terminating, monitoring, and evaluating their effectiveness and efficiency.

One of the areas of development, testing, and implementation of digital innovations is the financial market.

The following technologies used in the field of digital innovation are identified [4]:

(a) Neurotechnology and artificial intelligence;
(b) Technologies for working with big data;
(c) Quantum technologies;
(d) Manufacturing technologies;
(e) Technologies of robotics and sensors;
(f) Technologies of distributed registry systems;
(g) Wireless communication technologies;
(h) Technologies of virtual and augmented reality;
(i) Technologies of the industrial Internet (Internet of Things);
(j) Industry-specific digital technologies.

By digital innovations, the law proposes to understand new or significantly improved products or processes, new methods of sales or organization in business practice, and new methods of organizing the workplace or external relations introduced into use, created, or used with the application of these technologies [5].

Next, we will focus our attention on studying the possible use of artificial intelligence in the implementation of monetary policy.

The main areas of AI use are as follows:

- Development of natural language and machine translation interfaces for human–computer communication in natural language;
- Development of speech communication systems for improving the speed of information input, unloading of vision and hands;
- Processing of visual information for solving problems of image processing, analysis, and synthesis;
- Training and self-study as accumulation and formation of knowledge using data analysis and synthesis procedures;

- Image recognition, primarily of people, and their identification by appropriate attributes;
- Creation of intelligent robots that can independently interpret knowledge, process visual information, and perform operations to achieve their goals;
- Formation of software packages for the development of artificial intelligence systems focused on the processing of symbolic information and various languages;
- Implementation of logical programming capabilities that allow modeling human reasoning with the construction of direct and reverse logical inference;
- Designing tools to create artificial intelligence accelerators and improve chip design tools, allowing users to perform their work faster and get better results;
- Formation of knowledge-based information systems designed to solve unstructured and poorly structured problems.

The listed areas of the use of artificial intelligence fully reveal the potential of opportunities, due to which tasks are quickly solved with minimal costs and maximum accuracy.

One of the areas of practical use of AI tools is the analysis of information, modernized online cash registers (Cass), working in online mode, which, in addition to the huge range of benefits for the owner and the tax authorities, provide the possibility of price monitoring, including the socially significant goods, and automatic calculation of the consumer price index (CPI). This result is achieved by structuring the data and encoding translation systems used by retail chains, stores, and service companies into machine-readable formats.

The obtained result allows the Bank of Russia to have prompt and accurate data for regular monitoring and detailed analysis of statistical and other information, as well as on key events in Russia and the world that can quickly change the decision on monetary policy and affect the situation in the Russian economy and the dynamics of inflation. The experts analyze the compliance of the ongoing processes with previously obtained forecasts, which may become the basis for adjusting the forecasts of the Bank of Russia.

The result of this stage of analysis in the implementation of monetary policy is the clarification of the prerequisites for forecast scenarios, a set of external and internal economic factors that do not directly depend on the actions of the Bank of Russia but can significantly impact the Russian economy and the dynamics of inflation. Additionally, events are identified that may cause the situation to deviate from the baseline scenario and become risks for implementing the baseline forecast scenario. Based on the identified risks, proposals for alternative scenarios are formed.

The next stage of analysis in the implementation of monetary policy based on the received proposals to clarify the prerequisites for the basic forecast and risk factors is a discussion of potential requests for the analysis of additional variants that represent the importance of scenarios in making the decisions on the implementation of monetary policy and their reflection in the publications of the Bank of Russia. As a result of such discussions, a set of prerequisites and risks is formed, which is used in the further development of the basis for forecast calculations when constructing short-term (for a period of up to two quarters) and medium-term (for three years) forecasts of economic indicators using a wide range of analytical and modeling tools.

Thus, short- and medium-term forecasting is based on high-quality and promptly obtained data for forming key parameters of the Bank of Russia's basic macroeconomic forecast, including the dynamics of inflation and economic growth and monetary and balance of payment indicators. Additionally, the identified risks and the implementation of the basic forecast scenario form options for alternative scenarios. It takes a longer period to collect and process information quickly and present it in the required standard manually than when fully automating each stage of this organizational and analytical process based on artificial intelligence.

When implementing another key objective of the Bank of Russia related to ensuring financial stability, artificial intelligence allows identifying problems more quickly and signals about unfair practices in the banking system and financial markets.

Thus, the use of machine learning in the analysis of official banking statistics allows us to predict the impending violation of financial indicators and ratios that determine the stability and liquidity of credit institutions, which would signal the approaching deterioration of financial and social stability. Consequently, it allows the management of the credit institution to adopt adequate and optimal solutions to improve the management and quality of the portfolio [6, 7] and directs the recommendations of the Bank of Russia to the management of the credit institution for rehabilitation.

Additionally, the use of machine learning methods in linguistic analysis of banks' news sources can reveal negative news that will indicate an increase in risks and cause special attention from the supervision of the mega-regulator.

Another option of using machine-based linguistic analysis of news sources allows generating forecasts of stock price movements in the stock market, which will give rise to rapid decision-making by the Bank of Russia to prevent the collapse of the stock market. It will also be a signal of possible deterioration of financial and social stability.

A self-learning algorithm allowing to automatically find deviations from the norm for all market participants can provide the search and rapid identification of non-standard situations in the financial market for further appropriate decision-making by the mega-regulator.

When a market manipulation is detected, such measures to counteract unfair practices are taken in relation to credit institutions, their clients, and exchange market participants. These measures allow reducing the investigation time with the most complete verification and collection of supporting materials. After the finish of the work on an open investigation, if the fact of the manipulation or insider information is established, the Bank of Russia publishes this news information, and the materials are transferred to law enforcement agencies for investigation of the presence of criminal elements, damage assessment, and initiation of criminal proceedings. Allegations of manipulation and insider trading are too serious, so they should be comprehensively analyzed since each of such accusations nullifies the business reputation of a market participant. In a situation where it is necessary, on the one hand, to identify scrupulously worked out facts of unfair practices, and, on the other hand, the efficiency of regulatory decision-making is welcomed, the help from machine learning as one of the branches of artificial intelligence science is not appreciated.

The next option to use artificial intelligence capabilities to ensure financial stability in Russia is related to complement the potential of the blockchain, which is a distributed ledger technology.

As a technology, blockchain has weak points related to the following:

- High risk of a user having control over 51% of the nodes in a system with a small number of nodes, which can lead to failure;
- The need to understand that widespread adoption can also lead to failure because the blockchain infrastructure will not be ready for such a volume of operations, which, as a result, will reduce the speed of transactions and lead to problems with data storage and, consequently, with network efficiency;
- The anonymity of its participants in the blockchain network, which is associated with the risk of losing state control over important economic areas.

Artificial intelligence has several problems related to the following:

- The possibility of violating the privacy of information uploaded by users to the Internet in huge volumes, sometimes without understanding how their data are transmitted, stored, and processed;
- A lack of trust in the technology;
- The inability to explain the principle of its functioning to most users.

The combination of artificial intelligence and blockchain can effectively complement each other to build a fundamentally new generation of digital systems. Blockchain allows eliminating the need to implicitly trust artificial intelligence and provide privacy and explainability. Artificial intelligence will be able to form blockchain-based machine learning systems that are more secure, scalable, and better personalized and controlled.

By managing the blockchain, artificial intelligence could expand the use case and improve the reliability of the distributed registry. For example, with a sharp increase in transaction volume, artificial intelligence can automatically increase the speed of block creation, which will increase throughput at the cost of increased confirmation time.

Distributed ledger technologies (blockchain) have wide opportunities for application, primarily in the financial sector.

The introduction of smart contracts, functioning based on the distributed ledger technology, into the practice of Russian banks allows increasing the reliability of corporate governance control mechanisms and operations in the financial market.

The interaction of financial market participants in the current economy requires the institution of intermediaries, including payment system operators, exchanges, and credit bureaus. To ensure participants' trust in intermediaries, there is a need for a tool to verify that their operations meet the established requirements. Currently, this tool is an audit, which can be replaced by smart contracts.

A smart contract is a contract between two or more parties to establish, modify, or terminate legal rights and obligations. Part or all of the terms in such a contract are recorded, executed, or provided by a computer algorithm automatically in a specialized software environment.

The transition to the use of smart contracts based on distributed ledger technology as a means of ensuring trust allows us to increase the reliability of corporate governance control mechanisms and transactions in the financial market.

This is supported by the following advantages:

- Integrity and reliability of financial information required for conducting a transaction and its protection by cryptography;
- The use of a cryptographic signature allows one to verify the authenticity of a transaction or contract "blindly," without disclosing all content;
- Confirmation of the authenticity of the operation can be distributed to a large number of participants; there is no single "point of failure."

Simultaneously, there is a serious problem when combining these two technologies—their low transparency from the point of view of regulatory authorities, which only increases when they are used together. Thus, decision-making algorithms for complex artificial intelligence systems cannot always be fully disclosed by creators and third-party researchers, and blockchain technology declares the lack of control over the registry by one participant and the anonymity of participants as key features.

The most promising areas capable of functioning based on blockchain, including smart contracts, are the following:

1. Multi-variant implementation of interbank transactions, including cross-border ones, and settlement using blockchain technology. In turn, the use of smart contracts allows automating payments of the parties to the contract;
2. Placement of corporate bonds using blockchain technology. The first transaction of this kind in Russia was carried out by the National Settlement Depository in 2017 and was in the smart contract to execute the order of "Raiffeisenbank" JSC to buy bonds of "MegaFon" PJSC [8];
3. Factoring based on smart contracts on an open blockchain platform, for example, for factoring companies "Sberbank Factoring," "M.Video," and "Alfa-Bank" based on a consortium established in 2017 [2];
4. Optimization of the financial statements due to an increase in the quality and efficiency of incoming information;
5. Reduction of expenses from financial market participants on compliance with the requirements of the legislative framework caused by the transparency and ease of verification of the bank transactions;
6. Minimization of costs for centralized activities of financial market participants due to the introduction of digital identity and limited access to personal information;
7. Reduction of costs in the implementation of the operating activities of financial market participants due to the automation of transactions and their monitoring and error analysis;

8. The procedure of identification with the use of blockchain allows saving customer information in the required form for all participants in the public registry. No bank can change the database. Simultaneously, it is available to those who have the key;
9. When managing mortgage loans, banks tokenize securities. Using the blockchain platform, the institution issues loans to thousands of customers and then combines them into a single security, etc.

Thus, combining the broad capabilities of the blockchain and the flexibility of approaches based on artificial intelligence allows ensuring trust on the part of all participants and increasing the reliability of corporate governance control mechanisms and operations in the financial market, which significantly increases the financial stability of the Russian Federation, acting as one of the objectives of the activities of the Bank of Russia.

31.4 Conclusion

The analysis of the potential of using artificial intelligence in the implementation of monetary policy and its implementation in the economic and social areas allows us to positively assess the significant potential benefits and opportunities for increasing the efficiency of all financial market participants.

On the one hand, the advantages of artificial intelligence technologies allow one to quickly, with minimal costs and maximum precision, obtain the necessary information, analyze it, and inform about the facts of unfair practices and deviations from the standard situation. Moreover, these advantages allow the government agencies to take urgent decisions in the field of monetary regulation. On the other hand, the use of artificial intelligence technologies allows us to increase the reliability of the control mechanisms of corporate governance and transactions in the financial market and increase the speed of customer service in compliance with the principles of financial stability.

Such opportunities qualitatively increase the implementation of monetary policy and ensure the solution of the tasks assigned to it. Simultaneously, the implementation of technologies based on artificial intelligence in regulatory and control bodies faces a considerable technological problem (limitation)—the low explanatory ability of neural network algorithms in relation to their actions. In this connection, the megaregulator must control and audit financial systems based on artificial intelligence and blockchain as they create continuously growing risks for the state and the society and establish a legal basis for such activity.

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Chapter 32
Innovative Components of the Public Procurement Process in the Context of Digitalization of the Economy

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Abstract This paper presents the findings of the research on the innovative component of the public procurement system in the Russian Federation in the context of the global transition of contemporary socio-economic systems to digital platform solutions. The relevance of this issue is confirmed by the high demand for advanced digital tools that would provide full automation of public procurement, transparent pricing, simplification of procurement procedures, and streamlining the powers of control bodies. The paper aims to comprehensively study the current situation in the system of functioning of digital public procurement processes and determine the development prospects from the introduction of new IT solutions into this area, including artificial intelligence, cognitive computing, blockchain technology, "smart contracts," and others. During the research, the authors analyzed the dynamics of digitalization of procurement procedures from 2014 to 2020, presented a model of the Unified Information System in Procurement (UIS) in the context of Big Data, identified a new vector for the development of a smart (intelligent) contract system and its components, and provided recommendations for shaping long-term prospects for the development of state contract system.

32.1 Introduction

The contemporary context of the large-scale development and dissemination of digital technologies is forming fundamentally new formats in the work of the public administration system of the Russian Federation, opening breakthrough opportunities and new technological challenges for innovative solutions in the field of public procurement.

Technological transformations in this field require the creation and implementation of a wide range of tools that ensure high-quality automation of public procurement to achieve the following objectives:

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- Reduce the costs of customers and business;
- Improve the quality of goods, works, and services received;
- Increase the transparency and accessibility of government procurement contracts.

A transparent and well-organized public procurement system is indeed beneficial to all stakeholders in this process: the public sector (government, public authorities, and state-owned enterprises), businesses, and citizens.

In our opinion, in today's realities, compliance with these conditions is impossible without the formation of a digital intelligent government contract system based on predictive analytics, blockchain, artificial intelligence, the convergence of cognitive decision support systems, and cybernetic tracking.

32.2 Methodology

As the main methodological foundations of the research, the authors applied general scientific methods of cognition that allowed them to objectively and comprehensively investigate the conceptual provisions of public procurement in the context of current economic phenomena and digitalization trends, as well as private research methods that allowed processing and analyzing the scientific information received.

The research uses the methods of logical analysis and deduction and systemic, structural, functional, and comparative analyzes.

The collected empirical and statistical data allowed the authors to form the development trajectory of the public procurement sector and its transformation at the current stage of the country's economic development, focusing on the prospects for the introduction of artificial intelligence.

32.3 Results

Public procurement undoubtedly plays a meaningful role in the country's economy, having a qualitative impact on the sectoral structure and traditionally holding a significant share in the Russian GDP-about 27% in 2020. This indicator tends to increase.

Based on the dynamics of indicators of the procurement sector in the Russian Federation from 2014 to 2020, the expert and analytical report of the Audit Chamber of the Russian Federation [1–3] revealed that the average absolute value of structural changes from 2014 to 2020 was insignificant and did not exceed 1.2%, which, together with insignificant fluctuations in the dynamics of the proportion of purchases of the considered goods, works, and services, indicates relatively high stability of the sectoral structure in the field of public procurement.

The obtained results indirectly confirm the significance of the influence of government and corporate procurement on the development of a number of industries. Therefore, planning and implementation of procurement are highly possible to impact the magnitude of the multiplier of budget expenditures and, accordingly, on the GDP growth rate [4].

In this context, the public procurement system can be used as one of the key tools to stimulate the country's economic growth. The quality of functioning of the procurement system, its efficiency, and its continuity depend on the competent organization of procurement procedures at the government level and the formation of contract conditions and their execution in synergy with the capabilities of smart innovative digital solutions.

Digital solutions in public procurement provide access to new data formats, structure huge amounts of information, and make analysis more complex and structured, which leads to making purchasing procedures and strategies customized and more efficient [5].

In the Russian Federation, global work is being done toward digital breakthroughs and the transition to smart technologies in public administration and all areas of society. Thus, in December 2016, in the annual Address to the Federal Assembly, the President of the Russian Federation highlighted the need to form a digital economy in the country, especially noting the high development potential of the domestic IT industry. In the frame of implementing these initiatives, the deadline for the development of the "Digital economy" program was determined, reflecting the legal, financial, technical, and organizational measures for the development of the country's digital economy. The task was set to integrate the digital economies of the Russian Federation and the countries forming the Eurasian Economic Union. In May 2017, the Decree of the President of the Russian Federation No. 203 "On the strategy for the development of the information society in the Russian Federation for 2017–2030" was issued.

The implementation of these government initiatives resulted in adopting the national program "Digital economy of the Russian Federation" approved by order of the Government of the Russian Federation of July 28, 2017 No. 1632-r [6]. The program was prepared in partnership with the Ministry of Digital Development, Communications, and Mass Media of the Russian Federation.

The prerequisites for the formation of an intelligent contract system date back to 2018 with the entry of Federal Law No. 504-FZ into force. According to this law, all government customers, beginning from 2019, are required to conduct all procurement transactions in electronic form (with the exception of individual cases). It was then that the full-fledged digitalization of public procurement began.

In addition to the fact that Federal Law No. 504-FZ introduced a new "electronic trading platform" concept into the contract system, it also formalized the role of banks in procurement. Thus, participants in electronic procurement procedures open special accounts on which all financial transactions are carried out. In their turn, customers can now use bank guarantees to ensure the execution of contracts. Let us note that these services are provided only by those banks that meet the requirements of the Budget Code of the Russian Federation and the Government of the Russian Federation.

Therefore, the introduced model of financial support for participation in procurement envisages a differentiated amount of security for the application. It implies the opportunity of providing a bank guarantee in the electronic form, as well as placing funds in special accounts of the procurement participant in the bank instead of depositing them to the bank account of the electronic platform [7].

In the framework of these legislative innovations, it was assumed that the digitalization of procurement would contribute to the following:

- Reducing the time and financial costs of all procurement participants;
- Increasing the number of potential suppliers (contractors and performers) due to the possibility of submitting applications for participation in procurement in the form of an electronic document at any time of the day from any constituent entity of the Russian Federation, including those located at a considerable distance from the customer;
- Increasing the number of applications submitted for online competitions.

In the framework of the analysis of the indicators that assess the digitalization of procurement procedures, it was found that the share of electronic procedures at the end of 2019 was 95%, which is 24% higher than in 2018 and by 39% higher than in 2014. In 2020, this indicator amounted to 100% of the total volume of the initial (maximum) contract price of published notifications [1].

It should be noted that 80% of the procedures in 2020 were provided by the three largest electronic platforms: EETP JSC (32%), RTS-Tender LLC (28%), and Sberbank-AST JSC (20%); the remaining share was kept by other electronic platforms [1].

Nowadays, it may safely be claimed that the digitalization of public procurement has become, in essence, the automation of the existing processes of "paper" procedures with the subsequent refinement of its individual elements, such as electronic appeal and digital activation. However, in the context of rapid digital transformations, the digitalization of public procurement is only an intermediate stage in achieving the development of a smart (intelligent) contract system [8].

Despite the apparent positive structural changes in the public procurement system on the part of legislative regulation and the phased introduction of the innovative component [9], it hides drawbacks as well, which include procedural overload, lack of mobility, and the length of procedures, while public procurement remains the area of the highest corruption risk [10].

Continuous improvement of the procurement legislation does not reduce the number of violations detected by the procurement control authorities, the total number of which in the dynamics from 2014 to 2020 increased four times, from 21.5 to 83.5 thousand violations. The total number of financial violations increased almost six times as much as in the previous years, from 66.1 to 362 billion rubles [1].

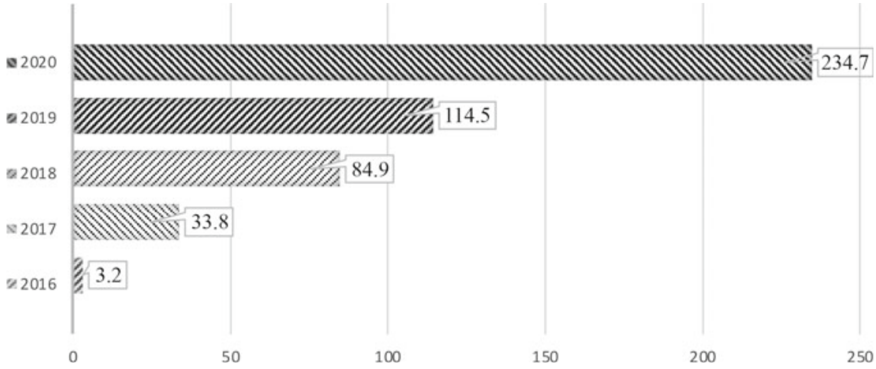

Fig. 32.1 Number of violations identified by the Federal Treasury. *Source* Compiled by the authors based on the results of the federal executive authorities exercising control over procurement

Thus, the Federal Antimonopoly Service of Russia (FAS) indicated the most typical violations related to selecting procurement participants (unlawful rejection of procurement participants), the procedure for placing information in a unified information system in the field of procurement and maintaining a register of contracts.

The subject of complaints received by the FAS is mainly procurement in violation of the requirements of Federal Law No. 223-FZ and procurement regulations (79% of the total number of complaints filed) and presentation of requirements to procurement participants that are not provided for in the procurement documentation (16%).

According to the Federal Treasury, there is a tendency for a significant increase in the value of detected violations. Since 2017, the number of violations has increased seven times, which is clearly reflected in Fig. 32.1.

Besides, the analysis of the violations revealed by the Audit Chamber of the Russian Federation showed that the largest volume of financial violations by number in 2020 were violations in justifying the guaranteed maximum price of the contract (GMP), which were over 96 billion rubles and amounted to 88.8% of the total number of financial violations.

The lack of a full-fledged electronic document flow in the unified information system in the field of procurement, the inadequacy of the regulatory framework in the field of regulating the collection of funds from the bank guarantee, and the lack of responsibility of the customer for not taking measures for the collection of penalties were noted as additional reasons negatively affecting the implementation of national projects and the functioning of the public procurement system.

The above makes the task of creating and implementing a wide range of tools that ensure the full automation of public procurement, transparent pricing, simplification of procurement procedures, and streamlining the powers of control bodies relevant.

Thus, digital technologies in the field of public procurement provide great opportunities for building a supplier's business reputation using artificial intelligence technologies.

In this direction, we should note the prospects of the Unified Information System in Procurement (UIS), which is an advanced state information system that interacts with a large number of external systems and counterparties and unites the entire big data of public procurement and procurement of other legal entities.

It is worth noting that the UIS contains numerous data on the performance/non-performance of contracts by companies and information on the existence of claims and payment of penalties. According to the data of the Federal Treasury of the Russian Federation, in 2022, based on the UIS algorithms, automatic verification of the suppliers' experience in fulfilling contracts for an amount comparable to the amount of the current purchase contract will be formed, which will become the foundation in the formation of the business reputation of suppliers.

Considering the UIS as big data, the following development prospects can be identified (Fig. 32.2):

- Traceability of the entire procurement chain from planning to contract execution;
- Online ad-hoc analytics for arbitrary indicators and sections (accounting for cash flows in the connection between the procurement and budget process; monitoring of purchases for national projects; identification of price anomalies in government contracts);

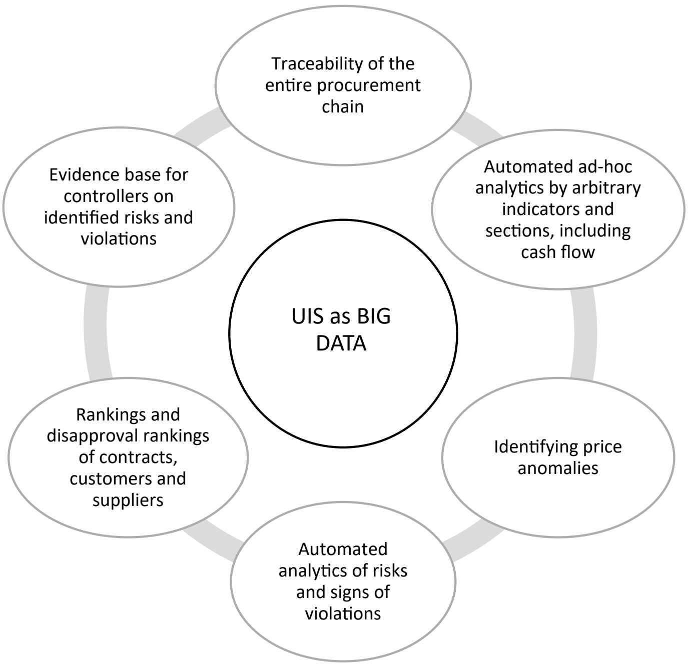

Fig. 32.2 Unified information system in procurement: a new vector of big data. *Source* Compiled by the authors

- Automated identification of procurement risks and signs of violations, which is an evidence base for signs of violations (primary invoice for inspections);
- Preparing a disapproval ranking of purchases and customers.

Aside from that, the introduction of new functionality into the UIS system, which allows employees of anti-trust services to prepare instructions in a structured form in the personal account of the system and check their implementation through personal accounts, is being discussed [11]. This, in turn, means that the subjective factor will be mitigated to the full in the activities of the regulatory authorities and, as a result, the number of errors and lost decisions will be reduced.

Additionally, the plans of the Federal Treasury set for 2022 define the following areas for improving the UIS system [12]:

1. Development of the UIS analytical functions, considering the growth in the demand for analytical data by public bodies;
2. Use of the UIS risk module as a compliance tool providing for automated workplaces of all controllers with rankings, risks, etc.;
3. Introduction of an interactive panel with analytics for each customer on his/her purchases, as well as the ability to analyze risks and violations for each customer and avoid their implementation;
4. Introduction of a constructor for calculating the fulfillment of quotas for the purchase of Russian products;
5. Full transfer to free software and UIS databases;
6. Increasing the level of information security of the UIS up to K-1 (the highest level, considering the conversion of closed procedures into figures);
7. Usability and business controls (the UIS will not allow violating numerous rules due to the multiple auto-controls).

The above testifies to the gradual introduction of new IT solutions into the public procurement sector, including blockchain technologies, neural networks, smart contracts, and neural networks.

In Table 32.1, the authors analyzed advanced technological solutions in the field of public procurement and considered the positive effect of their implementation.

Referring to the blockchain, it should be noted that the blockchain is a universal tool for building an intelligent procurement system because it has such properties as decentralization, complete transparency, confidentiality, and reliability, and can lead to the improvement in the economic and legal status of all subjects of procurement [13–15].

During the conclusion of smart contracts, the fact of distribution of information among users' computers increases trust between customers and suppliers. It thereby prevents the possibility of any unilateral change in contract conditions because each transaction is reviewed and verified by all network participants before it can be accepted and confirmed, i.e., a consistent process is applied to ensure pointed correctness in data distribution and data integrity maintenance [16].

Table 32.1 Digital transformation of public procurement: innovative IT solutions

IT-solution	Description	The effect of the introduction of technology
Cognitive computing and artificial intelligence (AI)	The use of machine learning algorithms that allow quickly classifying an enormous number of unrelated, often disparate, and unstructured sources of information about supplier costs (e.g., information on a public procurement portal, etc.)	• Consolidation of unrelated information into a single and constantly updated data source resulting in the simplification of its subsequent analysis and processing in the public procurement system
Blockchain	An innovative technology of a distributed data register that allows storing and transferring information with a high degree of protection	• Automation of procedures implying dehumanization of the procurement sector to reduce the scale of theft and errors • Accountability of contracts execution, which reduces the bureaucratic burden • Transparency, which allows regulatory authorities to access any document at each stage of the transaction, which significantly reduces the corruption component and the possibility of cartel collusion and increases the overall speed and efficiency of all transactions
Smart contract	A distributed database that stores transaction records accessible to all members connected to the register. A smart contract "is written in a programming language and executed without the participation of third parties, sealed by the parties with an electronic digital signature" [8, p. 3]	• Significant simplification of the participation in public procurement, reduction of transaction costs, development of the process of control over the quality of executed contracts

(continued)

Table 32.1 (continued)

IT-solution	Description	The effect of the introduction of technology
Neural network	One of the leading directions in AI creation, the principle of which is based on machine learning. The main feature of the neural network is that the "physical" formulas of the model are not programmed but trained	• Immediate detection of malicious attacks and assessment of the system's vulnerability, which allowed not only teaching artificial intelligence to highlight precedents and eliminate the consequences of hacker attacks and fraudulent attempts but also using this data in the future to prevent similar situations

Source Compiled by the authors

32.4 Conclusion

The conducted research allows concluding that the public procurement system is expected to undergo large-scale qualitative changes with the prospects for the introduction of smart information systems. The government gradually and systematically approaches the improvement of procurement effectiveness by optimizing the stages of procurement procedures and introducing end-to-end automation. However, a full-fledged transition to artificial intelligence technologies should be expected after the expiration of the objective amount of time required to fully engage the innovative component [17].

In this regard, the state faces the most important tasks grouped by the following objectives:

- Forming a long-term strategy for the development of the contract system in the field of procurement of goods, works, and services to meet state and municipal needs, considering the analysis of sectoral markets and the existing experience in the implementation of national projects;
- Developing a unified methodology to determine and implement indicators that show the efficiency of procurement of goods, works, and services carried out within the framework of the contract system;
- Forming a transparent cycle for placing government orders and executing government contracts, considering the introduction of innovative platform technologies.

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Chapter 33
Application of Artificial Intelligence Technologies in the Control Activities of the Federal Treasury

Kantemir L. Elmesov

Abstract The paper aims to present practical ways to implement the control function of the Federal Treasury in relation to the activities of audit organizations using artificial intelligence technologies. During the research, the authors applied statistical methods of quality control: checklist and Pareto diagram. The checklist "The results of the documentary verification of compliance with the requirements of the legislation in the audit organization" was developed. A list of control points that record the results of control procedures of the Federal Treasury during the documentary verification of audit organizations is proposed. The Pareto diagram "Causes of non-compliance in audit organizations" is constructed, allowing us to highlight audit organizations' risks and develop preventive measures in response to the identified risks. The research results can be applied in the methods of documentary quality control of audit organizations to select audit organizations for on-site inspections.

33.1 Introduction

During the documentary inspections of audit organizations, the experts of the Federal Treasury must identify the auditors whose activities have a high risk of errors and non-compliance with legal requirements in the auditing sphere. The review of scientific works [1, 5, 6, 9, 11] shows that the methods that allow applying the risk-oriented approach in the planning of on-site verifications of the activities of audit organizations are insufficiently investigated. To perform these functions, it is necessary to apply computer technology. Currently, digitalization is widely implemented in the area of control activities of the specialists of the Federal Treasury. The use of advanced computer technologies allows reducing the cost of verifications of audit organizations and increasing their efficiency. According to scientists [7, 12], the mass application of digital technologies provides legality, efficiency, and expediency of control actions of state bodies. One of the directions of digitalization of audit oversight is the use of artificial intelligence technologies. The authors [2] note that statistical methods can

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be used as artificial intelligence technologies in quality management systems. The paper aims to outline ways to apply static methods of quality control in the process of monitoring internal control in audit organizations. The objectives of the study are as follows:

- To develop a checklist on the results of the documentary verifications of compliance in the audit organization;
- To propose a list of control points that record the results of oversight procedures of the Federal Treasury during the documentary verifications of audit organizations;
- To build a Pareto diagram, which allows us to highlight the risks of audit organizations and develop preventive measures in response to the identified risks.

33.2 Methodology

The use of artificial intelligence technologies in the control activity of specialists of the Federal Treasury allows tracing the data received by the results of documentary inspections of audit organizations to analyze and interpret them.

Using computer technology, it is necessary to recognize the moments that indicate a decrease in the quality of internal control in audit organizations. This will lead to errors in the audits verifications and will require field audits by specialists of the Federal Treasury.

The concept of "quality management" emerged at the end of the nineteenth century due to the development of mass production, which required the development of quality control methods [4]. As noted by Chase and coauthors [3], the main purpose of quality control is to provide employees of the organization with timely information about the compliance of the objects involved in the implementation of the business process, the established requirements of quality indicators.

