Lecture Notes in Networks and Systems 1552

Valentina Vycheslavovna Mantulenko
Jakub Horák
Jiří Kučera
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Proceedings of the International Scientific Conference "Digital Future: Science, Education, and Innovative Development of Socio-Economic Systems"

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Lecture Notes in Networks and Systems 1552

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Digital Transformation of Science and Research

Applying BERT Language Model to Medical Data to Detect Drug Side Effects

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Abstract. The contribution is devoted to the application of the BERT language model for the analysis of drug data in order to identify side effects described in the instruction texts. The work focuses on the problem of text data extraction using named entity extraction methods, which allows for more accurate identification and classification of side effects. A drug database is used as an example, which demonstrates the practical significance of the study. The stages of data preparation and preprocessing required for model training are described in detail. The authors consider the adaptation of BERT for the analysis of medical instructions, which enables the effective identification of drug side effects. The study includes the analysis of the text description of instructions and the identification of similarities in the side effects of various drugs. The BERT-based model is capable of rapidly processing and analyzing large volumes of text information, which significantly simplifies the process of extracting data on side effects from instructions. The results of the work emphasize the potential of using modern language models in the field of medicine and pharmacology, opening up new horizons for the automation of medical text analysis.

Keywords: Language Model · Named Entities · Side Effects · Test Medical Data

1 Introduction

Medicines have become an integral part of everyday life. Almost every home has a box with various medicines. Some people keep only the most necessary drugs at home. Others try to have a supply for a variety of occasions. Most often, medicines are prescribed by the attending physician. According to the Federal Law of the Russian Federation «On the circulation of medicines» [1], doctors are obliged to warn patients about the harmful effects of drugs. The quality of information provided to the patient about the use of drugs is no less important than the quality of the drugs themselves. The effectiveness and safety of the drug will depend on how reliably and, at the same time, understandably the patient is informed. It is very important for a person to make the right choice when taking drugs, regardless of whether the drug is prescribed by the attending physician or not. This is determined by the fact that the medicine can get not only a therapeutic effect, but also a side effect from its usage.

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In order to protect himself from the consequences of taking a drug, a person first reads the instructions for use of a medicine, and then decides whether to use this drug or not. In some situations, there is a need to take several drugs prescribed by the attending physician, and then you will have to study not one instruction, but two or more. Studying the instructions for one drug takes from 10 to 15 min. The complexity of the action is that the information on side effects is distributed in several blocks, written in small print and there is a lot of it. A certain level of knowledge is required to correctly interpret pharmacological information. If a person does not have special knowledge in the medical sphere, then even a couple of hours will not be enough to decipher it. According to research, when evaluating a chaotic set of letters, the volume of perception is approximately 5–7 elements or approximately four related words that form a phrase. If a person studies the instructions for two or more drugs, this further complicates the task of finding, analyzing and comparing side effects from drugs [2].

The potential danger of drug interactions is that the combined use of different drugs can lead to unwanted effects, deterioration of the patient's health, or even critical conditions [3]. Mortality from side drug reactions is the fifth most common cause of death in the world after cardiovascular, oncological, lung diseases and trauma [4]. In 2023 alone, 5,000 people in Russia suffered severe complications after taking medications, of which 79 were fatal. The use of neural network-based recommendation systems can affect these statistics. The research purpose is to create a neural network that will analyze instructions for medical use of drugs and identify side effects using the pre-trained BERT language model.

2 Methodology

An important aspect of this study is the use of data processing algorithms and the Named entity recognition (NER) approach to identify named entities. Unlike most existing works, which are often limited to extracting features directly from classified entities and pay insufficient attention to context, the approach in this work will be aimed at a deeper understanding of texts. This will allow taking into account not only the entities themselves, but also their interrelations and contextual characteristics. Thus, the proposed approach to the study of side effects in drug instructions is distinguished by an emphasis on the use of modern language models.

3 Literature Review

N.Yu. Antonova [5] has empirically proven that consumers of medicinal products rarely read the text of medicinal product instructions in full. Reading is selective, and from a substantive point of view, the most informative and frequently read sections are «method of administration and dosage», «indications», «contraindications», «side effects». This study also confirms that the problem is relevant and requires more in-depth investigation. M. Zitnik, M. Agrawal and J. Leskovec [6] rely on the concept of a knowledge graph. In this graph, the vertices represent different entities, and the edges denote the relationships between these entities of different types. The relevance of this approach lies in the fact that polypharmacy, that is, the simultaneous use of several drugs, can lead to

complex interactions and side effects that are difficult to predict. This study highlighted the relevance of the topic, but at the same time the complexity and ambiguity of predicting side effects. I.S. Alimova and E.V. Tutubalina [7] present an experimental study devoted to the comparative analysis of various neural network models in the context of the problem of classifying side effects at the entity level in English-language texts. This area of research is relevant since side effects of drugs are a significant problem in the field of medicine and pharmacology, requiring effective methods for their identification and classification.

4 Results

The BERT model, known for its ability to understand language contextually, was chosen as a basis for this study. Small language models, despite their widespread use in modern smart devices, have received significantly less academic attention compared to their large language model counterparts, which are mainly deployed in data centers and cloud environments [8]. The selected model was further trained on a specialized dataset containing information on drug side effects. The data was preprocessed to use the Named entity recognition (NER) approach. The data was obtained by request on the website of DrugBank [9]. The obtained data were presented in *.xml format (Fig. 1).

```
<?xml version="1.0" encoding="UTF-8"?>
<drugbank xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
<drug type="biotech" created="2005-06-13" updated="2024-01-02">
  <drugbank-id primary="true">DB00001</drugbank-id>
  <drugbank-id>BTD00024</drugbank-id>
  <drugbank-id>BIOD00024</drugbank-id>
  <name>Lepirudin</name>
  <description>Lepirudin is a recombinant hirudin formed by 65
&#13;
```

Fig. 1. Presentation of data in *.xml format (Source: authors).

In order to use them conveniently in training the model, they need to be converted to the *.csv format. The program code is written in the Python programming language, version 3.12. The working code uses several files: drugs-full.xml is the input XML file from which drug data will be extracted, and drugs-full.csv and drugs-bio-full.csv are the output CSV files to which the processed data will be written. The loop goes through each element <drug> in the root XML element and extracts data on side effects. Several stages of data preprocessing were performed: 1) extracting the name and toxicity of the drug; 2) converting to lowercase, 3) cleaning toxicity from unnecessary characters: toxicity is also converted to lowercase and cleaned from unnecessary characters using regular expressions. According to the methods of extracting named entities, the training dataset was converted to the format: *B* – *I* – *O*. The data is divided into sentences. Sentences are divided into individual words and written in a column, one word per row. Each word is assigned a label: *B* – this label means that the word is either a single-word entity name or the first word in a multi-word entity name; *I* – this label means that the word is part of a multi-word entity, but is not the first word in the full name of the entity; *O* – this label means that the word is not part of an entity [10] (Fig. 2).

```
B-SIDE_EFFECT,rapid
I-SIDE_EFFECT,blood
I-SIDE_EFFECT,loss
O,after
O,the
O,subcutaneous
O,administration
O,of
O,lepirudin
```

Fig. 2. Assigning labels (Source: authors).

The data is transformed so that it can be placed in a two-column table. The Pandas library is used. The first column Word contains all the words from the presented instruction text, and the second column Labels contains the labels (Fig. 3).

```
pd.DataFrame({"Word":sentences[0],"Labels":labels[0]})
```

	Word	Labels
0	no	O
1	studies	O
2	assessing	O
3	the	O
4	mutagenic	O
...	...	...
76	not	O
77	indicate	O
78	pancreatitis	B-SIDE_EFFECT
79	fda	O
80	label	O

Fig. 3. Presenting data in a table (Source: authors).

The BERT language model has been retrained and adapted to analyze instructions for medical use of drugs to identify side effects in the instruction text. This improves the quality of text processing and increases the accuracy of side effect classification. BERT is a transformer model pre-trained on a large corpus of English data in self-supervision mode. This means that it was pre-trained only on raw texts, without any labels.

The BertTokenizer class from the transformers library is used, which provides tools for working with models based on the BERT architecture (Fig. 4). An instance of the BERT tokenizer is created and the pre-trained bert-base-uncased model is loaded. This model is case-insensitive (i.e. all letters are converted to lowercase).

```
from transformers import BertTokenizer
import numpy as np
tokenizer = BertTokenizer.from_pretrained('bert-base-uncased')
✓ 2.3s
```

Fig. 4. Using the BertTokenizer in code (Source: authors).

Method *from_pretrained* loads a tokenizer that has already been trained on a large set of texts. This allows it to be used to transform texts into tokens, which can then be fed to the BERT model. Tokens are units of text that can represent words, subwords,

or characters. Tokens are converted to numeric indices corresponding to the model's dictionary. On the first run, a warning was received from the system that the length of the token index sequence is greater than the specified maximum sequence length for this model (595 > 512). After the transformations, the maximum length of 365 tokens was obtained, which allows us to avoid system error warnings and continue preparing the data for further exploration. Handling special tokens includes adding special tokens, such as [*CLS*] for the beginning of a sequence and [*SEP*] for separating sentences. The distribution of sentences and their lengths is presented in the graph (Fig. 5).

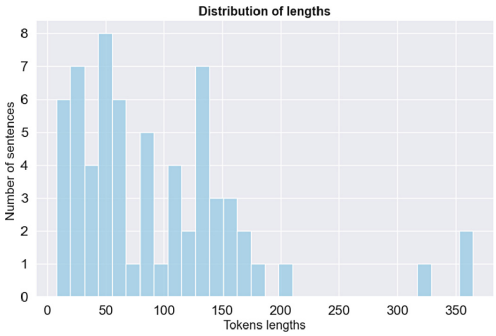


Fig. 5. Distribution of sequence lengths (Source: authors).

It is worth noting that what is considered as a sentence here is a consecutive stretch of text, usually longer than a single sentence. The only constraint is that the text stretch has a total length of less than 512 tokens [11]. The Padding token [*PAD*] is included in the input data to ensure that all sentences are of the same length. Two datasets were used to train the model: test_drugs-bio and traine_drugs-bio. The test_drugs-bio training set is split 90 to 10. The loss function reached a value of 0.01 in the last iterations (Fig. 6).

A loss value of 0.01 indicates that the model is well trained and has high accuracy on the training dataset. The best results were achieved at 20 epochs. Figure 7 presents a graph of the change in the loss function during the training stage.

At the model testing stage. Metric (1) showed an accuracy of 94.44% according to the scikit-learn documentation [12]:

$$F1 = \frac{2 \cdot TP}{2 \cdot TP + FP + FN} \tag{1}$$

where *TP* is the number of true positives, *FP* is the number of false negatives, and *FN* is the number of false positives.

The function receives two arrays as input: *real_toket_labels* is the array of original correct labels and *real_token_predictions* is the array of predicted labels. The parameter shows that the total number of true positives, false negatives, and false positives is used in the calculations. The calculation of the F1-score metric is presented in the code below (Fig. 8).

This result shows that when processing the text of the instructions for a medicinal product, the model identified words and phrases corresponding to side effects in 95.45% of cases.

```
======== Epoch 1 / 20 ========
Training...
  Average training loss: 0.85
======== Epoch 2 / 20 ========
Training...
  Average training loss: 0.44
======== Epoch 3 / 20 ========
Training...
  Average training loss: 0.30
======== Epoch 4 / 20 ========
Training...
  Average training loss: 0.21
======== Epoch 5 / 20 ========
Training...
  Average training loss: 0.17
======== Epoch 6 / 20 ========
Training...
  Average training loss: 0.13
======== Epoch 7 / 20 ========
Training...
  Average training loss: 0.11
======== Epoch 8 / 20 ========
Training...
  Average training loss: 0.09
======== Epoch 9 / 20 ========
...
  Average training loss: 0.02
======== Epoch 20 / 20 ========
Training...
  Average training loss: 0.01
```

Fig. 6. Values of the loss function at each training epoch (Source: authors).

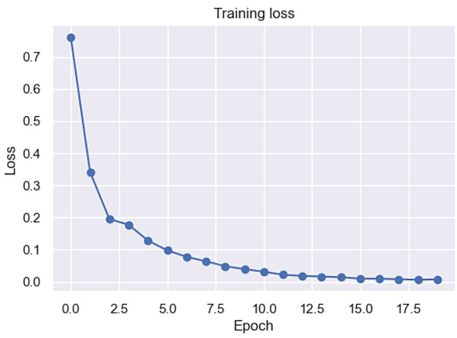


Fig. 7. Graph of the change in the loss function (Source: authors).

```
from sklearn.metrics import f1_score

f1 = f1_score(real_token_labels, real_token_predictions, average='micro')

print ("F1-score: {:.2%}".format(f1))
```

✓ 0.0s

```
F1-score: 95.45%
```

Fig. 8. Calculating the F1-score metric (Source: authors).

5 Conclusion

In this work, a neural network is adapted that analyzes instructions for medical use of drugs and identifies side effects using the BERT language model, retrained on medical data. The accuracy of the model is 95.45%. Based on this model, it is possible to create a recommendation system for both patients and doctors, which will optimize the process of prescribing drugs, speed up the diagnosis of side effects, reduce the risk of improper use of drugs and improve the overall safety of treatment.

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Small-Format Text as a Product of Digital Technologies

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Abstract. This study examines the rise of small-format texts in contemporary digital communication, a phenomenon driven by the pervasive influence of digital technologies. The shift towards brevity and conciseness in textual communication is evident across various online platforms, from social media to instant messaging. This paper explores the typological features of small-format texts, emphasizing their unique characteristics and the underlying mechanisms that enable effective communication within limited textual space. Key typological parameters of small-format texts include visual integrativity, minimized explicit plans, and mobility of linguistic norms. Visual integrativity refers to the ability to perceive the entire text at once, fostering a synergistic effect where all elements contribute to a unified semantic construct. Minimizing the explicit plans involves employing linguistic compression techniques and creating multi-layered structures to convey complex information efficiently. The mobility of linguistic norms reflects a tendency towards simplification and colloquialization, enhancing expressiveness while reducing the need for extensive verbalization. The analysis reveals that small-format texts exhibit an asymmetry between expression and content, where each element carries a high semantic load. Polycode character is another significant property, with non-linguistic elements playing a crucial role in constructing the textual semantic level. The examples from online literary formats and scientific abstracts illustrate how small-format texts can convey rich meaning within minimal linguistic resources. The study concludes that modern communicative conditions necessitate the re-evaluation of traditional textual norms, highlighting the emergence of small-format texts as a qualitatively new textotype adapted to the demands of digital culture.

Keywords: Communication · Digital Technologies · Linguistic Economy · Polycode Character · Small-Format Text · Text Typology

1 Introduction

Within the framework of the communicative approach, text is recognized as both the means and the unit of human communication. This is particularly pertinent in the digital age, when all types of communication can be conducted in text format. We can now talk about the emergence of a special type of text in real speech practice: small-format text (SFT), which takes various forms.

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The tendency to reduce the volume of communication segments in the modern communicative space, as well as the high qualitative and quantitative representation of small text formats, suggests the existence of common mechanisms for implementing pragmatic tasks with a small number of linguistic means organized in a compact textual space.

Despite the fact that the set of universal, basic criteria of textuality, understood not as immanent properties of the text, but as a flexible set of prototypical textual features, has been sufficiently developed, the identification of typological features of small-format texts, as well as the systematization of the whole variety of small textual formations of modern English, seems to be an urgent and not yet solved problem. The present study aims to identify and systematize the key typological parameters inherent in small-format texts as a topical format for designing speech-thought units.

2 Methodology

The empirical base of the study was made up of modern English texts, limited in terms of volume. These multi-genre texts belong to various discourse areas. In particular, the corpus includes media, scientific, journalistic, official business, and fiction discourse, as well as colloquial speech in the form of comments on various electronic platforms and social networks. The total volume of the corpus is approximately 5 000 textual units. The methodological basis of the research is a set of analytical methods, such as the method of empirical observation, the method of systematization, the method of analytical description, as well as the method of discourse analysis of text samples.

3 Literature Review

It is widely accepted that dynamism and changeability of the social environment are key characteristics of the modern world. As C. Vidal and F. Heylighen [1] rightly note, '…in our accelerating society, everything is changing faster and faster, even the change itself'. Researchers unanimously recognize the development of digital technologies and the transition of many social processes into an electronic format as determining factors in this acceleration of life.

Changes in the external environment determine various transformation processes that are relevant for both society as a whole and each of its members [2–4]. Human communication and language as the primary means of its actualization are highly sensitive to such processes and reflect them accurately. Consequently, the communicative system's obvious reaction to societal changes is the activation of the principle of linguistic economy [5]. Today, everything in the communication process is subject to reduction. Whereas people used to exchange letters and talk on the phone in the recent past, nowadays interpersonal interaction takes place via different kinds of messengers with minimalistic notes such as OK, BRB, TNX and OMG. Whereas people used to read newspapers, magazines and books in their leisure time, nowadays they browse news feeds with little or no time to read texts. In terms of literature, comics are very popular and, instead of reading lengthy classical works, people prefer listening to 'retellings in five minutes' [6, 7].

From a semantic and pragmatic point of view, it is clear that the volume parameter of a communicative unit is not just a mathematical value expressed as an absolute number of signs, symbols, words, or lines. Rather, it is the most important factor affecting the structure of the text, the selection of linguistic units, the formation of sense, and the meaning of the entire text.

At the same time, the opposite is also true: through language and small text forms, we influence cognitive processes, the categories we think in and how we express our intellectual and emotional content verbally. In this regard, it is crucial to understand and apply the pragmatic and communicative opportunities that small-format texts offer, while also overcoming the limitations imposed by this format.

The notion of 'small-format text' (SFT) has now taken its place in the conceptual and terminological apparatus of language research. It is understood as a special type and a productive model that determines the functional and structural features of specific texts with various thematic content [8]. In other words, SFT is a more general phenomenon in relation to speech genres, and it unites diverse formats belonging to different discourse segments, such as anecdotes, horoscopes, weather forecasts, advertisements, news reports, scientific synopses, various kinds of annotations and announcements, short literary works, and many others. At the same time, it is clear that all SFT representatives have a number of characteristic features in common and fulfil similar pragmatic tasks due to the compressed textual volume and limited linguistic means.

4 Results

One of the main issues that arises in discussions about SFT is the question of volume; that is, how short should a text be to be considered small-format? Different researchers offer different criteria for determining this parameter, as well as different units of measurement. These include the number of printed characters [9], words [10], lines [11], syntactic constructions [12], information blocks [13], and even the time taken to read the text [14]. In our opinion, the concept of visual integrativity is the most appropriate limiting factor. In other words, a small-format text should be visible in its entirety at once. Thanks to this integrity, there is a synergetic effect in which all elements of textual architectonics work simultaneously and cumulatively to influence the formation of an integral semantic construct.

The second typological parameter of SFT involves minimizing the explicit plan of the text by employing classical methods of linguistic compression alongside the creation of multi-layered, concentric structures at all levels of text organization. This mechanism can be manifested, for example, through the non-linear arrangement of structural elements or by connecting additional structural blocks to the text (e.g. by following electronic links) and so on. At the semantic level, multilayeredness is achieved by actualizing a small number of semantic dominants within the text that appear repeatedly in different text blocks. These dominants form a kind of mental focus around which a large amount of non-verbalized information is built.

The text, posted on the International Monetary Fund's website [15], can be used as an example of the above-described mechanisms. In this sample, the main semantic dominant is verbalized in the headline (*What does the **IMF do**?*). Then, within the subheading,

the verbal operators *foster* and *international financial stability* are introduced, thereby expanding the initial semantic meaning of the dominant. The text is then built non-linearly, with three iconic components involved in creating the semantic combinations; that is to say, the information conveyed through visual symbols is incorporated into the system of meanings. In this case, the captions accompanying the images are perceived as secondary elements of the textual structure in relation to the illustration, although formally it is them which make the part of the syntactic construction forming the whole sentence (including the subheading and the captions under the pictures):

The IMF fosters international financial stability by offering: policy advice, financial assistance, capacity development.

The following verbal information is then embedded into a system of meanings that can be expanded by clicking on the *Learn more* link.

As a result, a multilayered telescopic structure emerges. The verbal minimalism of this structure does not prevent the formation of a complete semantic construct.

This example also illustrates another integral property of small-format texts: **the asymmetry between the expression and content plans**. This gives absolutely all elements of the expression plan a high semantic load, that is literally every element within the SFT carries a semantic load and contributes to the overall construction of textual sense. As a rule, it also aquires additional meanings. For instance, the following mini-story in online literary format is realized verbally using only six lexemes: *Table for one, martinis for two* (Six Word Stories [16]). Nevertheless, this story contains an almost unlimited set of interpretative possibilities; on the basis of these six lexemes, the reader can infer semantic components such as the setting, the protagonist's age and gender, the cause of their loneliness, and the emotional undertone.

The next significant property of the small-format textotype is its **polycode character**. Due to the brevity of the textual explicit plan, the functional load of linguistic elements is transferred to the means of other semiotic systems. Even in the abstracts of scientific articles, italics are used as a paragraph-level means to set semantic accents. In advertisements, instructions for household appliances, memes, news reports and so on, iconic components play a significant role in text semantics and become an integral tool for constructing the sense of the SFT.

Another integral property of texts of small volume is **the mobility of linguistic norm**, manifested in the tendency to simplification and colloquialization of the verbal expression plan. In the format of a small text, shorter and at the same time more expressive lexical and syntactic elements of the colloquial register contribute to the harmonious addition of emotional and evaluative meanings without the need to verbalize this semantic layer, which also leads to the reduction of the explicit plan of the text without loss of semantics.

To illustrate this thesis, here is an abstract to an article in the scientific publication *English Today*, indexed, in particular, in the *Web of Science* database:

A student ***hovers over*** *red-underlined text,* ***clicks a button****, and* ***watches her errant writing replaced****. The red line disappears. She continues typing, pausing to address the flagged words and phrases. When she stops typing,* ***what appears before her is spotless*** *– its* ***errors coded out of existence*** *by a modern grammar checker.* ***Her teacher may never***

become aware *of the artificial intelligence that has augmented her writing production.* ***She submits her paper*** [17].