The so-called simple statistical methods of quality control can be used to monitor the functioning of the process of internal quality control in audit organizations [10]. These methods received their name because of their accessibility and uncomplicated nature. As Gorelik notes [8], the purpose of using statistical methods of quality control is to exclude random variations during the implementation of a business process.

33.3 Results

During documentary inspections, specialists of the Federal Treasury conduct testing of quality control systems of audit organizations. However, the methodology of this testing and assessment of its results has not been developed. We propose to use checklists to record the results of supervisory activities.

Checklists are a form that serves to collect and organize the examined data. A checklist is a form that records the results of the study of the functioning of the process. Checklists can be prepared in the form of tables and questionnaires.

We propose to use the checklist "The results of the documentary verification of compliance with the requirements of the legislation in the audit organization" at the stage of documentary control (Table 33.1).

The checklist "The results of the documentary verification of compliance with the requirements of the legislation in the audit organization" contains a table consisting of five columns. The first column shows the areas of internal control of the auditing organizations to be audited. As these directions, we propose to choose a list of regulatory acts, the compliance with which is checked during the external quality control of audit organizations by the Federal Treasury.

The following four columns reflect the control points used to check the establishment and functioning of the internal quality control of the work of the audit organizations. At the intersection of the horizontal and vertical columns of the checklist, the specialist of the Federal Treasury should record the results of the control measures.

Table 33.1 Checklist "The results of the documentary verification of compliance with the requirements of the legislation in the audit organization"

Compliance verification	Checkpoints			
	The auditor's working document is developed and reflected in the audit file	The auditor's regulations or working document is developed in accordance with the legal requirements	The auditor's regulations or working document is applied	The auditor's regulations or working document is filled out in accordance with the requirements of the audit methodology
Federal laws in the auditing area	Yes	Yes	Yes	Yes
Auditing standards	Yes	Yes	Yes	No
Auditors' code of ethics	Yes	Yes	No	No
Auditors and auditors' organizations Independence rules	Yes	No	No	No
Federal legislation in the field of combating money laundering and terrorist financing	No	No	No	No

Source Compiled by the author

By the control point, we mean a specific result of the control function performed by the specialist of the Federal Treasury. The control points allow controlling the risks that exist in the activity of audit organizations.

We have allocated four control points, which fix the result of control procedures in the directions of the work of audit organizations. Figure 33.1 shows the sequence of control points of the documentary verification of the auditors. Federal Treasury specialists should check the following:

(1) The auditor's regulations or working document are developed and reflected as part of the audit file (the first control point);
(2) The regulations or the auditor's working document have been developed in accordance with the requirements of the legislation (the second checkpoint);
(3) The regulations or the auditor's working document are applied (the third checkpoint);
(4) The regulation or the auditor's working document is filled out in accordance with the requirements of the audit methodology (the fourth checkpoint).

During the audit checkpoint, the Federal Treasury specialist must first find out whether the auditor's regulations or working document has been developed to meet the requirements of the audit regulations. To fulfill this control point, it is necessary to request all audit standards and methodologies, as well as the structure of the audit file that is applied in the organization conducting the audit and providing other services related to auditing activities.

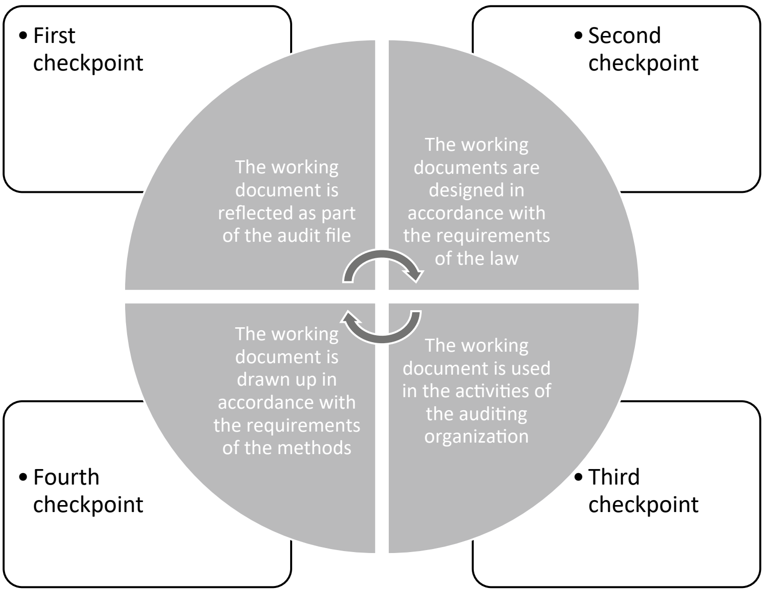

Fig. 33.1 Audit checkpoints. *Source* Compiled by the author

An auditor's regulations or working document may be developed, but the content of these internal documents may not meet the requirements of the regulations or contain information that is not current due to changes in the provisions of the regulations. Therefore, the next control point is the confirmation of compliance of the content of the internal regulations or working documents of the auditor to the legislative requirements. Practical implementation of this control function is performed by comparing the provisions of internal standards, techniques, and working documents of auditing organizations with the provisions of legislative acts. For this purpose, we suggest using the texts of the regulations containing the mandatory requirements, the compliance with which is assessed when exercising the external quality control of the audit organization's work. These requirements are published on the Federal Treasury website in the section "External quality control of the audit organizations work," in the subsection "List of mandatory requirements."

The next step is to make sure that the regulations developed by the audit organization and compliant with the legislation are actually applied when conducting audits. For this purpose, a specialist of the Federal Treasury must request the audit file with the audit results of one of the audit organization's clients. To pass the third control point, it is necessary to verify the completeness of the working documentation, depending on the specifics of the financial and economic activities of the audit client and the scale of its business.

Further, during the confirmation of the fourth control point, a specialist of the Federal Treasury must check the compliance of the filling in of the auditor's working documents with the requirements of the current legislation and audit techniques, which are developed by the self-regulating organization of auditors and the auditing organization. For the practical implementation of this verification stage, it is necessary to compare the data of the working documents filled out in the audit organization with the best practices of filling out these documents.

The Pareto diagram is a type of bar chart that is used to graphically represent the causes of identified non-compliance of process quality parameters in ascending or descending order of importance. In the nineteenth century, the Italian scientist Pareto identified a pattern of unequal distribution of goods among the population. The application of the Pareto diagram allows us to focus business process improvement actions on the main causes of defects.

Thus, we studied the causes of non-compliance in audit organizations. We considered 48 cases of non-compliant paperwork. The reasons for non-compliance of the auditors' documentation requirements were as follows:

- Ignorance of requirements of regulations;
- Ignorance of job responsibilities;
- Failure to comply with job responsibilities;
- Failure to comply with the established form of documents;
- Low qualification of persons responsible for the execution of documents;
- Lack of access to the documents of the self-regulating organization of auditors;
- Lack of structure of the audit file;
- Lack of document forms.

Based on these data, we constructed a Pareto diagram "Causes of non-compliance with legal requirements in audit organizations" (Fig. 33.2).

The diagram shows that the main number of non-compliance with legal requirements in auditing is caused by three reasons: ignorance of the requirements of regulations in auditing; non-compliance and ignorance of job duties of employees of audit organizations. Ignorance of the requirements of the regulations is the main reason for the identified non-compliance (25% of the researched facts). To reduce the risk of non-compliance with the requirements of regulations on this factor, we suggest training auditors in programs that include the study of the composition and structure of the audit file.

The Pareto diagram, presented in Fig. 33.2, shows that the average number of reasons for non-compliance with regulations in audit organizations is insufficient methodological support of audit verifications. In 30% of the investigated cases, non-compliance with legislation is associated with the lack of structure of audit file, lack of access to documents of self-regulatory organization of auditors, non-compliance with the form of documents, and the lack of forms of documents.

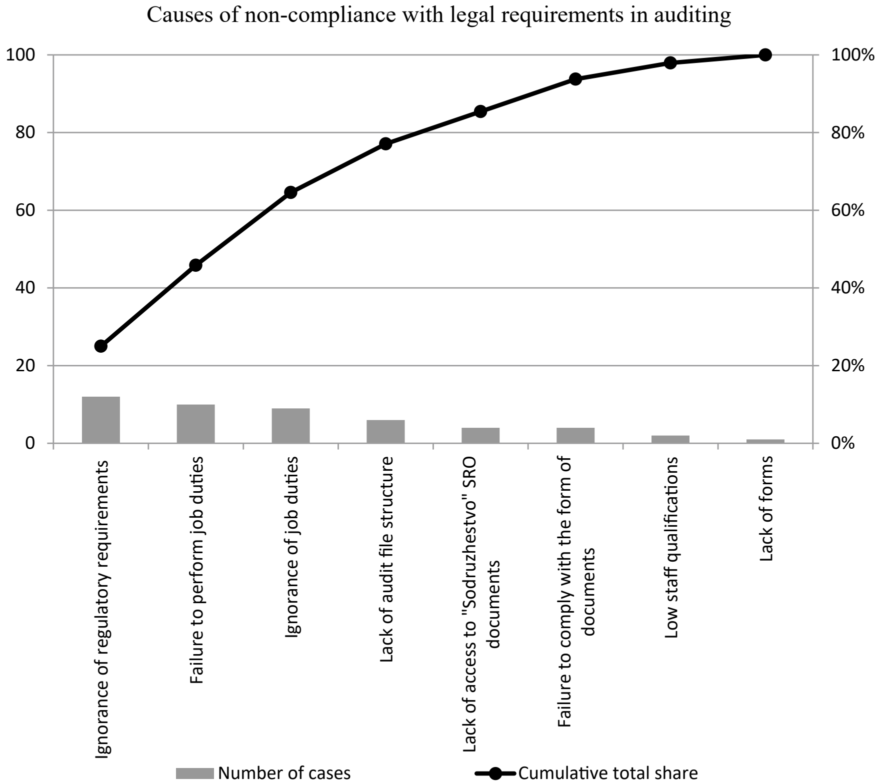

Fig. 33.2 Pareto diagram "causes of non-compliance in audit organizations." *Source* Compiled by the author

We propose to apply the presented Pareto diagram "Causes of non-compliance with legislation requirements in audit organizations" when developing preventive measures to control compliance with legislation requirements in the audit.

33.4 Conclusion

The conducted research allowed us to develop the methods of quality control of audit organizations, which can be used in the selection of audit organizations for on-site inspections. The developed checklist and the revealed control points of audit documentation check allow us to define the stages of control measures at carrying out documentary checks by the specialists of the Federal Treasury.

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Chapter 34
Types of Cyber Threats and the Need to Ensure the Cybersecurity of the Financial System

Elena N. Smertina, Ellina Yu. Demyanenko, Maria M. Popova, and Marusya I. Lyubcheva

Abstract In today's world, there is a sharp increase in various kinds of attacks on the servers of various companies. Cybercrimes have become more sophisticated. Thus, financial institutions constantly need to take all possible measures to strengthen their information security. This paper considers the problem of cyber threats in the financial system of the Russian Federation, their classification, and the main ways to deal with them, as well as the primary sources of cyber threats and their causes. The concept of finance is disclosed, and the structure of the financial system of the Russian Federation is considered.

34.1 Introduction

Nowadays, the world is on the threshold of the fourth industrial revolution. These tremendous changes were described by the chairman of the World Economic Forum, Klaus Martin Schwab [1]. In many ways, we began to feel the products of this revolution about 20–30 years ago, including the formation of the global information space, computerization, and automation in a long series of professions and activities. However, the truly global application of digital technology has yet to be seen and put into practice.

The growth of information security and the possibility of its automated management become major factors in achieving innovative and sustainable economic development of states in a globalized economy. For this purpose, Russia has formed a digital economy ecosystem that manages data in digital form, which is becoming the main tool for financial management in all spheres of social and economic activity, a key tool for effective interaction between business, scientific and educational communities, government and citizens based on smart (intelligent) technologies

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using cloud services [2]. In the future, artificial intelligence will become a "general-purpose technology" and the basis of industrial innovations. Key technologies, such as telecommunications technologies of the fifth-generation (5G), cloud services, video, the Internet of Things, and artificial intelligence will be combined and developed comprehensively, continuously creating value-added of colossal proportions [3].

The Strategy for the Development of the Information Society of the Russian Federation for 2017–2030 [4], approved in Russia, provides the following definition of the digital economy: "The digital economy is an economic activity in which the key factor of production is data in digital form, the processing of large volumes, and the use of the results of analysis, compared with traditional forms of business, make it possible to significantly improve the efficiency of various types of production, technology, equipment, storage, sale, and delivery of goods and services. The program "Digital Economy of the Russian Federation" was approved by Order No. 1632-r of the Government of the Russian Federation dated July 28, 2017 [5]. The program includes five areas concerning regulatory regulation, cybersecurity, education, human resources, and the formation of research competencies and IT infrastructure [6].

34.2 Methodology

The availability of intellectual assets is the main condition for the functioning of the digital economy, which is the most significant means of increasing the economic efficiency of activities. For investors, the most attractive companies are always those with a significant number of intellectual resources (e.g., Facebook, Uber, and Airbnb), which do not have large volumes of physical assets but represent digital platforms and surpass most multinational corporations in terms of capitalization. The basis for the digital economy is the widespread use of large amounts of data, their detailed analysis to stimulate the development of new products and technologies, lean manufacturing, etc.

According to analytical studies, over the past 20 years, the digital economy has had a capitalization of about three trillion dollars, which is six times higher than the annual trade deficit of the USA or more than the gross domestic product of the UK.

Let us dwell in more detail on cyber security. Nowadays, the issue of economic security is relevant at the international and national levels because its quality affects the independence and sovereignty of the country, the protection of personal data and health [6]. Despite the need to ensure the security of the entire economic system, some of its elements require special attention, in particular, the financial system, which is quite vulnerable to any threats. In this research, we will consider such a variety of threats as cyberthreats.

To analyze the problem of cyber threats in the financial system of the Russian Federation, it is worth understanding its essence and defining some concepts.

Finance is the monetary relations arising in the process of distribution and redistribution of the value of the gross domestic product (GDP) and part of the national wealth in connection with the formation and use of money savings to meet the needs of expanded reproduction, the needs of the state, economic entities, and the population. Finances emerged with the emergence of the state; without them, it was impossible for the state to perform its functions [7].

The financial system is a set of all financial areas, services, and institutions, the activities of which are aimed at implementing the country's financial policy. The financial system is built on relations between the government, individuals, and legal entities. Therefore, one's budget, finances of one's family, or finances of the whole population constitute a certain area of financial relations and are part of the financial system of the whole country [8]. The main parts of the financial system, which it includes, are the state finances, the finances of enterprises, and the population's finances.

Public finance is a form of organization of financial relations in which the government is a participant in one way or another. In this sector of the economy, there is a distribution and disposal of the national budget [9]:

- Enterprise finance is the monetary relations associated with the formation of income, receipts, and savings from commercial and non-commercial organizations and their further use in the interests of companies.
- Population finances are monetary relations tied to the formation of income and expenditures of small households.

The financial system can be built in different ways; its formation is conditioned by many different factors. For example, the financial system of the Russian Federation is presented in Fig. 34.1.

To effectively organize the management of the financial system at the stages of the turnover of cash and cash equivalents, financial planning, predictive analysis, and interaction with regulatory authorities, it is necessary to provide information and analytical support, which can be achieved by automated intelligent systems as part of digital technologies [10].

The financial system is the target of many attacks, and its security can be compromised from within and by external factors. However, cyber threats are one of the most dangerous and insidious types of threats that can negatively impact them.

34.3 Results

A cyber threat is a harmful intrusion or danger of malicious intrusion into networks that can compromise the security of personal data, finances, a person, a company, or a nation.

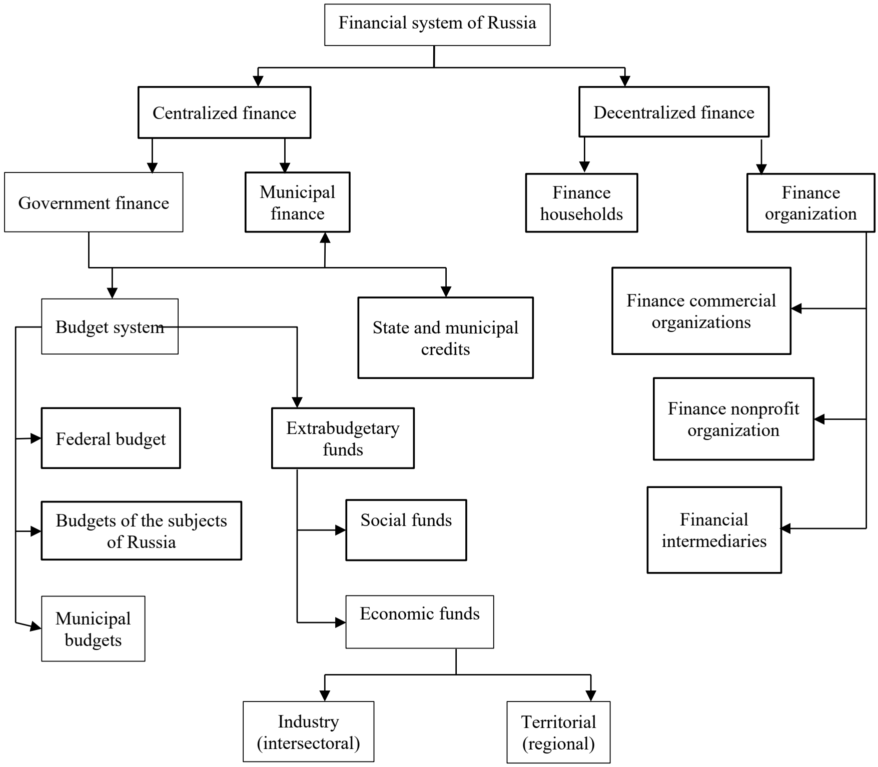

Fig. 34.1 Financial system of the Russian Federation. *Source* Compiled by the authors

Cyber threats aimed at damaging elements of the financial system of the Russian Federation may be caused by various reasons: economic, military, etc. The types and characteristics of cyber threats that can potentially negatively impact the financial system of Russia are as follows [11]:

1. Hacker attacks by other countries. These attacks are carried out to disrupt the functioning of the country's financial system, causing economic damage or taking control of certain financial institutions. As a rule, the objects of such attacks are banks, mining farms, stock exchanges, and financial information centers. This type of attack is characterized by highly qualified hackers and the scale and consistency of the attack.
2. Financial sabotage in the financial market initiated by major financial corporations. They are aimed at lowering the value or eliminating particular businesses, spreading false information, causing panic or spoiling the reputation of the objects of cyberattack, organizing leaks of insider information, and organizing, with the support of hackers, failures or accidents within companies. The peculiarity of this type of attack is a decrease in the investment attractiveness of the state and

deterioration of the rating positions of its largest businesses [12, state to perform its functions].

3. Constructing and launching social engineering Trojans. It is aimed at gaining access to the entire banking infrastructure through the accounts of bank customers and employees, theft of confidential data and funds by a third party, interference with data, its distortion, or other unlawful actions. This type of threat is characterized by the fact that the hacker attack usually takes place on less protected private and public accounts behind the mainline of the banking infrastructure.
4. Infrastructure attacks on the Internet of Things. These attacks are carried out on the data network between devices (e.g., "Smart Home," "Unmanned Office," remote payment systems). Such attacks are carried out to steal data, gain control over business processes of financial and industrial ecosystems, and cause damage by disabling these systems. A special feature is gaining access and the ability to affect the physical infrastructure by hacking remotely.
5. Open-source hacker tools for sale. This type of cyberthreats affects private bank cards and electronic wallets; hackers have the opportunity to access the money of the objects of the attack. Due to the transfer of a tool for cyberattacks, there are difficulties with identifying the attackers. The sale of hacker tools can involve citizens with certain motives or tendencies to commit crimes in the field of cybercrime in these illegal activities [11].

National cybersecurity specialists defend against the above types of threats. They use the most advanced and effective methods of repelling hacker attacks to protect information data, finances, and other objects of cyberattacks by collecting and analyzing malware, detecting suspicious activity, stopping the spread of phishing, protecting reputational risks, and others. Simultaneously, the security of non-credit financial institutions that are not currently required to strictly follow the requirements of the regulator depends solely on the interest of business owners in the protection of information assets and awareness of the need for information security in general. In the foreseeable future, large groups of intruders will restructure and continue their activities, probably using new penetration tools, which are currently only being developed.

34.4 Conclusion

According to the dynamics of cyberattacks on financial institutions of the Russian Federation, their number has increased significantly. Thus, according to the Bank of Russia, compared to 2016, in which the total number of cyberattacks on institutions of the national financial system equaled 489, the number of cyberattacks in 2020 increased to 968, which is 479 units or 98% more than in 2016 [11]. The reason for this was the development of hacking technologies and the COVID-19 pandemic, which forced many companies to implement remote working tools as soon as possible, which resulted in these companies becoming vulnerable to cyber threats.

One of the primary documents regulating the issue of financial security in the Russian Federation is the Presidential Decree "On the Strategy of economic security of the Russian Federation for the period up to 2030" (May 13, 2017 No. 208) [13]. This decree defines the main challenges and threats to security and establishes the goals and strategy of state policy up to 2030. Moreover, it provides an assessment of the state of economic security and defines the stages and main mechanisms of the implementation of the strategy, which makes it possible to identify and eliminate any threat timely.

In other words, information security must be at the top of the agenda throughout the company. Developing a robust cybersecurity framework provides a clear view of threats and helps ensure regulatory compliance. To comply with regulations and counter the growing number of cyber threats and fraud cases, the financial industry needs tools equipped with artificial intelligence and a layered cyber security system that supports rapid and scalable problem detection and remediation.

Based on the above, we can conclude that the Russian financial system is constantly exposed to cyberattacks, and their number is only increasing over time. Hacking methods are becoming more and more sophisticated, and the damage from successful attacks is extremely serious. To protect the financial system of the Russian Federation, it is necessary to continue developing and improving methods to counter this type of threat because its protection is a critical component of national security.

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Chapter 35
Issues of Using Artificial Intelligence in the Framework of Public Finance

Natalia G. Vovchenko, Olga B. Ivanova, Elena D. Kostoglodova, Anatoliy F. Khapilin, and Stanislav A. Khapilin

Abstract There are positive trends in the financial sector to actively enter digital transformation processes. One of the trends in improving the efficiency of public finance management is the study of the prospects of using artificial intelligence (AI), considering the best Western practices and priority areas developed in national strategies. Theoretical and practical understanding of new approaches to the use of high information technologies and digitalization of all fields of economic activity requires identifying the features of the use of AI in the public finance system. In this regard, the authors put forward and substantiated a hypothesis about the actualization of AI use in the public finance system: in the field of creating flexible and adaptive information technologies for the development of electronic interaction in the context of a new accounting and technological model; within the application of AI in the social sector by creating a new Unified Digital Social Security Platform; wider use of digital technologies and AI in the activities of tax and customs authorities.

35.1 Introduction

Being one of the drivers of the digital economy, the financial sector has a powerful capacity to create a service model for public finance management using state digital platforms. One of the national development goals of the Russian Federation for the period up to 2030 is digital transformation, including public administration [1].

In the context of the implementation of national goals to ensure sustainable development of the country, we are talking about a significant increase in the quality of the provision of public services and the quality of management of national projects and government programs, which requires the development of new approaches to improve the efficiency of management of the public finance system. The Government of the Russian Federation undertakes serious strategic initiatives in socio-economic development, which allows linking state programs, national projects, and national goals

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into a single whole, including in the field of scientific and technological development. All initiatives are conditionally divided into six areas: social sphere, construction, ecology, digital transformation, technological breakthrough, and service state. These initiatives were formed considering the actual resources available: budgetary resources, funds from private investors, state-owned companies, and development institutions. The total cost for the next three years is 4.6 trillion rubles. In the future, additional 736 billion rubles will be raised from the federal budget and the National Welfare Fund [2, pp. 6–7].

The new initiatives will provide an opportunity for flexible adjustment to rapidly changing external and internal conditions caused by the negative consequences of the COVID-19 pandemic around the world. The rise of the digital economy brings fundamental changes to the public finance management system. Models of effective interaction between government bodies in digital format should be considered as the most important factor in technological independence and increasing the country's competitiveness.

Key digital transformation processes unfolding in the current world increasingly contribute to the modernization of traditional areas of financial and other services, in which a significant place is given to innovative products and services for end consumers [3, p. 167].

Digital technologies in the field of public finance management allow transforming the information system to develop and implement measures in the field of program-target and project methods of budget planning, tax policy, optimization of budget expenditures, regulation of financial control and supervision in the budgetary sector, and development of financial technologies (FINTECH). The priority of state policy in the field of technological breakthroughs is to support the development of artificial intelligence. Simultaneously, it is necessary to consider the existence of various conceptual and methodological approaches to the development of research and the practical use of AI in the national strategies of states.

35.2 Methodology

The development of a risk-based methodology for building budget relations is now a significant element in the transformational mechanism of public finance management in the context of the digitalization of the economy. The COVID-19 pandemic had a significant impact on the state of public finances, which required the consideration of the entire range of external and internal factors, budgetary risks, and the need for continuous monitoring of public finances and measures to reduce budgetary risks based on information on the likelihood of their occurrence and macroeconomic consequences, including through the use of information technologies. In the context of instability of public finances in the new economic reality and in the system of measures taken at the state level to minimize budget risks, a special place is given for "stress" budget forecasting, which implies the search for effective methods of risk identification, the use of risk management tools, and stress testing in the framework of digital transformation.

The research methodology includes the methods of system-complex, abstract-logical, and theoretical generalization and provides the practical implementation of digital technologies. As a complex of technological solutions that allows simulating human cognitive functions, artificial intelligence involves the widespread use of the cognitive modeling method, which makes it possible, in the context of AI, to simulate situations for finding solutions without a predetermined algorithm and seek solutions for its use to implement strategic national priorities. The main principles of regulation in the field of AI technologies include the following:

- The use of a risk-based interdisciplinary approach;
- The expansion of the use of instruments of co-regulation and self-regulation;
- Human-centered approach (ensuring human rights and freedoms and improving the well-being and quality of life of citizens);
- Ensuring a balance of interests of developers, consumers, and other persons in the field of AI, etc. [4].

35.3 Results

The development of AI technologies poses serious challenges to the public financial management system. Each area of application of AI in the financial sector presupposes the presence of specific regulatory methods depending on the specific conditions of their implementation and requires flexibility in the approbation of new financial services and technologies. Simultaneously, the rapid development of digital technologies also requires a faster update of the regulatory framework, which, on the one hand, provides the necessary conditions for the implementation of digital innovations and, on the other hand, consumer protection and financial stability. According to the forecasts of Higher School of Economics experts, the volume of the AI market will increase 150 times by 2025 in relation to 2016 and will reach a value of $59.7 billion.

The emergence of an innovative generation of AI technologies, characterized by a deep level of learning, the integration of human–machine interaction, objectivity, and autonomous control, has marked the beginning of a new round of digital transformation.

Analytical company Gartner has published a list of technologies that will significantly affect business, society, and each individual in the near future and identified five key technological trends:

- Human digitalization (technologies increasingly integrated with people, allowing them to create digital versions of themselves);
- Algorithmic trust that ensures confidentiality and security of data, source of assets, the identity of people and things;

- Silicon-free technologies (DNA computing, biodegradable sensors, and carbon transistors);
- Formative AI (a type of AI capable of dynamically changing in order to respond to a changing situation);
- Composite business architecture that helps companies to adapt to changing reality quickly. It is based on the principles of modularity, efficiency, continuous improvement, and adaptive innovation.

Along with this, tools and indicators are developed to assess the AI level of a country and its readiness to implement and apply solutions for an AI base-the so-called AI-ready indicator [5].

There are many ways for AI to be attracted to the public sector. One of the most common should be the processing of documents, their recognition and extraction of the necessary information, and its further classification and processing. Working with incoming correspondence from various sources requires high labor costs. The use of artificial intelligence reduces time costs twice. There are frequent appeals from the public to government agencies. Acceleration of work with requests is associated with the involvement of virtual assistants. Decision support systems using AI are also in demand for government agencies.

Regarding the intelligent space, we have to talk about organizing a "smart work environment." The AI should recommend and highlight those who needs to send a request or document for consideration, suggest a typical response format for a specific situation, check whether the task was completed on time, etc. The smart search involves the use of intelligent tools, such as recognizing scans and photos, comparing versions of documents, and implementing the principles of one window (one-stop). Also, the digital transformation strategy involves the organization of "digital jobs"-the process of issuing digital passes.

The Ministry of Finance of Russia provides targeted work on the digitalization of public finance. First of all, this is connected with the functioning of the state integrated information system for managing public finances "Electronic budget," contributing to the design, development, and maintenance of technological and functional subsystems.

The implementation of the departmental project of the Ministry of Finance of Russia "Centralization of the functions of project participants in maintaining budget accounting, drawing up budgetary and other financial statements in the Federal Treasury [6]" is important in solving the problems of digitalization of public finances in general and artificial intelligence in particular. The ability of the Ministry of Finance of Russia and the Federal Treasury to use information from the state information resource of accounting (financial) statements in terms of government finance statistics contribute to the identification, measurement, and monitoring of tax and budgetary policy measures. All this presupposes the creation of a new accounting and technological model of centralization (specialization) of the powers (functions) of the participants in the budgetary process at the sites of the respective centers of competence. The main purpose of the centralization of functions is to reduce the cost and labor intensity of budget accounting while providing functionally and technologically centralized services in the "Electronic Budget" system [7].

The digital transformation of public finances and the use of AI in the social sector are priority areas that contribute to creating conditions for improving the population's living standards.

In the context of digital transformation, it becomes necessary to adapt the social sphere to new digital realities and create a fundamentally new Unified Digital Platform. The transfer of all socially significant state and municipal services into electronic format presupposes the implementation of the Social Treasury project. Its goal is to provide quick and targeted measures of social support to citizens upon application without requiring any paper documents and certificates, which will speed up the receipt of social assistance and simplify this procedure. AI takes a key role in this project. In fact, there is a radical revision of the interaction between public authorities. After receiving all information for payments in state information systems, it becomes possible to implement a mechanism of proactive information and provide individual measures of social support, considering the information in the Unified State Information System of Social Security.

Tax and customs authorities play a significant role in the context of exploiting the possibilities of using AI in the public finance system. The use of digital technologies in the tax sphere, in terms of the system of electronic payments and the improvement of the process of identification and monitoring of taxpayers, allows reducing the costs of tax collection, qualitatively improve tax administration, and ensure a significant increase in tax revenues through the use of the latest digital technologies [8]. Based on the information platform for interaction with banks, the Federal Tax Service is developing a new version of the automated information system "Tax-4," a system for transmitting administrative data to other interested government agencies. The system is used to support the citizens and economy of the country within the consequences of COVID-19.

Russia has introduced and is actively developing a system of interdepartmental electronic interaction that provides information exchange of customs authorities with key executive authorities, as well as a centralized automated subsystem of customs clearance and customs control at border checkpoints (APS checkpoint) software tool. Simultaneously, even in the existing single window systems, there are problems in the system of digitalization of customs operations that should be solved. These problems include poor coordination of the participants involved in the project, lack of communication between the technologies used and international forms and standards for the presentation of information in electronic form, requirements for the provision of paper documents along with electronic ones, different levels of automation of departments, weak interdepartmental interaction of individual departments, the low interest of participants in foreign economic activity, etc. [9, pp. 82–83].

To speed up the processes of customs operations and customs control at checkpoints, it is important to solve the issue of unified implementation at all checkpoints within the EAEU of advanced technological solutions (automated inspection and inspection complexes, weight and dimensional control systems, and number reading) and information technologies (automated image analysis of customs inspection system (CIS) using AI elements and a database of CIS reference images, the ability to monitor the actions of officials during customs inspections remotely). In conjunction with a system of automatic dispatching of vehicles through control lines at checkpoints, this will provide conditions for the accelerated passage of customs control for risk-free deliveries [10, p. 157].