It is well known that scientific discourse is one of the most strictly regulated forms of discourse, and the strict adherence to linguistic norms and a neutral style of presentation is required. In the presented abstract, however, there is a violation of normative requirements and an approximation of the textual style to the colloquial register. This is evident through the use of short, simple sentences (e.g. *The red line disappears. She submits her paper; hover over; click a button; modern grammar checker; spotless; errors coded out of existence; she; her; may never become aware of*). Thus, there is a clear shift in the norm, resulting in an increase in expressive meaning within the semantic structure of the discourse construction.

5 Conclusion

Analysis of the material has shown that modern communicative conditions, mainly determined by the spread of digital technologies, create the prerequisites for significant changes in the way speech and thought are expressed. These changes directly affect the text, which is the primary unit of communication. In particular, the quantitative aspect of communicative fragments, namely texts, is undergoing a systemic transformation. Consequently, a qualitatively new textotype emerges: the small-format text. This new type of text has a number of typological features due to the need to fulfil a pragmatic task within limitations of the textual space and the number of linguistic resources available.

The set of the most significant typological parameters of the small-format text includes the following components: the small volume of the text and its visual integrativity, compression of the verbal plan and creation of 'multi-layered' structures, actualization of a limited set of semantic dominants, asymmetry of the expression and content plans, a polycode character and transposition of semantic load onto elements of other semiotic systems, a shift in linguistic norms towards a more expressive colloquial register. Thus, we can conclude that the global semantics of SFT are formed through the complex, multidimensional interaction of all textual architectonic elements, with holistic visual perception playing a consolidating role. The pragmatic efficiency of short texts is achieved by reducing the content to the minimum necessary set of semantic dominants and transferring a significant part of the content to the level of implication. Additionally, a specific method of compressing the surface structure of texts involves creating 'multilayered' structures. The transfer of some content to elements of other semiotic systems, as well as the tendency towards colloquial style, are also typological features that characterize small-format textual formations in modern English. These features enable texts of limited physical length to effectively facilitate communication in the current socio-cultural context.

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Information Model in Making Investment Decisions at the Enterprise

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Abstract. Strengthening the technological and production sovereignty of Russia cannot be achieved without implementing investment projects. Various alternatives are considered to select projects. In the process of comparing alternative investment projects, management makes a decision. This requires relevant information. In this regard, a scientific problem arises about the need and expediency of determining not only methodological approaches to the composition of information for making an investment decision, but also tools for collecting and summarizing it. The research purpose is to determine and present the information component for making an investment decision in the form of a model that includes an integrated set of accounting information on the external and internal environment, analytical and evaluative information on investments. The paper analyzes theoretical and practical results on the use of methodological approaches and tools in forming an information field in the process of making an investment decision. It was revealed that at present, an integrated approach to the composition and use of the entire information component in the process of making an investment decision has not been sufficiently studied. The composition of integrated data, including accounting, analytical and evaluative information, is proposed. Recommendations for its use in the practice of making investment decisions at the enterprise have been developed.

Keywords: Accounting Information · Analytical and Evaluation Information · Enterprise · Information Support · Investment Decision · Model

1 Introduction

The economic sanctions imposed by the collective West against the Russian Federation have led to the fact that in the modern history of Russia a sharp turn towards technological and industrial sovereignty was required. The current situation required the Russian Government to take significant and rapid steps related to changing the investment climate, developing a number of state investment programs and projects. Growth of industrial production cannot be achieved without implementing a whole pool of investment projects. The task is to ensure accelerated growth of the manufacturing industry, to increase capacity in a short time, to create new production lines. The key issues here are the availability of raw materials, developments and technologies, equipment and

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investments. When choosing investment projects, various alternatives are considered. This cannot be done without a certain array of information data. In this regard, there is a scientific problem in determining methodological approaches both to the composition and sources of information for making an investment management decision, and to the tools for processing this information. A lot of researchers have devoted their works to this issue [1–7]. It should be noted that to date, an integrated approach to the formation of an information space that includes accounting, analytical and evaluation information for making investment decisions by an economic entity, based on existing and possible risks in the external and internal environment, has not been sufficiently represented in studies.

2 Methodology

The study was conducted using general scientific systems and complex approaches. Special methods and techniques were used: sampling, grouping, systematization, generalization. Scientific literature on management, accounting, analysis and evaluation of investments in the real sector of the economy was used as materials. The website of the Federal State Statistics Service was used as open sources. Industrial enterprises of the Russian Federation served as the experimental base for the study.

The study was conducted in several stages: 1) study of investments of industrial enterprises of manufacturing industries in Russia over the past five years; 2) determination of the composition of information for making an investment decision at the enterprise; 3) presentation of the information component for making an investment decision in the form of a model; 4) development of practical recommendations on the use of information flows by management in making managerial investment decisions.

3 Results

Enterprises of the extractive and manufacturing sectors of the economy play an important role in achieving technological and production sovereignty. To solve the tasks set, it is necessary to invest in fixed capital. A study of statistical indicators for the last five years, presented in Table 1, allowed us to draw the following conclusions.

The share of investments aimed at reconstruction and modernization in the total volume of investments in fixed assets by type of economic activity for the period 2019–2023 is in a constant range from 14 to 15%. If we analyze the indicators for individual branches of manufacturing industries, the largest share is in metallurgical enterprises from 20 to 27%, the smallest – in the production of machinery and equipment not included in other groups (10–13.4%). In the investment process, when choosing a project, an enterprise makes an investment decision based on the results of an analysis of alternative investment projects, relying on possible external and internal risks. Information is needed to make investment decisions. The conducted study made it possible to present the information array in making an investment decision in the form of a model (Fig. 1).

The proposed information model is a graphical scheme of information integration, which describes the main parameters for making investment management decisions. First, the requirements of regulatory legal acts on investments adopted by all levels of

Table 1. The share of investments aimed at reconstruction and modernization in the total volume of investments in fixed capital by type of economic activity in Russia for 2019–2023, %.

Indicator	2019	2020	2021	2022	2023
Total for the surveyed types of economic activity	14,7	15,7	14,6	13,7	14,6
Production of coke and petroleum products	18,3	18,4	14,0	14,4	15,3
Production of chemicals and chemical products	17,0	14,1	15,0	14,4	14,4
Metallurgical production	27,1	24,2	20,5	23,6	20,5
Production of machinery and equipment not included in other groups	10,0	12,2	13,4	11,1	11,0

Source: author based on [8].

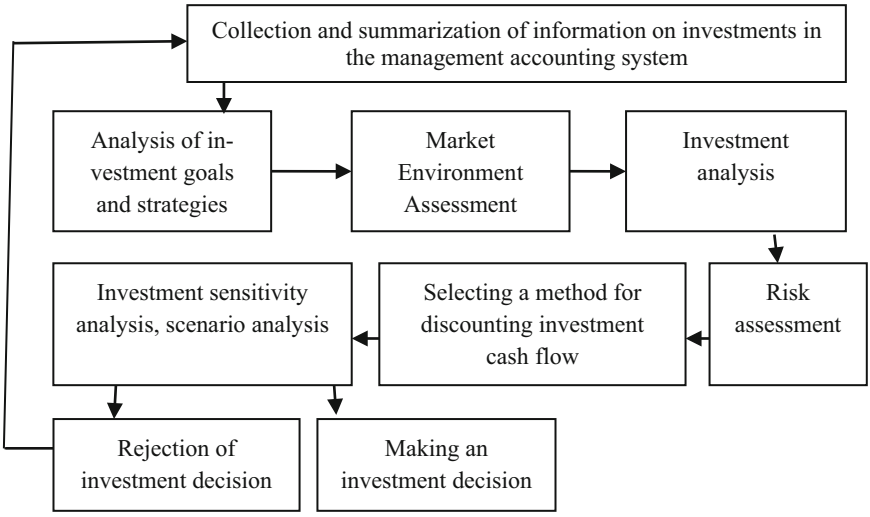


Fig. 1. Model of information system in investment decision making (Source: author).

government are summarized. This is done to analyze and assess the investment climate in the territory of federal subjects or municipalities. Next, the market environment is assessed. In this case, current trends and forecasts for the industry are analyzed, which in turn helps to determine potential opportunities and threats to investment, the competitive environment is analyzed, from the point of view of the advantages and disadvantages of the enterprise in comparison with competitors. Strategic goals for the development of the enterprise are determined in conjunction with their financial and production capabilities. Based on the analysis of the goals and strategies of the enterprise, the main criteria for investment policy and a list of investment projects are developed.

As part of the investment analysis, the profitability of projects is calculated and assessed, the cost and structure of capital are analyzed, the relationship between the expected profitability and the risk level of the project is assessed. An assessment of organizational, technological, financial, and regulatory risks for planned investments

is made. After that, the discounted cash flow method is selected using the following indicators: net present value (NPV), internal rate of return (IRR), profitability index (PI), modified internal rate of return (MIRR).

Investment sensitivity analysis and scenario analysis are used to determine how changes in key parameters will affect the results of the planned project. In particular, how the financial and other indicators of the project will change, for example, NPV, IRR, and payback period. The results of such sensitivity analysis are important for making informed decisions regarding the investment project. This may include both adjusting the strategy and searching for additional opportunities to mitigate negative consequences. The collected information allows either accepting the investment project or abandoning it. If a decision is made to implement an investment project, then at all its stages, costs, deadlines are recorded, analyzed, and monitored, and ultimately, the effectiveness is assessed.

4 Discussion

The study of expert assessments of investment objects allowed us to draw a conclusion about their diversity, applied in theory and in practice. Thus, E.S. Sorokina and I.V. Skripina [7] suggest using their ranking based on the method of hierarchical structure analysis when selecting priority investment objects. According to these researchers, the assessment should be based on the following indicators: net present value, profitability index, internal rate of return, discounted payback period, investment attractiveness coefficient and project efficiency. E.G. Sheina and O.T. Astavakulov [6] consider the enterprise as a whole as an investment object. The scientists suggest using an integrated approach to the analysis and assessment of the investment attractiveness of a given object and taking into account changes in the phases of its life cycle and financial position indicators. Researchers consider methodological approaches and management accounting tools as a source of information for assessing and analyzing investments [1, 3–5]. V.V. Kovalev [2] considers analytical information as a source of information for assessing investments in making investment decisions. The results of the study allowed us to conclude that in theory and practice, the composition of information data for making investment decisions is considered in separate blocks, while in the context of business digitalization, it becomes possible to form an integrated set of information, the constituent arrays of which complement each other, and its use increases the efficiency of investment decisions. The proposed recommendations for the creation and use of an integrated data array that includes accounting, analytical and evaluation information allow:

- firstly, in the management accounting system to summarize information about the external environment for the analysis of current trends and forecasts for the industry and territory, and information about the internal environment about investment sources, the state of fixed assets and technological processes;
- secondly, within the framework of investment analysis to evaluate and select investment projects from the alternatives under consideration;
- thirdly, based on the analysis of investment sensitivity, to adjust the strategy and search for the necessary additional opportunities to mitigate negative consequences in the process of implementing an investment project.

Thus, when making an investment decision, the entire complex of information is used: accounting, analytical and evaluation, on the basis of which managers make management investment decisions.

5 Conclusion

Modern geopolitical and economic challenges regarding Russia have set the task of achieving technological and industrial sovereignty. This task cannot be solved without the implementation of investment projects. The choice of an investment object is impossible without relevant information. It is quite relevant to determine methodological approaches to both the composition and sources of information for making an investment management decision, and to the tools for processing this information. This is seen in the use of a comprehensive approach to the formation of an integrated information space that includes accounting, analytical and evaluation information for making investment decisions by enterprise management, based on existing and possible risks arising both in the external and internal environment. The work proposes an information model for making an investment decision, which allows forming an integrated set of accounting information on the internal and external environment, analytical and evaluation information on investments. The use of this information set will increase the efficiency of investment decisions.

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Open Science and Digital Agriculture: Economic Benefits of Data Sharing and Collaboration

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Abstract. Digitalization of the agro-industrial complex is accompanied by exponential data growth, which opens up new opportunities for the application of artificial intelligence (AI) methods and analytics. This article considers the concept of open science in agriculture – the free exchange of scientific data and research results – and analyzes the economic effect of such openness and cooperation. A comparative analysis of the Russian experience and international initiatives aimed at unlocking the potential of data in the agricultural sector is conducted. It is shown that data exchange and the use of AI technologies can increase productivity, efficiency and innovation in the agricultural sector, contributing to the growth of farm profits. In particular, open data facilitates the implementation of advanced agricultural technologies, stimulates the emergence of new digital business models (platforms, ecosystems) and reduces transaction costs. At the same time, risks associated with the protection of data rights and privacy are identified, requiring the development of appropriate strategies and policies. In conclusion, recommendations are provided for agricultural enterprises and government bodies on the use of open science principles for sustainable economic development of agriculture.

Keywords: Agroeconomics · Artificial Intelligence · Collaboration · Data Sharing · Digital Agriculture · Innovations · Open Science · Transaction Costs

1 Introduction

Digital transformation of agriculture is today considered one of the key factors for increasing the productivity and competitiveness of the agro-industrial complex. A lot of data has been accumulated in global practice – from field observations to genomic information – which, if used correctly, can significantly improve decision-making in the industry. The concept of open science implies free access to scientific publications, data and methodologies, as well as active cooperation between researchers, business and the government. In the agricultural sector, the implementation of open science principles means that research results and agricultural data sets become publicly available, which can accelerate the exchange of knowledge and the implementation of innovations. There is growing attention to open data in agriculture around the world: open data sets – from

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weather observations to soil information – are considered a critical resource for the development of the industry [1, 2]. Open data play a key role in the transition of the agricultural sector to the Agriculture 4.0 model and have the potential to transform agriculture, contributing to global food security [1]. Russia has actively joined the process of digitalization of the agro-industrial complex. The state strategy provides for the implementation of the Digital Agriculture project within the framework of the national Digital Economy program, aimed at modernization and increasing the efficiency of the industry through the introduction of digital technologies and platform solutions. A technological breakthrough is expected, which should result in an increase in labor productivity in agriculture by 2030 [3]. At the same time, the concept of open science can enhance the impact of these initiatives, ensuring wider involvement of the scientific community and business in the use of available data. However, the degree of readiness of the industry for such a level of openness and digital interaction remains debatable – relevant questions include the motivation of agricultural enterprises to share data, their competencies in the field of data, as well as mechanisms for protecting the interests of participants in the open exchange of information.

2 Methodology

The aim of the study is to critically assess the economic benefits of implementing open science principles in digital agriculture. It is necessary to analyze how open access to data and collaboration affect innovation and efficiency of agricultural enterprises, whether they lead to the emergence of new business models and cost reduction. Special attention is paid to comparing Russian practice with international experience, as well as identifying the risks (threats to intellectual property, confidentiality, etc.) associated with increased openness. Thus, the study is designed to determine how open data and collaboration can stimulate economic growth in the agricultural sector, and what conditions are necessary to realize their potential.

The theoretical basis of the work is the concept of open science and open data. The open exchange of scientific information is designed to accelerate the dissemination of knowledge and reduce barriers to the implementation of new technologies. International experience shows that data availability can significantly improve the effectiveness of research and innovation: for example, global open data initiatives in the agricultural sector (such as GODAN – Global Open Data for Agriculture and Nutrition) declare that openness enhances private innovation, increases the productivity and efficiency of agriculture [2]. Open data is a key resource of the Industry 4.0 era, and their use in agriculture allows the implementation of AI, cloud services and IoT solutions for precision farming. Thus, freely available weather data, remote sensing data or soil data enable farmers to better plan crops and manage risks, increasing yields and resource efficiency [1]. To assess the economic effects of open science in the agro-industrial complex, a comprehensive methodological approach is used in the work.

An economic and statistical modeling of the impact of open access to data on the production and financial performance of agricultural enterprises was conducted. In addition, a qualitative analysis of several applied cases was performed – digital platforms and ecosystems in agribusiness operating on the principles of data exchange. These cases

allow us to trace what new business models and forms of value creation arise with open interaction between market participants. Additionally, expert assessments were taken into account: interviews were conducted with representatives of agricultural holdings, farmer associations, IT companies in the agricultural sector and the scientific community. This approach ensures a comprehensive consideration of the problem – from the macro level (statistical analysis of the general trend) to the micro level (the behavior of individual firms and projects in an open environment).

The data for the quantitative analysis were taken from open sources: statistics of the Ministry of Agriculture of the Russian Federation on innovative activity, farm efficiency indicators, as well as information on digital projects in agriculture (including regional ones). As part of the qualitative analysis, public materials of successful agrotechnological platforms were studied. Scientific publications from the Scopus and RSCI databases dedicated to the digitalization of the agro-industrial complex and the data economy were used. This methodology made it possible to compare Russian practices with international ones and identify general patterns of the economic impact of open data in agriculture.

3 Results

3.1 Open Data as a Driver of Innovation

The results of the study confirm the significant potential of open data for activating innovation in the agro-industrial complex. A comparison of groups of enterprises actively using external scientific data with those relying only on their own data showed a higher rate of implementation of new technologies and agricultural practices in the former. Open data allows agribusiness, especially small and medium-sized enterprises, to quickly gain access to advanced scientific achievements without the need for large investments in their own R&D. Thus, the conditions of competition are leveled: even small farms, using available data and ready-made analytical models, can implement elements of precision farming, biotechnology, new varieties, etc., increasing their productivity. This conclusion is confirmed by researchers who note that the accumulation of data and digital solutions directly increases the profitability of farms by improving decisions based on information analysis [4]. Moreover, modern AI tools make it possible to process large open data sets and generate practical recommendations for farmers. For example, machine learning algorithms based on open data on soils and climate can predict the optimal sowing and watering times, which leads to increased yields while reducing costs. According to experts, the introduction of AI in agriculture creates a significant economic effect: due to reduced labor costs and more accurate use of resources, yields can increase and costs can decrease. On a global scale, the total value creation from the use of AI in the «field» (due to cost savings and increased yields) is estimated at tens of billions of dollars annually. These figures illustrate what a powerful tool the combination of «open data + artificial intelligence» can be for the agricultural sector.

3.2 New Digital Business Models

An important result of data openness is the emergence of new models of cooperation and agribusiness. Analysis of practice has shown that in the conditions of data exchange,

platform solutions and digital ecosystems that unite different participants in the industry develop most successfully. For example, agricultural online platforms allow farmers, resource suppliers, processors and buyers to share information and material resources. Such platforms act as a central hub where data on supply and demand, prices, weather, technologies are aggregated, and services are provided based on this data – recommendations, forecasts, automated selection of counterparties, etc. The studied cases have established that the platform model in the agro-industrial complex leads to more efficient coordination of the supply chain and a reduction in losses. For example, a platform for the joint use of agricultural machinery (based on the «sharing economy» principle) allows small farms to access modern machinery on a rental basis, which increases their productivity without capital expenditures.

Digital ecosystems cover the full cycle from production to sales: uniting manufacturers, logistics companies, banks, insurance services, etc. on one digital platform, they create conditions for more transparent and rapid interaction. The data circulating in such an ecosystem is available to all participants (subject to access rights), which minimizes the information gap between them. As a result, the speed of response to market changes increases, the level of uncertainty decreases. In addition, thanks to the analysis of large arrays of data, analytical services appear in ecosystems – from forecasting yields and price trends to recommendations for optimizing technological operations on the farm. These services are often offered on a commercial basis, forming a new niche of the agrotech business. It can be stated that open data are becoming the basis for the emergence of a whole range of new products and services in agriculture, which were previously impossible. Russian studies note that the introduction of a digital platform for the distribution of agricultural products can radically change the economic behavior of agricultural producers and bring them additional income, many times exceeding the volume of state support for the industry. In other words, the market value of data and cooperation is already comparable or exceeds the effect of traditional government support measures. This clearly demonstrates the economic feasibility of developing open digital platforms in the agro-industrial complex.

3.3 Reducing Transaction Costs

One of the important economic benefits of open science in the agricultural sector is the reduction of transaction costs – the costs of searching for information, concluding and executing transactions. The availability of up-to-date data and the presence of common digital platforms significantly simplify communication between market participants. In traditional agriculture, a farmer faces high uncertainty: how much his products will cost on the market, where to find reliable buyers or suppliers, what are the weather forecasts, etc. Significant time and resources are spent collecting this information, or transactions are concluded through intermediaries, increasing costs. Open digital platforms make it possible to find out market prices, processor requirements, demand forecasts, bank interest rates and other relevant information in real time. This reduces excess marketing and negotiation costs. Our study found that enterprises that actively use open information systems, on average, conclude transactions faster and with lower costs than those that act in isolation. This is in line with expert findings that digital technologies increase efficiency by eliminating information barriers and significantly reduce coordination costs

[5]. More open data exchange reduces information asymmetry: all participants have a similar level of awareness of the market situation, prices, and innovations. In such conditions, the possibility of opportunistic behavior and the need for lengthy negotiations are reduced, since the information is transparently available. As a result, capital turnover in the industry accelerates – transactions are made faster, contracts are standardized (for example, using smart contracts based on blockchain), and the role of intermediaries is reduced. This is especially important for small businesses, for which high transaction costs were previously a serious obstacle to entering more profitable markets. Thus, open data acts as a «lubricant» for the market mechanism of the agro-industrial complex, making it more flexible and efficient.

4 Discussion

Global experience confirms the identified advantages of open science in agriculture. In the United States, the wide availability of government data has become a catalyst for the emergence of successful agricultural startups. An example is the Climate Corporation, which, based on open government data (long-term weather observations, soil maps, etc.), created risk management services for farmers and increased their profitability [6]. The success of this company (its value reached $930 million by the time it was acquired by Monsanto) shows that open data can be directly converted into economic value, stimulating private investment in agricultural technologies. Initiatives are being implemented in EU countries to combine agricultural data at a supranational level – publicly available data repositories are being created (for example, on plant breeding, genetic resources, agrometeorology), to which farmers, scientists and entrepreneurs from all over Europe are connected. This facilitates collaborations and the emergence of cross-border innovative projects. In developing countries, open data and mobile technologies also have tangible effects: they improve farmers' awareness of prices (reducing abuses by middlemen), increase crop yields by disseminating knowledge of best practices, thereby increasing the income of rural communities. However, international experience also shows the importance of taking local conditions into account. Thus, some researchers note that the promotion of open data in the agri-food sector often comes from a neoliberal paradigm, focusing on market values – private sector innovations, efficiency, individual benefits [7]. At the same time, for small farmers in poor regions, key factors can be collective forms of knowledge sharing, trust and protection from possible external risks. Thus, when borrowing the best global practices, Russia needs to adapt them to its own realities, combining openness with measures to support small farms and taking into account the specifics of the regions.

Despite the obvious benefits, the widespread use of open data faces a number of challenges. In the foreground are the problems of protecting intellectual property and confidentiality of information. For agricultural companies, data on cultivation technologies, agrochemical formulations, genetic material, and even economic indicators may constitute a commercial secret and provide a competitive advantage. It is unreasonable to expect that businesses will voluntarily share all valuable information unless mechanisms are in place to protect against the unfair use of this data. Otherwise, there is a risk that openly provided information may be copied by competitors and used to the detriment

of the initiator of disclosure, which will reduce the motivation of companies to be open. Our study revealed that a number of agricultural company managers are wary of the idea of open data: many express concerns that by disclosing data on their productivity or costs, they may lose their market positions. Another significant risk is the lack of resources and competencies among many agricultural producers to fully participate in digital ecosystems. Small farmers often do not have access to high-speed Internet and also experience a shortage of specialists capable of analyzing data. In Russia, there are only 5 IT specialists per 1,000 workers in the agricultural sector, while in the EU there are about 25 [8]. If this digital divide is not overcome, open science may increase inequality: advanced farms will benefit from the data, while traditional ones will be left behind. Finally, an appropriate legal and organizational infrastructure is needed. Without clear rules for data licensing, standards for their formatting and exchange, without trust between participants, open data cannot be effectively integrated into business processes. It is necessary to think about which data can be open, where anonymization or aggregation is needed, how to ensure cybersecurity in the context of wide access to information systems of the agro-industrial complex. These issues go beyond purely economic ones and require an interdisciplinary approach.

5 Conclusion

The conducted study showed that the principles of open science and digital collaboration have high economic potential for the agricultural sector. Open access to scientific data, their integration with artificial intelligence technologies and the involvement of a wide range of participants can accelerate innovation, increase the efficiency of agriculture and provide additional growth in enterprise income. Open data act as a new production resource, the use of which already brings tangible returns – from increasing yields and optimizing costs to the emergence of new markets for agro-technological services. The Russian practice of digitalization of the agro-industrial complex, in comparison with the international one, is moving in the right direction, but comprehensive support is required to realize the full effect of open science. Agricultural enterprises are encouraged to actively participate in the emerging digital platforms and data exchange networks, using them to increase their productivity and competitiveness. At the same time, it is important to develop internal strategies for managing information risks: determine what data the enterprise is ready to disclose and what to protect, how to monetize its data without losing control over it. Government agencies and scientific institutions, for their part, must provide the infrastructure and legal framework that stimulate the open exchange of scientific data. It is necessary to implement standards for openness of research results, develop public repositories of agricultural data and platforms convenient for small producers, and create mechanisms for protecting intellectual property rights and privacy in the digital environment. Open access to scientific data has already proven itself as an effective tool for stimulating innovation and economic growth in the agro-industrial complex. It is important that this tool is used in a balanced way: openness should be accompanied by trust and responsibility. Only in this case will the agricultural sector of Russia and the world be able to fully benefit from data and digital cooperation, contributing to food security and sustainable development.

This work covers a wide range of issues related to the open data economy in agriculture. A promising direction for future research is an in-depth comparative analysis of international experience in implementing open science in the agricultural sector with a focus on quantifying the effects in different countries. It is also of interest to study the socio-economic consequences of digital interaction in rural areas (e.g., the impact on employment, on the distribution of added value along the supply chain). Special attention should be paid to the development of models for managing rights to agricultural data, which will help find a balance between openness and protecting the interests of agricultural producers. Such research will help develop recommendations on how to most effectively integrate the principles of open science into the practice of digital agriculture for the benefit of the economy and society.

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Research Methodology for the Country's National Economy in the «Circle of Poverty»

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Abstract. Since the basis of the state structure of a country is its national economy, then economic threats to the state structure are formed, when the national economy of a country begins to function in a «circle of poverty». To identify economic threats, which may arise to the state structure and developing preventative measures, first of all, it is necessary to determine the emergence of the «circle of poverty» in the activities of the country's national economy. This work presents the methodology of the study of the emergence of the «circle of poverty» in the activity of the national economy of the country at the stage of declining development rates and stagnation. The methodology (algorithm) of assessing the criteria for the functioning of the national economy of the country in the «circle of poverty» is proposed. A research methodology and evaluation methods were developed using a systematic approach, comparative analysis and methods of economic and mathematical analysis.

Keywords: Calculation Methods · Cyclical Activity · Economic Threats · National Economy System of the Country · State Structure

1 Introduction

The national economy of the country has a cyclical nature of functioning, consisting of stages of development, a decrease in growth rates and stagnation, recession and stabilization. Along with the theories of economic development in Western Europe and the United States in the 20th century, scientific, theoretical and methodological concepts regarding the failure of the country's economic development have been put forward. Scientific research was related to the study of reasons for the failure of self-development of the national economies of «third countries»». The theoretical and methodological foundations of these economic studies were formed in line with three complementary theories: theories of the functioning of the country's economy in the «circle of poverty», the concept of a country's economy «capable of self-development», the theory of «effective impulse» of development of the country's economy. The reasons for the inability of the country's independent development of the economy are explained in the concepts of American scientists [1–3].

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2 Methodology

We believe that research to determine whether a country's national economy operates in a «poverty circle» in a given period T should be conducted in the following sequence.

1. Assessment of the level of incentives for expanding the scale of production.

   Investments in the national economy are measured primarily by the level of profitability φ profit Pk that can be obtained in the future from investments $\dot{I}k$ in fixed capital (in fixed assets). ROI is measured by Eq. (1):

$$\varphi = Pk/\dot{I}k, \tag{1}$$

   The dependence shows the level of profit that can be obtained from each unit of investment directed into the production sectors of the national economy.
2. Low income level.

   The level of national income Gm of a national economy in the «circle of poverty» can be estimated by the ratio of the actual average monthly income per capita Gn to the monthly subsistence minimum $\dot{I}x$. To this end, in the activities of the national economy in the «circle of poverty»:

   1) at the first stage, the level of income per capita in the country per month in real prices is determined by Eq. (2):

$$Gn = Gm/N, \tag{2}$$

      İn the ratio, N is the population of the country.

   2) at the second stage, the level of tax payments Vn per capita in the country per month in actual prices is determined by Eq. (3):

$$Vn = V/N \tag{3}$$

   3) at the third stage, consumer spending per capita per month $Ifxn$ in actual prices is estimated by Eq. (4):

$$Ifxn = \dot{I}fx/N, \tag{4}$$

   4) at the fourth stage, the level of national income Gm created in the country in actual prices is estimated by the structural identity of national income per capita in the country in actual prices, which expresses the levels of tax payments Vn, actual consumer spending $Ixfn$ and accumulated funds Qn saved from national income (Eq. (5)):

$$Gn = \left(a1 \cdot Vn + a2 \cdot \dot{I}xfn + a3 \cdot Qn + \varepsilon\right), \tag{5}$$

      In the structural identity (5): $a1$ shows that part, in real prices, of the national income per capita GN that is taxed Vn; $a2$ shows that part of the national income per capita Gn which constitutes consumer spending; $a3$ shows that part of the national income that is saved and accumulated by each person Qn.

3. Low-level *Im* consumption costs.

   The level of consumer spending of the population in actual prices in the «poverty circle» of the national economy can be assessed by comparing the actual consumer spending of the population per capita in the country with the consumer spending of the population necessary to satisfy the minimum living needs of the population, i.e. (Eq. (6)):

$$\chi = \dot{I}xn/\dot{I}Ixmin, \tag{6}$$

   The relationship presented in Eq. (6) expresses the level of actual consumer spending per capita in the country, providing the consumer spending necessary to satisfy the minimum living needs.

4. Method of assessing speculative price growth.

   The reduction in the total volume of products offered to the market through all commodity-money channels of the national economy, the increase in the money supply and the speculative artificial rise in prices create a state of inflation in the country's economy. The inflation indicator *If* in the country's economy, as a complex function that depends on the total volume of output *Y*, the volume of money supply *M3* available in all monetary and commodity channels in the country's economy, should be assessed taking into account the speculative artificial increase in prices *Sa*, i.e. (Eq. (7)):

$$f = (Y, M3, Sa), \tag{7}$$

   Also, changes in the inflation indicator *ΔIf* in the country's economy from changes in the total output of goods and services *ΔY*, from changes in the money supply indicator *ΔM3* in all monetary and commodity channels in the country's economy and from the speculative artificial rise in prices *Sa* should be studied in the form of a structural identity (Eq. (8)):

$$\Delta \mathrm{If} = (Sa + a1 \cdot \Delta \mathrm{Y} + \mathrm{a2} \cdot \Delta \mathrm{M3} + \varepsilon) \tag{8}$$

   In the structural identity eq. (8): *a1* shows how many units the inflation index *ΔIf* changes when the quantity of goods and services changes by one unit *ΔY*; *a2* – how many units the inflation index *ΔIf* changes when the money supply changes by one unit *ΔM3* in all channels of commodity-money circulation. In the structural identity eq. (8), *Sa* is an indicator of the change in inflation *ΔIf* in the country's economy, not associated with changes *ΔY* of the total output and *ΔM3* of the money supply in all channels of commodity-money circulation, but with the speculative growth of prices for goods and services. The limit ε in the identity expresses the calculation error.

5. Income saving function. After paying the taxes imposed by the government from the national income created in the country, part of the remaining national income is used by the population to pay for consumer expenses, and the rest is saved and accumulated for future use. One of the main provisions of neoclassical economic theory is that after paying taxes *V* and duties to the state budget, as well as consumer spending *Im*, the remaining part of income *Gmq* is saved for future use [3, 4]. Theoretically, the savings function of income *Qm*, like the consumption function *Im*, measured by Eq. (9):

$$\dot{I}m = \left(\dot{I}o + c \cdot Gmq\right) \tag{9}$$

is measured by Eq. (10):

$$Qm = (Qo + s \cdot \text{Gmq}), \tag{10}$$

In Eqs. (9) and (10): c – expresses the propensity of the population to consume; s – expresses the propensity of the population to save: (c + s) = 1 [5].

6. The relation between the consumption function *Im* and the savings function *Qm*.

The functions of national consumption *Im* and saving *Qm* are mutually inversely related functions. In the national consumption and saving functions, the algebraic sum of the marginal propensity to consume c and the marginal propensity to save s is always equal to one, that is Eq. (11):

$$(c + s = 1), \tag{11}$$

In addition to the above, the relationship between the functions of national consumption *Im* and savings *Qm* is defined as follows [6]. In Eq. (10), *Qo* represents the portion of saved income directed toward consumption in the current period when current income does not cover consumer spending *Im* [7]. Studies on the estimation of consumption and saving functions show that national saving *Qm* can be expressed by Eq. (12):

$$Qm = \left\lfloor \begin{array}{c} Gm - V - \dot{I}m) = \left(Gmq - \dot{I}m\right) = Gmq - \left(\dot{I}o + c \cdot Gmq\right) = \\ (-Io + Gmq - c) = \left[-Io + (1 - c) \cdot Gmq\right] = \\ (-Io + s \cdot Gmq) \end{array} \right\rfloor, \tag{12}$$

$$Qm = (Io + s(-Io + s \cdot Gmq),$$

As can be seen from the obtained Eqs. (10) and (12), the indicator *Qo* of the national savings function *Qm* is replaced by the indicator (−İ0) of the national consumption function *Im*. From the obtained condition of equality of the indicators $Qo = (-\tilde{I}o)$, the condition of equality of the indicators $\tilde{I}o = (-Qo)$ similarly follows. The sign (-) represents the sign of economic balance. In this case, the function *Im* of national consumption and the function *Qm* of national savings are expressed by Eqs. (12) and (13):

$$Qm = (Io + s \cdot \text{Gmq}) \tag{12}$$

$$Im = (Qo + c \cdot \text{Gmq}), \tag{13}$$

Equation (13) shows that each unit of growth of national income *Gmq*, remaining after payment of *V* taxes and duties in the period under study, increases consumer expenditures *Im* by the amount c. In addition, when current income does not cover consumer expenditures, part of the saved income $Qo = Io$ in the previous period is directed to cover current consumer expenditures *Im*.

In addition to the above, the obtained dependence eq. (12) shows that each unit of growth of the income *Gmq* remaining after taxes and duties *V* in the period under study increases savings by the amount *s*. In addition, when current income does not cover consumer spending, part of the savings of income $Qo = (-Io)$ for the previous period is directed to cover consumer spending.

7. Investment potential generated in the material production sectors of the national economy.

   The basis of the investment potential $\dot{Ip}$, formed in the production sectors of the national economy, is the saved Qm part of the income of the Gmq. We also believe that along with the saved part Qm of the national income, which forms the basis of the investment potential Ip, which was formed in the sectors of the national economy, when assessing the investment potential Ip, it is necessary to take into account the funds of the depreciation funds of fixed capital Af, calculated according to the standards established by the state and returned to investors. Thus, we believe that the investment potential formed in the national economy can be assessed as Eq. (14):

$$Ip = (Qm + Af), \tag{14}$$

   Thus, we believe that, having conducted a study of the functioning of the national economy of the country using the methodology we have developed, it is possible to assess the results of the country's functioning in the «poverty cycle».

3 Results

Conducting research on the methodology, we developed for analyzing the functioning of the national economy of Azerbaijan for the period 2015–2021 in the «circle of poverty», based on data from the State Statistical Committee of the Republic of Azerbaijan [4, 7], the following results were obtained:

1. Research conducted to assess the level of stimulation of expansion of production scales showed that the average profit per 1.0 ₼(manat) of capital was 0.23 ₼, and annually according to the linear equation (Eq. (15)):

$$\xi = (-0.043 \cdot \mathrm{t} + 1.069), \tag{15}$$

   It decreased on average by (-0.04) ₼. For this reason, investors were not interested in investing in fixed capital to create new production facilities and expand the scale of production.
2. Income level assessments showed that nominal and real per capita incomes were low and did not provide a minimum subsistence level. Studies conducted to assess the level of national income for the period 2015–2021 showed that nominal and real income per capita were below the minimum subsistence level of the population.

   Calculations have shown that in 2015–2021 the average monthly real income per capita in the country was insufficient to meet the minimum required amount of living expenses per month. According to the linear equation (Eq. (16)):

$$\theta = (-0.016 \cdot \mathrm{t} + 0,743), \tag{16}$$

   The subsistence minimum per capita decreased by an average of (-1.6) % per year.

3. Studies of price growth in the market of goods and services have shown that in 2015–2021 the change in the inflation index *ΔIf*, from the change in the total output of goods and services *ΔY*, the money supply *ΔM3* in all channels of commodity-money circulation, as well as from the speculative growth in prices for goods and services *Sa* is expressed by the linear structural equation (Eq. (17)):

$$1,000 \cdot \Delta \mathrm{If} = [0.949 \cdot \mathrm{Sa} + 0.385 \cdot \Delta \mathrm{Y} + (-0.334) \cdot \Delta \mathrm{M3}], \tag{17}$$

Identity eq. (17) means that for 2015–2021 the impact of a change in total output *ΔY* by one unit on the inflation index *ΔIf* was 0.385 units, and the impact of a change in the money supply *ΔM3* by one unit in all channels of commodity-money circulation on the inflation index *ΔIf* was (−0.334) units. The impact of a change in speculative prices of goods and services *Sa* by one unit on the inflation index *ΔIf* was 0.949 units. Thus, as can be seen from the linear structural Eq. (17), 94.9% of the growth in prices for products and services in the consumer market in 2015–2021 occurred due to speculative price growth.

4. It was found that in 2015–2021 the average monthly real income per capita was low, and the minimum monthly consumer expenditure necessary for living was not achieved. The calculations carried out based on the data of the State Statistics Committee of Azerbaijan showed that in 2021, consumer spending in actual prices increased by 2.2 times compared to 2015. It was found that in 2015–2021 average annual consumer spending, according to Eq. (18), increased by an average of 13.4%:

$$i = (0.134 \cdot \mathrm{t} + 1.011), \tag{18}$$

In addition to the above, calculations showed that the consumer function studied in 2015–2021 is expressed by the dependence (Eq. (19)):

$$\dot{\mathrm{I}}m = [(-0.992) + 0.797 \cdot \mathrm{Gmq}], \tag{19}$$

In the dependence (19): c = 0.797 expresses the share of consumer spending in the remaining part of *Gmq* income in the period under consideration, after paying government taxes and duties *B*. Dependency (19) means that when the residual income of *Gmq* changes by 1.0%, the share of consumption spending changes by 0.8%. It was found that the change in the consumption function of the country's population in 2015–2021 is expressed by the dependence Eq. (20):

$$\Delta \mathrm{Im} = \left[0.231 \cdot (\mathrm{Qo}) + (1.000 \cdot \Delta \mathrm{Gmq1} \cdot \mathrm{t} - 0.263(\mathrm{Q}(\mathrm{t}-1))\right], \tag{20}$$

Dependence (20) indicates that during the period under study, the population directed every billion manats of income growth *ΔGmq1* to increase current consumer spending. The population also attracted 0.231(*Qo*) billion ₼as a consumer loan from past savings to pay for current consumer spending. In addition to the above, on average 0.263(*Q(t-0)*) billion ₼from the current income of the *Gmq* was directed to repay consumer loans used in the previous period.

5. Since the saved portion of the national income generated in the Republic in 2015–2021 was mainly used by the population to pay for consumer expenses, the level of the saved portion of the national income turned out to be low.

Research has shown that the function of changes in savings created in the national economy over the period under study is expressed by a linear relationship – Eq. (21):

$$\Delta Qm = \left[-0.231 \cdot \mathrm{Io} + (0) \cdot \Delta \mathrm{Gmq1} + 0.263 \cdot \mathrm{I(t-1)}\right], \tag{21}$$

Functional dependence (21) shows that since in the period under study the propensity to consume c = 1.0, then the limit of the propensity to save is expressed as, s = (1- c) = 0. This indicates that since the remaining part of the increase in income *ΔGmq* for the period under study was completely directed to paying for consumer spending, then savings from the increase in income *ΔGmq* did not occur.

6. It was established that the share of investment potential of the national economy, directed to the national economy during the period under study, in investments directed to the national economy from all sources of financing, amounted to 0.529 or an average of 52.9%.
7. It was found that the level of return on investment in terms of profit was low for the period 2015–2021. Calculations showed that for the period under study, the dependence of the change in *ΔPT* of profit received in the sectors of material production of the economy on the change in *ΔIT* of investments directed to the sectors of material production of the economy is expressed by Eq. (22):

$$\Delta \mathrm{PT}(= 0.287 \cdot \Delta \mathrm{IT} + 3.784), \tag{22}$$

Equation (22) shows that in 2015–2021 every 1,000 billion manat of additional investment directed to the material production sector increased profits in the material production sectors by 0.287 billion ₼, or in percentage terms, every 100.0% increase in investment increased profits by a total of 28.7%. Thus, based on the above estimates, we believe that in the period 2015–2021. The national economy of Azerbaijan functioned according to the «circle of poverty».

4 Discussion

Based on the conducted research, we came to the conclusion that at the stage of development of the national economy, there are no intra-systemic economic threats to the state structure. The security of the state structure from economic threats is ensured by the self-regulating nature of the national economic system [8–10]. However, due to the slowdown in the rate of development of the national economy at the stage of stagnation, the country's national economy begins to function in a «circle of poverty». At this stage, the functioning of the national economy begins the process of shaping intra-systemic economic threats to the state structure (Fig. 1).

We believe that in the process of functioning of the national economy in the «circle of poverty» the following economic threats to the state structure arise: 1) loss of economic independence by the state; 2) lack of ability of the national economy to develop independently; 3) reduction of the export-import balance in the country; 4) a decrease in the balance of income transferred to foreign countries and received from foreign countries; 5) the emergence of macroeconomic damage in foreign trade relations; 6) the formation of a disproportionate ratio of profit and incentive to work – wages; 7) artificial (speculative) increase in prices of consumer goods; 8) a decrease in domestic investment potential in the production sectors of the national economy; 9) Inefficient use of investment potential created in the production sectors of the national economy.

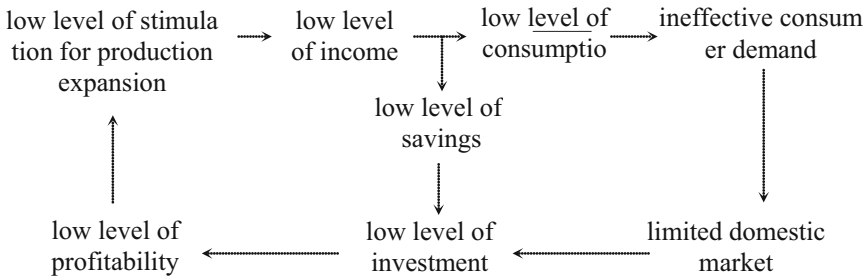


Fig. 1. Schematic description of the functioning of the country's economy in the «circle of poverty» (Source: author).

5 Conclusion

Low incomes in the country create economic problems in two directions.