35.4 Conclusion

The most promising areas of using AI in the system of digitalization of public finances are the following:

- Development of a methodology for generating information on government finance statistics by modernizing the information base, which allows automatically selecting financial information in accordance with the requirements of international standards. Ensuring the completeness and quality of public financial reporting is aimed at creating a new accounting and technological model for centralizing the powers of participants in the budget process, which ultimately should create opportunities for the adaptation of AI information technologies and the development of electronic interaction;
- Expanding the list of measures included in the program of social adaptation of recipients of state social assistance based on a social contract and the implementation of an "electronic certificate" as a mechanism for providing citizens with goods in the context of social support measures. The implementation of these measures is aimed at achieving national goals of socio-economic development to increase real incomes of citizens and reduce poverty through the use of AI technology based on the principles of fairness, targeting, and need;
- Further improvement of the customs administration system in terms of the functioning of an "intelligent" checkpoint in the presence of a unified information system, which ensures the possibility of its functioning as a point for receiving preliminary information for all state regulatory bodies; implementation of a full-fledged electronic document management system and electronic queue; customs transit management using navigation seals with RFID tags; integration of the information system with software that ensures the functioning of control and inspection complexes, weight and dimensional control systems, etc.

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Chapter 36
Financing Digital Transformation and Bridging Digital Divide: The Case of the European Union

Maria I. Tislenko

Abstract The paper analyzes the issues of digital transformation in the European Union in such key dimensions as financing digitalization and implementing public policy to bridge the digital divide in the EU member countries. The author approaches the problem using public policy analysis and comparative statistical analysis in retrospective and prospective aspects. The findings prove that the conventional European cleavages "North–South" and "East–West" are relevant to assessing the digital transformation of the EU member countries. However, the primary beneficiaries of financing the digitalization of the EU are the countries that show poorer digital transformation progress. The author also demonstrates that there is a shift from fighting digital divides to improving the overall competitiveness as the EU's top priority.

36.1 Introduction

Digitalization is one of the most influential contemporary trends, transforming society and the economy in the long term. It refers to the activity or process of digitization, i.e., the conversion from analog form (text, audio, or video) into a digital format using a binary system. One of the main revolutions in today's business is the shift from conventional business models to digital ones to achieve a higher level of competitiveness (e.g., gig economy, platform solutions, and sharing economy [1]). However, digital transformation brings positive and negative consequences. The benefits include gradual economic growth, improved quality of life, greater access to public services for citizens, and increased transparency and accountability of decision-makers. Some scholars point out that the key merit of digitalization is increased productivity, highlighting its disruptive nature to the existing economic order [2, 3].

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Nevertheless, the risks and challenges of digitalization are also significant, including rising unemployment due to labor market transformation, increasing social and economic differentiation, growing cybercrime, and issues related to protecting personal data and privacy [4]. Another negative outcome is the growing digital divide, explained as a gap between individuals, households, businesses, and geographic areas at different socio-economic levels regarding their options to access information and communication technologies and their use of the Internet for various activities, according to the OECD [5].

Therefore, some countries opt for pursuing their own strategies of digital transformation aimed at introducing ICT to the economy, public services, and security. Such countries include Australia, Germany, Israel, Russia, Uruguay, Vietnam, etc. Within the scope of this research, the author reviews the digital transformation policy of the EU as a supranational entity in two aspects: its approaches to bridging the digital divide and financing digitalization strategies within the current Next Generation EU plan. The author tests the hypothesis that there are a positive relation between EU public policy measures to foster digital transformation and progress in reducing digital inequality and that those countries that obtain more financial support demonstrate better results in bridging the digital divide.

36.2 Materials and Methods

The specific features and prospects of the digital transformation of the economy and its challenges are reviewed in the studies of Jovanović et al. [6], Li [7], Nambisan et al. [8], Richardson [9].

The digital divide in the EU and its overcoming has been the focus of such scholars as Caradaica [10], Mitrović [11], Szeles [12], and Elena-Bucea with co-authors [13].

Despite considerable attention of scholars to the adjacent topics, there remains a research gap concerning the understanding of the relation and effectiveness between financing digital transformation or ICT progress and bridging the digital divide.

This paper applies qualitative and quantitative approaches. The qualitative approach refers to a comparative analysis of public policy, considering the EU policy toward digital transformation and divide. The quantitative approach includes the application of comparative statistical analysis of financing recovery and resilience plans within the Next Generation EU initiative.

To test the hypothesis, the author addressed the European Policy Framework in 2010–2022. The following documents were analyzed:

- Digital Agenda for Europe (2010) [14];
- Digital Single Market Strategy (2015) [15];
- Bridging Digital Divide in EU (2015) [16];
- Six priorities for Europe (including “A Europe fit for the digital age”) [17];
- Next Generation EU (2021) [18].

In terms of resources, all data obtained is public and has been collected through open databases, academic articles published in research journals, expert research reports, and government documents published between January 2021 and April 2022 in online sources (technology websites, newspapers, expert blogs, etc.).

36.3 Results

The analysis of the European Policy Framework in 2010–2022 clearly shows that the digital divide has been an important part of the EU digitalization fostering measures involving enhancing ICT skills, digital literacy, and promoting inclusive digital services. In this case, the milestone was the publication of the report "Bridging the digital divide in the EU" in 2015, which presented a comprehensive outlook on the measures and progress in overcoming digital inequality in the EU.

However, the focus of digital transformation priorities shifts from fostering digital inclusion to overall strengthening digital transition processes. The essence of the analysis is presented in Table 36.1.

The next step was to compare the financing of digital transformation in the EU member countries within the new strategy-Next Generation EU. This strategic framework was chosen due to the recovery and resilience facility (RRF), created specifically to provide financial support to the EU countries based on their submitted recovery and resilience plans (RandR plans). For this purpose, the author conducted a comparative analysis based on the statistics dataset by Bruegel, a European think

Table 36.1 Analysis of the digital divide within the framework of the European Policy

Policy document	Features
Digital Agenda for Europe (2010)	A separate chapter devoted to bridging the digital divide through competence enhancement
Digital Single Market Strategy (2015)	Among the goals, building an inclusive digital society is set as a task
Bridging Digital Divide in EU (2015)	Comprehensive assessment of the digital divide in the EU based on Eurostat statistics and the Digital Economy and Society Index (DESI)
A Europe fit for the digital age (2019)	• Focus on the implementation of advanced digital technology: AI, big data, cybersecurity, 5G, and the Internet of Things • Less attention to digital inclusion or fighting disparities
Next Generation EU (2021)	• Digital transformation as means for the EU countries to recover and maintain resilience in the post-COVID world • Building-up digital skills based on gender parity

Source Developed and compiled by the author based on [10, 14–18] tank that monitors the submission and implementation of recovery and sustainability plans for the EU member countries [19]. All EU members are present in the selection of countries except the Netherlands because the Dutch RandR Plan had not been adopted as of April 2022. The Bruegel researchers identify seven categories of funding areas: green transition, digital transformation, social end institutional development, mixed categories for each pair, and the uncategorized one [19]. The most significant funds will be allocated for green transition 45%, considering mixed categories 49%, or 232.7 billion euros in absolute values out of 482 billion euros. Based on the proposed typology, the author took those categories that included aspects of digital transformation, including mixed categories. The total amount of allocated funding stimulating digitalization across the three categories is 120.95 billion euros or 25.1%. If we take a closer look at how countries finance digital transformation in absolute and relative terms, we should refer to Fig. 36.1.

The leader in absolute funding is Italy, with 44 billion euros, of which 33 billion euros will be spent on digitalization. Spain comes next with 30.9 billion euros; Germany occupies third place with 14.6 billion euros. The picture is slightly different if the shares are considered:

- Germany allocates 52.5% of funding to RandR plans for digital transformation;
- Spain allocates 44.4%;
- Austria allocates 35.8%.

The case of Luxembourg is remarkable: the total of its RandR plans is 93.4 million euros under the Fund, of which 30 million euros (32.6%) will be contributed to digitalization.

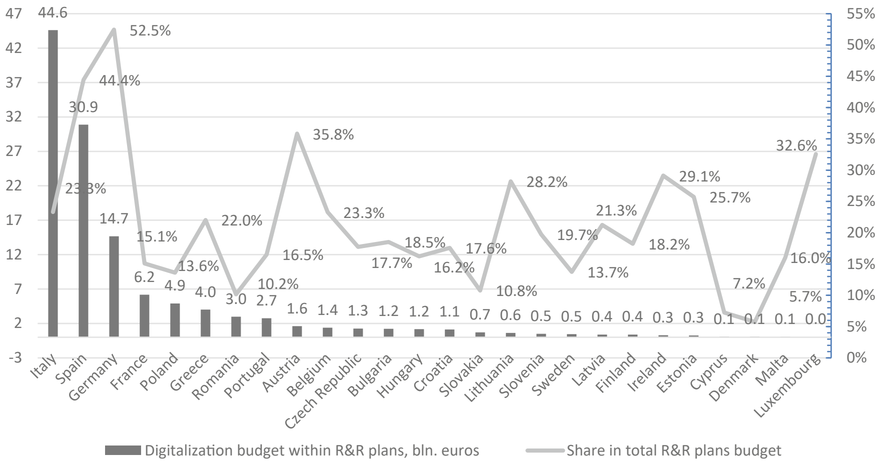

Fig. 36.1 Funding for digital transformation within the approved EU recovery and resilience plans by countries, in absolute and relative terms, billion euros and %. *Source* Calculated and compiled by the author based on the Bruegel dataset [19]

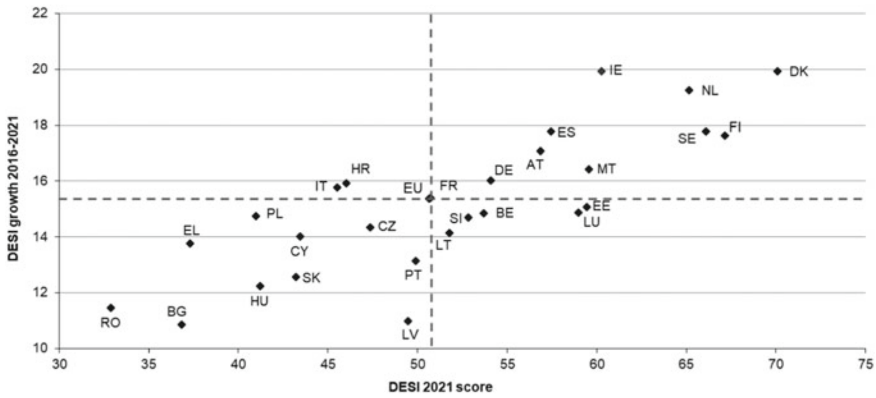

Fig. 36.2 Comparison of the progress of the EU member countries on the DESI Index progress in 2016–2021. *Source* Compiled by the author based on [20, p. 19]

When comparing the obtained results with the results of the European Digital Economy and Society Index in 2021 (Fig. 36.2) [20], it is worth noting the following peculiar aspects:

1. The leaders of European digital transformation, such as Denmark and Finland, do not invest much RRF budgets in the corresponding field in absolute and relative values.
2. Those countries that plan to significantly fund digital transformation projects within their RandR plans demonstrate average or below average DESI values (Spain, Italy, and France).
3. The conventional European cleavages "North–South" and "East–West" are relevant to the digital transformation assessment of the EU member countries if we look at the DESI progress in 2016–2021. The top performers in Northern and Western Europe (Netherlands, Sweden, and Austria) have significantly improved their positions, while countries situated in the south and east of Europe (Greece, Hungary, Romania, and Cyprus) have shown slower progress. Only Spain has demonstrated accelerated growth by 18 positions.

36.4 Conclusion

Therefore, the working hypothesis has been partially proved. There is a positive relation between financing digital transformation and reducing digital disparities. However, it is not linear and depends on whether policies were aimed at bridging the digital divide. Based on the results of conducted analysis of the EU countries and policies, the author substantiates that the fight against digital inequality has been gradually losing its acuteness as a point of the EU digital agenda. This is proved by the dynamics of DESI progress of the EU member countries compared to potential budgets for digital transformation within recovery and resilience plans. The main beneficiaries of this European strategic framework are countries with mediocre digital technology adoption. Nevertheless, the EU digital leaders have submitted RandR plans with significantly smaller digitalization budgets.

It is important to consider the constraints of this research. The research addresses the issue of digitalization of financial effectiveness in a preliminary form; its results do not claim to be fully comprehensive as they are limited geographically and obtained with a narrow set of analytical tools. To be precise, RandR plans are not the only source of financing the digital transformation or reducing digital inequality. Thus, further research is required to overcome these limitations.

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Chapter 37
Artificial Intelligence in Banking Systems: Trends and Possible Consequences of Implementation

Svetlana A. Urazova

Abstract The paper aims to form a pattern for assessing the use of artificial intelligence (AI) in banking systems, which allows consistently analyzing the application of AI at all levels of these systems and identifying the possible consequences of the introduction of AI in banking systems. The methodological basis of the study includes a systemic approach, methods of analysis, and generalization of information. The study allowed identifying the directions of the implementation of AI at each level of banking systems, giving a general assessment of the use of AI in banking systems, and identifying the possible consequences of the implementation of AI in these systems. The research novelty includes the assessment of the impact of AI implementation in banking systems in general, considering the specifics of the organization of these systems.

37.1 Introduction

AI actively enters everyday life and becomes a leading tool for digital transformation in various fields. In this regard, the study of Holmstrom is of particular interest [10]. Holmstrom proposes to assess the ability of an organization to deploy AI technologies to ensure digital transformation in four key dimensions: technology, activities, boundaries, and goals.

In most countries, banks actively apply AI. As a result, the banking sector has become one of the leaders in the implementation of AI. The use of AI in commercial banks is discussed in the studies of many Russian and foreign scientists, including Königstorfer and Thalmann [12], Wall [16], Dadteev et al. [3].

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Against the background of the active introduction of AI, especially in the banking sector, the issues of regulating the development and use of AI are becoming increasingly important. In this regard, the work of Vesnic-Alujevic et al. [15] devoted to social and ethical consequences, as well as AI regulation, is of interest.

Simultaneously, speaking of banking, most studies are devoted to implementing AI at the level of commercial banks.

The paper aims to form a pattern for assessing the use of AI in banking systems as a whole, which allows consistently analyzing the use of AI at all levels of these systems and identifying the possible consequences of the introduction of AI in banking systems.

The goal-setting predetermined the need to solve the following range of tasks:

- To determine the directions of using AI at each level of banking systems;
- To classify banks depending on the level of use of AI technologies;
- To give a general assessment of the use of AI at various levels of banking systems;
- To identify the possible consequences of the introduction of AI in banking systems.

37.2 Methodology

The methodological basis of the research includes a systemic approach, methods of analysis, and generalization of information. The logic of the research consisted in the formation of a pattern for assessing the use of AI in banking systems and promoting the analysis of the use of AI at all levels of banking systems, including organizing interaction between regulatory organizations and banks under their control. When forming this pattern, the aim was to make it universal for application to the study of the banking systems of individual countries and for generalized analysis of banking systems worldwide.

For the research, the author referred to materials from international studies, which included certain aspects of introducing digital technologies, including AI. Thus, the research was based on the materials of the World Bank Group, including International Finance Corporation and International Bank for Reconstruction and Development, as well as World Intellectual Property Organization, Financial Stability Board, Deloitte, Organization for Economic Co-operation and Development, De Nederlandsche Bank, Banque de France, and Bank of England. Along with these, the author used materials from Stanford University.

37.3 Results

The study allowed proposing a universal pattern for assessing the use of AI in banking systems (Fig. 37.1). The use of this pattern for a generalized analysis of the use of AI in general in banking systems worldwide allowed us to obtain the results presented later in this research.

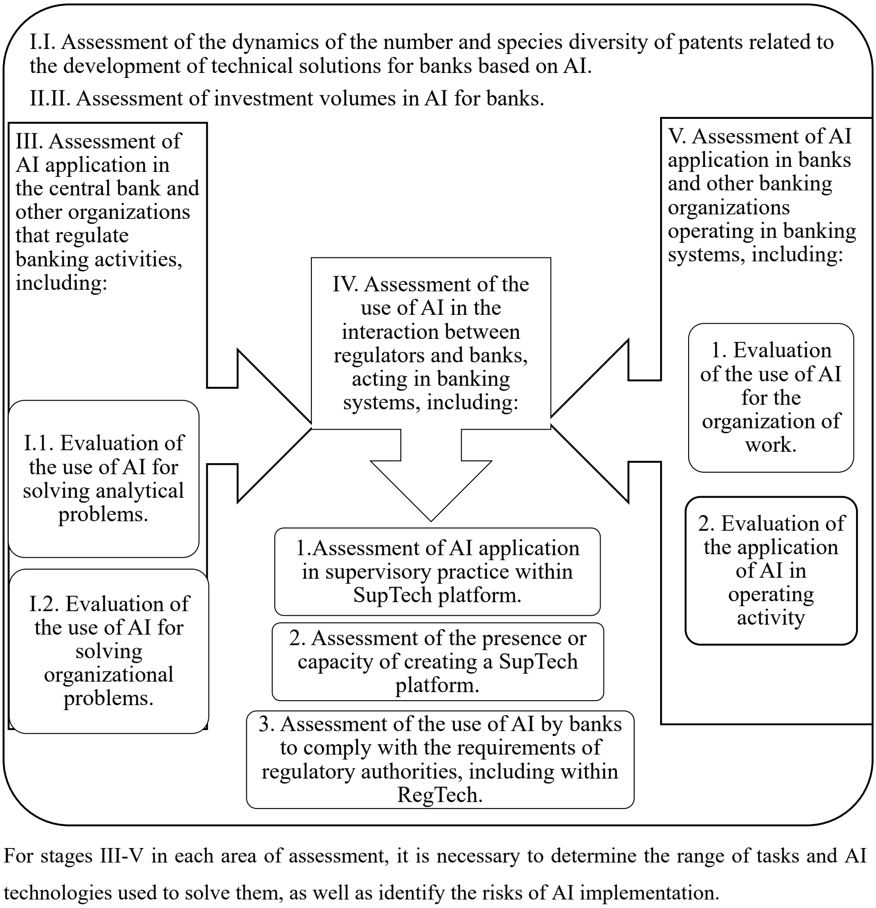

Fig. 37.1 Pattern for assessing the use of AI in banking systems. *Source* Developed and compiled by the author

Globally, we highlight a sharp increase in the number of patents related to the use of AI since 2013. More than half of the inventions have been made since 2013 [17, pp. 13–14]. According to the World Intellectual Property Organization, formed based on the world's largest patent database Questel Orbit, banking is one of the leading areas in terms of the number of patents related to the practical use of AI registered in the world. Against this background, there are high growth rates in the number of such patents [17, pp. 14–15, 22]. Simultaneously, banks use versatile AI-based solutions because many patented AI-related inventions are intended for use in various industries.

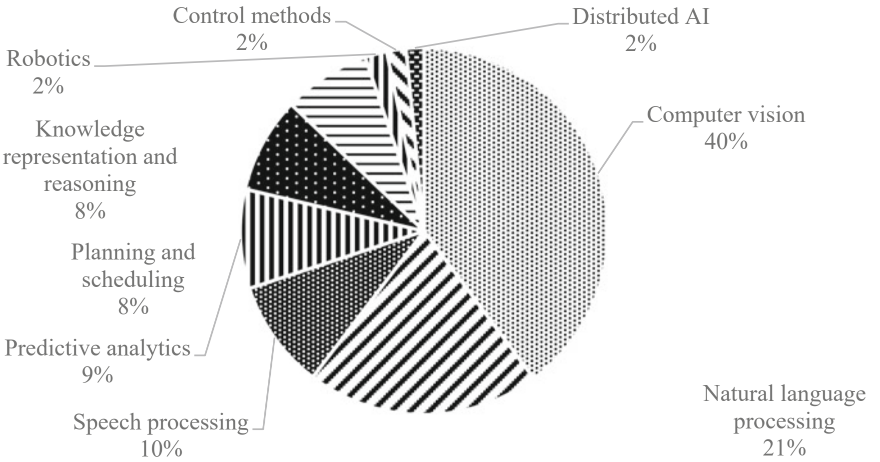

Fig. 37.2 Families of patents registered in the world from 1981 to 2016, developed based on AI for the use in banking and finance, in the context of functional applications (according to the World Intellectual Property Organization, formed based on the world's largest patent database Questel Orbit). *Source* Compiled by the author based on [17, pp. 22, 53]

The largest number of patents' families related to the use of AI directly in banking and finance involve the use of the machine learning method [17, p. 53]. If we consider the families of patents developed from 1981 to 2016 for banking and finance in the context of functional applications, the largest share of patent families falls on computer vision (40%) and natural language processing (21%) (Fig. 37.2).

In the context of the countries of the world, the largest number of families of patents involving the use of AI in banking and finance was registered in the USA, much less in China, Japan, the Republic of Korea, and Australia [17, p. 101].

According to Stanford University's 2021 Artificial Intelligence Index Report, banking is one of the world's top destinations for private AI investment in 2019 and 2020. Simultaneously, in 2020, there was a twofold increase in the volume of these investments [18, p. 97]. At the end of 2020, the financial industry was among the leading industries in terms of penetration of AI skills in the world [18, p. 92]. There is a fairly high level of the use of AI capabilities built into standard business processes in the financial services sector in 2020. At the same time, for most indicators (robotic process automation, NL text understanding, conversational interfaces, deep learning, NL speech understanding, NL generation, and other machine learning techniques), the level is higher than the generalized values for all industries in total [18, p. 100].

In 2020, 60% of respondents from financial services reported using AI in their business. A higher indicator, as in 2019, is demonstrated only by high-tech companies and the telecommunications sector [18, p. 99]. A fairly high level of AI implementation in the sector of financial services was noted for the organization of operational services, risk analysis and assessment, marketing, and sales. In these areas, the level of implementation is higher than in all sectors as a whole [18, p. 100].

In the financial services sector, 22% of companies reduced their investments in AI due to the COVID-19 pandemic; 28% of such companies increased investments; 50% noted that the pandemic did not affect their investments [18, p. 103].

Currently, AI technologies are generally used in banking systems due to their use at the level of central banks of various countries and banks and other organizations operating at other levels of banking systems.

In the activities of central banks, AI technologies could be applied to analyze the activities of banks and banking systems and improve the practice of supervision over the banks' activities, as well as financial markets in general.

Since 2016, central banks have started to pay significant attention to AI and big data analytics to solve the problems of forecasting, risk management, and supervision. This fact is confirmed, in particular, by a sharp increase in the number of mentions of AI in publications of central banks of 16 countries since 2016, with a peak in 2019. In 2020, there was a significant decline in the number of such publications, which is explained by the discussion of the economic recession amid the COVID-19 pandemic. The leaders in the number of mentions of AI in messages for the period from 2016 to 2020 are the Federal Reserve, Norges Bank, European Central Bank, Reserve Bank of India, and Bank of England [18, pp. 174–175].

A whole line of development called supervision technology (SupTech) has been formed. It is designed to improve the quality and efficiency of central banks and other bodies that supervise and control the activities of banks and other participants of the financial markets. According to the results of research conducted by the Financial Stability Board, starting in 2016, the practice of using SupTech development strategies by regulators has significantly expanded. Many countries have established official platforms for developing or testing SupTech tools. Simultaneously, AI is currently the most frequently used tool of SupTech, and in the following 3–5 years, regulators predict the preservation of its leadership and a significant increase in the number of SupTech tools developed based on AI [8, pp. 1–2, 27–28].

Regulators note that AI and machine learning (ML) will enable faster processing of surveillance data and will also enable better analysis. AI allows supervisors to identify non-compliance with requirements and form a better forecast based on analytical information generated to assess and reduce the risks of stability [8, pp. 6–7].

Returning to the consideration of the use of AI in the activities of banks that do not belong to the category of central banks, we note that technical solutions developed based on AI penetrate into many business processes of banks. Depending on the scale of banks' activities, the ability to conduct independent development or purchase ready-made software solutions that involve the use of AI, three groups of banks can be distinguished:

1. Leading banks that have their own AI implementation strategies and use not only technical solutions purchased from third-party companies but carry out independent developments related to the use of AI in banks;
2. Banks that are making a relatively large-scale transition to the use of AI, based on ready-made software products purchased on the market, as well as technical solutions developed by their order;

3. Banks implementing ready-made technical solutions based on AI offered on the market.

The rapid growth in the number of AI-based developments that could be applied in the activities of banks and the reduction in the cost of ready-made software solutions will lead to an active increase in the number of banks that can be attributed to the third group. Simultaneously, the increase in the volume of investments in the development of AI-based solutions by banks of the first group will lead to an increase in the digital divide between banks of the three groups.

We single out three consolidated areas of using AI technologies in banks and other banking organizations that are part of banking systems:

1. Application of AI in the framework of regulatory technology (RegTech) focused on improving the efficiency of meeting the requirements of central banks and other regulators of financial markets. According to IFC research, more than 250 RegTechs companies provide their services worldwide. In this case, AI is actively utilized [2, p. 3].

   Research conducted by the Financial Stability Board has shown that AI is used in the overwhelming majority of RegTech tools due to the fact that about half of RegTech technical solutions are implemented using machine learning, and the second widespread type of technology is also used to solve all types of RegTech problems is natural language processing [8, pp. 31–32].
2. Application of AI to organize the activities of banks. We are talking about solving the following tasks: preparing internal bank reports; analysis and forecast of dynamics of various directions and indicators of banks' activity, forecasting of cash flows; risk assessment and management; identifying threats and ensuring cybersecurity; staff performance assessment; and assessment of potential candidates when recruiting employees.
3. The use of AI in the operational activities of banks related to servicing private and corporate clients. In this case, AI is used to solve the following tasks: customer identification; reading and ranking documents; checking the correctness of the paperwork; assessment of the creditworthiness of borrowers; collateral assessment; making decisions on granting loans; identification of fraudulent transactions; countering money laundering and terrorist financing; the use of chatbots and robot-advisers for customer service; generation of personal offers for clients based on the use of recommendation systems; development of applications for financial trading; robotization of routine operations to improve operational efficiency; and increasing the level of personalization of banking services.

The results of an international study conducted by Deloitte indicate that the leaders of AI implementation in the financial services industry have developed reference AI implementation strategies that all departments should follow, have made significantly larger investments in AI development compared to other players in the market, and plan to increase the volume of such investment further. Leaders focus on increasing revenue (including through product and market entry and cross-selling), empowering customers, increasing customer engagement and satisfaction, and reducing costs. AI leaders achieved higher incomes due to staff reduction in the context of automation, reduction of operating costs, and optimization of external processes, including marketing and sales, due to the creation of new products and orientation to new markets [9, pp. 7–10].

Leading companies in the use of AI in financial services have various applications in mind, including AI as a service, AI embedded enterprise software, simulation tools, and automated machine learning, in collaboration with partners. Leaders use open-source AI tools, community of crowdsourcing developers [9, p. 12]. An international study conducted by Deloitte revealed that 70% of organizations providing financial services used machine learning, 60% used natural language processing, 52% used deep learning, and 58% implemented computer vision [9, pp. 18–19].

Highlighting the prospects of using SupTech and RegTech, the Financial Stability Board draws attention to the risks associated with the introduction of these technologies due, inter alia, to the fact that the value of the data used for analyzing and adjusting AI is rapidly decreasing due to significant changes in the markets. The use of SupTech and RegTech tools developed based on the use of the "black box" model can lead to questions about the interpretability and explainability of the initial data, as well as the results obtained [8, p. 31].

The main risks of AI implementation noted by the participants of the market for financial services are cybersecurity decline, incorrect strategic decisions made based on AI recommendations, risks of regulatory non-compliance, undermining customer confidence due to AI errors, ethical risks, legal responsibility for AI decisions and actions, and AI failure in critical circumstances [9, p. 15].

The large-scale introduction of AI in all spheres of the economy and public administration, as well as the development of more advanced software solutions and the awareness of the associated social, ethical, and economic risks, leads to the need to introduce regulation of the development and implementation of AI-based solutions.

This process started with the discussion and adoption of ethical principles for the use of AI. At the international level, similar principles were developed by the Organization for Economic Co-operation and Development (OECD) and signed by 42 countries [14], as well as at the European Union level [6]. Moreover, all listed documents are of a recommendatory nature. In April 2021, a discussion of the draft law of the European Union on AI [7] was started. The question is raised about the development of similar regulatory documents in the CIS. The introduction of regulatory norms in this area is an urgent need.

Simultaneously, it seems relevant to introduce an approach to regulating the introduction of AI in banking systems, which assumes the following:

1. Development by banks, associations of banks, and central banks of countries of ethical principles and standards for the application and use of AI by banks. The ethical principles for the use of AI in the financial sector, adopted by the Monetary Authority of Singapore [13], are advisory in nature. In 2019, De Nederlandsche Bank proposed for discussion the document "General principles for the use of Artificial Intelligence in the financial sector" [4]. In a document published

by the Bank of England, J. Proudman raised the issue of discussing AI governance principles [1]. In 2020, the Banque de France published a discussion paper on AI governance in finance, including proposed principles for AI design and development [5].
2. Development of ethical principles and standards for the formation and use of big data for the development of AI-related projects.
3. Development of recommendations for assessing the risks of AI implementation in banks.

Fundamentally new and globally significant is such an aspect of banks' activities as supporting the use of AI to achieve sustainable development goals. Thus, the need for AI management to achieve sustainable development is reflected in the first of five Principles on Artificial Intelligence [14] developed by the OECD.

It is possible to predict the intensification of participation in this process by central banks of various countries, banks supervised by them, as well as banks of development operating at the international and national levels. World Bank notes that to achieve sustainable development goals, it is necessary to use disruptive and transformative technologies (DTT), including AI technologies [11, p. XXXIV]. Development banks will be and already are the conductors of this policy. World Bank Group plans to help its clients to use the opportunities and reduce the risks of DTT implementation to achieve the dual goal of ending extreme poverty and improving the overall level of well-being [11, p. IX]. Since 2007, International Finance Corporation has been supporting the implementation of digital financial services using AI to achieve this dual goal of the World Bank Group [2, p. 6].

It seems appropriate to include the following possible consequences of using AI in banking systems:

- Increasing the importance of using AI in the processes of interaction between banks, including expanding the practice of using AI in supervision, as well as in the activities of banks related to compliance with the requirements of regulatory bodies;
- The use of AI in almost all business processes of banks, an increase in the number of projects involving the use of AI by banks, which is due to the strive of the banks to use these technologies in their work and the orientation of their clients toward the implementation of these projects. The most important signal in this direction will be given by development banks. The use of AI by banks, as well as their targeted support of AI implementation projects focused on achieving sustainable development goals, can significantly contribute to achieving these goals;
- The need to retrain personnel as AI technologies will become more widespread. Decrease in the number of bank employees due to the introduction of developments based on AI technologies, partially or completely performing routine operations;
- An increase in the number and scale of activity of neobanks operating exclusively on the Internet and, accordingly, actively using AI;
- Changing the structure of banks' expenses due to an increase in costs associated with the introduction of AI;

- Introduction of AI technologies into the work of banking ecosystems;
- The combination of AI with the use of various digital technologies will contribute to the development of fundamentally new technical solutions in organizing banking activities;
- The emergence of the digital divide between the largest and smallest banks due to the scale of AI implementation;
- The development of a strong AI can change the banking activity in a cardinal way;
- Large banks and international and transnational banks will become the owners of large amounts of data. Simultaneously, the increase in the amount of information in the databases will be actively carried out through the use of information from social networks and the banks' ecosystems;
- The spread of the influence of banks, massively introducing AI and becoming the owners of large data arrays, on the activities of enterprises, organizations, and all spheres of people's lives, including education, solving everyday issues, etc.