The first problem is related to the limited market for sales of products and services in the country's economy. The reason for the low income of the population in the country's economy creates a low level of consumer demand in the market of goods and services in the country. Low demand for consumer goods in turn becomes a reason that limits the domestic market for consumer goods. The reason for the limited domestic market does not stimulate investment in the country's economy. Low-level investments, directed into the country's economy, maintain the country's economy at a low-efficiency and low-profit level. This reason, in turn, does not create an incentive for expanding production in the country. The circle closes.

The second problem is related to the low level of investment directed into the country's economy from domestic sources, due to the low level of income. So, the reason for low incomes in the country leads to a low level of savings from the income received. Since the source of investments directed into the country's economy are the savings of the country's population, a low level of savings creates a low level of investment opportunities. In turn, small investments directed into the country's economy maintain its operation at a low-efficiency and low-profit level. The reason, why production in the national economy of a country is less profitable, in turn, does not create an incentive for expanding production in the country. The circle closes.

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Application of GIS Technologies for Analyzing the Water Factor in Territorial Management

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Abstract. The integration of Geographic Information Systems (GIS) with hydrological modeling is a crucial advancement in water resource management, particularly in urban areas. This study explores the application of GIS in the preparation of a hydrological model for surface runoff analysis in a small urban catchment area. By utilizing various GIS tools, including Digital Elevation Models (DEM) and land cover data, the study delineates subcatchments, determines surface runoff directions, and interpolates precipitation data. The analysis highlights the importance of combining GIS with specialized software for tasks like interpolation and vectorization, especially in smaller, built-up areas where accuracy is paramount. The results show that impervious surfaces cover a majority of the subcatchment areas, influencing runoff conditions. This work discusses the challenges of modeling urban hydrology and emphasizes the need for a multi-tool approach to achieve precise results. It also considers the potential role of artificial intelligence in enhancing the accuracy of hydrological forecasts. The findings underscore the significance of continuous development in GIS-based techniques and the need for researchers to adapt to rapidly changing environmental conditions and technological advancements.

Keywords: Digital Elevation Models (DEM) · Geographic Information Systems (GIS) · Hydrological Forecasting · Hydrological Modeling · Surface Runoff · Urban Water Management

1 Introduction

The application of Geographic Information Systems (GIS) in water resource management has evolved significantly, driven by technological advancements and growing awareness of the need for sustainable water use. Initially, GIS was used primarily for mapping and spatial analysis, with a remarkable capability to handle information from different sources, provided that both sources share similar spatial references [1]. However, its role has since expanded to include complex data management and decision-making support, which are essential for effective water resource management. As challenges in water management intensify because of urbanization, climate change, and population growth, GIS has become an indispensable tool for understanding and managing the complexities of water systems. A key factor in implementing this methodology is the continuously

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increasing availability of free digital data, new technologies and other accessible sources [2]. Key areas of GIS application in water resource management include water resources management, watershed management, flood control, groundwater management, water quality monitoring, biodiversity and habitat preservation, pollution prevention, regulatory compliance, sustainable development, and the operations of relevant agencies and organizations. In cases where the necessary data is not readily available, it can be generated [3].

In recent years, the integration of GIS with decision support systems has marked a significant advancement in water resource management, as GIS provides an efficient technology for generating results through spatial and visual interpretation [4]. Specifically, by integrating GIS with hydraulic models, planners and technicians are able to access more reliable and up-to-date information [5]. This innovation allows water managers to model various scenarios and assess the impacts of different management strategies. For example, some researchers argue that the impact of climate change on streamflow characteristics is a critical issue for the future management of water resources [6]. Research highlights the importance of developing intuitive models that combine both qualitative and quantitative data, thereby enhancing decision-making processes. As GIS technology continues to evolve and environmental sustainability becomes an increasing priority, its role in shaping effective water management policies and practices is becoming ever more critical.

It is essential to emphasize the role of water in territorial development, as its functions in modern society are multifaceted. The fundamental concepts of integrated water resources management are nearing their 100th anniversary [7]. However, this concept is currently facing challenges, as the implementation of holistic management is costly, politically challenging, and, in some cases, even unfeasible [8]. Nonetheless, neglecting these functions can lead to significant risks. Such issues are already apparent on a global scale, taking various forms, including drinking water shortages in certain regions, flooding of territories and settlements, catastrophic floods in specific areas, and the ongoing deterioration of surface and groundwater quality in major river basins.

At the same time, the importance of organizing surface runoff from urban areas cannot be underestimated as a crucial factor in territorial management. In this context, GIS technologies serve both as a tool for analyzing urban water bodies [9] and as a means of training specialists in this field [10]. This approach not only addresses the direct management of wastewater but also tackles issues such as the pollution of urban water bodies, the ecological health of which significantly influences the quality of life for citizens. In this work, we aim to describe the experience of using GIS to prepare materials for a hydrological model that simulates runoff from urban areas.

2 Methodology

Various distributed hydrological models have been developed for integration within GIS platforms [11], and these are frequently employed directly to create models that describe the distribution of surface runoff. For instance, there are plugins for both QGIS and ArcGIS that utilize DEMs to determine primary runoff directions. These plugins significantly streamline the researcher's work when describing large areas. However,

challenges arise when modeling smaller territories, particularly in built-up areas, as the accuracy of the resulting models can be compromised.

Experience in studying and modeling urban areas indicates that automated processes for constructing models using remote sensing data are often unsuitable in these cases. A considerable amount of manual work is required, especially in creating accurate terrain models. The selection of a specific GIS platform typically depends on the researcher's preferences; however, the most commonly used platforms are QGIS and ArcGIS, each with its own advantages. In our view, ArcGIS is more stable and capable of efficiently handling large datasets, though it is less widely used due to its relatively high cost. QGIS is more demanding in terms of input data, but it is highly adaptable to user-specific configurations and is freely available. Additionally, QGIS allows using custom scripts, provided the user has programming skills, which enables the execution of non-standard operations.

Optimal results are often achieved by employing both systems for different tasks –for example, using QGIS for data preparation and ArcGIS for rasterization and the creation of 3D scenes. Furthermore, for the preparation of high-resolution DEMs, the use of specialized software for interpolation, such as Surfer, or for data vectorization, such as Easy Trace, can be highly beneficial. These tools help construct more precise models, which is especially important when modeling smaller areas, where lower tolerances and minimal approximations are required. This need for high accuracy is particularly relevant in urban areas, where geodetic survey data, often found in paper document formats, must be incorporated. Standard methods, such as constructing terrain models from remote sensing data, frequently fail to meet the required level of precision. Consequently, even when using data from large-scale maps, data refinement through direct field inspections is often necessary.

3 Results

For modeling purposes using the Storm Water Management Model (SWMM) software, we chose to prepare a small area in the central part of the city. This area is a catchment basin for the urban water body and can be used for calibrating the model parameters, as it contains areas with varying slope gradients. The water body serves as a drain for this part of the city, and the locations where surface stormwater flows into the water body are known. Therefore, it is possible to measure the volume and chemical composition of the incoming water, verify the accuracy of the calculations, and make necessary adjustments. Based on our experience, it is necessary to overlay multiple layers, with a minimum of three. For our analysis, we selected the catchment area of an urban waterbody and defined the following layers, as shown in Fig. 1: terrain layer (represented by a DEM), land cover layer (represented by polygons), precipitation layer (represented by lines). This approach is certainly insufficient for assessing the chemical composition of the wastewater. In such cases, additional layers are necessary.

The incorporation of these data layers allows the extraction of nearly all the key characteristics necessary for constructing hydrological models. In the case of an existing stormwater drainage network within the studied area, its impact must be taken into account by adding a layer with marked junctions, even though this significantly complicates the model. A particular challenge lies in determining the nature of the underlying

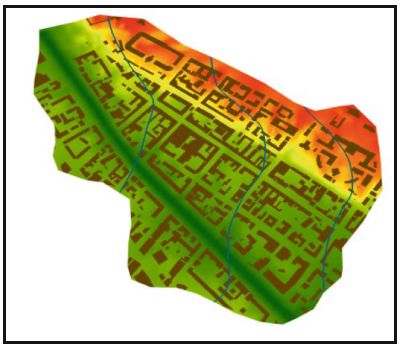


Fig. 1. Layers used for model construction (Source: authors).

surface. In an urban context, we believe it is sufficient to define the ratio of pervious to impervious areas and the extent of green zones, as adding more detailed information would only complicate the model without substantially improving the accuracy of the calculations. The use of a high-resolution DEM, created from detailed topographic maps, enables the precise identification of small depressions, facilitating the determination of primary surface runoff directions and the delineation of elementary subcatchments (Fig. 2).

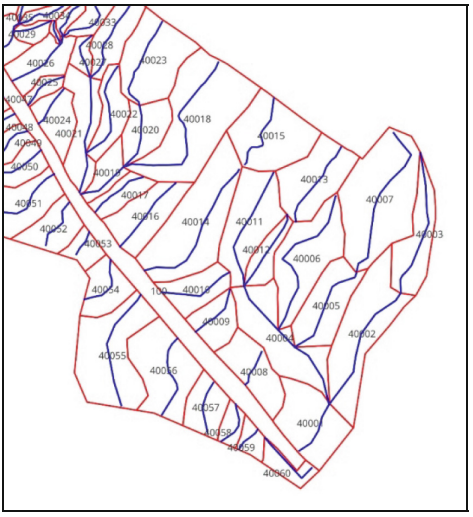


Fig. 2. Subcatchments and thalwegs in the model area (Source: authors).

In this case, it is most effective to use programs that represent the territory as a grid and calculate the flow direction from each cell. For example, the Flo-2D program uses grid element sizes ranging from 8 m to 130 m, which ensures very high processing speed. However, in urban conditions, the results still need to be carefully verified. Given the relatively small size of the area, it is possible to disregard the shape of the subcatchment

basins and focus only on the following parameters: the area of the subcatchment, the length of the thalweg, the slope of the valley, and the ratio of pervious to impervious surfaces. It is also important to identify green areas, as the runoff conditions change significantly in these zones. At this stage, the integration of artificial intelligence (AI) could significantly enhance the outcomes. When trained on data from individual subcatchments, AI can aid in determining runoff parameters for the most typical scenarios. This would facilitate the development of models capable of describing much larger areas, thus expanding the scale and relevance of the research. Such models could be applied to larger cities with dense populations, where effective stormwater management could substantially improve residents' quality of life. As a result, the application of a combination of specialized GIS tools for distinct tasks enabled the delineation of subcatchments, identification of surface runoff directions, interpolation of precipitation data across the urban area, and extraction of data characterizing the primary features of the catchment areas. A total of 60 subcatchments were identified, with an example of their parameters provided in Table 1.

Table 1. An example of subcatchment characteristics

ID	Area, sq.m	Pervious surface area, sq.m	Pervious surface share of total area, %	Green zones area, sq.m	Green zones share of total area, %
40001	26021	12481	48.0%		
40002	38537	18893	49.0%		
40003	20576	8837	42.9%	1363	6.6%
40004	17987	8517	47.3%		
40005	30388	16382	53.9%		
40006	22709	11182	49.2%	153	0.7%
40008	32530	13265	40.8%	185	0.6%
40007	50082	19498	38.9%	5929	11.8%
40009	12112	5284	43.6%		
40010	13458	6993	52.0%		

Source: authors.

According to the data, it can be observed that impervious surfaces make up more than half of the total area across all subcatchments, while green zones are only present in some. These factors play a significant role in shaping the conditions for runoff formation. The optimal size of delineated subcatchments is contingent upon the scale and scope of the study. Excessive subdivision can introduce unnecessary complexity, whereas unjustified aggregation may reduce the model's accuracy and its usefulness for predictive purposes.

4 Discussion

At the current stage of geoinformation technology development, tools for analyzing various territorial characteristics have rapidly advanced. These tools are crucial for understanding land management and for constructing models aimed at forecasting specific processes. In this study, we focused on a small urban area to determine key parameters for building a hydrological model. The model we developed can be used for informed decision-making in urban planning. Achieving the required level of accuracy in such analysis requires more than just a single GIS tool. It is essential to employ a combination of GIS models for effective results. Additionally, specialized software is necessary for tasks such as interpolation, vectorization, and data processing. Each of these tools plays a crucial role in ensuring the model's reliability.

We believe that AI will significantly enhance data processing in future applications. AI can improve the accuracy and reliability of forecasts by analyzing complex data sets. As urban systems and environmental conditions continue to evolve, there is an increasing need for researchers to improve their competencies. The challenges in modern water resource management are becoming more complex. Proficiency in just one analytical tool is no longer sufficient to address these challenges. Researchers must be skilled in using a range of tools to solve these problems. A multi-tool approach will provide a more comprehensive understanding of urban water systems. This approach will help develop more effective management strategies.

AI-driven models can further improve runoff predictions. They can adapt to new data and better forecast runoff patterns. The integration of AI will help scale these models to larger urban areas. This can lead to better stormwater management. By continuously improving both analytical methods and researcher skills, urban water resource management can be more effective. It is essential to stay current with technological advancements in this field. Combining GIS, AI, and other technologies will be crucial for tackling the evolving challenges of water resource management. The potential of AI in hydrological modeling is immense and should be fully explored.

5 Conclusion

This study demonstrates the effectiveness of GIS-technologies in modeling urban stormwater runoff. We developed a framework for hydrological modeling in urban environments. By integrating GIS layers such as terrain, land cover, and precipitation data, we successfully delineated subcatchments and defined surface runoff directions. The analysis also identified key environmental factors influencing runoff formation. Impervious surfaces, which cover a large portion of the urban area, were found to significantly contribute to increased runoff. In contrast, green zones play an important role in mitigating stormwater flow.

We applied a combination of QGIS and ArcGIS tools, along with specialized software for interpolation and data processing. This multi-tool approach enabled high accuracy in the modeling process. We focused on delineating subcatchments and identifying important parameters like area, slope, and impervious surface ratio. However, further refinement is needed to fully incorporate the chemical composition of wastewater, requiring additional layers for a complete analysis.

The results highlight the value of a multi-tool approach for creating reliable hydrological models. A single GIS tool cannot adequately address the complexities of urban stormwater management. The integration of AI holds significant potential for improving model accuracy and scalability. Training AI on subcatchment-specific data can enhance parameter selection for typical runoff scenarios. This would allow models to be scaled to larger urban areas, improving stormwater management.

The study also emphasizes the significance of continuous development of researchers' skills. Urban systems and environmental challenges are constantly evolving. To address these, proficiency in multiple analytical tools is essential. Combining GIS, AI, and other emerging technologies can help urban planners tackle these challenges. AI integration can optimize stormwater runoff models and improve their predictive power. Moreover, the study shows that combining GIS with AI-driven analysis can improve model accuracy. It also demonstrates that predicting wastewater chemical composition will make models more comprehensive. These methods can significantly enhance urban water management strategies. They ensure that stormwater systems are both efficient and resilient. By refining models to address chemical composition and incorporating AI, future research will be better prepared to handle challenges posed by urbanization and climate change.

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Macroeconomic Model for Assessing Economic Threats to the Country's State Structure

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Abstract. Since the beginning of the 21st century, along with the decline in the efficiency of the unipolar global economic system in the world, the formation of a risky period of geopolitical instability, as well as the emergence of new regional economic centers of power, the government of each country in the world began to pay primary attention to the implementation of policies that ensure the independent development of the national economy of the country. The contribution proposes a macroeconomic model for assessing economic threats to the state structure of the country, in the process of functioning of the national economy of the country. In the macroeconomic model, the author proposes methods for assessing economic threats that may arise to the state structure in the process of functioning of the national economy of the country. The research methodology and evaluation methods were developed using a systematic approach, comparative analysis and methods of economic and mathematical analysis.

Keywords: Economic Basis of the State · Economic Threats to the State System · Multipolar Global Economy · National Economy · Unipolar Global Economy

1 Introduction

In the late 80s and during the 90s of the last century, in connection with the formation of a unipolar global economic system in the world, as well as the change in the political, economic and social foundations of the countries of Eastern Europe and the countries of the post-Soviet space, one of the main tasks for the authorities of the countries of Eastern Europe and the countries of the post-Soviet space became the prevention of economic threats in the context of the national security of their countries. As a result of the process of formation of new poles around the People's Republic of China and the Russian Federation, starting from the beginning of the new 21st century, at present:

1) the regional Shanghai Cooperation Organization, covering an area of 35 million km^2 or 65% of the Eurasian space and having a population of 3.5 billion people, including the People's Republic of China, the Russian Federation, the Republic of India, the Islamic Republic of Pakistan, the Islamic Republic of Iran, the Republic of Kazakhstan, the Republic of Uzbekistan, the Kyrgyz Republic, the Republic of Tajikistan, and the Republic of Belarus [1];

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2) in order to prevent the brewing global financial and economic crisis, create high-tech production systems and improve the standard of living of the population, led to the creation of the international economic organization BRICS, which includes the Federative Republic of Brazil, the Russian Federation, the Republic of India, the People's Republic of China, the Republic of South Africa, Egypt, Iran, Ethiopia. Currently, Algeria, Belarus, Bolivia, the United Arab Emirates, Vietnam, Indonesia, Kazakhstan, Cuba, Malaysia, Nigeria, Thailand, Turkey, Uganda, Uzbekistan, participate in the work of the BRICS organization in various forms [2].

At present, the governments of the countries of the Shanghai Cooperation Organization and the BRICS economic organization are striving to ensure independent economic development of their countries, on a mutually beneficial basis with other members of the countries of the Shanghai Cooperation Organization and the BRICS economic organization.

The Organization for Economic Cooperation and Development (OECD) has lowered its forecast for global economic growth. This year, the OECD expects global economic growth to be 3.1 percent, and in 2026 – 3.0 percent, according to a report published in Paris on Monday, March 17 [3]. Also, the forecast for economic growth in the Eurozone was lowered from 1.3 to 1.0 percent in 2025 and from 1.5 to 1.2 percent in 2026. Germany, according to the OECD [3], can expect only minimal economic growth of 0.4 percent this year – 0.3 percentage points less than previously expected.

In addition to the above, there are currently signs that the European Union is entering a risky period of economic stagnation, trade fragmentation, and geopolitical instability. For this reason, in the European Union, the governments of Germany, Hungary, Slovakia, Serbia and Macedonia, in order to ensure the economic development of their countries, are exploring strategic ways to move away from the centralized economic policy implemented in the European Union. Since, intra-systemic macroeconomic threats to the state structure of the country begin to form at the stage of slowdown and stagnation of the national economy.

2 Methodology

The functioning of the national economy of the country consists of stages of development, decline in the rate of development and stagnation, decline and stabilization. At the stage of development of the national economy, economic threats to the state structure of the country do not arise. Manifestations of economic threats to the state structure of the country begin to form at the stage of decline in the rate of development and stagnation in the activities of the national economic system [4]. We list the following threats to the state structure within the macroeconomic system, which arise due to the decline in the development rates of the country's national economic system and its stagnation: the inability of the country's national economy to develop independently, a decrease in the export-import balance in the country, a decrease in the balance of income transferred to and received from foreign countries, a decrease in macroeconomic profits in foreign trade operations, the formation of a disproportionate relationship between the wages of hired workers and the profits of capital owners, when distributing income, artificial (speculative) increase in prices in the consumer goods market, a decrease in domestic

investment potential arising in the areas of production of the national economy, inefficient use of investment potential in the production sectors of the national economy.

3 Results

3.1 The Inability of the Country's National Economy to Develop Independently

Along with the economic independence of the country, the national economy of each country has the ability to self-develop. When a country's national economy loses its ability to develop independently, an economic threat to the state structure arises. The assessment of the ability of the national economy to develop independently is carried out in two stages. At the first stage, the economic foundations of the country's national economy's ability to develop independently are tested. And at the second stage, the ability of the country's national economy to develop independently is assessed [5].

Stage one. Development of a model for assessing the state of the economic basis of the country's national economy's ability to develop independently.

The state of the economic base is assessed using the acceleration coefficient α, which characterizes the macroeconomic activity of the national economy of the country. The acceleration effect coefficient α, which expresses the creation of an economic basis for the ability of the national economy of the country to develop independently, is calculated on the basis of the change in the primary macroeconomic income ΔGt, created in the activities of the national economy of the country, and the change in the internal investment potential ΔIpt formed in the national economy is investigated in the form of a linear regression relationship Eq. (1):

$$\Delta \mathrm{Ipt} = (\alpha_0 + \alpha_1 \cdot \Delta \mathrm{Gt} + \epsilon), \tag{1}$$

In dependence (1), the coefficient α1 expresses how much the internal investment potential *Ipt* changes due to a change in the primary macroeconomic income *Gt*.

In the econometric model we have developed, the acceleration effect coefficient α, which expresses the economic basis for the ability of self-development of the national economy in a certain time interval T(1,2,3,..,n), is estimated by a linear regression dependence Eq. (2):

$$\sum_{1}^{n} \Delta Ipt = (\alpha_0 + \alpha_1 \cdot \sum_{1}^{n} \Delta Gt + \varepsilon), \tag{2}$$

In the linear regression dependence (2), the acceleration coefficient α_1 shows the change in the internal investment potential $\dot{I}pt$ formed in the national economy, due to the change in the macroeconomic income of the country *Gt*. The number ε in Eq. (2) shows the error of the calculations performed.

The determination of the economic basis of the ability of self-development of the national economy of the country is determined in the following conditions:

1) The values of the coefficient of the effect of macroeconomic acceleration a1 in the interval $0 < \alpha 1 \leq 1.0$ shows that, that there is an economic basis for the self-development of the country's national economy;

2) The values of the coefficient of the effect of macroeconomic acceleration a1 ≤ 0 show that the country's national economy lacks an economic basis for the ability to self-develop.

Second stage. Development of a model for assessing the ability of the country's national economy to develop independently.

We believe that the indicator of the macroeconomic multiplier effect μ is an indicator of the efficiency of using the investment potential of the *Ip* formed in the national economy of the country. The indicator of the multiplier effect μ shows the change in output ΔYt at time t, caused by a change in investments $\Delta \dot{I}p(t-1)$ at time $(t-1)$. The change in output ΔYt at time t, caused by a change in investments $\Delta \dot{I}p(t-1)$ at time $(t-1)$, is measured by Eq. (3):

$$\Delta \mathrm{Yt} = \left(\mu_0 + \mu_1 \cdot \Delta \dot{\mathrm{I}}\mathrm{p}(\mathrm{t}-1) + \acute{\epsilon}\right), \tag{3}$$

In Eq. (3), μ_0 shows the change in output ΔYt at time t, caused by other factors of production.

Over a certain period of time $T(1,2,3,..,n)$ the ability of the country's national economy to self-development is examined by the linear regression Eq. (4):

$$\sum_{1}^{\mathrm{n}} \Delta \mathrm{Yt} = \left(\mu_0 + \mu_1 \cdot \sum_{1}^{n} \Delta \dot{\mathrm{I}}\mathrm{p}(\mathrm{t}-1) + \acute{\epsilon}\right), \tag{4}$$

We propose the following conditions for assessing a country's ability to develop independently:

1) Values of the macroeconomic multiplier coefficient in the range $0 < \mu 1 \leq 1.0$ indicate that, the increase in the sum of changes in domestic investment $\Sigma \Delta \mathrm{Ip}(\mathrm{t}-1)$ which can be directed to reproduction during the period T (1,2,3,..,n) by one unit, provides an increase in the total output of products $\Sigma \Delta \mathrm{Y}(\mathrm{t})$, by μ_1 units. In this case, it believed that the country's national economy has the ability to self-develop.
2) The values of the macroeconomic multiplier coefficient $\mu 1 \leq 0$ indicate that an increase in the sum of changes in domestic investment $\Sigma \Delta \mathrm{Yp}(\mathrm{t}-1)$, , which are aimed at reproduction during the period T (1,2,3,..,n) could not ensure an increase in the total output of products $\Sigma \Delta \mathrm{Yp}(\mathrm{t}-1)$. In this case, it is considered that the country's national economy does not have the opportunity for self-development.

3.2 Assessment of the Economic Threat Arising from the Reduction in the Export-Import Balance in the Country's Foreign Trade

When the volume of goods exported from a country *Ye* exceeds the volume of goods imported into the country *Yi*, the country's wealth increases. Conversely, a decrease in the amount of goods exported from country *Ye* and an increase in the amount of goods imported into country *Yi* leads to a decrease in the wealth of the country [6–8]. The balance of exports and imports of a country's products in foreign trade is estimated by the ratio Eq. (5):

$$(\pm \mathrm{Nx}) = (\mathrm{Ye} - \mathrm{Yi}), \tag{5}$$

In dependence (5), the condition (±Nx) > 0 indicates an increase in the country's wealth in foreign trade, and the condition (±Nx) < 0 indicates a decrease in the country's wealth in foreign trade.

In order to achieve sustainable functioning of the national economy of the country, all countries of the world strive to achieve a positive balance in export-import operations with other countries. The achievement of a positive balance for some countries is accompanied by the formation of a negative balance for others: Some countries become economically richer, other countries become poorer; the growth of wealth of one nation is accompanied by the impoverishment of other nations. This cause-and-effect relationship exists constantly, as a global economic law about the constant existence of poor countries in the world.

The economic literature indicates many reasons for the existence of poor countries - from the technological imperfection of the country's economy in particular, to the incapacity of the nation as a whole. Speaking about the reasons, we affirm that regardless of the many reasons, poor countries will always exist in conditions of competition between countries. The centers of wealth and poverty will move from country to country, from region to region, from one continent to another. This universal economic law is an eternal economic law and in transformed form expresses the universal law of survival of the nation [9].

We believe that at a certain time interval $T(1,2,3,\ldots,n)$, the dependence of changes in the country's export-import balance in foreign trade $\Delta(\pm Nx)t$ on changes in the volume of products exported from the country ΔYe and the volume of products imported into the country ΔYi can be estimated using a linear structural dependence Eq. (6):

$$\sum_{1}^{n} \Delta(\pm \mathrm{Nx}) = \left(\mathrm{a}_0 + \mathrm{a}_1 \cdot \sum_{1}^{n} \Delta \mathrm{Ye} + \mathrm{a}_2 \cdot \sum_{1}^{n} \Delta \mathrm{Yi} + \mathrm{e} \right), \tag{6}$$

In identity (6): coefficient a_1 – shows the change in the country's export-import balance $\Delta(\pm Nx)$ due to a change in the volume of products ΔYe exported from the country in foreign trade by one unit; coefficient a_2 shows the change in the country's export-import balance $\Delta(\pm Nx)$ due to the change ΔYi in the volume of products imported into the country through foreign trade operations by one unit; the coefficient a_0 expresses the change in the country's export-import balance $\Delta(\pm Nx)$ due to factors that do not depend on the change in the volume of exported products ΔYe and the change in the volume of products imported into the country in foreign trade ΔYi; ε expresses the accuracy of the calculations. The conditions Eq. (7):

$$\sum_{1}^{n} (\pm \mathrm{Nx}) < 0, \tag{7}$$

on the time interval $T(1,2,3,\ldots,n)$ indicate a decrease in the country's wealth in foreign trade and a threat to the country's state system in foreign trade relations.

3.3 Assessment of the Economic Threat Arising from the Decrease in the Balance of Income Transferred to and Received from Foreign Countries

We believe that a decrease in the country's wealth due to a decrease income balance, received from abroad and transferred to foreign countries, refers to economic threats to the state structure of the country.

The difference between the *Ga* income received from foreign countries and the *Gv* income given to foreign countries represents the balance of income received from foreign countries and given to foreign countries (±G), that is Eq. (8):

$$(\pm G) = (Ga - Gv), \tag{8}$$

In dependence (8), the condition $(\pm G) > 0$ indicates an increase in the country's wealth due to the balance of income received from abroad and transferred to foreign countries, while the condition $(\pm G) < 0$ indicates a decrease in the country's wealth due to the balance of income with foreign countries.

In the time interval T (1,2,3,…,n), the change in the balance of income $\Sigma\Delta(\pm G)$ received from foreign countries and transferred to foreign countries depends on the change in income received from abroad ($\Sigma\Delta Ga$) and on the change in income ($\Sigma\Delta Gv$) transferred to foreign countries, that is Eq. (9):

$$\sum_{1}^{n}(\pm G) = \left(a_0 + a_1 \cdot \sum_{1}^{n} \Delta Ga + a_2 \cdot \sum_{1}^{n} \Delta Gv + \varepsilon\right), \tag{9}$$

In the structural identity (9): coefficient a1 expresses the change in the balance of income $\Delta(\pm G)$ due to the change in the amount of income received from foreign countries ΔGa; coefficient a2 expresses the change in the balance of income $\Delta(\pm G)$ due to the change in the amount of income given to foreign countries ΔGv. İn structural equation ε represents the error of the calculations.

3.4 Assessment of the Economic Threat Arising from the Decline in Macroeconomic Profits Generated by Foreign Trade

We consider the reduction in macroeconomic profits received in foreign trade to be an economic threat to the state structure of the country. Macroeconomic profit *Pg* in foreign trade estimated by structural dependence:

$$Pg = (\pm Nx) - \left(Arx^1 + Yi_{11}\right), \tag{10}$$

In the dependence (10): (± Nx) - the foreign trade balance; Arx_1 – the costs of materials spent on the production of products in the raw material production areas; Yi_{11} – the costs spent on the purchase of materials imported from outside the country for the production of new final consumer products. From the dependence (10) macroeconomic profit $Pg < 0 \rightarrow$ arises in the case (Eq. (11)):

$$(\pm Nx) < (Ara_1 + Yi_{11}), \tag{11}$$

The case of macroeconomic profit ΣPg < 0, obtained in the activity of the national economy of the country in a certain time interval *T* (1,2,3,…,n) arises under the condition Eq. (12):

$$\sum_{1}^{n}(\pm \mathrm{Nx}) < \left(\sum_{1}^{n}(\mathrm{Arx}_1 + \mathrm{Yi}_{11})\right), \tag{12}$$

Thus, we believe that in a certain time interval *T* (1,2,3,…,n) in the national economy the case Eq. (13):

$$\sum_{1}^{\mathrm{n}}(\pm \mathrm{Nx}) < \sum_{1}^{\mathrm{n}}(\mathrm{Arx}_1 + \mathrm{Yi}_{11}) \rightarrow \sum_{1}^{\mathrm{n}} \mathrm{Pg} < 0, \tag{13}$$

creates economic threats to the state structure of the country.

3.5 Assessing the Economic Threat Posed by the Disproportionate Relationship Between the Wages of the Labor Force and the Profits of Capital Owners

We believe that the disproportionate ratio of wages in stimulating the labor force involved in the production of goods and services in the national economy and the profits belonging to the owners of capital is a factor that creates an economic threat to the state structure of the country. Since this factor contributes to the socio-economic stratification of the population in the country, leading to an increase in the number of poor and needy people. In neoclassical economic theory, the distribution of income Y generated in the national economy between capital K owned by capital owners and labor L is estimated using the Cobb-Douglas function [8, 9] – Eq. (14):

$$\mathrm{Y} = \mathrm{A} \cdot (\mathrm{K})^{\alpha} \cdot L^{(1-\alpha)}, \tag{14}$$

In the function: *K* expresses the fixed capital in the national economy; *L* – the amount of wages paid to the workforce in the national economy; *α* – the specific weight of the amount of capital *K* in total income *Y*, α = K/Y; parameter *A* expresses the technical and technological level of the national economy.

In addition to the above, there is a methodology for estimating the distribution of income *Y* generated in the national economy between capital *K*, which belongs to capital owners, and wages paid to labor force *L*, using the Eq. (15):

$$\mathrm{Y} = (\mathrm{Af} + \mathrm{Kd})^{\alpha} \cdot \mathrm{L}^{(1-\alpha)}, \tag{15}$$

proposed by us [9]. In the proposed function: *Af* is the sum of depreciation of fixed capital *K* used in the national economy, calculated according to depreciation rates established by the state and returned to the owners of capital; *Kd* is the amount of working capital used in the production process and owned by the owners of capital; α is the specific weight of the capital sum (Af + Kd) in the total income *Y*, α = (Af + KD)/*Y*; *L* is the size of the wages of the workforce in the national economy.

We believe that the evaluation of the distribution of income *Y* generated in the national economy between capital owners and the labor force through the function (15)

is scientifically methodologically sound. Since, unlike the Cobb-Douglas function, we consider as a factor of production the amount of working capital *Kd*, owned by capital owners and used in the production of products, along with the amount of fixed capital *Af*, owned by capital owners and used in the production of products.

On some time interval *T* (1,2,3,…,n) the distribution of the sum of income *ΣY* generated in the national economy between the owners of capital and labor force is estimated using the structural equation Eq. (16):

$$\sum_{1}^{n} Y = \sum_{1}^{N} (Af + Kd)^{\alpha} * \sum_{1}^{n} L^{(1-\alpha)}, \tag{16}$$

In the Eq. (16): α is the specific weight of the sum of fixed capital *Af* and working capital *Kd* in the total income *Y*, that is Eq. (17):

$$\alpha = \sum_{1}^{n} (Af + Kd) / \sum_{1}^{n} Y, \tag{17}$$

$(1 - \alpha)$ is the specific weight of wages of labor force *ΣL* in the total income *ΣY*, that is (Eq. (18)):

$$(1 - \alpha) = \sum_{1}^{n} L / \sum_{1}^{n} Y, \tag{18}$$

of the national economy of the country.

By assessing the level of proportion between the income of capital owners and the wages paid to the labor force in the country according to the dependence Eq. (19):

$$\Theta = (1-\alpha)/\alpha, \tag{19}$$

we can judge the difference between the income of capital owners and the wages paid to the labor force. In addition to the fact that a low level of the *Θ* indicator represents an economic threat to the state structure of the country, it creates a situation of social threats to the state structure.

3.6 Assessment of the Economic Threat Arising from Artificial (Speculative) Increases in Product Prices

We consider the case of artificial (speculative) increases in product prices in the consumer market to be an economic threat to the state structure. Along with the growth of the money supply, the reduction of goods and services offered to the market, as well as the speculative rise in prices of goods in the consumer market, create a state of inflation in the country's economy. There are economic instruments for balancing products and money supply on the consumer market of the country, with the help of which the government of the country does not allow the growth of inflation, preventing economic threats to the state structure. We consider the situation of artificial (speculative) growth of prices for products on the consumer market to be an economic threat to the state structure of

the country, since the government of the country often cannot influence the speculative growth of prices on the consumer goods market.

The inflation rate *If* in the country's economy, as a complex function, depends on the volume of goods and services *Y* offered to the market, the amount of money supply *M3* in the country's economy, as well as the speculative growth of prices in the market of goods and services *Sa*, namely – Eq. (20):

$$\mathrm{If} = \mathrm{F}(\mathrm{Y}, \mathrm{M3}, \mathrm{Sa}), \tag{20}$$

The assessment of the change in the inflation rate *ΔIf* in the country's economy over a certain time interval *T* (1,2,3,…,n) depending on the change in the aggregate output rate *ΔY*, on the change in the money supply rate *ΔM3* in the country's economy and on the speculative growth in prices Sa is studied by the structural Eq. (21):

$$\sum_{1}^{n} \Delta \mathrm{If} = \left(\mathrm{Sa} + \mathrm{a}_1 * \sum_{1}^{n} \Delta Y + \mathrm{a}_2 * \sum_{1}^{n} \Delta \mathrm{M3} + \varepsilon \right), \tag{21}$$

a_1 shows changes in the inflation index *ΔIf* depending on the change in the volume of goods and services *ΔY* by one unit; a_2 shows the change in *ΔIf* depending on the change in the money supply *ΔM3* by one unit; *Sa*, expressing the speculative increase in prices for goods and services, shows the change in inflation *ΔIf* in the country's economy when *Sa* changes by one unit. İn the equation ε, represents the calculation error.

3.7 Assessment of the Economic Threat Arising from the Reduction of Investment Potential in the Production Sectors of the National Economy

We consider the decline in investment potential in the manufacturing sectors of the national economy to be one of the economic threats to the state structure of the country. Neoclassical economic theory believes that the income generated in the national economy, after paying taxes and duties, as well as after paying for consumption expenses, constitutes the investment potential of the country as the savings of the population. In the process of distributing primary income generated in the national economy, part of the fixed capital consumed in the production of products, calculated according to depreciation rates determined by the state, is returned to investors. In our opinion, part of the fixed capital consumed and returned to investors in the process of distribution of primary income, as depreciation of the capital, should also be included in the domestic investment potential of the country. Thus, we believe that the investment potential of the *İp*, capable of ensuring the economic development of the country, may include, along with the saved part of the total national income of the *Qm* created in the country, as well as funds returned to the owners of fixed capital, as depreciation of the consumed capital of the *Af*, namely Eq. (22):

$$\mathrm{Ip} = (\mathrm{Qm} + \mathrm{Af}), \tag{22}$$

Investment potential in production sectors in a certain time interval *T* (1,2,3,…,n) is estimated by the ratio Eq. (23):

$$\sum_{1}^{n} Ip = \sum_{1}^{n} (Qm + Af), \tag{23}$$

In dependence (23), the case Eq. (24):

$$\sum_{1}^{n} Ip = \sum_{1}^{n} (Qm + Af) < 0, \tag{24}$$

showing a decrease in investment potential in production sectors in the time interval T (1,2,3,…,n), becomes an economic threat to the state structure of the country.

3.8 Assessment of the Economic Threat Arising from the Inefficient Use of Investment Potential in the Production Sectors of the National Economy

We believe that the investment potential of the country is used ineffectively in cases where the country's domestic investments directed to the sectors of the national economy $\dot{I}$ are less than the minimum investment limit *İmin*, that is: I < Imin; and also when investments I are greater than the maximum investment limit *Imax*, that is, I > *Imax*. So, for investment values I < Imin, the total output of production in the production sectors takes on values Y ≤ 0. Also, for investment values I > Imax, the total output in the production sectors takes on values Y ≤ 0. Thus, the case of inefficient use of investment potential arises under the condition: Imax < I < Imin.

The minimum and maximum investment limits directed to the production sectors of the national economy of the country *Imin* and *Imax* can be determined by solving the polynomial regression Eq. (25):

$$Y = \left(a_0 * I^2 + a_1 * I + a_2\right), \tag{25}$$

Solving the polynomial regression Eq. (25), under the condition Y = 0, as a quadratic Eq. (26):

$$\left(a_0 * I^2 + a_1 * I + a_2\right) = 0, \tag{26}$$

we can find the values of *İmin* and *İmax*, by Eqs. (27) and (28):

$$\text{Imin} = \frac{-a_1 + \sqrt{(a_1^2 - 4a_0a_2)}}{2a_0}, \tag{27}$$

$$\text{Imax} = \frac{-a_1 - \sqrt{(a_1^2 - 4a_0a_2)}}{2a_0}, \tag{28}$$

The assessment of the minimum *Imin* and maximum *Imax* limits of investments directed to the production and service sectors of the national economic system is carried out in the following sequence (algorithm):

- investments directed to the production sectors of the national economy are assessed;
- the total output Y volumes in the production and service sectors are assessed;
- the polynomial dependence of the total output Y volumes in the production and service sectors on the investments I directed to the production and service sectors is assessed;
- the minimum *Imin*, maximum *Imax*, and average *Ior* limits of investments are assessed.

4 Conclusion

We believe that economic threats arising to the state structure of the country in the process of functioning of the national economy can be prevented by assessing them using the macroeconomic model of assessing economic threats to the state structure of the country that we have developed. Based on the results obtained from the study of assessing economic threats to the state structure, it is necessary to develop a proactive program to prevent economic threats in order to ensure political and social stability in the country.

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Avant-Garde Teaching Methods: Future Technical Solutions and Methodologies

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Abstract. This work is aimed at analyzing modern methods in the digitalization of education aimed at improving its quality and productivity at universities, and studying their applied potential. The main focus is on the use of the latest technologies, including artificial intelligence, adaptive learning systems and the creation of virtual learning spaces that contribute to the creation of more dynamic and individualized learning. The key objective of the study is to identify successful ways to introduce digital innovations into the educational process and to formulate effective recommendations for educational institutions. To demonstrate possibilities of digital innovations, the authors consider the example of Bauman Moscow State Technical University, which integrated virtual laboratories for physical and chemical research in the 2020–2021 academic year. This gave students a chance to perform experiments in a virtual, safe environment, immediately receive feedback and repeat operations indefinitely. This approach significantly improved the assimilation of educational material and increased the motivation of students due to the interactivity of the process. This study is of significant interest to experts in the field of pedagogy, developers of EdTech projects, and heads of educational institutions, as it puts forward specific methodological guidelines for the effective integration of digital innovations into curricula, taking into account the specifics of multi-level education and differences in the regional context.

Keywords: Artificial Intelligence (AI) · Educational Outcomes · Higher Education · Independent Learning · Innovations · Teaching Methods

1 Introduction

E-learning is rapidly gaining momentum, becoming a critical element of education systems around the world. In the era of globalization and rapid technological development, innovative approaches are becoming fundamental in ensuring high quality of the educational process and its adaptation to current trends. Digital educational resources open up wide opportunities for personalization of learning, effective interaction between teachers and students, as well as for increasing the effectiveness of learning in general. The main objective of this research is to study current trends and future opportunities in the field of e-education. Significant attention is focused on the use of advanced techniques,

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including adaptive education, big data analysis and the use of artificial intelligence, as well as virtual and augmented reality technologies. The use of these innovations ables significant transformation of standard educational processes, turning learning into a more interactive and accessible enterprise for various groups of the population. This study also seeks to examine the practices of leading global universities and educational institutions that effectively integrate digital technologies. Analysis of best practices is invaluable for identifying key elements of success and formulating strategies to improve the digital educational process in Russia. It is noted that to achieve high results in the implementation of digitalization of education, not only modern equipment is critically important, but also a review of established educational practices, as well as advanced training for teachers.

Therefore, the purpose of this study is to classify information about the latest technologies in the field of digital learning and to create guidelines for their successful application in the educational process. In the modern world, society has faced a number of problems related to the modernization of educational processes in response to changes imposed by digitalization and new market demands. The era of digital transformation covers all spheres of life, transforming the educational sphere, which must adapt to the needs of the modern labor market and public expectations. Traditional teaching methods are losing their effectiveness, are not able to fully meet the needs of students seeking individualization of learning and unlimited access to information resources regardless of time and place. The significance of this study is determined by the increasing interest in innovations that contribute to increased productivity in the field of education. The focus is on technologies including artificial intelligence, big data analytics and machine learning that facilitate the development of individualized educational plans, adaptation to the needs of each student and increased effectiveness of feedback. However, the integration of these innovative solutions requires a comprehensive study of their impact on teaching methods and educational achievements [1].

Developing a methodology for integrating digital technologies into educational courses is a key concern. This means training teachers in digital skills, developing educational content that meets the latest educational requirements and ensuring that everyone has access to educational opportunities. At the same time, the emphasis on ensuring equal opportunities for quality education becomes more significant in the context of uneven distribution of digital literacy and tools among different segments of the population. Therefore, the purpose of this study is to identify optimal approaches and techniques for integrating innovative solutions in the field of digital education. It also aims to develop specific recommendations for educational institutions wishing to apply advanced technologies to improve the educational process.

2 Methodology

This study combines a theoretical analysis of scientific publications and a practical study of specific cases of introducing digital innovations in the education sector. The project methodology involves the use of combined research methods, namely: in-depth interviews with experts to obtain qualitative data and surveys among participants in the educational process along with case studies to collect quantitative information. The

project focuses on creating models and forecasting the impact of digitalization in order to develop practically applicable recommendations for educational institutions. The study plans to conduct a comparative study of international practices, which will identify advanced methods and approaches to adaptation that can be applied in Russia. An important part of the work is the analysis of the role of digital resources in improving academic achievement and motivation of students through monitoring their reaction to such tools and performance assessments. The results obtained provide a foundation for creating guidelines aimed at the effective implementation of digital technologies in education.