37.4 Conclusion

The presented paper proposes a pattern for researching the implementation of AI in banking systems. This made it possible, on the basis of international research data, to generalize the experience of using AI in these systems. The paper shows the risks of introducing AI in banking systems. It proposes an approach to regulating the introduction of AI in these systems.

The study made it possible to identify the consequences of using AI in banking systems. The introduction of AI at the level of central banks and other regulators of banking activities will help improve the efficiency of supervision and analysis of banks' activities. It is possible to predict the introduction of AI into most banking business processes. Particular prospects are associated with the orientation of banks to use AI to achieve sustainable development goals. The use of AI contributes to the automation of interaction with customers, conducting operations for their service, leading to a decrease in the cost of banking services, as well as an increase in their availability. The latter is especially important for developing countries, including to achieve sustainable development goals. In this regard, it seems important to pay special attention to supporting sustainable, responsible banking.

The practical significance of the pattern for assessing the use of AI in banking systems proposed in this research is the possibility of its application for in-depth assessment at the level of banking systems of different countries.

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Chapter 38
Risks of Banking Transformation in Digitalization

Olga G. Semenyuta and Irina E. Shapiro

Abstract The paper discusses the impact of the digitalization of the economy on the transformation of banking. The use of advanced digital technologies and technologies for managing big data allows to significantly expand the client base of banks and reduce the costs of banking services. Simultaneously, banking services have become more convenient and accessible to customers. It is noted that along with a new progressive development paradigm, digital channels of work in the banking market lead to an increase in the risks of banking activities in terms of their information component. At the same time, the most important and difficult in management is an information risk, which becomes a factor in all traditional banking risks.

38.1 Introduction

The rapid digitalization of the global economy radically changed the processes of development of commercial banks, giving a new vector of improving banking. In Russia, ensuring the accelerated introduction of digital technologies in the economy and the social sphere is one of the national development goals, in accordance with the Presidential decree "On the national goals and strategic tasks of the development of the Russian Federation for the period up to 2024" (May 7, 2018, No. 204).

The accelerated introduction of digital technologies is an ambitious economic goal, which is quite successfully implemented in the Russian market for banking services. The introduction of digital technologies is performed against the background of the impact of digital technology on the market of banking products and services, significant and, sometimes, cardinal changes in customer preferences, the decline in the banking sector margin, and, as a result, strengthening regulatory requirements.

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Nowadays, digital technologies are the driving force of the development of electronic banking services; they also create a new bank–client interaction system. Banks strive to expand the range of services offered while reducing their cost price through the use of new sales channels, mobile applications, and social networks. The client receives significantly more convenient and fast banking service channels. This significantly impacts the quality of banking services and banking operations and provides a new model of banking competition for the client.

The term “digitalization” means the transformation of information into a digital format. “Digital transformation” is a modification of all aspects of business processes of advanced digital technologies and analyzing big data. Thus, “digital” and “big data” here are only conversion tools, not an end in itself. The use of digital technologies and analysis of big data arrays allows one to create fundamentally new banking products.

The Russian Federation also pays attention to the development of digitalization in all spheres of economic activity. Presidential decree “On the strategy for the development of the information society in the Russian Federation for 2017–2030” (May 9, 2017, No. 203) defines what should be understood by the concept of “digital economy.” The digital economy is “economic activities in which the key factor in the production is digital form. Treatment of big data and the use of the results of the analysis, compared to traditional forms of management, make it possible to significantly increase the efficiency of various types of production, technologies, equipment, storage, sales, and delivery of goods and services” [4]. The decree emphasizes that digital data has become an important factor in contemporary production.

The information became an independent economic asset in the late 1990s when the article by Douglas Lanya was published. In this article, the author introduced the term “infonomics” and proposed his approaches to a quantitative assessment of information as a real asset. Nowadays, when banks have become pioneers in the digitalization of the economy, the management of the information accumulated in their activities becomes a great resource. Big data and digitalization in the formation of income are, in some cases, above some of the traditional assets.

When improving the quality of banking services through the use of digital technologies, it is necessary to consider the convenience of customers in obtaining banking services, the possibility of improving banking efficiency, and the need to perfect bank risk management. New technological decisions, creating new directions for improving banking business, bring fundamentally new risks to the activities of commercial banks.

38.2 Methodology

The research discusses and combines into a single plan the main regulatory acts of the President of the Russian Federation [4] to achieve the national goals of the breakthrough scientific, technological, and socio-economic development of the Russian Federation.

In a wide range of scientific researches [1, 5, 6], the need to introduce digital technologies is interpreted by terms “digital transformation” and “information risk.” Simultaneously, despite the high developments of the problem at the theoretical level, it is not sufficiently studied at the empiric level; for example, the quantitative advantage of leading digital countries of the world in terms of the size of the client base [3, p. 5] is not sufficiently analyzed. Also, there is no analysis of the informational risk of a digital bank [2, pp. 5–6].

High state involvement in digitalization and the introduction of a digital economy should ensure control over the risks of banking transformation in digitalization.

38.3 Results

Digitalization in banking allows a significant increase in the number of customer interaction with the bank against the background of reducing bank sales offices and redirecting customers from branches to remote banking offices. It contributes to a significant decrease in 40–60% of the operating costs of banks that are actively implementing digital technologies, which allows them to more effectively use their resources and improve the effectiveness of their investments.

New technological solutions to the organization of business processes in commercial banks, for example, based on neural networks, allow one to increase the efficiency of lending. The tasks of improving the efficiency of the lending process are greatly facilitated by the use of text recognition and classification in the electronic document management system, the calculation of texts by subject to certain classes, the search for question–answer pairs, and intelligent analysis of events in today’s digital world.

Thus, the transition of a banking business model into digital contributes to the transformation of commercial banks from classical financial intermediaries into digital financial institutions. Banking transformation into digital financial institutions is due to the formation of its ecosystem, the development of sustainable relations with the companies, and the creation of fundamentally new directions of banking business based on the use of cross-cutting technologies, such as blockchain. The intensity of this process is evidenced by the increase in the number of digital banks in the world, i.e., such banks that offer most of their products to customers in a digital form based on the use of Internet channels.

Cyber threats are the base banking risk today. There is a difficult task of providing secure digital services to customers over the Internet before the banking industry. Therefore, cybersecurity leaves far from classical bank risks (e.g., credit, percentage, operational, and other risks).

For some banks, web infrastructure is not only an important business development tool but often the foundation of the business itself. If we compare the volume of clients with the total population of the countries studied by Frost & Sullivan, we obtain the following data (Table 38.1).

Table 38.1 Proportion of the client base of leading digital banks in the world in the total population of the country

Country	Banks	Number of customers, million people	Population in 2021, million people	Specific gravity (%)
USA	Capital One 360 Discover Bank FNBO Direct TIAA Direct USAA Bank	28.2	335	8.4
Germany	ING Diba AG	11.5	83.2	13.8
Japan	Rakuten Bank	5	126.4	3.9
Russia	Tinkoff Bank	5	146.24	3.4
Poland	Alior Bank	3	37.88	7.9

Source Compiled by the authors based on [2] and [3]

We understand that this analysis is idealized, and part of the customers may be non-residents of a country of a digital bank. We believe that this analysis at the current stage of introducing digital technologies in the banking sector is possible because the verification of non-resident customers in digital banking is associated with high risks.

We suggest supplementing the source data [3] with information from Sberbank, which has been building its ecosystem since 2020. Its ecosystem optimally meets the needs of the customers. In 2021, the number of customers was 98 million clients, which is about 67% of the total population of Russia.

All banks specified in the Frost & Sullivan [3] analysis are exposed to information risks. The interruption of the work of IT services caused by, for example, DDoS attacks may have detrimental consequences for the bank's reputation in the market. Therefore, it is necessary to remember that during the transformation in a bank at the present stage, the main thing is reputational and information risks. Information risk is very unsafe for bank customers. According to the analytical data of Table 38.1, clients of Russian banks bear high risks; the second place is taken by clients from Germany, and the third by clients from Poland.

Digital transformation of banking modernizes all aspects of the financial and credit activities of the bank, including management mechanisms. Therefore, it is necessary to develop a digital development strategy as an integral element of the overall strategy for developing a banking organization. The authors are right to argue that a digital strategy should address not only the implementation of digital technologies, financial aspects of digitalization, and transformation of the process of forming the cost of services but also changes in the organizational structure of the bank.

Analysts point out that those banks that will create real partnership cooperation with fintech companies and companies specializing in big data analysis will retain their competitive positions on the market and even strengthen them. Banks that fail to keep this standard and build such relationships will leave the market.

Consequently, the growth of the digital transformation of banking contains the potential danger of reducing the number of banks due to the departure of those players who will not be able to make appropriate investments or offer profitable partnerships by fintech sector companies. These are primarily small banking organizations. Thus, the development of digital technologies, on the one hand, narrows the number of players but, on the other hand, intensifies competition between commercial banks and fintech corporations that provide similar services to customers based on digital service channels.

The situation is complicated because the labor market must provide banking organizations with unique employees with new technological competencies. Nowadays, the labor market does not give this quality of human resources. This problem objectively causes difficulties in retraining workers released from some banking specializations due to the introduction of new technologies, such as robotized decision-making on credit products in retail banking or lending to small businesses. As known, the reassignment of released workers entails additional costs for the organization.

There is a whole complex and other problems of developing a digital transformation of banking. It is an increase in the costs of introducing new technologies and software, dependence on systems or programs when making decisions about the possibility of lending, and, in general, the increase in operational risks, the complexity of the remote identification of the client, and so on.

Undoubtedly, in the first place, in the context of digitalization of banking and operational risks of transmission and processing of financial information, unauthorized access to information brings high losses to many participants in financial markets and the real sector of the economy. New technological information risks permeate all traditional banking risks, becoming their new factor, which is associated with the increasing role of the information component in business processes. As Zavgorodnyi correctly states in his article "The Paradigm of Information Risks," "In all economic risks there is information risk as a component… A part of economic risks is, in essence, entirely informational risks. These include, for example, management and investment risks" [6].

38.4 Conclusion

Thus, the global nature of the digital economy transforms banking and bank risks. On the one hand, the increasing complexity of the requirements for banks shows the need to introduce digital technologies. On the other hand, there is an actual need to create a new banking risk regulation system. This system of risk regulation should be organized because data in digital form has become a major factor in the development of all economic agents, and primarily commercial banks. Simultaneously, information risk management becomes key in managing a commercial bank and ensuring its economic security.

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Part V
Industry Overview of the AI Economy

Chapter 39
Digital Tools for Stimulating Russian Grain Exports

Olesya A. Drebezova and Petr V. Taranov

Abstract The paper aims to study various information technologies and their integrated application in the agro-industrial complex, considering the digitalization of all major segments and infrastructure systems of the grain complex, which can expand the competitive potential of IT products and artificial intelligence tools to stimulate Russian grain exports. The necessity of application and networking of grain supply chain at all stages of the grain life cycle from producer to end consumer is based on measuring information flows of the participants of grain export and active use of Internet of Things, capable of real-time tracking of grain cargo movement, recording the conditions of grain storage and promotion by various transport modes (road, rail, and sea), and defining the parameters of processing quality for further export of grain. In the context of the necessity of application and networking of grain supply chain, we can say that the most important aspect for the Russian grain export chain is to ensure the quality of grain products. Digital tags on the grain are an essential factor in the movement and tracking of cargo, which should be fixed in the documents when exporting grain. Simultaneously, different segments of the grain complex of the Russian Federation have different degrees of digitization of business processes, which makes it challenging to build optimized grain supply chains from grain production to its processing and transportation for grain export sales in the world grain market. The use of AI technologies in the grain complex is a fundamental factor in ensuring sustainable and stable development of agriculture and ensuring the long-term, high-quality supply of agricultural products on the world grain market. Thus, the use of AI tools to optimize grain flows will reduce grain losses during storage, processing, and transportation, which will strengthen the competitive position of Russia in the international grain trade.

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39.1 Introduction

The grain complex of the country occupies more than half of commodity crop production, and grain export accounts for 40.8% of the export of the Russian agro-industrial complex. Therefore, the sustainability and competitiveness of the grain complex is the most critical direction of the national economy. In recent years, the dynamics of the Russian grain complex have significantly changed. By 2024, the Russian government plans to increase grain exports by another 1.5 times as compared to 2021 and raise the sales value of Russian grain to $11.4 billion.

According to Altukhov, none of the sub-sectors of Russian agriculture has undergone such significant structural and functional changes as grain exports because, at the turn of the twentieth century, Russia was the largest importer of grain in international trade and has regained its export potential in the world grain market in twenty years [2]. Simultaneously, different sectors of the grain complex have different degrees of application of IT technologies, which makes it challenging to optimize grain movement processes and track grain flows in real time.

From this point of view, it is necessary to consider the application of IT technologies for agricultural producers and grain traders, the development of sensor technologies of the Internet of Things of agricultural lands, and the application of digital monitoring and control of crops in real time, AI technologies of digital registry of agricultural lands, and digital products of grain protection in storage, processing, and transportation of grain.

The research aims to study various information technologies and their integrated application in the agricultural sector, considering the digitalization of all major segments and infrastructure systems of the grain complex, which can expand the competitive potential of IT products and artificial intelligence tools to promote Russian grain exports.

39.2 Methodology

Russian scientists [4, 6, 9, 15, 16, 18] and foreign researchers [3, 5, 7, 8, 10–14] actively consider the possibility of using various IT products in agriculture, in the transportation of goods, and the formation of digital tags to accelerate the promotion of commodity flows in the export of products.

These studies cover in detail the application of IT products in different sectors of the grain industry. Nevertheless, they do not cover all sectors of the grain industry, which makes it challenging to understand the effectiveness of IT products in the entire reproductive cycle of the grain complex from "production–distribution–exchange–consumption."

This research proposes an integrated approach to studying the use of IT products in the grain industry to stimulate grain exports, considering the integration of various sectors of the grain industry, including the following:

- Grain production;
- Storage and processing of grain;
- Transportation of grain;
- Sale of grain;
- Export of grain; and
- Information infrastructure of the grain market.

39.3 Results

The following comprehensive approach to the use of IT products in the entire reproductive cycle of the grain complex from “production–distribution–exchange–consumption,” considering the specific functioning of various sectors of the grain industry, is proposed (Fig. 39.1).

According to Fig. 39.1, such a comprehensive approach to the use of IT products in the grain industry allows us to consider the functional purpose of IT products in each sector of the grain complex and determine the structural specificity of IT products for each sector of the grain industry. This allows us to systematize the use

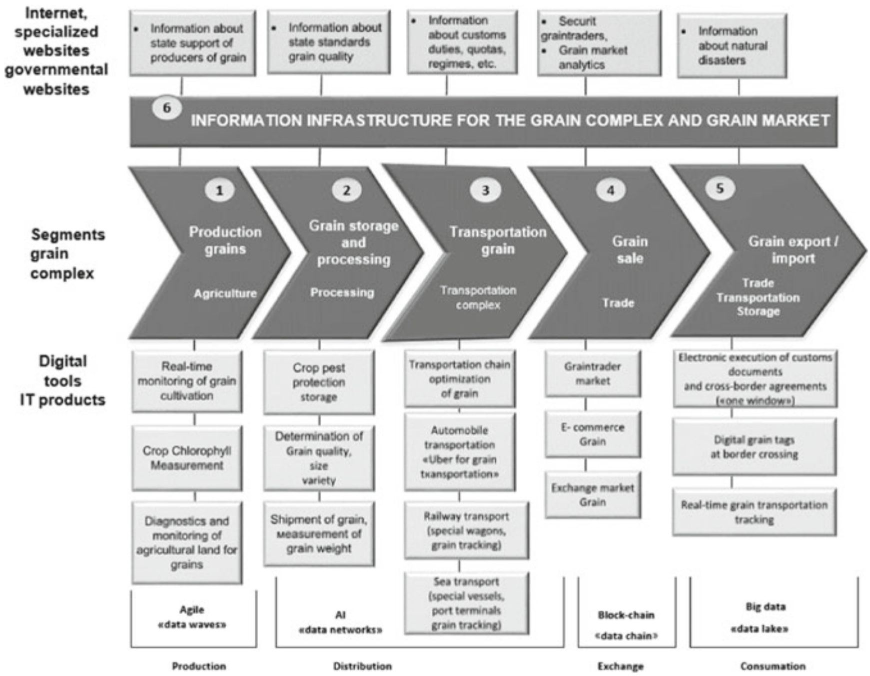

Fig. 39.1 Application of IT products and AI tools in various segments of the grain industry. *Source* Developed and compiled by the authors based on [1]

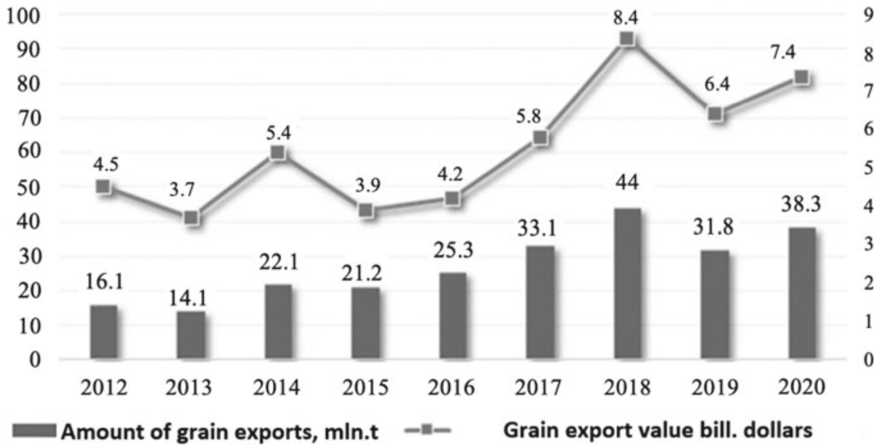

Fig. 39.2 Dynamics of Russian grain exports 2012–2020 (million tons, billion dollars). *Source* Developed and compiled by the authors based on [8]

of IT products in the grain sector and determine the main types of IT products to promote Russian grain exports.

It should be noted that the grain sector of the country accounts for more than half of crop production, and grain exports account for 40.8% of agribusiness exports. Thus, the stability and competitiveness of the grain complex is the most important direction of the national economy.

However, the positive dynamics of Russian grain exports are not sustainable because there is strong competition between exporting countries and high volatility of world grain prices. Additionally, the existing restrictions for Russian grain traders and trade barriers significantly affect the volume and cost of Russian sales on world grain markets (Fig. 39.2).

As can be seen in Fig. 39.2, the volatile dynamics of Russian grain exports in 2012–2014 was replaced in 2015–2018 by a 52% increase in grain exports in physical terms (from 21.2 million tons to 44 million tons) and a 54% increase in value terms (from $3.9 billion to $8.4 billion), which allowed Russia to take the first place in terms of grain exports in 2018 worldwide. However, in 2019, Russian grain exports fell by 27% in volume terms (from 44 million tons to 31.8 million tons); accordingly, the volume fell by 28% in value terms (from $8.4 billion to 6.4 million tons).

Unstable dynamics of Russian grain exports require stimulating measures, including through the use of IT products in the grain complex, which allows optimizing the supply chain of grain flows to international grain markets.

The use of IT products in the grain complex affects a wide range of industry parameters of agribusiness development. Nevertheless, different sectors of the grain industry related to production, transportation, and export have different needs for the use of digital products.

The introduction of a unified information system for the traceability of grain flows and the use of digital tags is necessary to stimulate Russian grain exports. By 2022, Russia plans to create a unified federal information system based on the federal law on grain quality control and traceability. The federal grain information system is designed to form a system for controlling the quality of grown grain and tracing the life cycle of the product from production to distribution and consumption. The use of GLN and GTIN to identify grain products, producers, and places of grain production is recognized by some experts as inexpedient because it requires a high degree of legislative harmonization, technological standardization, and unification of marking and traceability tools. Grain companies will be able to access a unified federal grain traceability system through the web interface of desktop or smartphone browsers that support ECMA 6 JavaScript and HTML5 syntax [17].

All companies of the grain complex involved in the production, processing, storage, transportation, and marketing of grain and grain products are obliged to register in the system and enter the data into it. They are responsible for the processing of any incorrect information.

The accompanying document contains information about batches of grain or grain products for traceability during transportation by any mode of transport and release. It would be impossible to sell or export grain in Russia without accompanying documents.

The unified federal information system of serviceability and digital labeling of grain is designed to perform the following tasks:

- Integrate the set of national components of the systems of marking and traceability of grain movement to stimulate Russian grain exports;
- Ensure a seamless exchange of information among all participants of the country's grain complex;
- Form seamless grain traffic gateways;
- Develop common technical and information resources and regulations; and
- Form common formats of data, classifiers, catalogs, etc.

By creating a unified federal grain tracking system, it may be possible to eliminate the "gray" sector in the grain export, which now fluctuates at the level of 15–20% of grain exports, in which the movement of grain flows is realized without accompanying documents and proper accounting of export receipts in the country.

Currently, state control over grain quality is not fully regulated by Russian legislation. The unified federal system for accounting for the movement of grain seeks to control the quality of grain from the field to the consumer. A single unified document for grain transportation based on digital tags is designed to improve the quality of export shipments and stimulate exchange trade in grain.

39.4 Conclusion

It is necessary to use various information technologies to stimulate Russian grain exports, considering the digitalization of all main segments and infrastructure systems of the grain complex along the line from “production–distribution–exchange–consumption.” The use of IT products requires a corresponding restructuring of business processes and the technical level of equipment. The transition to advanced solutions in the IT industry should be gradual. It is possible only if there is an updated technological base.

Agriculture is significantly behind other Russian industries in the use of IT products and even behind the average use of IT products in the country, including broadband Internet (11.0%), cloud services (6.7%), ERP systems (10.3%), e-commerce (4.1%), and RFID technology (2.7%).

To stimulate Russian grain exports, it is necessary to introduce a unified information system for the traceability of grain flows and the use of digital tags. By 2022, Russia plans to create a federal information system based on federal law to control the quality and traceability of grain. The federal information system on grain is designed to form a system of quality control of grown grain, tracing the life cycle of the product from production to distribution.

The unified federal information system for grain tracking using digital tags based on IT products is designed to eliminate the “gray” sector of Russian grain exports, which now hovers at the level of 15–20% and in which the movement of grain flows is carried out without accompanying documents and proper accounting of export receipts in the country.

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Chapter 40
Issues of Using Artificial Intelligence in Pharmaceutical Retail in Russia

Victoria A. Bondarenko, Svetlana S. Galazova, Dmitry D. Kostoglodov, Natalia V. Przhedetskaya, and Julia V. Solyanskaya

Abstract The paper examines the issues of using the demand for artificial intelligence in business, especially in the area of pharmaceutical retail in Russia. As a target setting, we consider the study of understanding what place AI occupies in the life of society, future trends, and the way it will affect the activities of the companies in which this technology will be introduced, using pharmaceutical retailers as an example. The primary goals of the research are to validate the prospects and limits for the development of AI in Russia, study the experience of various companies using this technology, and analyze the application of AI in pharmaceutical retail. A conclusion is made about the prospects of AI. A forecast about the intensification of the introduction of AI in pharmaceutical retailers in Russia is given.

40.1 Introduction

Artificial intelligence is currently used in various industries and fields to justify management decisions, build relationships with business partners, create a program of long-term interaction with consumers, and predict future trends. The area of its application will only increase over time, which is essential for the social and economic system of Russia, because the country is focused on digital transformation [1], which, in its turn, is largely based on the practical application of these technologies and effects the vector of territorial transformation [2].

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Besides the great significance of artificial intelligence for the economic system, in general, we underline that almost every individual faces artificial intelligence in their activities. Nevertheless, despite the widespread of artificial intelligence, not everyone can characterize it unambiguously, explain what technological solutions it is based on and the ways it manifests itself in various areas, such as interactive systems, voice services, uncrewed systems, and trained chatbots used for consultations and sales. There is an opinion that artificial intelligence is primarily the ability of a computer to act like a human, namely perform actions associated with learning, development, and decision-making and follow the chosen algorithm of actions [3].

The very idea of artificial intelligence (AI) is not new. For the first time, they began to talk about it in the 1950s, just at the period when the first computers appeared. This technology has progressed relatively slowly; only in the last decade has its development gone exponentially. Interest in this topic constantly changes; it rises and then drops sharply. Currently, this issue is extremely relevant. Tracing the interest in AI in retrospect, we have noted the interview of Vibhanshu Abhishek, a Professor of Information Systems Department, University of California, to RBC Pro. He states, "Every time AI attracts attention, a wave of decline and loss of interest follows; the first such decline happened in the 1960s, the second—in the 1990s. Such decline in interest is due to the overestimated expectations of people regarding the work of AI. Now, everyone is waiting for the third wave" [4].

Let us clarify that if we consider the opinion of many researchers in this area, most of them argue that the main reason why there will be no third wave of decline in interest is a huge amount of data accumulated, which is becoming more and more difficult for an ordinary person to process. The second reason, which also seems apparent, is the cheapness of computing power.

In this situation, an increasing number of companies and pharmaceutical retailers actively use AI. Large businesses were mainly interested in AI before, but now relatively small businesses take an interest in AI as well. Fundamental changes in the very nature of companies associated with digitalization, digital transformation, and the introduction of AI eliminate many restrictions on the scale, coverage, and training, giving rise to huge opportunities for startups and already established companies [5, p. 13]. In this case, the forecasts about the future of society are contradictory because there is an opinion that AI can cause massive unemployment. In contrast to this opinion, not everyone believes that at present, despite the success in the use of AI, it will be able to compete with human intelligence fully.

It can be unambiguously argued that the problem of using AI is relevant. The paper aims to underline the place of AI in the life of today's society, the ways it will develop further, and the effect it has on the activities of the companies that will introduce this technology. The authors use pharmaceutical retail as an example.

The research objectives are as follows:

- To assess the prospects and limits of the development of AI in Russia;
- To study the experience of various companies using this technology; and
- To analyze the use of AI in pharmaceutical retail and identify development trends.

40.2 Materials and Methods

The research deals with the use of artificial intelligence in the current world. The prevailing opinions of scientists and practitioners specializing in this area are analyzed. The authors conduct a theoretical study of the areas of applying this technology in various businesses worldwide, as well as an empirical study on the use of AI in pharmaceutical retail in Russia; the pros, cons, and development prospects are noted. The methods of scientific generalization, search, comparison of scientific opinions, comparative analysis, and synthesis of the obtained research information are used.

40.3 Discussion

The issues of the application of "smart technologies" and the consequences of digital transformation are studied by many scientists, who associate them with the possibility of further positive evolution of society and finding opportunities for sustainable development, which allows optimizing consumption without losing the quality of life, which is quite visible in health care [6].

AI is actively used in marketing research, market analytics, planning the location of trade enterprises, and creating communications with customers, all aspects being analyzed in the works of various scholars [7–9].

However, the systemic research of the problems of AI shows that there are currently several subsections in the area of artificial intelligence: robotics, computer vision, natural language processing, and machine learning.

The researchers group AI under three headings:

- Weak AI (narrow AI) is designed to solve a well-defined, narrow task. Acting only within a narrowly defined framework, it can perform this task better than a human being. Weak AI is not able to learn. In this case, any changes in the given conditions lead to the failure in using AI to solve the problem. An example of AI of such kind would be the computer program Deep Blue, which beat Garry Kasparov at chess in 1997. Such a program is not trainable and cannot progress in its development.
- Strong AI is non-trainable or partially trainable chatbots and intelligent voice assistants that provide assistance at certain activities. Such a type of AI can imitate the communication of individuals in society. Nevertheless, it operates within the framework of given algorithms, without any possibility of making independent decisions.
- "Artificial superintelligence—the Turing test, developed in 1950, is a test of a machine's ability to exhibit intelligent behavior equal to or indistinguishable from human behavior. If such a level is ever reached or surpassed, it will be an artificial superintelligence" [3].

According to Amid Joshi, a professor at the Swiss Business School IMD (specializing in AI and digital technologies in business), "The opinions of scientists differ, a half of them assumes that such superintelligence cannot be created, the other half claims that it will be created by 2035–2040" [10].

In fact, the scientist believes that society is ready for transformation from conducting analytical, expert research to the formation of a full-fledged data system. Such data systems imply the use of effective AI algorithms based on such components as "large amounts of data, computing power, and labor of capable—but not necessarily outstanding developers of AI algorithms" [10].

In the current situation, the reliance on these components and their competent application in a developing business area can contribute to a breakthrough in the entire industry; it may be a chance for certain leading players to get ahead of competitors.

40.4 Results

According to McKinsey's research, in 2020, the use of AI in business grew by 25% and is expected to continue. According to Russian statistics, "more than 30% of businesses in Russia are already using AI in their activities, and another 23% plan to implement AI in the future, while 91% of business representatives are aware of the existence of such technologies. These conclusions were made by Project Management Office for Implementing the National program "Digital Economy" of the Analytical Center under the Government of Russia and the Russian Public Opinion Research Center (VTsIOM), which published the results of a study of the Russian business attitude to AI" [11].

The question arises, why does an increasing percentage of companies use AI in their daily activities? According to IDC, an analyst firm, the amount of data contained on Internet servers equaled 33 zettabytes in 2018. The growth of data on the Internet is estimated by IDC at 30% per year, with a forecast of 175 ZB by 2025. Nowadays, there should be 45–50 ZB of data on the Internet, half of which is contained in cloud storage [12].

It turns out that the accumulation of such a large amount of data is problematic to analyze using the traditional means. Additionally, the analysis of large data stores with the help of AI can free up the labor potential of employees previously involved in this area to solve other urgent operational production tasks, which results in innovations and an increase in overall labor productivity.

Several obstacles prevent AI from spreading as fast as a business requires. Some of these reasons are as follows:

1. Cybersecurity (no matter how strange it may seem). AI is quite vulnerable and is included in the list of the main cyber threats of 2021. For example, hackers massively use machine learning in targeted and automated attacks [13]; therefore, it is necessary to think about information security before starting to use AI in business. The same can be said about the robotics subsection; everyone

remembers the iconic film “Terminator,” in which a smart machine became a threat to humans. Perhaps, a high risk of cyber threat is one of the reasons why this area is still not so actively developed.

2. Legal regulation. The most serious question is who will be responsible for the mistakes made by the AI: the AI developer or the user who applied it appropriately or improperly. For example, legal regulation is beginning to take shape in Russia. Nowadays, the concept to regulate relations in the field of artificial intelligence and robotics technologies until 2024 has been approved [14]. It raises the issues of further development of the legal practice of using AI in business and the life of society. Legal regulation may not keep pace with the rapid development of AI, which will hinder its large-scale application.
3. Reliable technological infrastructure. AI is not a stand-alone technology; it needs the support of well-functioning data and infrastructure [15]. The issue of reliability is extremely relevant because failures in the operation of infrastructure create additional risks for the economic system and society.
4. Insufficient qualification of personnel. Another significant risk is the insufficient level of qualifications of personnel who do not have the necessary competencies in the field of AI. For the majority, this factor acts as a limiting one for the application of AI in their daily work. According to VTsIOM, about 11% of respondents admitted that they have no knowledge of relevant technologies, about 69% of respondents reported a shortage of qualified specialists in the field of AI, and 43% of respondents do not use or plan to use AI in their work [11]. This reason is also associated with financial issues because such training requires costs and maintaining a relatively constant level of expenses for improving the qualifications of employees in this area.
5. Long development cycle of AI. According to various sources, the development and implementation of AI take about six months, in some cases even longer, which is a limiting factor for small and most medium-sized businesses. As a rule, they are limited in the resources required to work on the development and implementation of AI. Understandable cases related to Russian realities in the use of AI are in high demand, as are digital products and technological solutions available to most companies and competencies which specialists get while applying them [11].