3 Results

Global trends and experiences from different countries confirm that interest in digital educational resources is growing, which is due to a number of reasons: technological development, changing student demands, and new qualification requirements imposed by the modern economy. Personalized learning is a significant trend, providing the ability to customize the educational process taking into account the unique requirements and abilities of each student. Methods such as flipped classroom learning have already demonstrated their effectiveness, offering adaptive curricula and supporting independent study of the subject. The increasing use of virtual reality (VR) and augmented reality (AR) technologies is a key area in the field of education, providing unique immersive learning spaces. In particular, leading medical schools have integrated these technologies to effectively simulate surgeries, giving future specialists the opportunity to hone their skills in a controlled and safe environment. An example is the launch of a virtual surgery program by Sechenov First Moscow State Medical University in 2022, which offers students the opportunity to thoroughly understand complex surgical procedures before working with live patients. This approach has significantly reduced the likelihood of making mistakes in real practice and increased the self-confidence of novice doctors [2].

The use of artificial intelligence (AI) technologies to effectively automate standard tasks and provide tailored assistance to students is becoming a key area in modern education. Innovative educational platforms use AI algorithms to thoroughly analyze academic progress, identify knowledge gaps, and create individualized curricula. An example is Yandex. Textbook, widely used in educational institutions in Russia, which automates the process of assessing students' written work, offering adjustments and instructions for eliminating deficiencies, thereby relieving teachers of routine tasks and giving them the opportunity to focus on direct communication and teaching students. The main challenge faced by e-education is to guarantee universal access to educational materials of the highest quality. The implementation of this idea faces obstacles related to the digital divide, especially pronounced in places with limited connectivity to reliable wireless internet and a lack of modern technological devices. Developing and supporting programs that provide free or discounted access to digital educational content in marginalized and remote areas represents a possible solution to this critical problem.

In addition, the development of digital learning materials must take into account the cultural and social context. Educational institutions such as schools and universities should aim to create an inclusive learning environment that meets diverse learning needs

and teaching preferences. For example, St. Petersburg State University has developed a set of educational programs specifically designed for students based on their individual learning needs, using multisensory strategies and interactive content. Training teachers to work effectively in the context of digitalization of education is becoming a critical aspect. To successfully master and apply the latest educational technologies, teachers must have not only technical skills, but also advanced pedagogical competencies to organize a high-quality digital educational process. Advanced training courses similar to those offered by Moscow City Pedagogical University cover the study and application of interactive whiteboards, web platforms and smartphone applications in educational activities, facilitating the timely integration of digital tools into the regular educational process. E-learning has significant potential to transform established approaches to learning, making education more accessible, individualized and effective. However, its full implementation requires addressing a number of issues, including ensuring equal access, adapting content to cultural specifics and developing teachers' competencies in the field of digital technologies.

The introduction of digitalization into the educational process is associated with obstacles caused by the need to move away from classical methods to innovative educational approaches. An important element of this transition is the difficulty of integrating teachers into the environment of new digital resources and educational platforms. A study conducted among teachers of Moscow educational institutions in 2022 revealed that about 60% of respondents faced problems in mastering digital innovations, even with access to professional development programs. The main challenges for them were the lack of time to study innovations and the lack of adequate technical support in the workplace. An example of the difficulties accompanying the reorientation to digitalization of education concerns the integration of information technology into the standard educational process. In particular, teachers face problems with the availability and reliability of software and hardware, which leads to interruptions in the conduct of lessons. For example, at one of the regional universities, about a third of students encountered frequent technical problems when trying to pass exams or complete homework using online platforms [3].

The introduction of digital innovations certainly helps to improve the efficiency of learning. For example, at the Moscow Institute of Physics and Technology, the use of adaptive educational platforms to prepare students for important exams led to a 15% increase in the number of candidates who successfully passed exams with high marks compared to previous years. This confirms that effectively developed digital educational tools can significantly improve the results and quality of learning. Comprehensive support from the government and educational institutions is essential for effective adaptation to new teaching methods. This means investing in the professional development of teachers, providing the necessary technical equipment and forming national criteria in the field of digital learning. This approach allows us to minimize challenges and maximize opportunities provided by the digitalization of the educational process.

The integration of digital technologies into the educational process is hampered by a number of practical challenges, the key one being the mandatory comprehensive retraining and advanced training of teaching staff. It is not enough to simply get acquainted with new opportunities, it is important to understand how these tools transform the learning

process and communication with students. Most educational workers face a problem when advanced training programs are superficial and do not provide the proper level of knowledge and skills for the effective use of digital tools in daily activities. In addition, there is a weak motivation of teachers to adapt innovative teaching methods. Some teachers perceive the introduction of new technologies as an unnecessary burden, and not as a means of simplifying and optimizing their work. This emphasizes the need to form an educational environment where teachers could realize the benefits of using digital tools and would strive to implement them in their teaching activities. It is important to take into account the spread of technology application competencies among teachers. Some already have advanced digital tools, while others are still at the stage of mastering basic technical skills. Consequently, the structure of advanced training courses should provide for an individual approach, allowing each teacher to acquire the knowledge and skills that they really need.

4 Discussion

The introduction of advanced educational methods significantly improves the efficiency and accessibility of education, demonstrating high achievements in top universities around the world. Key attention is paid to the introduction of adaptive educational systems and AI technologies, which significantly improves academic performance and active participation of students in the educational process. An example is Massachusetts Institute of Technology (MIT), where the use of adaptive programs in mathematics and science ensured a 20% reduction in the number of students with low grades, while increasing the percentage of active participation in learning by 35%. An example of the effectiveness of the introduction of virtual reality (VR) technologies are projects carried out at Stanford University, where future doctors are trained in virtual simulators that recreate the conditions of a real clinical environment. This has increased the level of accuracy of students in diagnostics by 25%, confirming the significant prospects for the use of VR in the training of qualified specialists. Higher educational institutions in Russia are actively developing in terms of digitalization of the educational process. An example is the National Research Nuclear University MEPhI, where the implementation of e-learning contributed to an increase in the percentage of students who successfully completed annual programs by 12 percentage points. At the same time, the use of IT solutions for automatic knowledge testing reduced the time spent on analyzing test answers by 40%, which made it possible to devote more attention to the development of personalized educational plans [4].

These findings highlight the importance of continuing to develop and expand the use of information and communication technologies in education. They open up new opportunities to improve the learning process, make education more accessible and contribute to the creation of highly qualified specialists. At the same time, the effective use of these innovations requires comprehensive support from the state, including funding for the renewal of educational infrastructure, staff training and the development of a legislative framework for the use of electronic resources in educational institutions. The development of digitalization in education leads to profound transformations in both teaching methods and communication methods within the educational space. The inclusion of tools such as cloud technologies for collaboration and data storage, represented

by the Google Workspace for Education and Microsoft Teams platforms, significantly facilitates the implementation of educational projects and effective interaction between teachers and students. Empirical data confirms that the use of these services contributes to an increase in the efficiency of group research by 18%, while reducing the time spent on organizational processes by 22%.

A key breakthrough has been the use of AI to study large datasets of student learning outcomes. At Oxford University, the introduction of predictive algorithms has reduced the dropout rate among first-year students by 27% through the prompt identification and correction of educational risks. A comparable initiative at Peter the Great St. Petersburg Polytechnic University demonstrates an increase in the average success of graduates by 7%, highlighting the effectiveness of predictive analytics in the context of Russian education. It is important to note that, despite significant achievements, the implementation of digital technologies faces a number of challenges. The main ones are issues of ensuring information security and protecting the personal data of students and teachers. The creation of effective encryption systems and user verification methods is becoming a key aspect in preventing unauthorized access to sensitive data and increasing trust in online learning platforms. In conclusion, it is emphasized that innovative methods in the field of education open up important prospects for improving the efficiency and accessibility of the educational process. However, to achieve meaningful and sustainable progress in education, targeted cooperation between governments, educational institutions and IT companies is necessary. This cooperation should help to create optimal conditions for progress and adaptation of the latest technological developments.

5 Conclusion

This study clearly shows that the integration of advanced technologies into the educational process leads to a noticeable improvement in educational outcomes and increases its accessibility. Technological innovations, including adaptive learning, the use of artificial intelligence, the use of virtual reality and cloud computing, demonstrate impressive effectiveness in improving academic performance, increasing student motivation and effectively organizing the educational process. The analyzed cases from advanced educational institutions confirm that the targeted use of digital resources significantly improves educational outcomes and contributes to the formation of high-level professionals.

However, there are barriers that need to be addressed. These include an imbalance in access to information, a lack of qualifications among teachers in the field of high technologies [5, 6] and the need to adapt educational programs to new methods. Effective use of digitalization opportunities will require organized support from the state, including funding for infrastructure upgrades, expanding professional development programs and creating a legislative framework for the integration of digital technologies in education. The study leads to a proposal for specific actions:

– updating infrastructure facilities with an emphasis on integrating advanced information and communication technologies and modernizing the technical base of educational institutions to ensure equal access to electronic educational resources;

– expanding professional development courses for teachers, focusing on the effectiveness of using digital resources and ways to implement them in the educational process;
– forming strict standards and guidelines that control the use of digital innovations in educational institutions;
– expanding global partnerships with leading academic institutions and companies developing educational platforms for knowledge sharing and adapting innovative methods;
– disseminating innovative approaches, including the use of virtual reality technologies in the educational processes of medical universities and the introduction of predictive analytics in the curricula of traditional universities, at the national level.

In conclusion, it should be emphasized that the transformation of the educational sphere through the integration of digital technologies is an inevitable process conditioned by objective trends. This opens up broad prospects for improving and developing the potential of human resources. To achieve high results in the direction of digitalization, coordinated work and interaction between key participants is necessary: government institutions, educational organizations, representatives of the business sector and the academic community.

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Architecture of Digital Transformation of Science

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Abstract. This work is devoted to a comprehensive analysis of the architecture of digital transformation of science as a key factor in the modern research process. The paper considers technological (artificial intelligence, big data, cloud computing), organizational (digital platforms, Agile methodologies) and regulatory (legal and ethical standards) aspects of digitalization of scientific activity. Particular attention is paid to the interdisciplinary nature of the transformation, uniting computer science with traditional research areas. The methodological basis is a system analysis of scientific publications and a comparative method. The study revealed key trends, including the growing importance of Open science, the spread of FAIR principles and the development of smart laboratories. At the same time, the problems of digital inequality, resistance to change in the academic environment and the lack of uniform data exchange standards are identified. The practical significance of the work lies in the possibility of applying its results to develop digitalization strategies for scientific organizations. The theoretical value lies in the systematization of modern ideas about the architecture of digital transformation of science. The work identifies promising areas for further research, including the development of universal digitalization models and the study of the impact of AI on scientific methodology.

Keywords: Artificial Intelligence in Science · Digital Platforms · Digital Transformation of Science · FAIR Principles · Open Science · Smart Laboratories

1 Introduction

The relevance of developing the architecture of digital transformation of science is due to the rapid development of technologies that radically change the methods of research, data processing and scientific communication. In the context of growing volumes of information, traditional approaches to managing scientific processes are becoming ineffective, requiring the introduction of digital solutions to increase the speed and accuracy of analysis [1]. Digital transformation allows scientists to use big data, artificial intelligence and cloud computing, which significantly accelerates the receipt of results and opens up new opportunities for interdisciplinary research. In addition, modern technologies contribute to the globalization of science, ensuring the collaboration of researchers from different countries through digital platforms and open repositories. The introduction

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of digital tools also increases the transparency and reproducibility of scientific experiments, which is especially important in the context of the fight against data falsification [2]. Automation of routine processes, such as data collection and processing, frees up scientists' time for creative and analytical work, enhancing the innovative potential of the scientific field. Digital transformation facilitates the creation of smart laboratories where equipment and information systems are integrated into a single ecosystem, optimizing resource costs. Adaptation of education is also an important aspect, since training new generations of scientists requires mastering digital competencies and working with advanced technologies. Public and private investments in the digital infrastructure of science stimulate economic growth, since innovations become the driver of the development of high-tech industries. In the context of global challenges such as climate change or pandemics, digital science plays a key role in the prompt search for solutions based on the analysis of large amounts of data. Thus, the architecture of digital transformation of science is an integral element of the modern research landscape, ensuring the competitiveness and sustainable development of the scientific sphere in the long term.

2 Methodology

The study used methods of system analysis for a comprehensive study of the architecture of digital transformation of science. Content analysis of scientific publications allowed us to identify key trends and problem areas in the topic under study. The comparative method was used to analyze the differences in approaches to the digitalization of science in different countries and scientific disciplines. The synthesis of the obtained data allowed us to formulate a holistic vision of the architecture of digital transformation of science and the prospects for its development. The study is of great theoretical importance, as it systematizes modern ideas about the architecture of digital transformation of science and identifies key patterns of this process. The practical significance of the work lies in the fact that the results obtained can be used by scientific organizations in developing strategies for the digitalization of research activities. In addition, the problem areas and promising areas identified during the study set the vector for further scientific research in this relevant interdisciplinary area.

3 Results

The architecture of digital transformation of science includes several key components that ensure the effective implementation of digital technologies in research activities. These components form a single ecosystem of digital science, increasing the efficiency of research, global collaboration and innovation potential. Their integration requires both technological solutions and organizational changes in scientific institutes. Let us consider these components in more detail in Table 1.

The digital transformation of science is a complex process that requires the integration of technological, organizational and educational components. The introduction of digital solutions allows us to accelerate research, improve data accuracy and ensure global scientific collaboration. However, the successful implementation of this transformation depends not only on technology, but also on the adaptation of the regulatory

Table 1. Components of the architecture of digital transformation of science.

Component	Description	Meaning
Digital Infrastructure	Technical foundation including high-performance computing (HPC), cloud platforms, big data storage and processing systems	Provides scalability, speed of information processing and access to computing resources for scientific tasks
Data Analysis and AI Tools	Use of machine learning, artificial intelligence (AI), data science methods and data visualization	Allows you to automate analysis, identify complex patterns and accelerate scientific discoveries
Open Science Platforms and Repositories	Systems for publishing and exchanging data (e.g. arXiv, Zenodo), open knowledge bases, electronic journals	Increase transparency, accessibility and reproducibility of research
Automation and Smart Labs	Robotic laboratory setups, IoT sensors, systems for automatic collection and processing of experimental data	Reduce human errors, speed up experiments and allow remote management of research
Scientific Project Management Systems	Digital tools for research coordination (e.g. electronic laboratory journals, collaboration systems)	Improves the organization of scientific groups, data version control, and collaboration
Data Security and Protection	Cybersecurity, authentication systems, blockchain for verification of scientific results	Ensures the safety of intellectual property and protection against falsification
Educational and Training Digital Systems	Online courses, simulators, VR/AR simulators for training scientists	Helps researchers master digital technologies and new working methods
Regulatory and Ethical Framework	Regulations on the use of AI, processing of personal data, copyright in digital science	Provides a legal basis for digital transformation without violating ethical standards

Source: authors.

framework and personnel training. In the future, the development of the digital architecture of science will become a key factor in ensuring competitiveness and sustainable progress in the research field.

4 Discussion

Modern scientific research in the field of digital transformation architecture of science demonstrates a comprehensive approach to the integration of digital technologies into scientific activities [3]. In modern science, three key areas of research are distinguished:

technological (implementation of Big Data, AI and cloud computing) [4], organizational (Agile methodologies and digital collaboration platforms) [5] and normative (legal and ethical aspects of digitalization) [6]. Particular attention is paid to the interdisciplinary nature of the transformation, where the convergence of computer science with traditional scientific disciplines is of particular importance.

There is a steady trend towards openness of the scientific process, expressed in the active development of the Open Science concept and the implementation of the FAIR principles (Findable, Accessible, Interoperable, Reusable) [7]. At the same time, researchers note significant technological gaps between various scientific organizations and countries, which creates the problem of digital inequality. The conservatism of the academic environment, slowing down the processes of digital adaptation, remains an important barrier. Promising research areas include the development of unified architectural models for various scientific disciplines, the study of the transformation of scientific methodology under the influence of AI (in particular, generative models), and the analysis of long-term cognitive and organizational consequences of the digitalization of science [8, 9]. Modern works emphasize the need for a balanced approach that takes into account both technological capabilities and institutional constraints. Further development of this area requires comprehensive research aimed at harmonizing technological innovations with the needs of the scientific community and existing regulatory frameworks.

5 Conclusion

Modern studies of the architecture of digital transformation of science reveal the complex process of integrating advanced technologies into scientific activities, which requires a systematic approach. Scientists highlight three key aspects of digitalization: technological (implementation of artificial intelligence, big data and cloud computing), organizational (transition to Agile methodologies and digital collaboration platforms) and normative (development of legal and ethical standards). Of particular importance is the interdisciplinary nature of the transformation, where computer science intersects with traditional research areas. In recent years, there has been a steady increase in interest in the Open Science concept, which is manifested in the creation of open repositories and the implementation of FAIR principles for scientific data. However, researchers note significant differences in the level of digitalization between countries and scientific organizations, creating the problem of technological inequality. An important challenge remains resistance to change in the academic environment, slowing down adaptation to new digital realities. Promising research areas include the development of universal architectural models applicable in various scientific disciplines. The study of the influence of generative AI on the process of forming scientific hypotheses and conducting research deserves special attention.

The need for a comprehensive analysis of the long-term consequences of digitalization for the cognitive processes of researchers and the organization of scientific work is emphasized. Modern publications demonstrate that technological innovations in science are ahead of the development of the regulatory framework and the adaptive capabilities of the scientific community. Further development of the digital transformation of science requires a balanced approach that takes into account both technological progress and

the socio-cultural aspects of scientific activity. Solving these problems will create a sustainable ecosystem of digital science that will contribute to the acceleration of scientific and technological progress and global scientific collaboration.

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Economic, Managerial and Institutional Aspects of Decision Support Systems Based on Artificial Intelligence

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Abstract. This contribution considers economic, managerial and institutional aspects of the implementation of decision support systems based on artificial intelligence technologies (AI-DSS) in agriculture. The main advantages of using AI-DSS, such as increased efficiency, productivity and sustainability of agricultural production, are analyzed, and obstacles hindering the widespread use of these technologies in the agro-industrial complex are identified. Particular attention is paid to the specifics of the Russian context, including modern initiatives for the digitalization of agriculture, the role of universities, agro-industrial holdings and the state. The authors note the existing challenges that need to be overcome in the implementation of AI-DSS, including shortcomings in regulatory frameworks, difficulties in technological integration and a shortage of qualified personnel. The study compares the results with global trends and practical experience in implementing AI-DSS in the European Union, the USA and China. The conclusion contains recommendations on how to take the necessary measures for the successful implementation of AI-DSS in the agricultural sector of the economy.

Keywords: Agriculture · Artificial Intelligence · Decision Support Systems · Digital Competencies · Digitalization · Innovations · Sustainable Development

1 Introduction

In the context of global population growth and climate change, modern agriculture faces the challenge of increasing productivity and sustainability of production. Artificial intelligence (AI) technologies are considered a key driver of the new agro-technological revolution, which can help achieve the UN Sustainable Development Goals. AI-based decision support systems (AI-DSS) are software and analytical complexes that analyze large arrays of heterogeneous data (from sensors, meteorological services, markets, etc.), identify hidden patterns and generate recommendations for optimizing agro-technological operations [1]. In the agricultural sector with its high degree of uncertainty (climate, biological, price), such intelligent systems enable more accurate yield forecasting and

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risk assessment, rational use of resources and a proactive response to problems, while reducing the influence of the human factor. Globally, the use of AI-DSS in agriculture is rapidly expanding. In 2022 alone, more than 3,900 scientific papers on AI in the agricultural sector were published, reflecting the rapid growth of interest among researchers in the implementation of innovations. The world's largest economies are investing in the digitalization of the agro-industrial complex: for example, the total volume of global investments in agritech startups tripled from 2014 to 2019 and reached $20 billion [2]. In the EU, the smart farming infrastructure is being created and research on the use of AI in agriculture is supported (the Horizon 2020 programs and test sites for AI solutions), in the USA, the private sector and agribusiness startups are actively implementing AI on farms, and in China, the state and technology giants (Alibaba, Tencent, etc.) are developing smart agriculture platforms with the integration of AI at all stages: from production to logistics [3].

Russia also recognizes the strategic importance of the digital transformation of the agricultural sector. In recent years, the country has become one of the largest players in the global agricultural market, and based on the draft changes to the development strategy for the agro-industrial and fisheries complexes for the period up to 2030, an increase in agricultural exports to $40 billion is expected in 2025 [2]. To achieve competitiveness in the digital era, emphasis is placed on innovations. Government initiatives have been launched (the project «Digital Agriculture», pilot projects on precision farming and robotization are being implemented). However, there is a gap between the potential of technologies and their practical implementation. This work aims to analyze the economic benefits, management changes and institutional conditions associated with the implementation of AI-DSS in the agricultural sector, with a special emphasis on the realities of the Russian market.

2 Methodology

The study is conducted in the format of an analytical review with elements of comparative analysis. The methods of system analysis and case study were used as a methodological basis: a review of current scientific literature, industry reports of international organizations and strategic regulatory acts of the Russian Federation in the field of digitalization of the agro-industrial complex was conducted. The analysis covers examples of the implementation of AI-DSS in various sectors of agriculture (crop production, livestock farming and agrologistics) and assesses the associated economic effects, management changes and requirements for institutional conditions. Particular attention is paid to identifying barriers and success factors in the integration of AI-DSS into agricultural production, for which purpose the Russian experience was compared with the best foreign practices. The reliability of the conclusions is ensured by relying on research data confirming the theses and the principle of triangulation of sources.

3 Results

All over the world, intelligent technologies are becoming an integral part of agricultural technologies. The main economic benefits of using AI-DSS are primarily manifested in increased production efficiency, reduced costs and increased yields. Thus, AI models

make possible more accurate forecasting of weather conditions and yields, optimization of sowing and harvesting dates, and effective detection of disease and pest outbreaks in fields [4]. For example, the use of machine learning algorithms for agrometeorological data allows farmers to plan sowing campaigns and irrigation work in advance, which reduces losses from adverse weather events. In the field of plant protection, computer vision-based solutions are able to recognize diseases from images of leaves and ensure targeted application of protective equipment, reducing costs and the burden on the ecosystem. As a result, farmers receive increased yields and product quality with more rational use of resources.

In animal husbandry, AI-based DSS helps to monitor the health and productivity of livestock. A striking example is the IDA system, created using AI technologies: it is capable of analyzing the behavior of cows on dairy farms 24/7. During a pilot project in the EU, this system learned to detect deviations in animal behavior and diagnose diseases two days before the onset of visible symptoms. The result is a reduction in average treatment times from 3.16 to 1 day per cow (68–77% less) when using IDA sensors compared to the control group. This led to an equivalent reduction in the use of antibiotics and, as a result, a reduction in treatment costs, the risk of loss of productivity, and an increase in the quality of the final product. This case demonstrates how AI-based DSS improves the economic performance of farms through early detection of problems and preventive actions. In agricultural logistics and sales, AI is used to optimize supply chains and reduce product losses. For example, in China, the Alibaba Cloud Agriculture ecosystem integrates AI for crop quality analysis (fruit ripeness assessment, sorting) and supply management. This allows farmers to directly access markets via electronic platforms, and logistics operators to forecast volumes and optimize delivery routes. As a result, storage and transportation costs are reduced, crop losses are reduced, and satisfaction with product quality among end consumers is increased.

The implementation of AI-DSS not only brings tangible economic benefits, but also transforms management processes in agriculture. Management decisions are increasingly based on data and algorithm recommendations which require new competencies from managers. Farmers and agronomists are increasingly becoming users of digital platforms, and they need skills to interpret analytical reports and develop trust in AI prompts. One of the limiting factors in this context is the lack of digital literacy and a cautious attitude towards new technologies among farmers. Among the global challenges in the dissemination of AI in agriculture, there are insufficient awareness of farmers about these solutions and the lack of skills to use them. Therefore, the role of educational institutions and advisory services in training new specialists – «digital agronomists» – is increasing. A network of relevant educational programs is already developing in Russian universities: as of 2023, there are 95 university centers in 35 regions implementing about 298 educational programs in the field of AI, annually graduating thousands of specialized specialists [5]. Such personnel are capable of ensuring the adaptation and support of AI-DSS in production. However, the problem is not limited to user training – reengineering of business processes in agricultural enterprises is often required. AI technologies make it possible to revise technological chains, get rid of inefficient nodes in information flows, etc. However, only large players can do this, while small farms experience difficulties because of the lack of resources to ensure transformation. In Russia as a whole, only

5.4% of organizations use AI technologies, and these are mainly large companies (with more than 10 thousand employees) [5]. This management barrier is also typical for other countries, where small farmers often lag behind in digitalization. It can be overcome through cooperation (for example, the use of subscription-based AI services or through agricultural IT platforms), the participation of specialized universities in the transformation of business processes of small agricultural enterprises (consulting, outsourcing) and government support (subsidizing the acquisition of technologies, organizing competence centers).

Successful integration of AI-DSS requires an appropriate institutional environment. Key factors include infrastructure development (broadband Internet in rural areas, sensors and IoT networks), standardization of data and protocols, and regulatory framework. The lack of common standards and compatible platforms is currently recognized as one of the global barriers: the fragmentation of data and technologies makes it difficult to scale solutions. In addition, data protection and cybersecurity mechanisms are required, especially when exchanging information between different participants in the agricultural production chain. Since the factors influencing the development of AI in the agro-industrial complex (infrastructure, investment, human resources, etc.) are under the control of different stakeholders, cross-sector interaction and coordination of efforts are necessary. The role of the state is to create conditions for such interaction. Various approaches are used around the world: governments finance scientific research and pilot projects, create experimental sites («sandboxes») for testing agricultural robots and AI, launch preferential lending and insurance programs for farms implementing digital transformation. Such initiatives stimulate the implementation of technologies, linking them directly to economic benefits for agricultural producers. Finally, institutional support is important in terms of updating the regulatory framework to new realities – from allowing the use of unmanned equipment in the field to regulating the circulation of large agricultural data.

In Russia, there is significant interest in AI-based innovations among agricultural market players. Large agricultural holdings are introducing elements of precision farming, unmanned agricultural machinery, and field monitoring platforms. Joint projects are being created between universities and production (for example, AI solutions for managing feeding and breeding work are being tested on educational and experimental farms of agricultural universities). However, the realization of the potential of AI-DSS is hampered by a number of institutional barriers. In particular, the following problems are highlighted:

– incompleteness and inconsistency of the regulatory framework (legislation does not keep up with the development of technologies: a number of aspects (data flow, use of AI, responsibility for decisions of automated systems) remain unregulated or are regulated by outdated standards);
– weak dialogue between science and business (agricultural research institutions, universities and agricultural companies are not sufficiently integrated: there are no effective mechanisms for transferring technologies from laboratories to the field; this is facilitated by a shortage of modern equipment in a number of research institutes, a shortage of highly qualified personnel, a low level of interdisciplinary developments, as well as differences in research priorities and practical needs of the industry);

– inertia of support measures and a lack of incentives for innovation (current government programs to support the agro-industrial complex are focused primarily on traditional areas and large-scale production. Instruments for financing breakthrough digital solutions are poorly developed).

The above barriers lead to the fact that even successful pilot projects are slowly scaling up. At the same time, there are some positive shifts: the federal scientific and technical program for the development of agriculture is being updated taking into account the tasks of digitalization, competence centers are being created. To overcome the gap between the innovative potential and its implementation, coordinated actions are required from all participants – from training specialists at the intersection of IT and agriculture, to the formation of markets for new technologies.

4 Discussion

Based on the conducted analysis, the following key aspects can be identified:

– economic effect of AI-DSS: intelligent decision support systems demonstrate tangible benefits (increased productivity and reduced costs);
– barriers to implementation: the spread of AI-DSS is hampered by high start-up costs, a shortage of high-quality data, and the lack of uniform standards for technology integration, in addition, there is a lack of digital competencies among end users - farmers and agricultural managers;
– the Russian specifics: in the agricultural sector of the Russian Federation, despite the high interest in AI solutions, additional institutional problems have been identified; these include an outdated and fragmented regulatory framework, weak interaction between scientific institutions and businesses, as well as an acute shortage of specialists;
– the role of stakeholders: successful integration of AI-DSS is possible only with the joint efforts of all participants in the agricultural and technological sectors of the economy.

5 Conclusion

AI-DSS is a key tool for increasing the efficiency and competitiveness of agriculture in the digital economy. Their use facilitates the transition of the agricultural sector to data-based management, which strengthens the validity of decisions and reduces costs and risks. Global experience (EU, USA, China) shows that with sufficient investment and support for innovations, AI solutions in the agro-industrial complex lead to a significant increase in productivity and sustainability of production. Russia has significant agricultural potential and scientific groundwork in the field of AI, but to realize these benefits, it is necessary to overcome institutional barriers. It is necessary to adapt the regulatory framework to new technologies, introduce standards for the exchange of agricultural data and ensure the availability of digital infrastructure in rural areas. The most important task is personnel training: training and retraining programs should provide the industry with specialists capable of working with AI-DSS and integrating them into

business processes. At the management level, the success of implementing AI-DSS is associated with openness to organizational changes: heads of agricultural enterprises should view AI not as a threat, but as a support tool that allows strengthening human expertise. Institutionally, it is necessary to establish mechanisms for technology transfer – from pilot projects and scientific developments to widespread practical application. To summarize, we can conclude that the integration of decision support systems based on artificial intelligence in the Russian agricultural sector can become a catalyst for its sustainable growth. Provided that the state, science and business take coordinated actions, AI-DSS will help the domestic agro-industrial complex increase efficiency, reduce costs and strengthen its position in the global food market. Further research and practical experience in this area should be aimed at finding optimal implementation models, assessing the long-term economic impact, and creating an institutional ecosystem conducive to digital innovation in agriculture.

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The Role of Research Human Capital and Digitalization in Regional Economic Development

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Abstract. In the context of innovations and digital technologies, human capital has become one of the factors of regional growth and the elimination of interregional disparities. Human capital is a set of extremely heterogeneous components – from average health indicators to characteristics of the structure of specializations and the degree of qualification of workers. The research purpose is to assess the role of human resources engaged in research and development (R&D) in regional growth. The study verifies the significance of the digital transformation in determining the degree of influence of such human resources. A lot of studies have noted that the implementation of human capital depends on the level of industrial development and the degree of urbanization of the region. The absorptive capacity of organizations – the ability to adapt and apply new technologies, especially digital ones – is also associated with the level of agglomeration development. The authors consider the impact of the demand for R&D and the pace of change in organizations' efforts to implement digital technologies on the regional economies. Particular attention was paid to the dynamics of the number of R&D personnel. The statistical data were analyzed using a dynamic panel data model. The study showed that the demand for R&D and the capital intensity of research personnel, in interaction with the pace of digital transformation of the Russian economy, have a positive impact on the development of the regions of the Volga Federal District. The presence of concomitant structural changes in research personnel was also noted.

Keywords: Digital Transformation · Economic Growth · Human Capital · Innovation · Regional Development

1 Introduction

Human capital is an integral characteristic of the labor resources of the economy. The judgment about the direct influence of human capital on the economic development of countries and regions is obvious. Human capital determines the level of productivity of companies and budget filling, the efficiency of intangible assets and material resources, as well as increasing the results of using human resources at all stages of social production. The level of human capital is also a factor in reducing the gap between the local and general levels of technology.

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The education system is the main source of human capital development in society. At the same time, the effect of such investments is long-term. In this context, the problem of the scale of the history of statistical observations is acute. However, the dynamics of the number of graduates of educational institutions, or personnel with a certain level of qualification is short-term in terms of impact on the economy. The number of highly qualified personnel, on the one hand, characterizes the national economy by the level of human capital development. On the other hand, such personnel are also the most productive component of human resources. In addition, such a part of human resources is a source of the mechanism for the flow of knowledge into innovations, thus providing a multiplicative return on their labor. Based on this, it can be assumed that within the regional ecosystem, research personnel play a key role in determining the ability of enterprises to adapt digital technologies and carry out other digital transformation activities.

Despite the participation of human capital in all spheres of the economy, its concentration in the branch of economic activity may vary depending on the level of knowledge intensity of the branch and the specifics of the branch disproportionality of the national economy. Individual branches may be the core of the human capital of the economy, forming a basis of the transmission mechanism of knowledge transfer to the real sector of the economy. Thus, the presence of the influence of the most qualified personnel on the economy of individual regions may not be so unambiguous – representatives of individual branches may not be involved in the branch specialization of the region. As a result, their work may not be fully effective, and, in addition, they may be outside the processes of knowledge flow. This problem does not exist in the context of regional innovation systems.

2 Methodology

Our goal was to study, using economic and statistical methods, the impact on regional economic development of the interaction of research human capital and demand for R&D with the digital transformation taking place in the Russian economy. The dependent variable in the model described below will be the gross regional product (GRP). As a research tool, we chose the analysis of dynamic panel data using the generalized method of moments (GMM). This choice is based on the size of the history of statistical observations, as well as the risks of endogeneity of the studied indicators. The details of the application of the dynamic panel method in the study of regional economies were studied based on the works by [1–5]. The methodology for assessing the dynamics of economic growth in our case consists of constructing a specific model for the empirical analysis of indicators characterizing the level and dynamics of the use of research human capital.

The indicators of the level of research human capital in this study is a number of personnel engaged in R&D related to the level of demand of regional companies for the labor of researchers and developers. In addition to the obvious direct approximation of the capital-labor ratio of researchers, this relative indicator reflects the expected performance of human resources in this area by firms, which more accurately reflects the level of human capital in the R&D field of a region. It is also assumed that digital transformation processes have a significant impact on the level of such demand. Research

and development within the region are aimed primarily at reducing the technological gap. Based on this assumption, this indicator, like the second one described below, were adjusted for the proxy of the pace of digital transformation in the Russian economy. The indicator of internal costs of organizations for the implementation and use of digital technologies was used as such a proxy. This indicator was transformed into an index of growth of such costs – where the costs of the current period were related to the costs of the previous period. Directly, the demand for R&D approximates the indicator of current expenditures on them. Among other things, this indicator also characterizes the level of need of economic entities for highly qualified personnel.

For this study, panel data were collected for the period from 2018 to 2021 for 14 regions of the Volga Federal District (VFD), including: the Republics of Bashkortostan, Mari El, Mordovia, Tatarstan; Kirov, Nizhny Novgorod, Orenburg, Penza, Samara, Saratov, and Ulyanovsk regions, the Perm Krai and the Udmurt and Chuvash Republics. All data used were obtained from the Federal Statistics Service database, as well as from the results of statistical studies of the Institute for Statistical Studies and Economics of Knowledge of the Higher School of Economics (HSE). The GMM was used to estimate the parameters, this method is suitable for controlling for the specifics of regions and for solving problems of endogeneity, bias of estimates under the influence of missing values. In addition, this method is more desirable for studying variables with a fairly short time series [2].

3 Literature Review

The theory of human capital as a concept for economic analysis dates back to the 1950s and 60s. Modern ideas about human capital as a factor in economic growth have been developing since the mid-20th century under the influence of the transition to the post-industrial stage of social development. The «knowledge economy» that emerged as a result of this transformation process required a new assessment of the role of qualified and highly qualified human resources [6]. According to [7], each additional year of education contributes to a person's income growth by 7%. Further studies show the relationship between the average level of human capital and the economic growth of regions.

I.N. Karelin and A.V. Koritsky [8] note that the high quality of human capital in the country contributes to the inflow of foreign direct investment, and also highlight that foreign direct investment also affects the development of the quality of human capital in a particular state. According to A.V. Koritsky [9], the influence of human capital on the regional economy has the characteristic features of externalities. The benefits of highly educated human resources cannot be fully appropriated by an individual firm. This creates external effects that contribute to the choice of localization of firms. One of the results of this is that regions with a higher level of human capital also have a higher level of investment attractiveness.

An increase in the average level of human capital can also contribute to the socio-economic development of the region. L. Lochner and E. Moretti [10] developed an economic and mathematical model according to which subsidizing education reduces crime, and the savings in social losses from reducing crime can fully offset the costs

of subsidies. A.B. Dankyi [11] notes in his scientific works that there is a relation between human capital and foreign direct investment, but such a correlation is of average significance. The researcher argues that the inflow of foreign investment (especially in countries with low and medium living standards) is effectively and positively influenced by a combination of investments in human capital, medicine, urbanization and control of harmful emissions. Evaluation of the contribution of training and education of employees affects the growth of the economic indicators of the organization [12].

Sociologists and economists who supported the filter theory in the 1970s [13] influenced the development of the human capital theory. According to this theory, companies initially select more promising candidates for work with certain skills and education, thereby filtering personnel. R.J. Barro [14] notes the presence of a relationship between a high level of human capital and the rate of economic growth of a country.

U. Akcigit and S.T. Ates [15] argue that large firms are more intensively implementing digital technologies. Following the results of their analysis, the ability to invest in digital transformation, in sufficient volume, determines the required scale of the corporation. The process of digital transformation exactly follows the already known patterns of innovative activity. Y. Cheng, X. Zhou and Y. Li [16] considered processes of digital transformation in conjunction with innovative activity. According to the results of their study, investments in digital transformation not only require a certain level of human capital, but also lead to structural changes in human resources. In addition, researchers note the possibility of scenarios where such investments reduce productivity indicators not only in the short term but also in the medium term, due to the significant time lag in the adaptation and market realization of the results of such investments.

4 Results

Investments in science and R&D to a certain extent come from the need for the state to perform its social functions. As a result of this, and communication problems, the demand in the labor market, arising from the industry specification of a region, and the provision of the market with personnel of a certain qualification may not correspond to each other. Thus, with the undeniable positive role of human capital development for the national economy, certain aspects of the sources of funding for the research sector raise the question of a quantitative assessment of the role of human capital in the regional economy. Similar difficulties with identification are also associated with digital transformation processes – factors and consequences of such processes are often not localized in a single agglomeration, since the use and development of digital technologies are least associated with transport costs. At the same time, the demand of firms to maintain the intensity of digital transformation can be approximated through their costs of implementing and developing relevant technologies. In this case, issues of digital transformation of regional systems are closely dependent on regional innovation sectors, since often the adaptation of production processes is associated with the development of new solutions. Thus, the significance of the indicators characterizing the innovation systems of regions depends on their compliance with the processes of technological change and digital transformation observed in the Russian economy. In order to verify this, the indicators were transformed into interaction variables by multiplying the number

of researchers and R&D costs by the growth rate of Russian organizations' costs for the implementation and use of digital technologies.

Since the studied variables cannot sufficiently explain the dynamics of GRP, a dynamic panel model was constructed, including lagged values of GRP. In addition, such an approach will allow solving the possible problem of endogeneity in indicators of a common nature. The study used a two-step GMM estimate, since the two-step system is better in handling autocorrelation and heteroscedasticity. The parameters were estimated using the «gretl» software. The results of the model parameter estimation are presented in Table 1.

Table 1. Estimates of model parameters.

Two-step dynamic panel, observations used – 70					
14 spatial objects included					
H-matrix as per Ox/DPD					
Dependent variable: l_WRP					
Asymptotic standard errors					
	Coefficient	Statistical error	z	P- value	
l_WRP(-1)	0,880957	0,00214361	411,0	< 0,0001	***
l_interaction 1 (RDemp * C)	0,128196	0,00678853	18,88	< 0,0001	***
l_interaction 2 (RDsp*C)	0,0452447	0,00478659	9,452	< 0,0001	***
Residual sum of squares, RSS	0,712762	Statistical error of the model	0,103142		
Number of instrumental variables = 16					
Test for AR(1) errors: z = -2,232 [0,0256]					
Test for AR(2) errors: z = -1,57281 [0,1158]					
Test of overidentifying restrictions: Sargan Test: Chi-square (9) = 13,6988 [0,3954]					
Tests for normally distributed errors: Chi-square (2) = 1,52834; p- value = 0,46572					

Source: authors based on [17, 18]

where:

WRP – gross regional product (GRP), million rubles;

RDemp – ratio of current R&D costs to the number of personnel engaged in such work in the region, rubles per person;

RDsp – current expenditure on R&D in the region, million rubles;

C – index of growth of internal costs of organizations for the implementation and use of digital technologies in Russia.

The results of the model parameter estimation confirm the assumption about the positive and significant influence of both interaction variables on the regional economy.

The estimated coefficients are in the same order of magnitude as the coefficient of the lagged GRP variable, which may indicate sufficient explanatory power of the synthetic interaction indicators.

In a more general sense, the results indicate that the rates of expenditure on the implementation of digitalization do not distort the influence of R&D expenditure and the dynamics of human resources in this area. At the same time, the analysis of the influence of the capital-labor ratio indicator requires consideration of the observed structural changes in R&D personnel.

The variable of capital-labor ratio of researchers can be influenced by a process common to Russia, characterized by positive dynamics of R&D expenditure, with simultaneous negative dynamics of the number of researchers. It is worth disaggregating the indicator of the number of researchers, paying attention to the features of structural changes in this area. It seems to us that such features are the dynamics of the number of researchers in the context of fields of science. The corresponding statistical information is presented in Table 2.

Table 2. Dynamics of the number of researchers by field of science, Russian Federation.

Year	Total	including by fields of science					
		natural	technical	medical	agricultural	social	humanitarian
Researchers							
2018	347854	78661	214233	14327	9575	19046	12012
2019	348221	79270	213942	14416	9459	19466	11668
…	…	…	…	…	…	…	…
2022	340666	84461	201513	14190	9315	18665	12522
2023	338900	83346	201569	14231	9445	17708	12601
Doctors of Science							
2018	25288	11302	4259	3365	1243	2862	2257
…	…	…	…	…	…	…	…
2023	22626	10014	3464	3227	1122	2491	2308
Candidates of Science							
2018	75042	30804	19816	5947	3940	8970	5565
…	…	…	…	…	…	…	…
2023	69975	29827	16893	5595	3711	8046	5903

Source: authors based on [17, 18]

The data provided show that the number of researchers with academic degrees in the social sciences and humanities decreased by less than 2.5% over the period 2018–2023. At the same time, the number of researchers in medicine, agriculture, and natural sciences decreased by more than 5% over the period under review. At the same time, a similar increase is observed in the number of representatives of the natural sciences – about

6%. However, in this scientific field, there is a decrease in the number of researchers with doctoral and candidate degrees – by 11% and 3%, respectively. Similar dynamics in intensity are in the case of doctors and candidates of technical, medical, and agricultural sciences – a decrease in the total number by 12% and 15%, respectively. At the same time, the relative decrease in researchers with academic degrees in the social sciences and humanities is significantly lower and amounts to about 5%. At the same time, the dynamics of the total number of R&D personnel in the regions under study is multidirectional and does not have a constant trend – with short periods of growth or decline. Interaction with the used indicator of the digital transformation rate increases or decreases the degree of influence of these heterogeneous trends.

5 Conclusion

Our analysis expands understanding of consequences of digital transformation and the role of human capital for regional systems. The work investigates the short-term dynamics of the indicators of the research sector of the regional economy. This dynamics was correlated with the conjuncture of structural changes at the macro level. The example of the Volga Federal District regions shows that the processes of structural and technological changes do not change the expected nature of the impact on the regional growth of demand for R&D and for human resources in this area.

Accelerating processes of digital transformation can interact with the described structural changes. It can also be assumed that such interaction changes the requirements for the research sector. In other words, the changing technological paradigm requires greater capitalization of the R&D industry. When analyzing the results of the model assessment, it is also worth considering that the results of R&D, especially those carried out at the corporate level, are protectable intellectual property (patents, know-how, etc.). This also ensures the sustainability of the influence of the research sector on the regional economy – intangible assets are taken into account in the GRP. At the same time, the efficiency of using such assets directly depends on their compliance with the current dynamics of technologies. In this study, the compliance of R&D with the requirements created by the dynamics of digital transformation was checked. For this purpose, the interaction factor modeling approach was used.