The issue of the use of AI technologies in various Russian companies is also significant. Figure 40.1 shows all areas of using AI in Russian companies.

According to the data presented, we can conclude that AI is actively used in such sectors as telecommunications, banking, marketing, logistics, and retail. These industries are current leaders in the application of advanced AI technologies.

We emphasize that one of the key issues for our study is the use of AI in pharmaceutical retail. Analyzing the use of AI in pharmaceutical retailers, we can conclude that everything is at an early stage of development. AI is most often used for automating product orders. As for general digitalization and the active use of various tools in online stores of pharmaceutical retailers (automated sales funnels, virtual assistants, chatbots, etc.), there is still work to be done. However, partial automation of product

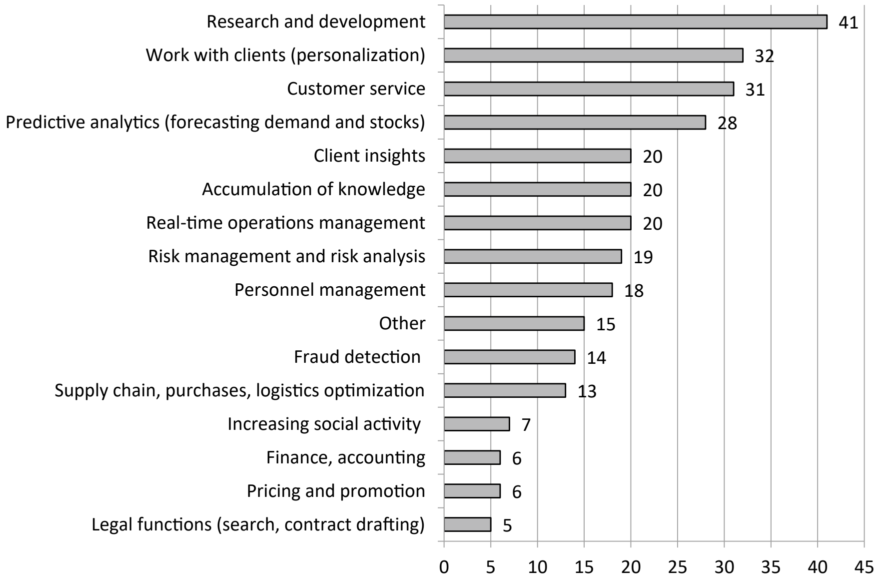

Fig. 40.1 Areas of using AI in Russian companies. *Source* Compiled by the authors based on [11, 16]

orders has been introduced only in large pharmacy chains, and most of the pharmacies continue to order manually. It is also worth noting that the current algorithm created to automate the order is not perfect; it most often calculates the average sales for a given period and rarely considers any changes associated with an increase or decrease in demand for a particular product, which periodically leads either to overstocking or to the formation of defects in some items.

Logically, the next step to improve the algorithms for automating drug orders in pharmacies was to make a change, which allows not only considering the average sales for the period, but also the seasonality of demand, an increase in demand in a short period, and the launch of various promotional activities. This improvement can positively affect the financial status of pharmacy organization—the absence of defects or, on the contrary, excessive overstocking, will free up the time of the management personnel for the implementation of another type of activity, which is now especially important since there is an acute shortage of personnel in almost all pharmacies in large cities of the country.

As for the additional sales channel in pharmaceutical retail, namely online trading, which became possible in Russia due to the amendments made on April 3, 2020, to the Federal Law "On the circulation of medicines" (April 12, 2010, No. 61-FZ) (Federal Law No. 61) [17], there is still work to be done, and the introduction of AI will contribute to the active development of this channel and the minimization of the costs associated with the involvement of employees in sales in this field. Automation of the system for forecasting the demand for products will help identify trends and basic consumer requests, thereby quickly creating the best offers for online and offline customers of pharmacies. With the introduction of AI, all offers will be maximally personalized, clearly corresponding to the request. A virtual assistant will facilitate navigation through the online pharmacy website, help make the right choice of the necessary products, and carry out up-sale, which will have a positive financial effect. In the nearest future, leading retailers will have mobile apps that work with the existing voice assistants or offer their own unique self-learning chatbots.

40.5 Conclusion

The research shows that the share of AI in business in the world and in Russia will grow, despite the existing risks associated with its use and further implementation. The prospects for using AI in different industries and areas are apparent; the demand for it varies in these areas, but it is invariably relevant.

Concerning the pharmaceutical segment, we note that due to the low marginality of the pharmacy business and its high competitiveness, the use of AI and predictive analytics will enable pharmacy chains to analyze the accumulated volumes of information effectively—to identify patterns in customer behavior and effectively manage stocks, which will have a positive effect on the financial position of companies and will increase the level of consumers' loyalty.

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Chapter 41
Using Heterogeneous Neural Networks to Optimize Treatment Tactics for Various Diseases

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Abstract The use of neural networks in health care plays an increasing role in selecting relevant treatment methods. Information systems have accumulated large amounts of data describing the course of disease cases over the past 10–15 years. The task is to develop an algorithm for automated diagnosis with subsequent automation of the choice of treatment tactics. The algorithm allows us to significantly reduce the time and quality of diagnosis and create a library of standard treatment methods in relation to the capabilities of a specific medical organization. As a result of the study, it is shown that the consistent use of various types of neural networks, as well as the Delphic procedure, leads to almost complete automation of the diagnosis and treatment of diseases.

41.1 Introduction

The use of neural networks in health care plays an increasingly important role in selecting relevant treatments for patients with various diseases. Information systems have accumulated large amounts of data describing the course of individual cases of diseases over the past 10–15 years. Simultaneously, there is a large variability of the original information caused by its inaccuracy associated with input errors and the desire to ensure that the accumulated information meets the approved methods. Correct formalized processing of such data is extremely difficult due to several reasons:

- Different views of specialists on the correct treatment tactics for a particular disease;
- Different capabilities of individual medical organizations in the treatment of certain diseases. The variability can be explained by different qualifications of

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doctors or differences in the diagnostic procedures implemented in the treatment process, as well as the diagnostic equipment used;
- Different treatment tactics depending on the severity of the disease; and
- Direct notes of the staff of medical organizations.

41.2 Methodology

The research aims to develop an algorithm for automated diagnosis with subsequent automation of the choice of typical treatment tactics.

The description of any disease case can be represented using a vector of the form:

$$z < t, d, a, l, r >, \tag{41.1}$$

where

t is the date of primary fixation of the disease;
d is the final diagnosis (according to the international classification of diseases, 10th revision);
a is a description of diagnostic procedures, while element itself is described by a two-dimensional vector < *n*, *r* > (*n* is the name of a diagnostic procedure, and **r** is its result);
l is the sequence of therapeutic procedures (procedures used in therapeutic rather than diagnostic purposes); and
r is the result of treatment of the disease in general.

Time *t* is used to prevent incorrect analysis of cases whose treatment tactics have changed due to external causes (new equipment, medicines, treatment standards, or staff qualifications). To simplify the analysis, the parameter *t* is considered in the future. We will assume that the analysis uses only those cases of diseases whose treatment corresponds to current medical views.

At the first stage, we do not consider treatment procedures and treatment results; that is, we consider a reduced vector:

$$z1 < d,\ a > \in z. \tag{41.2}$$

41.3 Results

During the research, we developed the following algorithm for processing the extraction of initial data for automated diagnosis:

- For each unique diagnosis in the information system, all cases of diseases are selected. Otherwise, $\forall d \exists v1(d, a) \in z1$, where $v1$—many cases of the disease with a diagnosis d;
- For each $v1$ automatic classification of diagnostic data is performed using the Kohonen neural network [1, 3, 7].

The essence of the method is to transform the source set into a group of classes, using a transform function of the form: Ψ: $D \rightarrow \{1, 2, \ldots, K\}$.

At the input, we have a set of vectors of dimension N: $X^m = (X_1^m, X_2^m, \ldots X_N^m)$, $m = 1, 2, \ldots, M$.

When dividing this set into K-classes, sets of weight coefficients are given by the formula: $W^k = (W_1^k, W_2^k, \ldots, W_N^k)$, $k = 1, 2, \ldots, K$.

1. The training algorithm is given:

   1.1 Perform the normalization: $\mathrm{Max}_n = \max(X_n^m)$, $\mathrm{Min}_n = \min(X_n^m)$, $n = 1, 2, \ldots, N$;
   1.2. $a_n = \frac{1}{\max_n - \min_n}$, $b_n = \frac{-\min_n}{\max_n - \min_n}$, $n = 1, 2, \ldots, N$;
   1.3. $x_N^m = a_n x_n^m + b_n$, $n = 1, 2, \ldots, N$, $m = 1, 2, \ldots, M$;
   1.4. Initialize the weights $\{W_n^m\}$ with random variables distributed evenly on [0.98, 0.39];
   1.5. We will use the learning coefficient $\lambda = 0.32$;
   1.6. While $\lambda > 0$ perform steps 1.4–1.5;
   1.7. Repeat j times (in our case $j = 17$). For each x^m, we search for the nearest vector w^k; for the found vector w^k, we correct the components $w_N^k = w_N^k + \lambda(x_n^m - w_N^k)$, $n = 1, 2, \ldots, N$;
   1.8. Reduce learning coefficient $\lambda = \lambda - \Delta\lambda$, where $\Delta\lambda = 0.04$.

The algorithm allows varying a number of parameters for its best convergence.

As a result, cases of treatment of the same type of disease will be classified into several groups depending on the nature of the disease. Practical application of the algorithm has shown that the classification of data into 3–5 groups is stable. An attempt to divide by fewer classes leads to the loss of important information; an attempt to divide by more classes leads to the degeneration of some classes.

The resulting classification for each diagnosis should be interpreted by medical professionals. In general, these classes can be characterized as follows:

- Class 1 ($k1$)—wrongly diagnosed;
- Class 2 ($k2$)—mild course of the disease;
- Class 3 ($k3$)—moderate course of the disease;
- Class 4 ($k4$)—severe course of the disease; and
- Class 5 ($k4$)—inaccurate disease data.

For each particular disease, the composition of these classes is individual, and their number may differ.

2. Some stages of the analysis should be carried out with the involvement of medical professionals. Therefore, to improve the speed and quality of their further work,

it is advisable to visualize the results using self-organizing Kohonen maps [5]. They provide a visual representation of information. For this purpose, we use a modification of the algorithm, in which each neuron has its own geometric position relative to other neurons.

2.1 Initialize the vectors W_m with random numbers that have the same order as the source data.
2.2 Setting the time parameter t to 1.
2.3 Randomly select an arbitrary element from X.
2.4 Find the neuron whose weights are closest to X (neuron m*).
2.5 Adjust the weights of all neurons:

$$\omega_n^m = \omega_n^m + \mu(t)h\big(t, q\big(m, m^*\big)\big)\big(x_n - \omega_n^m\big),$$

where

$$\mu(t) = \mu_0 e^{-at},\ \ h(t,q) = e^{\frac{q^2}{2q(t)}}, q(t) = q_0 e^{-bt}.$$

2.6 Appropriate $t = t + 1$. If the maximum t is exceeded, the output is as follows. Otherwise, return to step 2.3.
The results can be displayed graphically (Fig. 41.1).

3. The final stage of classification is advisable to allocate the center of each class, or the average of the representative of each class ($k1_m$, $k2_m$, $k3_m$, $k4_m$, $k5_m$).
4. The obtained results are carried out by involving medical experts. As initial data, experts are offered a list of diagnoses and vector values ($k1_m$, $k2_m$, $k3_m$, $k4_m$,

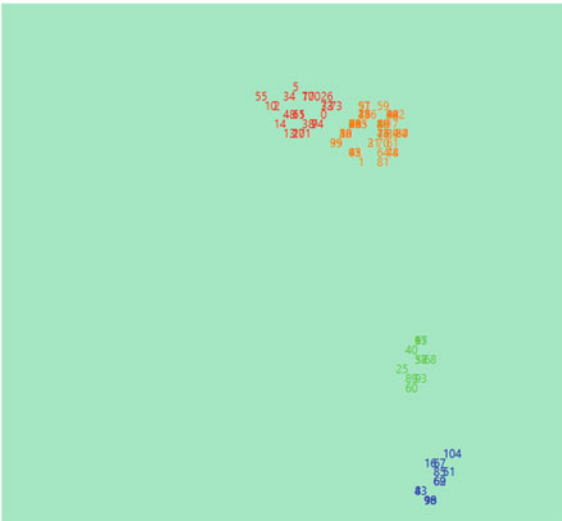

Fig. 41.1 Appearance of a self-organizing Kohonen map. *Source* Developed and compiled by the authors

$k5_m$). Each expert can agree to an average set of diagnostic procedures and (or) their results or make changes that are important in his or her opinion. The main stages of expert analysis are described in the work of Khubaev and Kalugyan [4].

The sequence of steps of examination are as follows:

4.1 The organizers of the examination provide each expert with vectors ($k1_m$, $k2_m$, $k3_m$, $k4_m$, $k5_m$), and, as a goal of the examination, it is proposed to confirm their correctness, modify them, or supplement with new correct vectors;
4.2 Each expert independently formulates their own proposals;
4.3 Using standard software, statistical processing of questionnaires is carried out and collective judgment of the expert group is formed, arguments corresponding to different judgments are summarized;
4.4 The resulting information, together with the initial information, is communicated to the experts; participants in the examination are asked to explain the reasons for disagreement with the collective judgment and, if desired, to revise the original point of view; and
4.5 Repeat the examination to narrow the range of expert assessments. The procedure (examination cycle) is repeated 3–4 times before establishing stability in the judgment of experts.

The examination is interrupted if the degree of discrepancy between the opinions of experts stabilizes. This is usually achieved after the third to the fifth round of the survey.

As a result, one of the following situations may occur:

(a) The responses of the majority of experts form a homogeneous group; individual experts with sharply differing opinions are few in number;
(b) There are several stable and well-organized groups; and
(c) Groups for which expert responses were evenly dispersed in space were identified.

In the case of “a,” the selected group can be taken as a reference; on its basis, the factors are ordered in accordance with the collective opinion.

The case “b” allows us to put forward a hypothesis about the heterogeneity of the team of experts. In this case, it is necessary to identify the objective reasons for this heterogeneity or add their opinions to the reference samples.

The case “c” means that the problem is incorrectly formulated, the set of factors in the questionnaire is poorly chosen, the team of experts is significantly heterogeneous and (or) incompetent, or both. In this case, the following solutions are possible:

- Change the composition of the expert group;
- Use only those factors for which there is a high degree of agreement.

5. Classification allows us to determine the correct diagnosis using the Hopfield neural network automatically. Comparison can be made with the instances obtained in items 3–4 of the present algorithm. If necessary, in the future, it

is allowed to consider all representatives of the classes highlighted in item 1 of this algorithm, using the fuzzy set apparatus, to ensure greater accuracy. The comparison of the functioning of the Hopfield neural network is organized as follows.

Let us have M reference images $X^m = \left(x_1^m, x_2^m, \ldots, x_n^m\right)$, $m = 1, 2, \ldots, M$.

The Hopfield neural network is completely described by the $N \times N$ square matrix of neuronal interaction weights. Actually, there will be no neurons in our network, but only the weights of their interaction. In this single-layer network, it is assumed that all neurons interact with all.

Thus, the network is represented by a matrix $W = \left\{w_{ij}\right\}_{i,j}^{N} = 1$.

Simultaneously, it turns out that weight w_{ij} reflects the interaction of a neuron i with a neuron j.

Describe the Hopfield network learning algorithm [2, 6, 8].

5.1 Let $w_{ij} = 0$, $i, j = 1, \ldots, N$.
5.2 Perform weight adjustment for all reference samples $w_{ij} = w_{ij} + x_i^m x_j^m$.
5.3 Let $w_{ij} = 0$, $i, j = 1, \ldots, N$.
5.4 Normalize $w_{ij} = w_{ij}/N$, $i, j = 1, \ldots, N$.

Now, we have a trained Hopfield network. The following steps are used to recognize a particular noisy case of the disease. Let us have some cases of the disease $y = \{y_1, y_2, \ldots, y_n\}$.

5.5 Cycle on j from 1 to N.
5.6 Let $d = 0$.
5.7 Nested cycle on i from 1 to N.
5.8 $d = d + w_{ij} y_i$.
5.9 End of nested cycle.
5.10 If $d > 0$, then $z_j = 1$, else $z_j = -1$.
5.11 End of external cycle.
5.12 Received a new vector $z = (z_1, z_2, \ldots, z_n)$.
5.13 If the vector z coincides with some reference image of x, then we assume that the algorithm recognized x in the original y.
5.14 Let $y = z$.
5.15 Go to 5.5.

Thus, we get a tool for automated preliminary diagnosis.

6. At this step, it is necessary to classify treatment methods for each class found in item 1. For this purpose, we use the vector parameter $z2 < d, l, r >$ obtained from the expression (41.1). Otherwise, $z2 < d, l, r > \in z$.

   The described Kohonen algorithm is used (see item 1 of the present algorithm) but is already applied to medical procedures.
7. For the treatment methods obtained in item 6, self-organizing Kohonen maps are constructed (see item 2 of the present algorithm).
8. Experts analyze the adequacy of the selected treatment method, make adjustments, and approve the introduction of information into the standardized "library of treatment methods," in accordance with item 4 of the present algorithm. At this

stage, it is often carried out a substitution of algorithmically selected treatment tactics for standardized tactics approved by regulatory documents.

41.4 Conclusion

Thus, this algorithm significantly reduces the time and quality of establishing the correct diagnosis, as well as creates a library of standard treatment methods in relation to the technical and organizational capabilities of a particular medical organization.

As a result of the study, it was shown that the consistent use of Kohonen, Hopfield neural network algorithms and self-organizing maps, as well as the Delphic procedure for the opinion of medical experts, leads to almost complete automation of the disease diagnosis process and the selection of an adequate method of its treatment.

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Chapter 42
Application of Artificial Intelligence in Computer Gaming and Game Content

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Abstract The paper focuses on the tools for applying artificial intelligence in the implementation of game content. The development of productive forces led to digitalization, further leading to the emergence of various goods and services via the Internet. New goods and services include computer games, music services, online cinemas, mobile applications, social services, etc. The COVID-19 pandemic and the self-isolation regime have expanded human needs for the benefits of digitalization in terms of the consumption of various Internet content, including gaming. The expansion of remote interaction under the pandemic comes into contact with objective economic realities—the introduction of elements of artificial intelligence and the spread of automation processes in the economy. Thus, science is updating the issue of studying the economic laws of the development of the game content market in the context of the introduction of artificial intelligence.

42.1 Introduction

The development of productive forces of society contributes to the strengthening of digitalization in all sectors of the economy. Digitalization accelerates the dynamism of economic relations and contributes to the formation of new instruments for the

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sale of goods and services. The impact of digitalization, the introduction of a self-isolation regime, and the need for remote work lead to the fact that a person receives part of the benefits via the network of the Internet environment. The benefits obtained through the "network" include computer games.

Currently, the market of computer games has reached impressive capacities (the terms "computer games" and "video games" are synonymous). According to the expert organization "DFC Intelligence," there are approximately 3.1 billion computer game fans in the world [4]. Research confirms the positive growth dynamics of the market for computer games in the world. Dataset "Global Games Market to Generate $175.8 Billion in 2021; Despite a Slight Decline, the Market Is on Track to Surpass $200 Billion in 2023" confirms the conclusions of the study. The data is available on the service https://figshare.com/ with the identifier https://doi.org/10.6084/m9.figshare.17049734.v1.

The market for computer games was formed at the end of the twentieth century. In turn, the emergence of new technologies (i.e., high-speed Internet, cloud technologies, and telecommunications and information communications) makes adjustments to the development of the economy of the Internet services, actualizing the research of the market of computer games in the context of digitalization of human activity.

Computer games are an intangible product, which makes them inexhaustible. As a property, inexhaustibility forms other methodological approaches to the analysis and study of the computer games market; in business, it contributes to the formation of new business models and methods of selling goods and services in the digital space [2]. These changes affect the nature of the use and implementation of computer games as intangible benefits in terms of changing the emphasis on restrictions on the use of computer games. Computer games do not disappear when consumed. In turn, the consumers of computer games are limited by their financial budget and time. Consumers can use a computer game many times without destroying its consumer properties, considering only the availability of free time.

For a detailed study, we could consider some examples of the implementation of large game projects and the impact of time constraints on the economy of the market of computer games.

The classical theory of pricing of most goods in the economy in the twentieth century was based on the theory of supply–demand (S–D) interaction. It consisted of the ratio of two parameters: price (P) and quantity of goods (Q)—in the theory of supply and demand, non-price factors of supply and demand were separately distinguished, but they all seemed to be secondary to the main one (the price). The ratio of the price and quantity of the goods formed the equilibrium price of the goods.

This approach could not be applied to some products of the current Internet services market. Due to the fact that services are intangible and inexhaustible, it is not always possible to measure and compare their quantitative characteristics. Today's Internet services include a wide range of benefits of the digital age: computer games, music services, online cinemas, and mobile applications.

An example of the influence of time on the sale of computer games and other digital content is the release of the AAA game project (expensive game projects supported by major publishers)—Battlefield V. The release date of the game on sale fell in November 28, 2018 [9]. The gaming community of consumers and fans of the “Battlefield” series negatively met the project, which affected the game’s sales. Electronic Arts, the publishing company, decided to discount the purchase of the game during the New Year holidays. Companies always offer discounts on New Year’s holidays, but in the case of Battlefield V, it is necessary to note the amount of the discount and the time of its announcement. After the first month of sales, the discount on the game was about 33% [19].

The time factor indirectly and directly affects the price of a computer game. The example of Battlefield V highlights the effect of time on price reduction. The creator of a computer game should constantly support the fanbase of a computer game because today’s computer games are primarily multiplayer. Multiplayer games are computer games where players play together or against each other. Therefore, these types of computer games require a constant increase in the fanbase of new players because these games function without a constant rotation of new and old players. Battlefield V received many negative reviews when it was released, which led to an exodus of fans. In this case, the company tried to increase the game’s fanbase by lowering the price after only a month of release. Falling sales of Battlefield V and a significant discount on the product impose costs for the manufacturer in the form of lost profits. The current situation is similar to that of the sale of a material product that is not in demand. In the case of Battlefield V, the first negative signal was a decrease in the time spent playing the game by players who had already bought the game.

Another example of the influence of the timing aspect is the release of Titanfall 2. The game was released in October 2016, simultaneously with the release of the major game project Battlefield 1 (the previous parts of the game Battlefield V). The young company Respawn Entertainment, the creator of Titanfall 2, suffered huge losses in the form of lost profits. Unlike the major publisher of Battlefield 1, Electronic Arts, Respawn Entertainment was unable to provide adequate marketing support for its product because most gamers have implemented their time fund in the game Battlefield 1 [17]. However, the games have approximately the same rating on the website “Metacritic”: Battlefield 1 (88 points) and Titanfall 2 (86 points) [15, 16].

The example of private marketing campaigns for various computer games does not provide a complete basis for asserting the reliability of the theory of the prevalence of time constraints over financial ones in the consumption of intangible goods. In turn, we could observe the effect of indirect factors on the consumption of intangible goods. An example of the action of indirect factors could be the impact of the COVID-19 pandemic in China. During the pandemic in China, the population had to spend time in self-isolation, as a result of which there was a peak in downloads of mobile applications, online cinema services, and computer games and gaming content on the Internet; sales of services in this area grew by $150 billion thanks to the activity of Chinese players [24].

In the case of self-isolation, consumers freed up a huge fund of time, which was implemented in computer games and mobile applications [12]. The above fact may indicate that there are financial costs when buying computer games. Nevertheless, financial costs are less significant than time costs when choosing a game. A similar fact is used by manufacturers of computer games, adding extra services or content to the game. Extra content in games is represented by various types: new levels and functions of games, new items of equipment, location maps, and so on. Separately, it is necessary to highlight such types of services as "boosts" and "timesavers" ("time-saver" allows the player to save time to achieve certain game goals). Timesavers for a fee allow the player to reduce the time to receive a certain reward. On the contrary, "boosts" speed up the process of character development, for example, such as double experience based on the results of matches or experience boosters, which also allows achieving a result faster than without it.

In computer games, virtual worlds appear, which people design for themselves. Nowadays, artificial intelligence is used in computer games, providing a more comfortable virtual world for a person; the desire of players to enjoy the created comfort increases the time they spend in the game [13]. In practice, the time factor contributes to the branching of marketing strategies and programs regarding the sales of computer games and gaming content. The possibility of remote communication, instant and accurate delivery of game content, and the ability to identify consumer predicates and preferences by analyzing Internet statistics and user actions are a favorable basis for implementing various marketing policies—from loyalty programs to building communities. It should be emphasized that a person does not always use their resources (including temporary ones) rationally; therefore, systems and algorithms designed for convenience and time optimization can help them [21].

42.2 Methodology

The time aspect of the consumption of computer games is important in the context of the reflections of the contemporary thinker Yuval Noah Harari. In the book "Homo Deus. A Brief History of the Future," he asserts that in the case of total mechanization of routine professions, a useless class could be formed in society—the people who are not in demand on the labor market. In society, the issue of the use and preservation (less humanely—conservation) of their potential will inevitably become. Computer games are great for realizing their creative capacity [8].

In the current economy, there are specialists in the creation and implementation of artificial intelligence in computer games. The goal of its introduction is to create a strong and interesting rival (not a human), more believable behavior, and variability of interaction with inanimate characters of the game for deeply artistic filling of the virtual world [14].

In this case, it should be noted that companies are interested in expanding the player's time fund in the game. As a result, corporations use different tools to extend the playing time, such as increasing the complexity of tasks and rivals, additional tasks. In computer games, the opponent is represented either by a program (artificial intelligence) or by another person (e.g., a player of another faction). However, some companies use "bots" in the game process to keep the interest and activity of gamers in the game sessions (a competitor in an online game represented by a program or artificial intelligence) [23]. Currently, the market for computer games sees increased competition, due to which the players have increased requirements for games, including in terms of the behavior of artificial rivals. Therefore, companies are forced to use artificial intelligence to improve gameplay.

Methodologically, it is possible to change the value of computer games for society. From extraction tools, they could turn into an opportunity to form new skills of human capacity, where artificial intelligence could help society.

In this case, a shift in the value perception of computer games could be observed in economics. Nowadays, computer games are considered an entertainment tool, while the potential of computer games in digitalization has changed from an entertainment product to an independent cultural environment of human interaction. For example, according to the research of the expert agency "Newzoo," the players revealed different motivations for consuming computer games. Dataset "Younger Gamers are Likelier to Value Competitive and Social Elements," which confirms the research conclusions, are available on the service https://figshare.com/ with the identifier https://doi.org/10.6084/m9.figshare.16917352.v1.

Gamification is a leading trend in the life of our society; it is considered by representatives of various sciences. Among economic studies, we can single out the book by S. Beck and M. Wade, "We Got Bad! How a generation of gamers is changing the business environment forever" [25]. In their work, the co-authors analyze the opportunities that have emerged for businesses in connection with the growing need for computer games among young people, along the way criticizing the typing of gamers presented by other researchers. The co-authors conclude that Generation Y or Millennials will radically change such areas of business as internal corporate governance: from the motivation of employees and consumers of the products created to the ways of solving creative tasks of any level arising in the course of doing business (a gamer means a person playing computer games, or a person for whom computer games are the dominant form of entertainment).

Pedagogical research has not yet used the term "gamification" to describe the addiction to computer games and the process of games itself. Thus, E. Yu. Ilaltdinova uses the term "gamification," which means "the introduction of game elements into non-game spaces in order to stimulate the activity of participants" [10]. Despite the fact that the author of the cited study proposes using a virtual environment for the learning process, she considers such elements of this environment as virtual currency, insignia, rewards, ratings, etc., as playful. This difference in terms is explained by the fact that in pedagogy, the game was traditionally viewed as an important factor in learning and transfer of experience, and in economics, the understanding of games, in fact, began with the growth of this segment of the consumer market [5].

An example is a geometry lesson taught by a teacher of one of the American schools in the virtual reality game "Half-Life: Alyx." Separately, it should be noted that the game of virtual reality with its interactive potential and possibilities of demonstrating the laws of physics could also serve as a simulation model for demonstrating various visual experiments in various sciences [7].

It is important to understand that artificial intelligence and game mechanics are also used to sell other consumer goods and services. For example, artificial intelligence is used in the dating market (online dating industry and services). According to "Statista," the global online dating market reached a turnover of $3.6 billion in 2021; in 2025, it will reach 5.3 billion dollars [22]. The conditions of self-isolation and the closure of public communication places form new needs of a digital and remote society. Some dating companies already use the ELO algorithm for matching partners (an algorithm based on the mechanics of matching an opponent in games) [18]. In Japan, given the problems of self-isolation and the specifics of interpersonal relationships, artificial intelligence is used to form married couples. In this way, the authorities try to solve the demographic problems facing the country [11]. Also, artificial intelligence is used by online cinemas. With the help of artificial intelligence, the users of cinemas select films, serials, and documentaries [1]. In the context of the COVID-19 pandemic and self-isolation, the turnover of the online cinema market in Russia amounted to 38.9 billion rubles [6]. Separately, it should be noted that Netflix, the largest player in the online movie theater market (worth $200 billion), is launching a program to develop and sell video games. As a result, one can observe the convergence of online services and the erasure of the framework of their usual activities [20].

42.3 Conclusion

In conclusion, it should be noted that digitalization and the COVID-19 pandemic are interdependent factors. As a result, a synergistic effect is formed to increase the needs of society not only for new goods and services, for example, computer games, online cinemas, and other types of content but for the "new" services of the twenty-first century—artificial intelligence (AI). The combination of the communication potential of computer games and other sectors of the Internet environment forms a new society where the needs of people are met by artificial intelligence.

Mathematical algorithms, AI, and machine learning introduce people and provide them with development and entertainment. Such processes, spurred on by the process of digitalization, contribute to the transition of "human" into the state of "digital human." According to the authoritative expert agency Gartner, automation and artificial intelligence are among the top ten main technology trends now and in the future. Time is an irrecoverable resource and, therefore, one of the most valuable in the twenty-first century. Artificial intelligence is introduced into many areas of online services, not only because of the replacement of a person in work but also because it could save the consumer's time resources by making more rational decisions [3].

Due to the above, a significant number of questions are formed before society: issues of trust in artificial intelligence, the issue of assessing its (AI) real effectiveness, and the issue of humanity of decisions made by AI.

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Chapter 43
Conceptual Model of a Regional Center for Cenological Monitoring of Factors Affecting the Development of Cardiovascular Diseases

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Abstract The scientific problem discussed in this research is the limitations of existing methods for identifying and interpreting factors recognized in scientific practice, which are newly identified through the use of advanced information technologies that provide a deeper understanding of the nature of the considered phenomena. One of the manifestations of this scientific problem is the need to consider critical non-medical factors, including socio-economic, natural, and ecological conditions. This understanding arises due to the development of technologies for the treatment and diagnosis of socially significant diseases in the development of treatment and rehabilitation programs. An important obstacle to solving this scientific problem is that the necessary requirement of natural science research—reproducibility of experimental results—cannot be fully met due to the uniqueness of these systems. The second key obstacle is associated with the complexity of the current socio-economic systems, which does not allow for their full formal description. This is evidenced by the result of a review of current approaches. The solution is proposed by integrating interdisciplinary approaches based on the patterns of fuzzy-multiple and cenological modeling, which have shown their effectiveness in various fields of knowledge. The authors propose a scheme of the operational center for monitoring the dynamics of parameters influencing the development of cardiovascular diseases in the region, based on the VSMA architecture and specialized models.

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43.1 Introduction

The formation of adequate interdisciplinary interpretive models for the study of complex systems, including the diagnosis of high-risk diseases at the preclinical stage, is one of the leading areas in applied mathematics, economics, statistics, and medicine. Due to the accumulation and processing of significant volumes of unstructured data using intelligent digital methods and tools, it becomes possible to describe phenomena in various areas of human activity, which is sufficient, among other things, for their use in the field of preventive medical diagnostics. This requires the development of existing approaches in the field of complex modeling and their adaptation to the conditions of the medical field, which currently does not fully use the potential of analysis of non-medical factors. This problem is considered in the research from two main positions: the hypothesis about the special nature and nature of the emergence of significant non-medical factors that affect the course of socially significant diseases, the effectiveness of their treatment, and the concept of complexity reduction as a universal tool for data interpretation.

There are no generally accepted criteria for identifying several socially significant diseases in the early stages and assessing the effectiveness of their treatment, including due to the lack of consensus on the relationship between the parameters accompanying various types of exposure and subsequent rehabilitation. There is no generalized data on the influence of various external and endogenous factors on the onset of the disease, the effectiveness of treatment, and the rate of rehabilitation.

The development of criteria for assessing the influence of non-medical factors on the effectiveness of treatment will allow developing a methodology for studying indirect data for the object of research, standardizing the tactics of patient management by specialists, and scaling it to other areas of diagnostics of socially significant diseases. Large-scale complex tasks are as follows:

- To develop an approach based on the possibility of processing big data of various nature using classical and special mathematical methods;
- To form a universal methodological and instrumental base that provides an increase in the predictive and descriptive accuracy of the study of factors of various natures for the diagnosis of socially significant diseases;
- To achieve the required quality of treatment and rehabilitation with methods of reduction, phenomenology, fuzzy logic, cognitive modeling, and cenology.

The paper provides an overview of the existing approaches to studying non-medical factors influencing the occurrence of cardiovascular diseases (CVD). An algorithm for their subsequent formalization and analysis by instrumental methods is proposed based on several contemporary concepts and theories, including biophysics, cenology, and fuzzy-multiple modeling.

A universal information pattern of the regional healthcare system is proposed, which describes the invariant, resource, and structural properties of related socio-economic, geographic, and other subsystems. An automated system based on the obtained patterns will allow continuous monitoring of the dynamics of factors affecting CVD and enable operational decisions to be made.

43.2 Research Review and Issues

The study of the characteristics of the determination of non-medical factors on the onset and course of the disease is a promising scientific problem, which is considered, among other things, based on the laws of biophysics. It is recognized that the theoretical complexity of the type of the considered systems, which complicates their study, mediates the use of complex systems of phenomenological modeling, traditional in biophysics, and the search for invariants from the standpoint of "common sense" [23].

A symmetry search is used to simplify the description of an object by preserving information about its device, which means the immutability of an object under various transformations. There are known examples of symmetry in biology [5, 11].

Despite the uniqueness of such systems, it is necessary to select several extreme principles (or one principle) from a variety of possible options. The identification of these principles reduces the complexity of descriptive models and brings generality to their description. The work of the Moscow School of Biology is devoted to solving such problems [16], as well as problems in biocenology [25], ecosystem analysis [5], synergetics, etc.

The generality of the network description and the similarity of the processes of evolutionary changes in the structure allows studying the properties of the complexity of systems using abstract neural network models. The methodology of the computational experiment consists of the creation and comparative analysis of CME ensembles performing the same function [5].

Cardiovascular disease (CVD) has been a particular health problem in most countries over the past 50 years. The global socio-economic activity of CVD is determined not only by mortality; the global burden of CVD is also the number of years lived in a state of partial or complete disability [21]. Grigorieva and Demkina investigated the statistical relationship of standardized mortality rates due to CVD with the following factors [12]:

- Sale of strong alcoholic beverages per capita of the able-bodied population;
- The density of highways and railway tracks;
- Provision of sewerage and hot water supply to the population;
- The level of comfort of climatic conditions;
- Unemployment rate;
- The proportion of the population with incomes below the subsistence minimum;
- GRP volume per inhabitant;

- The volume of deposits of individuals in banks, etc.

These indicators can be considered as external socio-economic factors.

There are very few studies showing the connection of health care with politics, economics, social, and managerial areas. However, according to the authors of the research, the creation of an interdisciplinary team of specialists contributes to solving the problems of the social block. The studies of Germanova, using developed European countries as an example, show the effectiveness of programs to reduce mortality from CVD [8].

In 1972, in North Karelia (Finland), a program involving all population segments was launched to promote lifestyle changes and eating habits. According to the report of the project organizers, this project led to a decrease in mortality from coronary heart disease by 73% by 1995. The project linked the work of the media, health authorities, agricultural reforms, and cooperation with the food industry.

In Poland, among the residents of right-bank Warsaw, mortality from CVD decreased by about 50% in 1991–2002. The decrease in this indicator is associated with a change in eating habits. During this period, the consumption of butter and other animal fats, milk, beef, and potatoes decreased, and the consumption of vegetable fats, polyunsaturated fatty acids, poultry meat, and fruits increased.

Thus, it is possible to obtain high results by influencing modifiable risk factors for CVD, conducting primary prevention, and working with the population. A set of such measures will be effective for high- and low-income countries.

Over the past decades, many studies have been carried out to study the impact of urbanization on the prevalence of proven cardiovascular risk factors among the population [24]. For example, populations in highly urbanized areas have poorer health outcomes compared to less urbanized areas. Thus, a decrease in the indicator of adaptive potential [17] and a high prevalence of hypertension [4] was noted among the child population. Urbanization is accompanied by a change in the regime and nutritional value of food products, which significantly impacts the population's health [9] and the prevalence of proven cardiovascular risk factors and mortality from CVD [22].

Martínez-García et al. (2018) analyzed the PubMed database for all articles related to the social determinants of CVD identified by the relevant medical subheading classifiers (MeSH) [18]. They processed data on the management of CVD patients to discard irrelevant content and encode information content using manual and automated methods. Once the authors had a curatorial corpus, they built semantic networks (using the co-occurrence of grid terms as references) and performed a topological analysis of such networks to find associations between various SDCVDs. The study included detailed analyses of historical trends to provide context for such relationships. Finally, the authors discussed the main takeaways from these steps to contribute to the creation of an integrated framework for SDCVD. Harper et al. [14] note that social determinants of health—factors occurring mainly outside the healthcare system—play a considerable role in understanding the structure of mortality from CVD. The dynamics of morbidity and mortality from CVD and their relationship with various modifiable risk factors for CVD development were also discussed.

In addition to demonstrating the importance of age-old trends in relation to traditional CVD risk factors, the authors of the study also revealed a strong effect of the spread of vital treatment methods (e.g., the development of a network of vascular centers, advanced pharmacological treatments, and angioplasty and bypass surgery) and the development of new medical innovations for the treatment and prevention of CVD.

New prevention guidelines from the American Heart Association and the American College of Cardiology recognize that "socio-economic inequality is a strong determinant of cardiovascular risk" [2].

Healthcare providers must consider social determinants when working with patients in the same way they might consider smoking habits or strategies to lower blood pressure or cholesterol. Social determinants should be part of the conversation with patients about cardiovascular disease prevention. Doctors know that these aspects are important, but they tend to focus on traditional risk factors.

Scientific research is still ongoing because structural problems such as the topology of complex architecture and the nature of interactions remain unresolved. An overview of the approaches and problems of modeling in many different fields of scientific knowledge, from nonlinear science to biology, from statistical mechanics to medicine and technology, is presented in the fundamental work of Bocaletti [6]. Thus, it is necessary to combine these studies in the framework of some general paradigm, for example, a cenological paradigm, which has shown high applied universality, including in solving complex interdisciplinary problems [15].

43.3 Methodology

The primary approach to studying the correspondence between systems of different nature is based on identifying some common properties. Within the framework of the optimization approach, the complexity of the description of the considered metasystem can be reduced by reducing the number of possible variants of its topology by means of a formal description of the resulting macrosystem (system of systems), search for optimality parameters, and calculation of integral indicators of complexity. The biosphere representation of the considered metasystem allows approaching the study of the considered entity not only as a unique object but also as a set of variants of closed ecosystems within the region.

The basic research paradigm is based on structural identification approaches in interpreting results, such as reducing complexity and uncertainty [1] and managing complexity [7]. The interpretation component of the models in the proposed model is based on the provisions of the epistemological approach [26] and the complexity management toolkit [13].

The idea of the research is to recognize the hypothesis of the presence of functional (cenological) symmetry of socio-economic and medico-biological systems, which allows multivariate transformations of descriptive models by reducing complexity, reducing it, and increasing the effectiveness of preventive diagnostics of socially significant diseases. The achievability of the set scientific task is ensured by the possibility of analytical research in a new quality of processes and factors influencing the occurrence, course, and treatment of complex diseases, as one of the achievements of advanced analytical medicine, statistical and mathematical methods.

The known methods of preventive diagnostics are well studied for describing highly structured causes and parameters in the field of health care and medicine. However, they require a high level of determinism in modeling, which is not always achievable in the specific conditions of contemporary unification of diagnostic and treatment procedures. Fuzzy-multiple modeling aims to assess the parameters of socio-economic and medico-biological systems and is a technique for aggregating various integrated indicators not by the geometric mean method but based on a universal methodology based on the use of a system of multi-level [0, 1] classifiers. Compared with the standard, this technique has the following practical potential:

(1) To analyze each subsystem of the considered complex system for a set of the most important indicators and form a numerical assessment of the subsystem, considering both the level of individual indicators and their dynamics;
(2) To consider an arbitrarily large number of heterogeneous indicators without their dimensioning for the formation of the subsystem's assessment;
(3) To vary the contribution of each indicator to the final assessment by means of weighting factors;
(4) To use the estimates built for each of the individual subsystems as source material for building a comprehensive assessment of the entire system;
(5) To rank the systems according to the given criteria using the constructed estimates;
(6) To use the proposed methodology without the use of special software.

The use of advanced technologies has led to the identification of many factors that can influence the results of treatment. Identifying them and determining their role in the formation of the final result of treatment seems to be extremely urgent. This will require specific data on the following factors:

- Factors affecting the predetermining dynamics of the disease, which are defined as socio-economic;
- Factors affecting the effectiveness of treatment (including economic, technological, economic, labor, etc.), which differ depending on the implemented medical technology, material support of the medical institution, and professional skills of specialists involved in the treatment process;
- Factors affecting the accuracy and timeliness of diagnosis and the resulting timeliness of determining treatment tactics;
- Factors influencing the degree of achieved success of treatment and rehabilitation.

The proposed approach for assessing the state of systems is based on a methodology for assessing complex systems based on complexes of heterogeneous indicators based on a system of fuzzy-logical conclusions—fuzzy multi-level [0, 1] classifiers, which allows for "cascade" aggregation of estimates. The technique is the author's modification of the algorithm for the operation of fuzzy five-point [0, 1] classifiers [19, 20].

The technique allows us to analyze each of the subsystems for a set of the most important heterogeneous indicators and form a normalized numerical assessment of the area based on the consideration of the level of particular indicators and their dynamics.

43.4 Result

Thus, regardless of which subsystem is identified as key, the solution algorithm will consist in performing the following steps.

(1) Statement of the problem. It is assumed that it is necessary to calculate a comprehensive assessment of the state of any system based on a time series of dissimilar indicators. The task is to aggregate the available data for a variety of indicators, as well as for the time series of these indicators.

(2) Obtaining a linguistic variable "a comprehensive assessment of the state of a subsystem based on a set of indicators." In accordance with the theory of fuzzy multi-level [0, 1] classifiers, a linguistic variable is introduced into consideration: g = "a comprehensive assessment of the state of the system based on a set of indicators." A universal set for a linguistic variable is a numerical segment, and a set of values is a term-set of five terms $G = \{G1, G2, G3, G4, G5\}$. Depending on the formulation of the problem, they can be assigned different meanings:

- Static classifiers or classifiers of the first type. If we are talking about assessing the level of the state of the system, then the terms can be assigned the following meaning: $G1$—"very bad"; $G2$—"bad"; $G3$—"satisfactory"; $G4$—"good"; and $G5$—"excellent."
- Dynamic classifiers or classifiers of the second type. If it is required to assess the dynamics of the state of the system, then the terms can be designated as follows: $G1$—"a steady tendency toward the worsening of the situation"; $G2$—"tendency for the worsening of the situation"; $G3$—"stabilization of the situation"; $G4$—"tendency to improve the situation"; and $G5$—"a steady trend toward an improvement in the situation."

The next step in setting a linguistic variable is to set membership functions for each of the terms. The membership functions of the standard five-point fuzzy [0, 1] classifier have a simplified trapezoidal shape.

(3) Linguistic variables "investigated indicators." Let the state of the system be assessed based on M heterogeneous indicators for which some of their numerical estimates are known (each of them can take any real value). Let the normalized values of the corresponding fuzzy numerical variables $X = (X1, X2, \ldots, \mathrm{XN})$, which belong to the interval [0, 1], be obtained on their basis (the method used for

calculating the normalized values is determined by the meaning of the problem under consideration).

The linguistic variable Bi = the "level of the *i*th indicator" ($i = 1, 2, \ldots, M$) is introduced. The set of values of the variable Bi is a term-set of five terms $B = \{B1, B2, B3, B4, B5\}$: $B1$—"very low level of the indicator"; $B2$—"low level of the indicator"; $B3$—"average level of the indicator"; $B4$—"high level of the indicator"; and $B5$—"very high level of the indicator." Each investigated indicator will be compared with the value of the membership functions that refer it to the corresponding term of the linguistic variable. Membership functions can be specified in a standard way and, if necessary, in a special way, depending on the meaning of the problem being solved.

(4) Significance of indicators. The indicators for which the system is assessed, as a rule, have different significance. Therefore, it is necessary to enter weights for each indicator. The following options are possible:
(a) The indicators are equivalent, therefore, have the same weights;
(b) The indicators are ranked in descending order of their importance; the weights are determined according to the Fishburne rule;
(c) The weights are determined based on the share contribution of the direction;
(d) The weights are determined based on the values of the coenoses index.
(5) Calculation of a comprehensive assessment of the state. A fuzzy-logical transition from the numerical values of indicators Xi to statements about $G = \{G1, G2, G3, G4, G5\}$ of the state of the system is carried out based on a set of indicators using a standard algorithm.

The architecture of a possible platform for the GCC Monitoring Center presented in Fig. 43.1 is a development of the model for monitoring regional energy consumption in the Kaliningrad Region [10]. Its basic principles are implemented at the database, middle layer, and interface levels. At the database level, this is ensured by using the data storage model "Categories of entities and linguistic variables," at the middle layer by using the VSMA architecture, and at the interface level by using the specialized plugin "Visonarium of the CVD Monitoring Center" (Fig. 43.1).

<table>
<tr><td>Visionarium</td><td colspan="3">HTML, CSS, JAVASCRIPT</td><td>jQuery.
Bootstrap</td></tr>
<tr><td rowspan="3">Middle layer
plugins</td><td>Services</td><td>Service registry</td><td>Services</td><td rowspan="3">IIS
ASP.NET
CORE
MVC</td></tr>
<tr><td>Plugins</td><td>Plugin manager</td><td>Plugins</td></tr>
<tr><td colspan="3">MS Visual Studio. C#</td></tr>
<tr><td>Database</td><td colspan="3">T-SQL</td><td>PostgressPro
MS SQL</td></tr>
</table>

Fig. 43.1 Scheme of the architecture of the CVD monitoring center. *Source* Developed and compiled by the authors

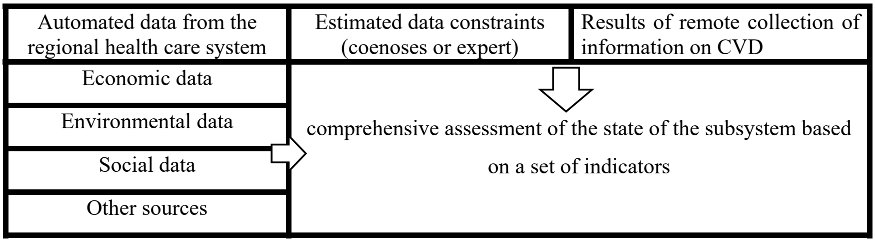

Fig. 43.2 Logical data schema for multiple fuzzy analysis. *Source* Developed and compiled by the authors

The functionality of applications is concentrated in plugins that allow us to dynamically expand the system's functionality without building the entire project. Data come to the CVD Monitoring Center from various external sources (Fig. 43.2).

Data processing is carried out using a set of computational and graphic modules (RGM), which is a specialized configuration "GCC Monitoring Center," reflecting the coenological properties of the subsystems included in the studied object (Table 43.1). Each RGM is aimed at the automated solution of certain tasks, while the order of their work and interaction can be determined both programmatically and by the user.

Based on the results of the module's work, the user receives the necessary information for analysis in numerical and graphical form. RGM "detection of anomalies in data" is designed to identify anomalous values that deviate unnaturally far from the center of distribution of the considered data sample. RGM "trend revealing" is designed to identify long-term and stable properties. Knowledge of the nature of the trend is used for investment planning. RGM "forecasting" is designed to determine the probable future values of the considered individual time series or a set of system indicators.

The proposed automation platform for the CVD Monitoring Center ensures the creation of a service center for the regional healthcare system, considering the influence of various non-medical factors. This significantly simplifies and shortens

Table 43.1 Principal structure of the CVD monitoring center

Settlement-graphic model	Mathematical methods	Database
Identification of key parameters	Fuzzy-multiple modeling	CVD situation data
Identifying data anomalies	Math statistics	Subsystem performance data
Identifying a trend	Time series analysis	Automated systems data
Forecasting	Rank analysis	Results of processing previous data
Standardization	Cluster analysis	
AWP of the head	AWP of the analyst	AWP of the specialist

Source Developed and compiled by the authors the time and increases the effectiveness of preventive measures to reduce socially significant diseases.

43.5 Conclusion

The proposed approach, as a synthetic method, is methodologically based on the ability to identify and interpret the influence of socio-economic and medico-biological factors on the occurrence and progression of socially significant diseases, considering the interdisciplinary nature of their occurrence, using advanced experimental mathematical models that identify socio-economic patterns based on complexity reduction technologies.

The novelty of the approach lies in the technology of formalizing the influence of non-medical factors on CVD, characterized by a high degree of uncertainty, using fuzzy-multiple modeling and subsequent cenological assessment within the framework of the reduction paradigm.

The mathematical interpretation and cenological assessment of the identified factors is an abstract pattern of a complex system that will allow evaluating possible functional deviations from the point of view of a violation of a certain optimum and automatically reacting, taking into account their influence on the basic functionality.

The resulting set of the obtained key factors is included in mathematical templates based on a number of principles of the "viable systems" model. The cenological interpretation of such a model has shown its applicability in various fields of knowledge [3] and is confirmed empirically in the analysis of complex systems of an interdisciplinary nature on a structural-topological basis.

The whole region, its separate subsystem, its potential in the development or prevention of CVD, the ecological state of the subsystem, etc., can be considered as a system. The technique is versatile; it allows us to change and supplement the complexes of the studied indicators for each of the areas and change the weight coefficients of indicators in accordance with the values of the cenological assessment.

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Chapter 44
The Role of Early Warning System in the Building of Smart Organization

Bahzad T. Salim and Vladimir A. Ermakov

Abstract The paper addresses two important variables for current organizations, particularly the early warning system and smart organization. Because organizations are smart, they need the capacity of these principles to be driven to achieve value to reach their primary goals, which are success, survival, and affirmation of superiority among their competitors. Theoretically, the study includes a brief theory on the early warning system and smart organization with their principles. In terms of practice, the authors selected two major mobile phone companies (Korek and Asiacell), showing tough competition with each other. The questionnaire was used as an important tool for data collection. The studied samples represent the executive management team working in the two companies, with six top directors from each company chosen as the sample. The research problem focuses on the diagnosis of the adoption of elements of the early warning system in the investigated organizations, as well as the extent to which the principles of smart organizations are presented in the examined organizations. The research is summarized in two points: (a) the surveyed organizations have acceptable levels of smart organization principles and adopt the elements of the early warning system; (b) the examined organizations tend to consider the three principles of smart organization as desirable and somewhat equivalent, depending on the availability of the components of the early warning system.

44.1 Introduction

Today's world is undergoing rapid changes that pressure business organizations to rethink how they do their business and how to add value to stakeholders. This era has been characterized by the concentrated knowledge that has contributed to the transfer of business organizations from attention to their tangible physical assets to attention to their intangible assets, so that intellectual capital and social capital are the most valuable to them. Information, knowledge, and intelligence have become the driving capital of the economic revolution. The increasing use of information

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and knowledge requires the creation of a new generation of business organizations with the ability to rapidly process information, learn and use knowledge efficiently, and adapt to competitive situations and environmental change. Organizations need to have a unique ability to outperform their competitors, through which they integrate their different skills and contribute to increasing value to customers. In short, organizations need to work intelligently to be able to possess the principles that lead to achieving value to reach their ultimate goal; these principles are the principles of smart organization [23].

A growing interest in smart organizations is related to the need to improve the competitiveness and sustainability of organizations. By relying on an early warning system and smart organization principles, the organization will be able to maintain its competitive advantage and achieve greater value. In this regard, it is necessary to state the most important of these principles, which lead organizations to achieve progress and development by building intelligent organizations capable of keeping up with changes in the environment [30].

The concept of an early warning system is one of the contemporary management concepts based on predicting negative situations before they occur by monitoring and interpreting danger signs and sending reports to decision-makers and implementers [21]. It can be defined as the system that achieves the organization's rapid response to environmental developments and changes. It brings surprises to an organization that cannot face the risks or seizes opportunities proactively from its competitors. The importance of an early warning system stems from the importance of its basic purpose of survival and continuity. Environmental change can be met without adaptation in the short term. However, over the long term, early warning becomes an unavoidable necessity to ensure that the organization remains and continues to function according to the three important components of this system: smart leadership, smart strategy, and smart process [13, 14].

There is some research in these fields. Jackson and Finkelstein [17], in their study "Immunity from implosion: Building smart leadership," aimed to describe the smart organization, where smart leadership, smart process, and smart strategy were considered the main components of the early warning system and the three main pillars of the smart organization. The research was based on the findings of a six-year study, which compared organizational patterns and revealed key differences between companies that were successful and then failed, as well as differences between other successful companies that were able to maintain their viability and sustainability in the success and dominance of the market (these companies are called "smart organization"). The authors noted that these organizations are characterized by working to track and regularly improve the three pillars—smart leadership, smart strategy, and smart process. The study also focused on addressing the concept of smart leadership, mainly on the characteristics it enjoys. The study concluded that the first step in building a smart organization is to have smart leadership and understand and evaluate its components on a consistent and regular basis to ensure that the leadership maintains its vitality and opens its mind, which distinguishes it as a smart organization. However, the discussed study did not elaborate on the components of the early warning system.

Rather, it focused on one element—leadership, a cross-section of the set of characteristics to be provided without detailed exposure to the smart strategy or smart process that requires extensive and in-depth research to identify their impact on the organization.

Wiig [38] studied the intelligent enterprise and knowledge management, described the organization and its relationship to knowledge management, and discussed a range of issues related to the concept of a smart organization, including the importance of smart organization, the factors that prevent organizations from behaving intelligently, the dimensions of intelligent organizational behavior, and the support provided to smart organizations by knowledge management, as well as knowledge management and its applications in the smart organization. He noted that making or transforming the organization into a smart organization was a matter of good governance. According to him, knowledge management is a permanent intelligence of the organization; it enables organizations to be intelligent disposition. The degree to which the organization can behave intelligently depends on the competencies of the staff. Chastukhina [6] describes the development of an emotionally intelligent organization—effective implementation and measurement process. The study sought to highlight the importance of emotional intelligence in organizations and its role in organizational success on the basis that the organization is like an organism and possesses human characteristics such as intelligence, emotions, discipline, considerations, and the ability to control oneself and influence others because it consists mainly of humans. The study reached some conclusions: it is necessary to apply for the emotional intelligence program in any organization that faces the challenge because it is a complex process. For the sake of success, this organization must understand and adhere to the challenges and benefits of the program through all necessary efforts and resources; all employees should participate at all levels and make positive contributions to this process. The organization must realize that it is not easy to become a smart organization overnight. This process is long and consists of several stages. It requires commitment in effort and time. Finally, the consensus is the key to success in any project.

Schafer [29] examined organizational IQ: characteristics common to smart organizations and applicability to the US military. The study aimed to learn how to build a smart organization by collecting empirical data on harnessing and analyzing the group's common intelligence to learn and adapt to the changing environment. The study concluded that there are three characteristics necessary to build a smart organization: (a) a clear strategic vision, (b) a pluralistic organizational culture that respects the idea of every individual, and (c) an incentive program that supports vision and culture.

44.1.1 Research Problem and Questions

The research problem can be formulated in preparation for the research process through the following questions:

- Identification of elements of the early warning system and smart organization principles;
- Diagnosis of the adoption of elements of the early warning system in the examined organizations;
- The extent to which the principles of smart organizations are available in the examined organizations;
- Whether managers implement the early warning system and the principles of smart organizations in the examined organizations.

44.2 Material and Methods

The studied community is represented by mobile companies located in the Kurdistan region (Iraq): Korek and Asia cell telecommunication companies. As for the sample of the study, they were represented by the senior management team in each company. Six top managers from each company were selected. The research questionnaire contains 122 questions covering all 17 sub-variables of the research for 2017.

SPSS V.18 was used in the statistical analysis to find answers to the research questions using the following indicators:

- Duplicates and percentages to describe the research sample and make comparison and analysis among its categories;
- The arithmetic average and the standard deviation identify the views of the research sample and its categories toward the research variables.

Table 44.1 gives a simple view of the companies studied.

Table 44.1 Description of the community and sample of the research

No.	Company name	Year founded	Type of sector	Type of activity	Number of employees	Number of managers
1	Korek Communication Co.	2000	Special	Service	1945	45
2	Asia Communication Co.	1999	Special	Service	7000	98
Total					8945	143

Source Compiled by the authors based on the records of the studied companies for 2017

Early warning system		
Smart process	**Smart strategy**	**Smart leadership**
Organizational structure	Smart assumption analysis	Leadership skills
Communication channels	Strategy alignment	Structure of the senior management team
Engaged culture		Senior management team operations

Principles of smart organization		
Resource mobilization	**Understanding the environment**	**Achieve the goal**
Disciplined decision making	Embracing uncertainty	Value creation culture
Alignment and empowerment	Outside-in strategic perspective	Creating alternatives
Open information flow	Systems thinking	Continual learning

Fig. 44.1 Default study model. *Source* Compiled by the authors

44.2.1 The Default Model of the Study

The methodological treatment of the studied problem in light of the theoretical framework and its implications requires building an integrated model that reflects the nature of the relation between the dependent and independent variables of the research. It also clarifies those variables that refer to the initial perceptions and answers to the questions the study is trying to test. The researchers constructed the study model, which is shown in Fig. 44.1.

44.3 Results

44.3.1 Early Warning System

44.3.1.1 Concept and Importance of Early Warning System

Some researchers define an early warning system as collecting and analyzing information, sharing the results of crisis analysis. Some argue that information analysis should lead to the development of proactive strategic options or possible confrontation of crises or conflicts, which allows conducting continued access to relevant information and assisting senior corporate and management executives, leadership, and strategy. Some studies have been launched from this point to define the concept of an early warning system, according to which the concept of the system is to explore risks or opportunities before they emerge to achieve growth for the organization. It is not a crystal ball through which to explore the future but a technique by which to see and identify the factors that shape or hinder the future of the organization [21].

Another study argues that a system based on a combination of components enables the organization to respond quickly to threats and seize opportunities from competitors, which achieves high growth for the organization [17].

In general, the essence of the early warning system of business enterprises is as follows: a system for detecting and anticipating the possibility of crises or conflicts of any kind to make appropriate decisions, policies, and procedures to address, prevent, or, at least, minimize their damage and risks and effectively manage the policies and strategies of the organization.

44.3.1.2 Components of Early Warning System

The study by Finkelstein and Jackson [14] indicates that the early warning system consists of a set of components that can be addressed according to the following paragraphs:

Smart Leadership

Smart leadership at all levels of the organization is one of the most important elements of an early warning system. The smart word that describes leadership does not reflect the high IQs of these leaders at high levels according to the standards of intelligence adopted. Rather, it refers to the combination of personal skills of each member of the leadership team that puts them at the service of the organizations in which the leadership team works. Smart leadership includes a range of dimensions, namely the following [17]:

(a) *Leadership Skills*

In general, leadership skills are defined as behavioral practices, capabilities, and specialized capabilities, including methods, procedures, and techniques to deal with all situations and work in the organization that a leader faces efficiently and effectively, which include areas of personal skills, technical skills, human skills, and intellectual skills.

(b) *The Structure of the Senior Management Team*

Kennie and Woodfield [19] define this team as a group of senior managers of the organization whose roles are to exercise positive processes to make informed and articulated decisions about the organization's strategies, allocate resources, draw plans, and monitor the operations of managers to implement the policies and orientations of the organization.

Katzenbach [18] showed that the structure of the senior management team represents the formal framework through which the team exercises its roles and responsibilities and challenges the emergence of new roles, especially with regard to the skills and talents of the team members because this structure has a direct impact on strategic change processes and associated challenges in the external environment.

(c) *Senior Management Team Operations*

Kennie and Woodfield [19] set a model for the operations to be performed by the senior management team. It was built on four axes as follows:

- Internal processes, which are the work of the team within the organization;
- External processes, which include those processes within the organization's external environment;
- Strategic processes, which deal with long-term prospects;
- Operations and a set of operations that occur daily.

Smart Strategy

A smart strategy is the second essential component of the early warning system because it is the means by which the organization can achieve and add value to the organization because it works on the following:

- Reduce costs and time and increase return on investment, which increases the organization's efficiency;
- Improving information technology infrastructure through additions that give impetus to information systems in the organization;
- Making better use of resources in the organization [2].

The smart strategy includes a set of dimensions that can be illustrated by the following:

(a) *Smart Assumption Analysis*

Smart assumption analysis refers to "processes that address the strategic analysis of all aspects of an organization." It is an important subject of studies in strategic management. The strategic analysis aims to identify the various alternatives that have helped the organization achieve its mission and objectives. Smart assumption analysis involves the analysis of the external and internal environment of the organization. The analysis of the external environment includes two aspects:

1. The indirect analysis of the external environment, namely the process of exploring economic, technological, political, social, cultural, and competitive forces to identify opportunities and threats in the external environment of the organization and identify the sources and components of these opportunities and threats. The external environment analysis helps the administration establish an early warning system to timely perform necessary preparations before the potential threats emerge. Thus, efficient strategies are designed to counter the threat and reduce

its negative impact on the organization or turn it positively toward achieving the strategic objectives.

2. Direct analysis of the external environment. Porter's competitive forces analysis includes five factors: threats of new entrants, bargaining power of processors, bargaining power of buyers, threats to alternative products or services, and the presence of a strong competitor in the competition [2].

A number of researchers believe that the analysis of the internal environment is the analysis of the organization's strategic advantage. The strategic advantage lies in the process of examining and analyzing the factors related to the functions and activities of the operational, production, marketing, financial, and human resources, public relations, and other departments to identify the internal strengths and weaknesses so that the organization can work as efficiently as possible to exploit the opportunities and confront the threats in the external environment [2].

(b) Strategy Alignment

Strategic alignment refers to the process of redesigning the organization's strategies. The strategic objectives, business model and processes, and the organization's culture are aligned with the core business values. Strategic alignment involves a range of dimensions, including the following [22]:

- The external dimension—the competitive environment: the organization's effectiveness in meeting the requirements of its environment depends on the elements of the various subsystems that make up the organization, which are designed according to the demands of the environment with which they interact.
- Internal dimension—the internal environment: in the changing environment, reconciling the strategic objective of the organization with the strategic activities is neither continuous nor permanent. Strategic actions and activities are likely to begin by directing or obstructing the strategic objective.

Smart Process

It comprises a range of processes with direct contact with many of the organization's internal structures and components, including:

(a) *Organizational Structure*

Individuals and departments are linked to form the organizational structure. The organization's structure gives it the shape to fulfill its function in the environment [25]. The term organizational structure refers to the formal configuration between individuals, groups, and departments regarding the allocation of tasks, responsibilities, and authority within the organization [15]. The organizational structure consists of activities such as task allocation, coordination, and supervision, which are directed toward accomplishing organizational goals. It can be considered the viewing glass or perspective through which individuals see their organization and its environment [34].

(b) *Communication Channels*

Corporations are going through rapid changes; the role of strategic management is challenged. If an organization is threatened by changes in the environment, such as crises or competition due to advances in information technology or increased customer demands, the need for communication increases. Communication is used for many reasons, such as exchanging knowledge and ideas or creating relationships [4]. Henderson [16] states that managers who have good encoding and decoding skills in their communication positively impact internal performance in projects.

The introduction of communication channels is a strategic driver and plays an integrated approach to the management and development of employees. Many researchers considered communication as one of the main factors affecting the effectiveness of management systems based on the quality, regardless of the type of implemented system.

(c) *Engaged Culture*

There are many definitions of organizational culture [20]:

- The system of political values adopted by the organization;
- The philosophy that governs its policies toward employees and customers;
- The way in which the tasks are accomplished;
- The assumptions and beliefs shared by the members of the organization.

Furthermore, organizational culture is classified into six types: bureaucratic organizational culture, creative organizational culture, assistive organizational culture, process culture, mission culture, and culture of the role.

44.3.2 The Smart Organization

44.3.2.1 The Concept of Smart Organization

Smart organization and its concept are one of the advanced concepts in management thought. Teresko [35] has defined that the smart organization has emerged as a contemporary concept that emphasizes the research and development processes of various organizations. Next, the authors have transferred this concept from within the organization to include the evolution of the organization as a whole to the necessity it has acquired within the organization. Matheson and Matheson [23] defined a smart organization as "the organization that makes good strategic decisions," the decisions that "produce the best opportunities to generate value." The smart organization is also known as "the organization that first manages and coordinates information and ideas to meet the needs of customers, relying on the development and spread of intellectual resources rather than the management of physical and financial assets" [27].

Williams [39] defines it as an organization that learns and adapts to the environment in which it operates while emphasizing the value of the external survey of the external environment. The organization must learn how to be smart by linking elements related to information management and learning. Teresko [35] went on to say that it is an organization that develops on an ongoing basis—superior products and services globally and at prices that realize the value-driven strategy. Some are defined as "a knowledge-driven organization that adapts effectively to new organizational forms and practices, and rapid learning, such as creating and exploiting opportunities provided by the digital economy or engaging in virtual collaboration with other partner organizations" [12].

Finkelstein and Jackson [14] considered a smart organization as a highly performing organization that is still successful and able to grow, continue to succeed, and maintain its dominance over its target market. It is a highly performing organization whose main objective is to achieve the flexibility, knowledge, and skill of employees. Brătianu, Vasilache, and Jianu regarded a smart organization as "an organization that integrates the intelligence, development, and integration of all staff to use it for achieving competitive advantages that enable it to adapt to rapid changes in the environment and ensure survival and continuity" [3]. Filos [11] defined it as an organization that has the ability to be agile due to the ease and speed of knowledge generation and takes advantage of this knowledge in grasping the opportunities and adapting quickly to the challenges that face it.

44.3.2.2 The Principles of Smart Organization

Many authors and researchers agree on the characteristics common to smart organizations [1, 4, 23, 29]. The three sub-principles of a smart organization are illustrated in Fig. 44.1.

Achieve Purpose

The purpose here is the reason for the organization's existence [37]. To achieve this goal, the organization's ability to achieve its cause is meant to focus its efforts on its goals and the reason for its existence. The goal is to clarify the values of the organization and the form of continuing hard work to increase them [23]. The first basic principle is the process of achieving the goals of the business organization. The organization must strive to achieve the objectives because it is impossible to work without goals, which prepare the organization's work map during the basic stages of its various operations. Achieving their goals based on these principles and objectives is the fundamental purpose of the organizations' work or the basis for which they were found [37]. The principle of achievement of the purpose includes three sub-principles [24]:

(a) *Value Creation Culture*

The philosophy of this principle is that the organization's purpose is to create value and maximize it for customers and that everyone in a smart organization should know this purpose that the focus of decisions will be value creation [23]. Pratali [26] points out that organizations can achieve value by adopting competitive and technical priorities. The smart organization needs to know the purpose of its existence. Everyone in the smart organization must know this purpose and use this understanding as a final test of each of their strategies and activities that create value for the organization and its customers. The creation of value dictates the need for change and transcends the barriers imposed by tradition, the obstacles imposed by function, and personal aspirations [24].

(b) *Creating Alternatives*

Daft [8] noted that the process of generating alternatives means that the organization "develops new ways of choosing what meets its needs." It can be seen as a tool to reduce the gap between current and desired organizational performance, develop a range of valuable options and new and alternative work methods in advance to choose from them to meet their needs, and take strategic action. Without them, there can be no real choice or search for a chance to create the best value.

(c) *Continual Learning*

The philosophy of this principle is that the organization's purpose is to continue to learn how to create greater value and how to connect it. Being smart means that one continually learns how to create more value in terms of changing policy and demographic structure, rapid advances in technology, and globally competitive markets. Smart organizations constantly identify opportunities and find new and evolving ways to create greater value [24]. The smart organization learns faster than competitors because the only way to ensure the organization's competitive advantage is to learn continuously and quickly [33].

Understand the Environment

Understanding the environment by business organizations is a prerequisite for their success. Thompson [36] explains that the organization's understanding of its internal and external environment leads to the identification of the best ways to respond to rapid changes and exploit them to achieve optimal performance. Matheson and Matheson [23] showed that a smart organization could understand the environment by applying it to a range of important functions. This group includes three sub-principles:

(a) *Embracing Uncertainty*

This principle is the practice of the smart organization to mitigate uncertainty. There are no facts about the future except for uncertainty, so the organization must match the internal structure and the external environment [7, 9]. Smart organizations equip themselves with a smart early warning system that ensures long-term success. The system continuously scans the environment for useful and relevant information and informs the organization of the current internal risk level to deal with this risk [14].

b) *Outside-In Strategic Perspective*

When confronted with important strategic decisions, the organization starts by understanding the external environment and then internally works on the results. It starts the thinking process by assessing its current situation, understanding the vast environment in which it operates, and exploring the big picture, such as global trends, changes in the world, the industry in which it operates, and its customers. The organization then works internally, cumulatively, on the results of this and examines the impact of non-emphasis to achieve its interests and determine the desired future position. This means that the organization starts the process of thinking to assess its current position and then ponders, cumulatively, in which direction it will go [24].

c) *Systems Thinking*

It refers to the field of understanding the interdependence, complexity, and role of feedback in system development [5]. Systemic thinking calls for detecting these inter-related relationships and helps expand the boundaries of mental models to use and improve their ability to generate and learn from evidence and stimulate effective change [32]. Systemic thinking is the framework for seeing interrelationships and seeing patterns of change instead of seeing static stills. It is a language that changes the ordinary ways people think about complex issues. It helps people to see systems from a broad perspective and includes a comprehensive view of structures, patterns, and loops in systems, not just seeing certain events in the system [31].

Mobilize Resources

Resources in their tangible and intangible dimensions represent important strategic elements and the basis for the organization's choices and performance. In general, an organization's resources can be seen as tangible resources such as funds, equity, marketing, distribution, and intangible resources, including technology, fame, culture, knowledge, and finally, human resources—skills, knowledge, communication, collaboration, and motivation. These resources are organized through the administrative pyramid and the network of formal and informal relationships that must be coordinated and mobilized to create meaningful work. Mobilizing resources means defining strategy actions and taking them to achieve the organization's purpose in the face of a dynamic and turbulent environment [23]. This principle covers the following sub-principles [24]:

(a) *Disciplined Decision-Making*

The decision-making in the smart organization is determined by strategic options, the participation of the right individuals, the use of the right information at the right time, and the selection of alternatives based on the higher value. On this basis, individuals in smart organizations understand the philosophy of this principle and begin the appropriate process to address the decision. Through a set of logical steps, sophisticated decision-making processes turn prospects into value for their benefit and use every opportunity to develop the decision-making process. This principle defines the necessary decisions that must be made and taken with the highest quality until clear results are achieved. This process can be summarized in six dimensions: the appropriate framework, possible creative alternatives, reliable and meaningful information, clear values and exchanges, sound and rational thinking, and commitment to implement the decision [23].

(b) *Alignment and Empowerment*

Empowerment is one of the most important strategies, allowing all levels of management to be involved in decision-making, attitude-taking, opportunity utilization, and avoiding potential risks. It is defined as the process that enables employees to take responsibility for their work [28].

(c) *Open Information Flow*

The concept of information flow refers to an organization providing open access to information and work-related databases for all its employees, enabling them to exchange and communicate with each other in the sense that official information is available to all employees [10].

44.4 Results and Discussions

44.4.1 Description of the Respondents

The core characteristics of the individuals interviewed can be described by analyzing the field data obtained (Table 44.2).

44.4.2 Description and Diagnosis of Study Variables

This section includes a descriptive analysis of the views of the sample members toward the variables included in the study and diagnosis to identify the study variables represented by the early warning system and the principles of the smart organization. The description and diagnosis were carried out as follows.

Table 44.2 Description of the respondents

Variables		Frequency	%
Age	18–24	–	–
	25–30	2	16.7
	31–45	10	83.3
	More than 46	–	–
	Total	12	100.0
Gender	Male	11	91.7
	Female	1	8.3
	Total	12	100.0
Specialization	Administrative	7	58.3
	Technical	5	41.7
	Total	12	100.0
Education	High-school	–	–
	Diploma	2	16.7
	Bachelor	10	83.3
	Postgraduate	–	–
	Total	12	100.0
Duration of service in the company	1–5 year	7	58.3
	6–10	5	41.7
	More than 11	–	–
	Total	12	100.0

Source Compiled by the authors

44.4.2.1 Description of Early Warning System

The results demonstrated in Table 44.3 indicate that respondents at the macro-level of firms surveyed and through their indicators (X1–X59) tend to agree on the availability of early warning system requirements in the surveyed companies. Moreover, 60.2% of respondents always work according to smart leadership, smart strategy, and smart process. However, 36.9% of respondents sometimes agree to use the dimensions of the early warning system, and 2.9% agree that they rarely work according to these dimensions. These results were with a mean of 2.54 and a standard deviation of 0.538.

The overall indicator to describe the opinions of the study sample shows the arithmetic mean index, where the smart strategy variable ranks first with a mean value of 2.60. This is a high significance on the survey response scale. They are followed by the variables smart process and smart leadership with high importance, according to the response scale of the study, which ranges from (1) at the minimum level and takes the title (rarely), and (3) at the top level, which takes the title (always).

Table 44.3 Overall indicator of early warning system description

Variables	Response scale			Arithmetic mean	standard deviation
	Always (%)	Sometimes (%)	Rarely (%)		
Leadership skills	52.1	46.6	1.3	2.47	0.574
Structure of the senior management team	51.3	46.4	2.3	2.49	0.517
Senior management team operations	72.6	26.2	1.2	2.71	0.404
Smart leadership	**58.7**	**39.7**	**1.6**	**2.51**	**0.589**
Smart assumption analysis	53.3	44.3	2.4	2.50	0.510
Strategy alignment	74.7	21.5	3.8	2.70	0.517
Smart strategy	**64**	**32.8**	**3.2**	**2.60**	**0.514**
Organizational structure	59.5	37.1	3.4	2.56	0.466
Communication channels	64.3	34.5	1.2	2.63	0.489
Engaged culture	46.8	46.1	7.1	2.38	0.580
Smart process	**57.9**	**38.3**	**3.8**	**2.52**	**0.511**
Total indicator	**60.2**	**36.9**	**2.9**	**2.54**	**0.538**

Source Compiled by the authors

44.4.2.2 Description of Smart Organization

The results in Table 44.4 indicate that respondents and the overall level of firms surveyed at this level, and through their indicators (Y60–Y122), tend to agree on the availability of the principles of a smart organization in the surveyed companies as they always work according to the principles of achieving the goal, understanding the environment and resource mobilization, with a ratio of 62.8%. However, 34.4% sometimes agree to use the principles of smart organization, and 2.8% agree that they rarely work according to these principles. The results were in the mean of 2.58 and with a standard deviation of 0.507.

The overall indicator for describing the views of the research sample shows that there is a difference in the opinion of the sample toward the hierarchical importance of the dimensions of this variable. Through the index of the arithmetic mean, the resource mobilization variable came in first place with an arithmetic mean of 2.60, which is of high importance according to the response scale of the study. It is followed by the variables of understanding the environment and achieving the goals, according to the response scale of the study, which ranges from (1) in the minimum and takes the form (rarely), and (3) in the upper level, which takes the title (always).

Table 44.4 Overall indicator of smart organization description

Variables	Response scale			Arithmetic mean	standard deviation
	Always (%)	Sometimes (%)	Rarely (%)		
Value creation culture	51.5	46.2	2.3	2.54	0.529
Creating alternatives	62.8	37.4	2.3	2.60	0.463
Continual learning	62.7	36.5	2.3	2.60	0.532
Achieve the goal	**59.6**	**38.1**	**2.3**	**2.55**	**0.508**
Embracing uncertainty	68.7	27.8	3.5	2.64	0.504
Outside-in strategic perspective	57.1	39.6	3.3	2.48	0.537
Systems thinking	68.7	27.8	3.5	2.64	0.491
Understanding the environment	**64.9**	**31.7**	**3.4**	**2.59**	**0.510**
Disciplined decision-making	59.5	40.1	1.2	2.58	0.487
Alignment and empowerment	61.9	34.7	3.4	2.58	0.531
Open information flow	70.3	26.3	3.4	2.65	0.493
Resource mobilization	**63.9**	**33.4**	**2.7**	**2.60**	**0.504**
Total indicator	62.8	34.4	2.8	2.58	0.507

Source Compiled by the authors

44.5 Conclusions

The main conclusions of this study can be summarized in the following points:

1. The results of the descriptive analysis of the research sample on the extent to which the elements of the early warning system (smart leadership, smart strategy, and smart process) and the resulting sub-elements were acceptable and high in the surveyed organizations. The mean of these elements is 2.51 for the smart leadership and 2.60 for the smart strategy element, which can lead to the conclusion that the companies surveyed do not operate according to contemporary systems in the exploration of the work environment, thus weakening their potential in the face of competitors.
2. Analysis of the views of the research sample on the levels of availability of principles of a smart organization in the surveyed organizations leads to the agreement of most respondents on the existence of intermediate levels of the principles in them: achieving the goal, understanding the environment, and mobilizing

the resources and sub-principles emanating from them. The arithmetic mean values of these principles ranged between 2.55 for the principle of achieving the goal and 2.60 for the principle of resource mobilization. It can be concluded that the surveyed companies have fairly acceptable levels of these principles. However, they remain below the level of ambition compared to other international companies.

3. On the extent of accreditation of the organizations to the smart leadership, most respondents agree that the organizations that work in them adopt smart leadership at an acceptable level, which shows the weakness of this index (58.7%). By examining the partial indicators of this variable, we can see the weakness of the leadership skills of the executives of the surveyed companies and an inadequate structure of the top management team in these companies, with high levels of top management processes in the studied companies.
4. The results indicate that the level of the smart strategy of surveyed companies has recorded average levels (64%). The reasons for this are primarily due to the weakness of the capabilities of virtual analysis of the studied companies.
5. The smart process variable recorded the weakest value among the early warning system variables, which reached 57.9%. A review of the results showed that the reasons for this were low levels of the culture of participation and the lack of clarity in the organizational structures of the companies surveyed.
6. Based on the results, there are weak levels of achieving the goals, which amounted to 59.6%. The reasons for this are due to low levels of adoption of the culture of value creation and the weakness of the capabilities of companies looking for continuous learning.
7. Most respondents agreed that the organizations provide the principle of understanding the environment at intermediate levels, which amounted to 64.9%. Embracing uncertainty has significantly contributed to raising the levels of this principle.
8. The principle of resource mobilization showed the best results among the principles of smart organization, amounting to 63.9%. Thus, we can conclude that the surveyed companies make efforts in making the right decisions and matching their own goals with the status of empowering employees, as well as the open flow of the information system.

The research results show that the senior management team in the surveyed companies should seek to develop the smart leadership index by developing the leadership skills of the team members through theoretical and field training, as well as reviewing the structure of the senior management team and adapting it to the new opportunities in the work environment. To enhance the levels of availability of the principles of a smart organization in the organizations investigated, it is necessary to develop the skills of managers and employees in how to make their organizations work intelligently by organizing specialized training courses on how to guide employees to achieve the goal, understand the environment, mobilize resources, deal with these resources, and control and manage uncertainties appropriately.

Managers should emphasize the analysis of smart assumptions, paying more attention to the ability of the studied organizations to incorporate critical success factors for solving performance problems. It is important to consider the clarity of the organizational structure. The investigated organizations must be confident in the efficiency of their operations by rationalizing the use of their resources, streamlining their organizational structures, and adopting more flexible membership structures in accordance with their real needs, thereby reducing costs. Furthermore, it is particularly important to ensure continuous learning by guiding the potential of the research organizations and their resources and encouraging the employees to learn continuously. Finally, there is a need for an administrative unit in the companies investigated under the title: "Early Warning Unit," concerned with collecting data related to studying the work environment and addressing them to serve those companies.

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Chapter 45
Methodological Aspects of Assessing the Effectiveness of Digital Transformation of Oil and Gas Industry Enterprises

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Abstract The paper discusses a relevant problem of digital transformation, its specifics, and its characteristics. The authors indicate a complex contemporary concept of development and indicate the breadth of the application of this concept in business, including in the oil and gas industry, where the digital transformation looks like an effective way to protect and adapt to the worldwide crisis on the basis of the long-term effect of its implementation. This effect provides the growth of profits of the oil and gas companies due to the increased economic potential of the use of new technological capacities. The authors show the possibility of using the assessment of the economic potential for the implementation of digital transformation, which allows using the optimization economic-mathematical development models to choose the option of digital transformation. The following grouping of the research process is proposed: setting goals, assessing the digital maturity of the transformation object, and diagnosing the company. The authors conclude that for the process of digital transformation, it is possible to use the classical way of transformation and operation of business models, such as the methodological version, the resource version, and their combination—the models based on open innovation. The authors propose certain grouped sets of parameters for assigning a business model to a certain type of transformation and its evaluation. During the research, the authors applied the methodology for a comprehensive performance assessment of an oil and gas company based on the definition of key performance indicators of its business segments together with the business segments themselves. The methodology of normalization of integral indicators for each business segment for their correct comparability and separate calculation is proposed. The main conclusions on the mechanism of digital transformation of business processes in the oil and gas company to provide a stable development of the oil and gas industry are made.

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45.1 Introduction

Being a driver for the development of the national economy, the oil and gas industry enterprises are currently developing in conditions of systemic technological, economic, environmental, social, political, and other challenges. Therefore, the digital transformation of oil companies entering the fuel and energy complex today seems to be the most effective tool for protecting and adapting to the crisis phenomena of the surrounding world [1].

The paper will discuss some methodological aspects of evaluating the effectiveness of the results of digital transformation in relation to oil and gas companies considering such peculiarities of the business as pronounced industrial division into segments as follows: Upstream (exploration, development, and production), midstream (transportation), and downstream (refining and marketing). The called segments have their own features for digitalization. For example, the upstream-segment is the most suitable for implementing the "Intelligent oilfield" mechanism that makes it possible to organize common digital management of the production process capable of constant updating since the beginning of exploration. In its turn, the midstream and downstream sectors are characterized by a logistical digital decision and the wide range of the Internet of Things to fully satisfy the customers of a product of the oil and gas industry [2].

45.2 Problem Statements

The advantage of digital transformation lies in its long-term impact on production processes, including investment/CapEx management and continuous improvement to find the most effective management solutions [3]. Simultaneously, it is important to realize that digital transformation does not cancel and cannot fully solve the tasks of strategic and investment development of vertically integrated oil companies for the commissioning of new or reconstruction of existing production (processing) and transport capacities based on the expected demand for refined hydrocarbon products [4, 5]. Therefore, the effects of reducing the production costs of vertically integrated oil companies will always manifest themselves outside the planning horizons provided for by business strategies and enterprise development models, which determines an important long-term result of digital transformation as an increase in the profits and production efficiency of oil companies by increasing economic **potential of using** new technological capacities [6].

No less important is an objective assessment of the results of enterprises' digital transformation. Therefore, this research aims to study the known methodological approaches to assessing the effectiveness of changing the business model in relation to the digital transformation of an oil and gas company.

45.3 Main Formalisms

Modeling belongs to the group of descriptive methods and imitates the development of technological/digital competition. It allows us to determine economically justified directions and depth of application of digital solutions for each vertically integrated oil company, considering the objective economic criterion of digital transformation—the minimum total discounted costs for the operation and development of the company, ensuring internal and external needs in its final product [7]. To select the option of digital transformation of the business model that is optimal for a particular vertically integrated oil company, it is necessary to carefully monitor current digital trends and the actions of market competitors, organize scouting, study startups, and monitor technological solutions in the oil and gas industry [8].

Considering modeling as a method of scientific knowledge, it is advisable to group the research process into the following stages:

- Setting a goal and developing a general task of digital transformation. The object of modeling is selected, and monitoring and study of its properties are carried out to obtain information on the basis of which the model of the object is built;
- Research and analysis of the constructed model using a substitute object;
- Comparative experiments;
- Verification and evaluation of the effectiveness of the obtained results of digital transformation in practice (real object).

  Before proceeding with the analysis of methods for assessing the effectiveness of a digital transformation project of a company's business model, it is necessary to answer several questions that will allow us to conclude on the degree of "digital maturity" of the transformation object:
- What is happening in the digitalization world?
- What stage is the digitalization of the oil and gas industry at, and what scale has it reached?
- What requests and needs are sent by clients, how relevant and consonant are these requests with the business strategy of the vertically integrated oil company, and how are the needs of customers changing considering digitalization?
- Is the current business model of an oil and gas company vulnerable: if yes, then what is its vulnerability?
- Does the company have the skills to quickly build partnerships in similar and supportive business models?
- Is the potential of using big data known, and which digital transformations are the most beneficial [9]?

Having the answers to these questions, we can conclude that it is possible to use the well-known classical approaches of transformation and work of business models in the implementation of digital transformation projects: methodological (the concept of "entry–exit") and resource-based view (the concept of "from the inside–out"), as well as their combinations—models based on open innovation (Open innovation business models, OI BM) [10].

The methodological approach works with sufficient or insufficient availability of resources, identifying, as a result of the analysis of the external environment, additional sources and opportunities for business development that can enhance the transformation process [11]. With the correct application of such a concept, the principle of "outside–inside" is achieved, where success is achieved mainly due to the intuition of managers based on experience and knowledge, as well as the ability of the current business processes of vertically integrated oil companies to adapt to changes in the economic environment. In combination, this allows us to quickly solve problems associated with the timely delivery of ordered goods to consumers, create individual product offers, and develop in advance promising commodity items for the formation of future demand.

As the name implies, a feature of the resource-based view is the effective use of industrial potential based on the unique competencies and production resources inherent in the company for its economic growth, including the possibilities of the results of R&D. The resource-based view is typical for companies building their business based on an "inside–out" strategy [12].

Assessment of the effectiveness of digital transformation based on the resource-based view determines the number of resources involved in the transformation process and the new balance of income and expenses of the company. The disadvantages of the resource-based view compared with the methodological approach include the high probability of a delay in responding to new external challenges caused by the high volatility of the economic environment.

Therefore, when choosing transformation tools for the digital transformation of business models, it is advisable to use a combination of the advantages of methodological and resource-based view to forming models based on open innovations, a feature of which is the ability to combine the results of internal R&D with innovations of the surrounding business environment.

To classify a business model as one or another type of approach, the authors propose the following set of parameters:

- Information about the company's clients ("client bases");
- Combination of industry and organizational structures;
- Combination of a strategic goal and the current production process as vectors of business development;
- Techniques and methods for identifying success factors;
- Methods and ways of identifying key performance indicators;
- Strategic maps of indicators (strategy map) and control panels (dashboard) for existing and operating segments of ways of doing business (the company as a whole, the level of business processes, MOS, and workplace);
- Ways to encourage and retain (motivate) employees;
- Effective techniques for the profitability of ideas in innovation.

Methods for assessing the current competitiveness of business models are proposed to be identified and grouped according to the following parameters:

- Performance assessment—reflects the growth rates of sales and their profitability relative to competitors (comparative indicators of the dynamics of changes in the market value of a company using competitive business models);
- Productivity assessment—reflects the level of transformation of various kinds of resources (labor, financial, and material) into the final product; the comparative resource intensity of the business is estimated, equal to the cost of resources per unit of added economic value created in the company;
- Assessment of efficiency—reflects the level of unit costs for the formation of a unit of resource, coefficients of elasticity of costs per unit of resource compared with competing companies [13].

45.4 Results

The methodology of a comprehensive efficiency assessment based on the definition of key performance indicators (KPIs) of its constituent business segments is used as a basis for the system of indicators of the digital transformation project of the vertically integrated oil company business model [14]. The advantage of the proposed approach is that it considers the importance of performance indicators for each segment, giving confidence that a comprehensive VIOC performance indicator is based on the aggregate effectiveness of the elements of value creation. In this case, it allows one to clearly see how digital transformation has impacted the performance of each segment. Any model of an oil object, as a multidimensional dynamic object, is a set of characteristics and defined quantitative indicators of the development of each element of the value chain in the context of various changes necessary for the aggregate level of competitiveness of vertically integrated oil companies.

The main resources of the production activities of oil and gas companies are upstream (exploration, development, and production), midstream (transportation), and downstream (refining and marketing); these types of resources are the main key performance indicators (KPI):

As follows from Table 45.1, a feature of the main performance groups is the calculation on different measurement scales, which limits the calculation of integral estimates. Consequently, a correct comparison of values (indices) of the efficiency of economic activity is impossible. The methodological approach, with the help of which a solution to the problem is proposed, is based on the application of the method of standardizing the values of indicators for individual business segments by moving from different measurement scales to a single normalized scale, where the indicators are assigned values from 0 to 1. The best indicator of the historical period in the studied segment is taken as the norm. The proposed methodological approach ensures correct comparability of indicators and allows calculating integral indicators separately for each segment of the activity.

Based on the above, the transformation function $y = f(x)$ will have the following properties and restrictions:

Table 45.1 Key performance indicators of upstream, midstream, and downstream segments, adopted to assess the effectiveness of the project of changes

Key indicators	Upstream	Midstream	Downstream	Unit of measurement
Production results	Oil production volume	Oil pumping volume	Oil refinery volume	Million tons
Operating cost level	Costs per unit of production	Costs per pumping unit	Costs per unit of oil refining	Rubles per ton
Financial activity	Return on assets	Return on assets	Return on assets	%
Technological efficiency	Oil recovery index	Loss ratio of transportation	The Nelson index	Fraction of unit
Efficiency of labor resources using	Labor productivity	Labor productivity	Labor productivity	Tons per person

Source Developed by the authors

$$y(X_{\min}) = 0;\ y(X_{\max}) = 1;\ \mathrm{d}y/\mathrm{d}x > 0 \tag{45.1}$$

After determining the indicators, we proceed to calculate a comprehensive assessment of the efficiency of the upstream and downstream segments of each of the "innovative" oil and gas companies using the formula:

$$I_i = \sqrt{X_1 * X_2 * X_3 * X_4 * X_5}, \tag{45.2}$$

where

$X_1 * X_2 * X_3 * X_4 * X_5$—key indicators of business segments;

I_i—an integral indicator of the ith business segment (I_{up}—upstream-segment, I_m—midstream-segment, and I_{d}—downstream-segment).

Based on the competitiveness of each of the segments of the value chain, the overall competitiveness of the company (IK_0) can be determined as the root of the third degree from the result of multiplying the components of indicators of the segments:

$$\mathrm{IK} = \sqrt[3]{I_{\mathrm{up}} * I_m * I_{\mathrm{d}}} \tag{45.3}$$

The obtained value of calculating the integral level of the company's efficiency shows by how much the efficiency of the vertically integrated oil company has increased after the implementation of the digital transformation project.

To assess the industry enterprises after transformation from the point of view of the effectiveness and efficiency of their production activities, the authors propose to calculate such an indicator as the index/indicator of integral economic efficiency—I_{bm}:

$$\begin{cases} I_{\mathrm{bm}} = \Delta\mathrm{MV}/\Delta C \to \max, \\ \Delta\mathrm{IC} \to \min, \\ \mathrm{IC} \geq 0 \end{cases} \tag{45.4}$$

where

ΔMV—the rate of change in the market value of a company's business

$$(\mathrm{MV}_{(t+1)}/\mathrm{MV}_t);$$

ΔIC—the rate of change in the value of invested capital ($\mathrm{IC}_{(t+1)}/\mathrm{IC}_t$).

This indicator makes it possible to assess the increase/decrease in the value of the calculated integral efficiency index and estimate the dynamics of changes—how exactly the indicator grows or decreases. The priority of digital transformation is the sustainable growth of the economic efficiency of vertically integrated oil companies. If sustainable growth is present, this confirms that the proposed business model of the company's development is effective and efficient, and it is recommended for implementation and further use. If the value of the integral assessment index falls below one for three or more years within the planning horizon of the business model, then the chosen option for digital transformation is erroneous, and the company should abandon it beforehand. The method proposed by the authors has been tested at a large Russian oil company; the first results of the comprehensive assessment of the implementation of the digital deposit project are presented in Table 45.2.

As can be seen, the proposed methodology for the comprehensive assessment of digital transformation projects positively assesses the results of the project implementation, noting an increase in efficiency by 9%. An analysis of the production and financial performance of the oil company after implementing the digital transformation project also established the achievement of the significant economic effect and confirmed the data of a comprehensive assessment.

Table 45.2 Evaluation of the effectiveness of the digital transformation project

Integral indicator	Before transformation	After transformation	Deviation, (%)
Downstream-segment	0.79	0.8	1
Midstream-segment	0.56	0.67	20
Upstream-segment	0.68	0.72	6
Comprehensive performance assessment	0.67	0.73	9

Source Developed by the authors

45.5 Discussion

Outside the scope of this work was such methods of assessing efficiency as the balanced scorecard, benchmarking, the development of comparative templates, reflexive monitoring of the state, and others. Each of these methods also allows managers of a vertically integrated oil company, who control the process of creating a business value chain, to identify bottlenecks in existing and promising business models in time, choose a direction for improving current economic practices, or completely abandon the current (usual) form of doing business and move to a new business model.

45.6 Conclusion

The main conclusions of the study are formulated below:

1. Digital transformation is an integral priority of contemporary corporate strategies for developing oil and gas companies.
2. A preliminary assessment of the degree of "digital maturity" of the company facilitates the project of digital transformation of the business model.
3. During the digital transformation of the business model, the authors do not recommend being limited by the framework of one of the theoretical approaches to the company's transformation—it is advisable to use a combination of different methods.
4. To measure the results of the digital transformation of the business model, the authors suggest using the key performance indicators (KPIs) of the economic activity of vertically integrated oil companies.
5. To assess the economic efficiency of the results of the business model transformation, it is proposed to take the integral efficiency index according to the methodology created by the authors.
6. In a variety of economic transformation processes, including digital solutions for business processes, the goal is to ensure the sustainable development of oil and gas enterprises.

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Chapter 46
The Impact of the Development of Fiber-Optic Cable Market on the Formation of Global Digital Economy: The Example of Russia

Natalia S. Rytova

Abstract Currently, the development of the digital economy in Russia is limited by the insufficient level of development of fiber-optic lines, associated digital technologies, and their geographical heterogeneity of distribution. The research focuses on the problems of limiting participation in the world market of fiber-optic cables. The author analyzes the life cycle model of A. Veron. By the example of studying the optical cable market, it is shown that the application of the Chinese model of the spread of innovations in production is impossible for use in the Russian economy because it does not allow forming a condition for technology transfer and compliance with competition policy. The factors determining the dynamics of the development of the optical cable market are highlighted, and the demand for products in developed and developing countries is analyzed, which allows identifying the factors of technology transit and the spread of innovations. The research used the approaches of the theory of industry markets, antimonopoly analysis, and new institutional economics. The author concludes that to establish the production of optic fiber in Russia in order to ensure at least 50% of the demand for fiber within the country in support of import substitution, direct investments in R&D are needed to develop the scientific and technical base for the possibility of producing primary preforms for enterprises producing fiber. Despite the government's achievement in implementing the optical fiber production project in Russia and reaching a production capacity that provides 50% of the demand for fiber within the country, the measures are not sufficient because the manufacturer is directly dependent on primary preforms for fiber production, which Russia does not produce.

46.1 Introduction

The digitalization of the world economy depends significantly on the development of the telecommunications industry, which is determined by the dynamics of fiber-optic

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cable consumption [1]. Thus, over the past 15 years, the growth rate of the global digital economy has been two and a half times faster than the growth of global GDP, according to the financial expert of Huawei Technologies Co., Ltd. [2, 3].

World experience in the development of the market of fiber-optic cables indicates that its development is determined by the needs of the domestic telecommunications market. At a time when there is a need to develop backbone fiber-optic networks, including underwater, as well as to develop cellular infrastructure, the demand increases significantly.

Demand for fiber-optic cables in the world market is determined by the change in technological systems of national economies, while the following is observed:

- Less developed countries form the telecommunications infrastructure; for example, in African countries, South of the Sahara, the construction of the backbone lines was started in early 2010 and continues into the present (while in other countries, the construction of this infrastructure was started in the early 1990s);
- In developing countries, the demand for fiber-optic cables is determined by the need for further development of cellular infrastructure in the transition to 5G standards [4];
- In developed countries, the demand for fiber-optic cables is diversified. Fiber-optic cables are used not only in the telecommunications industry but also in other industries. Consumption is increasing due to the introduction of the concept of the Internet of Things and the development of inter-machine communication in the production of innovative machines and equipment.

The spatial distribution of capacity for the production of fiber-optic cables is described by the provisions of the product life cycle theory in international trade developed by A. Verona. According to this theory, the production of products is shifted to the consumer countries if the cost of production factors is lower there. Thus, the growth of production in China due to the transit of technology and diffusion of innovation has allowed the country to become a leader in producing fiber-optic cables [5].

These aspects raise the question of finding an institutional model for developing the market of fiber-optic cables for the Russian economy.

46.2 Methodology

The author uses general and special methods of scientific knowledge, including economic analysis of world economic relations, statistical analysis, analysis of commodity flows, and system analysis of economic systems.

46.3 Results

The production of fiber-optic cables has first been organized in the mid-1970s. However, according to the expert assessment, the quality of the cables produced at the beginning of their production was significantly inferior compared to foreign analogs. However, since the early 1990s, the production of fiber-optic cables in Russia completely stopped, and its consumption was replaced by foreign products, which, among other things, were used for laying the first fiber-optic backbones.

The resumption of production of fiber-optic cables in Russia was carried out in the late 1990s based on the establishment of joint ventures with foreign manufacturers of optical fiber and final products.

Simultaneously, the increase in production in the domestic market was not based on diffusion of innovation because foreign components were used in the production of fiber-optic cables, their production technology was not transferred, and Russian manufacturers, unlike the Chinese, did not have enough impact on foreign companies since the domestic market was underdeveloped [6].

Thus, the existing institutional model of production of fiber-optic cables in Russia had significant limitations related to the lack of opportunities for diffusion of innovation and reducing dependence on foreign-made components. Only imported optical fiber was used in production. Manufacturers were often limited in choosing a supplier by the terms of a contract with consumers of products. Domestic scientific research within the national economy in this area was not carried out, while Russian consumers were completely dependent on foreign manufacturers.

This situation worsened significantly in 2000 when there was a crisis in production in the world market. As a result, the prices for fiber-optic cable significantly increased, and access to raw materials was limited. This significantly affected the opportunities for the development of telecommunications infrastructure. However, since 2003, the world market has constantly been reducing the price of fiber-optic cables, which also significantly limited the possibility of developing domestic production because it determines the need for the production of products that can compete in terms of price indicators [7]. This was the reason for the departure of some major manufacturers in the market of fiber-optic cable. Accordingly, this was the reason for the slow development of this industry in Russia.

Simultaneously, the prices of domestic manufacturers are constantly increasing the prices of fiber-optic cables. It is apparent that the decline in prices on the world market has an additional negative impact on the results of economic activity. According to the Federal State Statistics Service of the Russian Federation (Rosstat), at the time of the beginning of a new stage of the development of the production of fiber-optic cables in 2012 and 2013, the level of return on sales did not exceed 2.5%, which, on average, is three times lower than similar indicators for other processing industries and two times lower than the indicators of production using non-metallic materials.

Despite the price reduction, product requirements are constantly increasing; currently, only manufacturers offering innovative products have a competitive advantage.

These factors led to the search for industrial policy tools to form their own production of fiber-optic cables. In 2002, the first patent for producing fiber-optic cable was registered.

By 2007, the production of fiber-optic cables was carried out by 13 enterprises, and more than 50 patents for the production were registered; as well as research in the field of formation of national standards for the production of cables was carried out, the first of which was introduced in 2005. Nevertheless, all this time, only the production of fiber-optic cables from raw materials of foreign production was carried out in Russia, which had little effect on the cost of final products [8]. According to a significant number of researchers, the dependence on the supply of foreign raw materials significantly affects the security of the national economy.

There are significant limitations to developing the domestic market and producing fiber-optic cables in developing countries. They primarily relate to the availability of raw materials and new technologies. Additionally, the models used significantly differ in the different institutional conditions of the national economies of developing countries.

It should be noted that it is the limitation associated with the need to use foreign-made optical fiber that is characteristic of all developing countries, including China and India. Therefore, the actions of the Russian Government were focused on reducing the dependence of the national economy on this type of product. Thus, many experts suggested that the availability of raw materials is no less important than the availability of production technologies. However, to date, the criteria of independence from the supply of optical fibers are not a significant indicator of the security of the national economy, while it is necessary to ensure the own production fiber and its components to maintain a high rate of digitalization of the socio-economic system.

The practice of spreading innovation in the digitalization of China's economy shows that the implementation of measures to support the production of fiber-optic cables can have a significant economic result and reduce the risks to the implementation of scientific research [9]. Thus, the production of fiber-optic cables in China is the largest in the world, while it took no more than 6–8 years from the moment of the organization of the first production to achieve significant results.

Therefore, according to the author, a new stage in the development of the market of fiber-optic cables began in 2015, when the production of optical fibers by the company "Fiber systems" began in Russia. This project was implemented by the state company "Rosnano," the volume of investments amounted to 3.5 billion rubles, more than 50% of which were financed by the government [10] (Fig. 46.1).

Large-scale production of optical fibers began in 2016. According to experts, in the conditions of work at the level of 50% of capacity utilization, about 25% of the needs of the domestic market were met [12].

Various instruments of state regulation are used to strengthen import substitution processes in the digitalization of the Russian economy. In particular, within the

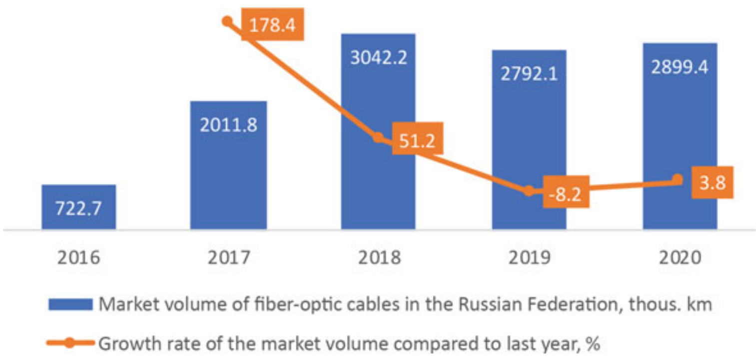

Fig. 46.1 Dynamics of changes in the Russian market of fiber-optic cables 2016–2020, thous. km. *Source* Compiled by the author according to the Federal State Statistics Service [11]

framework of the government program "Digital economy of the Russian Federation," all cable deployments relating to 4G/5G network construction, alongside metro loops and CO–CO trunks, are planned to conduct high-speed Internet through fiber-optic lines to all schools, medical institutions, and other social facilities in Russia [13]. Additionally, to strengthen import substitution processes, import duties on optic fiber manufactured in the USA increased from 3 to 30% in response to sanctions associated with increased duties on exported metals [14].

These measures made it possible to increase the competitiveness of high-tech equipment in China, the production of which uses fiber-optic cables. However, despite the significant results achieved, this model has its limitations. Thus, the source of competitiveness of Chinese products in the international market is a relatively low price compared to competitors, and not the quality characteristics of fiber-optic cables. Simultaneously, the possibility of price competition is significantly reduced because innovative types of fiber-optic cables are made from foreign-made components, but the most common types of cables have sufficient quality characteristics for developing advanced infrastructure. However, the further development of digitization requires further improvement of this technology.

For this purpose, it is possible to use different types of collaborations with foreign companies, purchase of technologies on the world market, and ensure development on the basis of fundamental domestic research. Simultaneously, the search for these models has significant limitations because the production technologies of the most common superconducting fiber cables are exclusively owned by a limited number of companies in the USA and Japan, which, in the conditions of reducing the production of fiber cables, do not transit technologies on the world market but carry out their own production (Fig. 46.2).

Despite the fact that the signal transmission by means of optical fiber is innovative, according to a significant number of experts, it will not be replaced by fundamentally different methods of signal transmission in the coming decades. Therefore, the first stage of the life cycle of A. Verona in relation to the production of superconducting

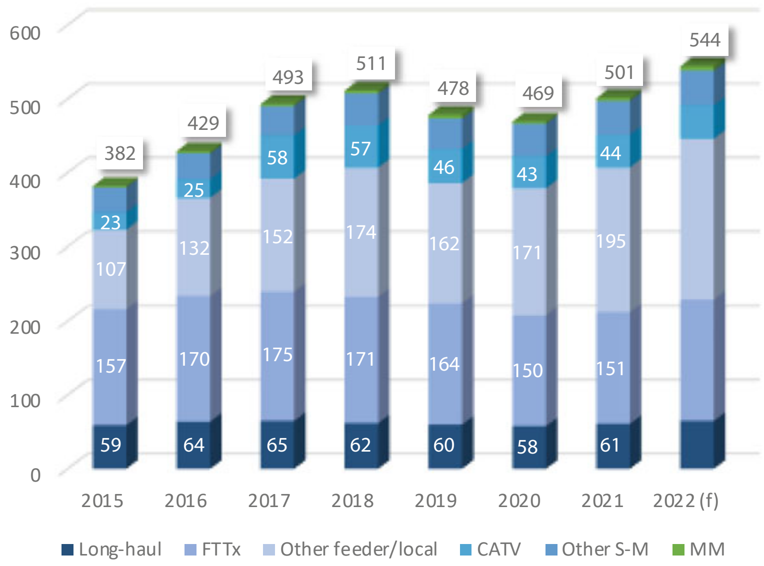

Fig. 46.2 World optical cable demand by application, M F-km. *Source* Compiled by the author based on the information and analytical agency CRU Monitor [15]

fiber cables can continue for a considerable time until new product modifications are created [16]. Russia uses a fundamentally new model of telecommunications infrastructure development focused on developing its own technologies, raw material independence, and producing innovative products. This model does not allow significantly increasing the production of fiber-optic cables even in the conditions of a significant increase in domestic demand because the diffusion of innovation is slow. However, in the long term, it can reduce the dependence on the consumption of innovative products produced in the USA and Japan. To stimulate this production, customs and tariff regulation methods are used, such as increasing customs duties to 30% of US optic fiber.

46.4 Conclusions

Thus, the model of diffusion of innovations in the production of fiber-optic cables used by the Chinese Government allows forming an institutional environment conducive to the diffusion of innovations, which makes it possible to increase the production of this type of product. However, the use of such a model is impossible for application in the Russian economy. This is due to the fact that the Russian market does not allow forming such a strong negotiating position that allows technology transfer on more favorable terms. In the context of the Russian economy, the demand for fiber-optic cables is determined primarily by state-owned companies and the state investing in the development of telecommunications infrastructure used both for the development of the socio-economic environment and for ensuring defense capability, which makes the growth of consumption unstable, depending on the regularity and volume of purchases [17].

The priorities of the state program of the Russian Federation "Development of industry and increasing its competitiveness" include the reduction of the dependence of the Russian economy on the import of products, equipment, and technologies critical for sustainable development, which is ensured by the implementation of import substitution plans in different industries [18]. Import substitution plans contain the following prescription: the products must meet the requirements for their classification as products manufactured on the territory of Russia, which means that at least three of the following operations must be carried out on the territory of the country from January 1, 2016, and from January 1, 2021, at least four of the following operations:

- Production or use of preforms produced on the territory of the member states of the Eurasian Economic Union;
- Fiber extraction from preforms;
- Application of acrylates;
- Winding on coils of finished fiber [19].

Thus, the priorities of the industrial policy of the Russian Federation in the field of optical fiber production are determined by the requirements of import substitution.

The shortage of preforms and fiber is another factor affecting the supply dynamics in the fiber market—the dynamics of the preform market (the main intermediate product for the production of fiber); it shows a shortage on a global scale and in the Russian market. Digitalization is a significant driver of the growth in the demand for optical cable and, as a result, for optical fiber. The implementation of the national project "Digital economy" and the program "On the elimination of digital inequality in Russia" stimulates the consumption of optical fiber used for trunk lines (Internet backbone networks) [20].

The main task to ensure this strategic industry sector is the creation of a number of enterprises that will provide a full production cycle from the extraction of raw materials such as quartz sand to the production of a finished product—fiber-optic cables for various purposes.

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Chapter 47
The Contribution of Universities to Digitalization on the Example of Scientific Consortiums (WCRC) Created in Russia

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Abstract The current period is characterized by a continuous increase in the role of science in solving various problems of the world community. In the twenty-first century, science has acquired a qualitatively new image—the image of the science of the information society based on developing digital technologies. Additionally, the global space is actively moving along the path of transformation toward a knowledge society and a knowledge-based economy. In this regard, higher education acquires a huge role in the form of its main elements—universities. In turn, this necessitates the development of science as a methodological basis for studying the scientific activities of universities—participants in world-class scientific centers. This paper aims to analyze the possible contribution of universities participating in world-class scientific centers (WCRC universities) to providing technological breakthroughs based on advanced digital technologies based on the methodological approaches of science about science. The paper focuses on fundamental scientific and applied research of universities—members of consortiums of world-class scientific centers in the field of advanced digital and intelligent production technologies. One of the main drivers of digital transformation is designated—the technology of "digital twins." An assessment is made of the possible contribution of universities—participants in world-class research centers to the digital transformation of Russia. The significant

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contribution of universities participating in consortiums in the form of WCSC to the development of the digital economy is shown.

47.1 Introduction

The increase in the number of digital technologies over several years determines the direction of the development of society and the economy as a whole and also radically changes people's lives. The development of the digital economy is extremely important for many countries of the world. Countries are characterized by different stages of digital development—from creating a basic information and communication system to forming a targeted state policy that includes various state support tools aimed at widespread digital transformation.

In recent years, the pace of digitalization in Russia has dramatically increased. Thus, the Strategy for Scientific and Technological Development of the Russian Federation (approved by Decree of the President of the Russian Federation of December 1, 2016 No. 642) defines seven priority areas for the scientific and technological development of Russia, one of which is the transition to digital technologies.

The world-class research centers created as part of the national project "Science and Universities" can become the most important tool for accelerating the introduction of digitalization of the Russian economy, production, and the social sphere. In 2020, ten world-class scientific centers were created in the form of consortiums, including scientific and educational organizations of higher education (universities) and performing research on the priorities of scientific and technological development, including such a key priority as the transition to advanced digital technologies. As of January 1, 2022, there are ten WCRCs created on the basis of 41 organizations, 18 of which are universities.

47.2 Methodology

Scientific areas and the structure and forms of scientific activity in the field of digital technologies are studied based on the scientometric approaches, according to which research and development are carried out by universities—participants in world-class scientific centers that conduct research and development on the priorities of scientific and technological development and the interaction of science with other social institutions and spheres of the material and spiritual life of society.

47.3 Results

Current trends in the renewal of science and higher education speak of the increasing importance of universities in improving scientific education, the emergence of new knowledge, and their practical application in high-tech and innovative areas. The importance of generating new knowledge and its implementation in education, the socio-economic sector, and the life of society is increasing.

Consolidation of universities and scientific organizations into consortiums expands the possibilities of research and development for the former, as well as bringing the results of research to educational products that turn into new knowledge [7].

Eighteen Russian universities, along with scientific organizations, are active participants in scientific consortiums, where they conduct research and development on digitalization.

An active participant in the formation of the national digital and technological agenda is Peter the Great St. Petersburg Polytechnic University, on the basis of which the WCRC “Advanced Digital Technologies” was created, which also included St. Petersburg State Marine Technical University and Tyumen State University [2].

The WCRC “Advanced Digital Technologies” conducts fundamental and applied scientific research on advanced digital technologies, artificial intelligence, robotic systems, and next-generation materials. Consider the most significant of them, for which it is planned to obtain results by 2025:

- Technologies for the development and application of digital twins of products, machines, structures, and cyber-physical systems and products in priority industries: automotive, engine building, aircraft building, shipbuilding, and mechanical engineering, including nuclear, oil, gas, chemical, heavy, and special engineering, as well as railway transport;
- Digital technologies for modeling and managing processes that occur during the production and storage of hard-to-recover hydrocarbon reserves;
- Technologies for optimal control, protection, and security of cyber-physical systems;
- Algorithms and AI technologies for solving the problem of continuous improvement and optimization of the production process;
- Promising platform solutions for integrating industrial technologies of cyber-physical systems and artificial intelligence systems;
- Digital solutions and devices for 5G networks and the industrial Internet of Things;
- Methods of digital design of micro- and nanoelectronic component base for wireless info-communication systems;
- Technologies for digital modeling, forecasting, and management of developments in the field of medicine, including research aimed at developing RNA and vector vaccines;
- Digital technologies for designing individual endoprostheses of large joints based on mathematical models of bone tissue regeneration, computational approaches to continuum mechanics, and advanced additive manufacturing technologies;

- Digital technologies for creating arctic energy facilities using new-generation adapted materials and robotic systems;
- Systems of heterogeneous extra massive parallel computing and machine learning technologies;
- Algorithms and AI technologies for solving the problem of continuous improvement and optimization of the production process for companies in the real sector of the economy.

The results obtained by the WCRC "Advanced Digital Technologies" as part of ongoing scientific research will impact the development of almost all high-tech sectors of the economy. Thus, the introduction of technology for the development and use of digital twins by industry enterprises will reduce the time and costs for the development and production of products, ensure the flexibility of production through the possibility of rapid changeover of production, increase transparency at all levels of the process of developing new high-tech products, and implement new business models.

The development of digital technologies for modeling and controlling processes that occur during the production and storage of hard-to-recover hydrocarbon reserves is of paramount importance for Russia's oil and gas industry. The development of deposits with hard-to-recover reserves requires the constant improvement of digital technologies.

The results of research on digital technologies for creating Arctic energy facilities using adapted new-generation materials and robotic systems are of paramount importance for developing the Russian Arctic zone. The information base for decision-making in the format of an interactive geographic information system, created by the WCRC "Advanced Digital Technologies" within this scientific area of research, will allow real-time information on the state and spatio-temporal predictive variability of meteorological, natural-climatic, and resource characteristics of the territory of the Arctic region of Russia in the context of climate change; to study the physical and mechanical properties of ice formations, their drift under the influence of wind and currents; explore the mechanisms of the variability of waves and other natural influences under the conditions of climate change in the Arctic.

The introduction of algorithms and artificial intelligence technologies developed by the WCRC "Advanced Digital Technologies" will ensure the transition from discrete and fragmented analysis of production processes to continuous monitoring, predictive analytics, and integrated optimization of the production process for companies in the real sector of the economy.

Additionally, for accelerated digital transformation, the most relevant and promising area is such a new field of science as photonics [6]. The scientific research carried out by the WCRC "Center of Photonics" is of paramount importance. In the WCRC "Center of Photonics," universities are represented by the Lobachevsky National Research Nizhny Novgorod State University.

The WCRC "Center of Photonics" conducts research in all major areas of photonics: power and adaptive optics, fiber optics, biophotonics, nanophotonics, and quantum optics. Thus, within the framework of the scientific research direction

"Power and adaptive optics," fundamental and applied scientific research is carried out in the following areas:

- Adaptive optics for precise control of the spatial and temporal distribution of the amplitude and phase of the field of petawatt laser pulses;
- Increasing the time contrast of femtosecond laser pulses using nonlinear optics;
- Control of spatial, temporal, and polarization parameters of laser pulses of powerful nanosecond lasers;
- Control of the 3D shape of picosecond laser pulses to minimize the emittance of the electron beam in electron photoinjectors and to generate THz radiation;
- Femtosecond lasers with high average power; microstructuring of materials by femtosecond laser pulses;
- Laser-plasma sources of structured photon beams.

The results of intellectual activity obtained in these areas have a significant potential for technological impact on the digitalization of the country's economy. Optical and quantum technologies related to photonics are involved in almost all sectors of the real sector of the economy.

Also, the digital transformation of health care is highly important for accelerated digital transformation and the country's economy as a whole [9]. The WCRC "Digital Biodesign and Personalized Health Care," created on the basis of Sechenov University, contributes to the development of the digital transformation of health care. In addition to Sechenov University, Novgorod State University named after Yaroslav the Wise, also joined the WCRC "Digital Biodesign and Personalized Health Care" in the format of a consortium.

As part of the WCRC "Digital Biodesign and Personalized Health Care," a technological platform is being developed to form a prototype of a digital healthcare ecosystem based on the principles of health management through the creation of a "digital twin" of a patient when modeling pathological processes in the context of the development of socially significant diseases (oncology and cardiology) [8]. This technological platform includes bioinformatics platforms for remote monitoring of patients' conditions, digital consultations, a digital preclinical research platform for modeling the testing of new drugs for oncology and cardiology, and a prototype of the "digital twin" for advanced forecasting of the development of oncological and cardiological diseases [5].

For the accelerated digitalization of medicine, scientific research conducted by the WCRC Pavlov Center "Integrative Physiology to Medicine, High-Tech Healthcare, and Technologies of Stress Resistance" is also of interest. Universities in this WCRC are represented by the country's oldest university in the field of electronics—St. Petersburg State Electrotechnical University "LETI" named after. V. I. Ulyanov (Lenin). Within the framework of the WCRC, a laboratory of neurotechnologies has been created, whose scientists are engaged in the construction of new information technologies based on neurophysiological and psychophysical studies of the architecture and algorithms of neural networks of the visual system of the human brain. A laboratory for complex modeling of human cognitive processes has also been created to build a strong artificial intelligence, whose scientists create models and software and hardware solutions based on them to support integrative medicine.

The development of an accelerated digital transformation of the country is unthinkable without the coverage of such a strategic industry for Russia as agriculture by digital technologies [10].

According to experts, digitalization will help the Russian agro-industrial complex to make a powerful leap forward. The Ministry of Agriculture of Russia is actively working in this direction, implementing the National project "Digital agriculture" [3], which sets ambitious goals—digital technologies should help double the productivity of agricultural enterprises by 2024 [4].

In this vein, scientific research in the field of digital technologies in agriculture, conducted by the WCRC "Agrotechnologies of the Future," is of particular relevance and significance.

The WCRC "Agrotechnologies of the Future" united the leading universities of the country: Russian State Agrarian University—Moscow Timiryazev Agricultural Academy and St. Petersburg State University.

Thus, in the direction of "New digital technologies in agriculture," the WCRC "Agrotechnologies of the future" carries out the following fundamental and applied research:

- Research and development of the digital platform for the sharing of data from remote sensing of the Earth in the interests of the agro-industrial complex of Russia;
- Development of new digital technologies for accurate melioration and restoration of degraded lands;
- Digital land use: the creation of an automated planning system for optimal land use and land management on a landscape basis;
- Research and development of the digital platform for the management of the agro-industrial complex of Russia;
- Research and development of the digital platform for information and analytical support of research activities in the field of the agro-industrial complex;
- Development of a platform for accelerated breeding of high-yielding and resistant varieties and hybrids of plants with specified quality characteristics;
- Development of science-intensive technologies for intensive cultivation of plants.

A significant contribution to the digitalization of the hydrocarbon economy can be made by the WCRC "Efficient development of the global liquid hydrocarbon reserves," created on the basis of four universities at once: Kazan Federal University, Gubkin Russian State University of Oil and Gas, Ufa State Petroleum Technological University, and Skolkovo Institute of Science and Technology.

To date, the WCRC "Efficient development of the global liquid hydrocarbon reserves" is conducting fundamental and applied scientific research in the field of digitalization of the hydrocarbon industry, the results of which will be ready for implementation by 2025.

As a result of the scientific research of the WCRC "Efficient development of the global liquid hydrocarbon reserves," new and existing remote technologies for the search, exploration, and evaluation of hydrocarbon reserves will be created and developed using satellite methods and light geophysical methods in the land, water, and air variant, including using uncrewed vehicles (aero—and underwater). An unparalleled model of an underwater vehicle for searching the shelf with sensors will be created that will most likely identify and outline oil and gas deposits on the shelf to a depth of one km.

The processes of digital transformation are actively occurring in such an industry as aviation. Domestic developments in this direction are not inferior to foreign competitors. Thus, one of the most significant areas of research in the field of digital aviation—"artificial intelligence and flight safety"—is actively developing within the framework of the "Supersonic International Center" created by the WCRC.

The WCRC "Supersonic International Center" united such large universities as Lomonosov Moscow State University and Moscow Aviation Institute (National Research University).

Thus, the WCRC "Supersonic International Center" conducts research in the field of ensuring the safety of the flight of a supersonic passenger aircraft, including the intellectualization of control, the development of an integrated multimodal information and control digital field of the aircraft cockpit using artificial intelligence, technical vision, and augmented reality technologies. The implementation of the research results will improve the level of flight safety, automation, and intellectualization of the control of the aircraft and air traffic.

In addition to fundamental scientific and applied research in the field of digitalization, another important aspect of the accelerated digital transformation of the country is the training of scientific personnel. This area of science and technology requires highly qualified specialists. The WCRC is also working in this direction. Thus, by 2025, the WCRC "Advanced Digital Technologies" plans to develop 57 new educational and research programs in the field of advanced digital and intelligent manufacturing technologies for undergraduate and graduate students. The WCRC "Center of Photonics" will develop 36 new educational and research programs. In general, for the programs of both WCRCs, 3748 people are to be trained for 2020–2025, which will further replenish the country's human resources potential.

Many scientific results obtained by the centers during the implementation of their programs will be commercialized in the near future. The WCRC has already concluded several agreements with representatives of the business community to implement the results of their work.

47.4 Conclusions

Thus, the universities participating in the centers significantly contribute to research and development related to digitalization, the use of artificial intelligence, and new materials and technologies in the field of working with large amounts of information.

The results of the universities participating in the creation of the centers can affect the digital transformation of all priority sectors of the country's economy, including automotive, engine building, aviation, health care, mining, manufacturing, transport and energy infrastructure, agriculture, etc. One of the main drivers of such a transformation can be the technology of digital twins, which is being developed within the framework of the WCRC "Advanced Digital Technologies" and the WCRC "Digital Biodesign and Personalized Health Care."

Nowadays, the "digital twin" technology is one of the most active areas of digitalization and is a collective technology based on cloud storage, the Internet of Things, and machine learning. Among the many advanced digital technologies, the digital twin technology is an integrator technology of almost all end-to-end digital technologies, such as new manufacturing technologies, virtual and augmented reality, wireless communication technologies, robotics components, artificial intelligence, distributed ledger systems, and most advanced subtechnologies. Compared with traditional approaches, the development of products based on the "digital twin" technology can reduce time, financial, and other resource costs by up to ten times or more, which will allow for the digital transformation of priority sectors of economic development and bring Russian companies to international markets [1].

Additionally, in the era of the influence of the "green agenda" on the global economy, the ongoing research of the WCRC "Center of Photonics" is particularly important. A unique, unparalleled device for measuring ultra-low impurity concentrations in quartz glasses for crucibles, in which silicon is melted for large integrated circuits and solar batteries, created within the framework of the WCRC, occupies a special place. This will allow for further glass cleaning, which, in turn, will lead to the development of technologies for the production of large integrated circuits and the improvement of the parameters of solar cells.

In continuation of the "green agenda," as well as in the context of the country's food security, the ongoing research within the framework of the WCRC "Agrotechnologies of the Future" is of utmost importance, which will accelerate the digitalization of processes and systems in the agro-industrial complex.

The model of association in the form of a consortium chosen by the WCRC participants allowed connecting industry scientific organizations with leading universities of Russia, thereby ensuring a synergistic effect in the field of digital technologies.

Further, development of universities participating in the centers will significantly contribute to ensuring a technological breakthrough in Russia, which will be based on digitalization, the introduction of advanced technologies related to artificial intelligence, and the processing of large amounts of information.

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Conclusion

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The transition to a new model of development of economic systems – the AI economy – has been marked not only by breakthrough technological trends, opening up new opportunities for the socio-economic crisis, but also by new crises. The COVID-19 pandemic and subsequent crisis, which led to social distancing and lockdowns worldwide, dramatically increased the demand for smart technology and supported the latest technological trends such as Internet commerce, digital finance, distance learning, e-government, and telemedicine. Nevertheless, in the fight against the viral threat, the countries of the world faced a shortage of funding for the AI economy, which is forced to refocus on private investment and self-sufficiency.

The international sanctions crisis, which escalated in 2022, disrupted global high-tech value chains, endangering the current technological trends. To support them, countries are forced to concentrate new value chains in domestic economic systems and rely on high technology of their own production. Violation of the international division of labor inevitably reduces the efficiency of the AI economy and hinders its development.

The global energy crisis that broke out in 2022 also considerably impacted the AI economy. The rise in world energy prices has significantly reduced the investment appeal of high-tech projects, most of which involve automation and are, therefore, associated with the increased energy intensity of the economy. In this regard, the AI economy must refocus on energy-intensive technology.

Thus, resilience to crises forms the basis for the future development of the AI economy. The review of international experience in this book outlines the latest

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technological trends in the AI economy and identifies the prospects for socio-legal and business adaptation to them. Simultaneously, the book revealed a significant exposure of the AI economy to crises of various natures and unpreparedness to deal with them. In this regard, it is proposed to devote further scientific research in the continuation of this book to the study of issues of resilience to crises of the AI economy.