This contribution considers not only the specifics of the impact of R&D on the regional economy. The importance of this correspondence is indirectly confirmed by other observed processes. A significant decrease in the number of representatives of natural, technical and agricultural sciences was noted. This fact may indicate a change in the scope of application of digital transformation. There is an increase in the share of researchers in the fields of humanitarian and social work. This may be a consequence of the increasing demand for R&D of digital transformation in the area related to the interaction of firms and consumers, through the analysis of large data sets. As a result of the model evaluation, a significant impact of the capital intensity indicator of researchers was noted while maintaining the growth of demand for digital transformation and R&D. This may indicate the increasing productivity of R&D personnel, which is reflected in the performance indicators of regional enterprises. Among other things, this result may indicate that the overall pace of digital transformation may increase the need of economic entities to borrow and adapt ready-made technologies.

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Grant Support for SMEs: The Path to Technological Development of the Region

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Abstract. Among the main national priorities of the Russian state policy, there is obtaining competitive advantages in solving problems of global scientific and technological frontiers, as a basis for sustainable economic development. In this regard, in order to ensure the increase of financial and quantitative indicators in the scientific sphere, studies are needed on the effectiveness of national measures to support and stimulate entrepreneurial activity, including at the regional level. The relevance of the work is determined by the growing need to generalize knowledge about the role and economic dependence of small and medium-sized businesses as a basis for ensuring the sustainability of the country in the interests of scientific and technological development of regions. The research objective is to solve problems of assessing criteria for determining small entrepreneurship, taking into account fundamentally new sectors of the economy on a global scale. The scientific novelty of the study consists in providing additional arguments in favor of the theses on the need to build up the scientific and technological potential of territories. The share and contribution to the development of the entrepreneurship sphere of various countries are considered, forms of state support for small businesses in Russia are described, an approach to the concept of a regional innovation ecosystem is defined.

Keywords: Economic Development · Grant Support · Region · Scientific and Technological Potential · Small and Medium Enterprises

1 Introduction

There is a large amount of information in the scientific literature on the role of small and medium-sized enterprises (SMEs) in the development of the economic system of any state. Over the past three decades, the private sector has been at the forefront of major economic transformations, job creation and poverty reduction around the world [1, 2]. Thus, N.V. Kovalenko and T.A. Suleymanova [3] note that countries with a high level of economic development are characterized by the popularization of SMEs as the basis for ensuring the economic sustainability of the country. The share of the population employed in the SME sector in some countries is: in the European Union – 75%, in

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the USA – 65%, in Russia – 26%, in Japan – 80%. Currently, Russia is significantly lagging behind the countries – technological leaders in terms of innovative activity [4]. Entrepreneurial ecosystems include organized stakeholder communities and external resources that focus on identifying opportunities, implementing them, and scaling them [2].

2 Methodology

Global problems and their place in sustainable development today are an integral part of the modern world. There is a lot of works on the specifics of scientific development in the interests of a sustainable future, including scientific, technological and innovative potential, in Russia and internationally. Assessing the role of scientific and technological potential and analyzing the existing system of state support for small businesses, its subsequent effectiveness has long been the subject of in-depth study by specialists in the field of economic sciences [5–8]. In addition, important sources of information on issues under consideration are official and statistical materials and regulatory documents reflecting the state of the scientific and technological potential of Russia [9]. But it is worth noting that today, in the current political and economic reality, existing studies on this issue have not sufficiently developed theoretical, methodological and practical approaches to justifying the stimulation of innovative activities of small and medium-sized enterprises that do not have their own funds and capabilities for research, as well as building links for technology transfer between scientific organizations and businesses [10, 11]. The purpose of the study is an economic assessment of the sufficiency of government support measures for the development of small and medium-sized businesses (in the innovation market segment) and the constraints in the field of scientific research and development of the Russian state (in the context of the socio-economic agenda and as one of the tasks of national technological sovereignty). A specific task, within the framework of the problem, which this study and a number of other works of the authors are aimed at solving, is to develop recommendations for clarifying and adjusting the set of measures to support research and entrepreneurial activities, including in the regional aspect.

The methodological basis of the study is made up of the following methods of scientific knowledge: retrospective analysis, hypothetic-deductive method, secondary analysis of data on the issue under study, as well as grouping and rating methods. The conducted study deepens the existing works of the authors on the assessment of the scientific and technological potential of territories in the regional aspect and involves in theoretical understanding of directly related legislative initiatives to develop a system for selecting and subsequently financing the most promising innovative projects of small and medium-sized businesses and those entrepreneurs who are ready to develop inventive projects. Based on the results of the analysis, a conclusion was made about the direct relationship between the rating of regions in terms of scientific and technological development and statistical data on the share of supported applications of the Innovation Assistance Fund, and the authors' recommendations were given on increasing the scientific and technological potential of the territories. The work presents results of the secondary analysis [12–14]. The use of a systematic approach to the study of new forms

and methods of support for small and medium-sized businesses will allow us to evaluate the active state policy that today provides assistance to SMEs.

3 Results

The Strategy for Scientific and Technological Development of the Russian Federation [15] sets the priority goal of ensuring the country's independence and competitiveness by creating an effective system of technological development and building up intellectual potential. Today, there are several ratings of regions in the Russian Federation by scientific and technological development. Let's consider several of the most common of them. In August 2024, a rating of innovative development of regions of the Russian Federation was published. The leaders were Moscow, St. Petersburg and Tatarstan. Nine regions significantly improved their positions (by 10 or more points), and the number of leaders in the quality of innovation policy increased from 15 to 19. The success of «breakthrough» regions is associated with the improvement of socio-economic conditions and scientific and technical policy. For example, the Omsk Region rose by 36 positions, the Khabarovsk Territory – by 33 [16]. In December 2024, at a meeting of the Commission for Scientific and Technological Development, a rating of scientific and technological development of regions based on the results of 2023 was presented. The national rating is published by the Ministry of Education and Science of the Russian Federation for the third time and is designed to stimulate regional administrations to take effective measures to develop the scientific and technical sphere.

The rating is formed on the basis of 43 indicators, combined into three groups:

1. Involvement of regional authorities in the development of the scientific and technological sphere.
2. Conditions for attracting knowledge-intensive businesses to the region.
3. Conditions for the work of researchers and scientists.

The rating serves as an important tool for assessing and stimulating the scientific and technological development of regions, promoting the implementation of best practices and strengthening Russia's position in global technological competition. The newest rating for assessing the innovative development of regions was developed by the Association of Innovative Regions of Russia. Based on the index values, regions are combined into five groups from group A (the highest level of innovation development in this area) to group D (low level). It should be noted that only the Republic of Tatarstan fell into category A for all integral indicators, two regions, Moscow and St. Petersburg, into 5 of 6 categories. According to the conducted study, the level of innovative development from region to region is characterized by high unevenness. Most of the regions demonstrating a high level of innovative activity are located in the Volga Federal District, the lowest level is in the North Caucasian Federal District [17].

Three regions, Moscow, St. Petersburg and the Republic of Tatarstan, are leaders in each of the ratings provided. This is largely determined by the presence of a powerful scientific and educational base, human resources, developed innovation infrastructure, active involvement of the authorities in the development of technological entrepreneurship, high concentration of business and investment in these subjects of

the Russian Federation. All this contributes to the accumulation of successful practices in the implementation of innovations.

Federal state programs for support of innovative projects have been approved and are in effect in the Russian Federation. These programs are implemented by the Innovation Assistance Fund. Table 1 provides a list of the main programs and expected results in case of support of an innovative project or company.

Table 1. List of programs in the Innovation Assistance Fund.

Program name	Expected results
InnoShkolnik	Involvement of schoolchildren in innovative and scientific activities
Student startup	Support for student startup projects
Umnik	Support for commercially oriented scientific and technical projects of young scientists. A pre-acceleration program was completed at an organization included in the register of pre-accelerators accredited by the Fund, with the aim to develop prospects for the commercial use of R&D results
Start – 1 Start – 2 Business startup	The program is aimed at creating new and supporting existing small innovative enterprises seeking to develop and master the production of a new product, item, technology or service using the results of their own scientific, technical and technological research Promoting international cooperation, supporting projects for the development of non-resource export-oriented products. IP protection in the process of R&D, including in the markets to which the delivery of products under the project was planned
Internationalization	Increase in the volume of sales of innovative products created as a result of the project, including products supplied to foreign markets
Commercialization	Support for small innovative enterprises that have completed R&D and are planning to create or expand production of innovative products
Development	Support for companies with experience in developing and selling high-tech products. IP protection during R&D. Creation of own production of high-tech products
Digital Economy	The programs are aimed, among other things, at stimulating the transition to Russian digital solutions in the context of foreign software vendors leaving the market

Source: authors.

As we can see from Table 1, the Innovation Assistance Fund implements a wide range of financial support, which is aimed at a different range of objects – schoolchildren, students, start-ups, SMEs. The main criterion for large-scale financing is the amount of extra-budgetary financing. It should also be noted that in the column «Expected results» almost all large programs have IP protection, which is an important indicator in distributing the rating of regions by scientific and technological development.

All the results are aimed at increasing the scientific and technological development of a company and, as a consequence, a region where it operates. For large grants, the SIE (small innovative enterprise) indicators have been established, according to which the company must report for 5 years upon completion of the grant. Among these indicators, there is registration of intellectual property results, therefore the effectiveness of grant support has an extended validity period to increase the scientific and technological development of the region. The support also extends to the acquisition of high-tech equipment, the creation of technology parks and advanced training of employees [3].

4 Discussion

Let's try to correlate the rating of regions by scientific and technological development and the statistics of support for applications of the Innovation Assistance Fund for competitions by region for 2024. According to the results of the «Start-Stankostroenie-1» competition in August 2024, 14 applications were supported for a total of 70 million rubles. In total, 143 applications were received for a total of 695 million rubles, i.e. Every tenth application submitted to the competition was supported. Table 2 shows the rating of regions by the number of supported applications.

Table 2. Results of the «Start-Stankostroenie-1» competition for August 2024.

Region	Number of applications
Moscow	5
The Republic of Tatarstan	2
St. Petersburg, the Nizhny Novgorod region, the Penza region, the Saratov region, the Arkhangelsk region, the Chelyabinsk region, the Moscow region	1 application per region

Source: authors based on [18].

Based on the results of the «Business Start» competition (stage I), 33 applications were supported in August 2024 for a total of 372 million rubles. In total, 220 applications from 47 subjects of the Russian Federation were received for the competition for a total of 2.5 billion rubles. Table 3 shows the rating of regions by the number of supported applications.

Thus, based on the results of the analysis, we can say that there is a direct relationship between the rating of regions for scientific and technological development and the statistics of support for applications from the Innovation Assistance Fund – Moscow, St. Petersburg, and the Republic of Tatarstan are leaders in both the ratings and the grants won.

Table 3. Results of the «Business Start» competition (stage I) for August 2024.

No	Region	Number of supported applications
1–2	The Republic of Tatarstan and Moscow	5 applications per region
3–7	St. Petersburg, the Penza region, the Ivanovo region, the Moscow region, the Yaroslavl region	2 applications per region
8–20	The Republic of Bashkortostan, the Nizhny Novgorod region, the Orenburg region, the Arkhangelsk region, Kaliningrad region, the Leningrad region, the Novosibirsk region, the Sverdlovsk region, the Tyumen region, the Khanty-Mansiysk Autonomous Okrug – Yugra, the Voronezh region, the Volgograd region, the Rostov region	1 application per region

Source: authors based on [18]

5 Conclusion

Regions that plan to increase their scientific and technological potential should establish work with SME representatives at the time of participation in grants of various funds, conduct educational and consulting support, create accelerators and support programs for innovative SMEs. They can start working with companies that did not pass the programs of the Innovation Assistance Fund on formal grounds. The scientific literature repeatedly emphasizes the importance of financial restrictions for the development of young firms [19–21]. In our opinion, this is a growth point for increasing the competitiveness of regions, since all formal features are spelled out, then individuals and legal entities at the time of filing an application lack competencies, so regions can open consultation centers on formal features of filing applications, filling out forms in personal accounts and provide support to competitive ideas through letters of support. Thus, grant support for SME companies is a key factor in increasing the scientific potential of a region. To develop scientific and technological entrepreneurship and create new markets in the regions, an active policy is required to introduce new technologies by creating sustainable links between universities, research centers, small and medium-sized innovative businesses and large companies.

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Problems of Applying AI in Scientific Research

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Abstract. The authors analyze key problems of using artificial intelligence (AI) in scientific research. It considers such current challenges as insufficient interpretability of algorithms (the «black box effect»), dependence on data quality, the risk of false correlations, and ethical issues of authorship. Particular attention is paid to the problem of reproducibility of results obtained using AI, which calls into question their reliability in the academic environment. The work uses the methods of a systematic literature review, comparative case analysis, and conceptual modeling, which allowed us to identify the main trends and contradictions in this area. The study is interdisciplinary in nature, combining approaches from computer science, science studies, and the philosophy of science. As solutions, the authors propose the development of hybrid models that combine AI with traditional scientific methods, the introduction of explainable artificial intelligence standards, and the creation of a regulatory framework for verifying results. It is emphasized that AI should not replace, but rather complement classical research practices, enhancing the analytical capabilities of scientists. The work is of interest to researchers working at the intersection of artificial intelligence and fundamental science, as well as to specialists involved in the methodology of scientific knowledge in the digital age. The research materials can be used in the development of curricula on data science and scientific ethics.

Keywords: Artificial Intelligence · Ethics of AI · Explicable AI · Methodology of Science · Reproducibility · Scientific Research

1 Introduction

The use of artificial intelligence (AI) in scientific research opens up new opportunities, but also faces a number of serious problems, which makes this topic extremely relevant. Firstly, the lack of transparency of AI algorithms makes it difficult to interpret the results, which is especially critical in fundamental sciences, where accuracy and reproducibility are important. Secondly, the use of AI requires large computing resources and high-quality data, access to which is often limited. In addition, there is a problem of data bias, which can lead to erroneous conclusions and reinforce existing scientific stereotypes [1]. Another pressing issue is the integration of AI with traditional research methods, since not all scientists are qualified to work with these technologies. Ethical issues, such as responsibility for decisions made by AI, also remain underdeveloped. At the same time, despite the difficulties, AI is already demonstrating high efficiency in processing large

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amounts of data, modeling complex systems and accelerating scientific discoveries. Its use is especially relevant in medicine, climatology and materials science, where the analysis of huge amounts of information is required [2]. However, for the widespread implementation of AI, it is necessary to develop a regulatory framework, standardize methods, and improve the digital literacy of researchers. An important area remains the creation of hybrid systems that combine human intelligence and machine learning to minimize errors. Thus, despite the existing problems, the potential of AI in science is enormous, and their solution can lead to revolutionary changes in research practice. The relevance of this topic will only grow as technology develops and the role of data in the scientific process increases.

2 Methodology

This study used a comprehensive methodological approach to analyze the problems of using AI in science. The main method was a systematic review of scientific literature, which allowed us to identify key trends and contradictions in the area under consideration. A comparative method was used to analyze specific cases, which helped compare different approaches to solving similar problems. A critical analysis of scientific publications made it possible to assess the reliability of the data and conclusions presented. To summarize the results obtained, a synthetic method was used, combining data from different disciplines. Particular attention was paid to an interdisciplinary approach combining methods of computer science, science studies, and philosophy of science.

3 Results

Artificial intelligence is widely used in scientific research to process large data sets, which helps speed up analysis and identify patterns in areas such as biology, physics, and climatology. With AI, scientists can model complex systems, from molecular interactions to climate change, opening up new opportunities for forecasting and experimentation in a virtual environment [3]. Machine learning helps automate routine tasks, such as classifying images in microscopy or processing scientific texts, freeing up researchers' time for creative work. However, the use of AI faces challenges, including insufficient interpretability of algorithms, dependence on data quality, and ethical issues related to authorship and reliability of results [4]. Despite the challenges, the potential of AI in science is enormous, from discovering new materials to personalized medicine, making it a key tool in modern research. Table 1 discusses the key issues in the use of AI in scientific research, their nature, and possible solutions.

Successful implementation of AI in science requires a comprehensive approach: improving model transparency, developing data infrastructure, training researchers, and creating a regulatory framework. This will minimize risks and unlock the potential of artificial intelligence to accelerate scientific progress.

Table 1. Key issues in applying AI in scientific research.

Problem	Essence	Solutions
«Black box» and lack of interpretability	A lot of AI models (especially deep learning) operate as a «black box», making their output difficult to understand and reducing scientists' trust	Development of Explainable AI methods, use of more transparent models (e.g. decision trees) and post-hoc interpretation
Lack of quality data	Training AI requires large, representative, and labeled datasets, which are often unavailable in highly specialized fields of science	Application of data augmentation methods, generative models and development of open scientific databases
Biases in data	If the training data contains systematic errors, the AI reproduces and amplifies them, leading to incorrect scientific conclusions	
High computational costs	Training complex models requires large amounts of processing power, making research expensive and energy-consuming	Thorough audit of datasets, use of class balancing methods
Problems of integration with traditional methods	Scientists are not always ready to trust AI due to its incompatibility with classical approaches and the lack of standards	Development of hybrid methods, training researchers in the basics of Data Science, creation of user-friendly tools
Reproducibility of results	Due to the stochastic nature of neural network training and differences in experimental conditions, the results may not be reproducible	Publishing code and data, using replication studies
Ethical and legal risks	Automation of scientific decisions raises questions of authorship, liability for errors, and AI abuse (e.g. falsification)	Development of ethical rules, legal regulation, systems for verifying results
Limited adaptability to new tasks	AI trained on specific data may be poor at generalizing knowledge to related areas	Using transfer learning and multimodal models

Source: authors.

4 Discussion

Modern scientific research increasingly uses artificial intelligence, but this process is accompanied by a number of serious problems that require understanding. As A.A. Maksimenko [5] notes, the «black box effect» remains a fundamental limitation – the inability to understand the logic of decision-making by complex neural network models, which is especially critical in fundamental sciences, where the interpretability of results is important. This problem is exacerbated by AI's dependence on large amounts of data, as shown in the work of P.M. Lukichev and O.P. Chekmarev [6] in a number of cases, algorithms identified false correlations, mistaking data artifacts for scientific patterns.

The issue of reproducibility of research using AI is especially acute. A.V. Gusev and D.E. Sharova [7] give examples when the same models on similar data gave fundamentally different results, which calls into question the reliability of such methods. Coddington proposes a solution through the creation of hybrid systems that combine machine learning with known physical principles, which could increase the predictive power of models [8]. The ethical aspects of AI application in science are analyzed in detail by C. Zhai, S. Wibowo and L.D. Li [9], paying attention to the problem of hidden biases in training data, which can distort scientific conclusions. The authors insist on the need to develop standards for data documentation and procedures for independent audit of algorithms. P.P. Groumpos [10] describes even more alarming scenarios: in some areas, AI has begun to generate plausible, but in fact false scientific hypotheses, which requires the creation of new verification mechanisms. Thus, despite the obvious potential of AI in accelerating scientific progress, its widespread implementation is constrained by a set of interrelated problems – from methodological to ethical. As the studies reviewed show, solving these challenges requires not only technical innovations, but also the development of new standards of scientific practice that ensure transparency, reproducibility and critical assessment of the results obtained using artificial intelligence.

5 Conclusion

The use of artificial intelligence in scientific research opens up new horizons, but at the same time raises complex issues that require a systemic solution. As the analysis shows, key problems – insufficient interpretability of models, dependence on data quality and the risk of false correlations – significantly limit the reliability of AI methods. Of particular concern is the reproducibility of results, without which it is impossible to talk about the reliability of scientific conclusions.

Ethical aspects, including potential biases in algorithms and authorship issues, also require the development of a clear regulatory framework. At the same time, modern approaches – such as hybrid models, explainable AI and verification standards – offer ways to overcome these limitations.

It is important to emphasize that AI should not replace, but complement traditional scientific methods, enhancing the analytical capabilities of researchers. Successful integration of technologies requires the development of interdisciplinary cooperation between data specialists and subject scientists. No less important is the educational component – the training of a new generation of researchers with both subject knowledge

and AI skills. In the long term, if current problems are solved, artificial intelligence can become a powerful catalyst for scientific progress. However, this potential can only be realized if a critical approach is maintained and the fundamental principles of scientific methodology are followed.

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AI in Contemporary Research of Students

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Abstract. The work is devoted to the study of the possibilities of introducing artificial intelligence (AI) into the educational process of students engaged in research work. The advantages and limitations of using AI tools in the preparation of scientific articles, data analysis and creation of visualizations of research results are considered. Modern machine learning technologies and natural language processing methods used by students to improve the quality of analysis and presentation of research materials are described. The need to develop students' competencies in the field of digital literacy and the ethical use of intelligent assistants is emphasized. The research is based on the results of a survey among Russian universities studying the experience of using AI technologies in educational institutions of Russia. Recommendations are received for improving educational programs, including the use of digital platforms and services that ensure the effective use of AI tools in research by students of various specialties.

Keywords: Artificial Intelligence · Digitalization · Education · Research

1 Introduction

Modern trends in the digitalization of the educational space significantly affect the development of the research potential of future specialists. The use of artificial intelligence technologies allows students to solve a wide range of problems related to the processing of large amounts of data, automation of routine operations and improvement of the quality of scientific communication [1]. Despite the obvious benefits of integrating AI solutions into the educational process, there are also risks of incorrect use of algorithms and insufficient preparation of students for effective interaction with such tools. Therefore, studying the experience of using AI by students is a relevant area of pedagogical research [2, 3]. The purpose of this work is to study the possibilities of effective use of artificial intelligence methods in the educational and scientific activities of students of higher educational institutions in Russia, to identify problems and propose solutions.

To achieve the research goal, a number of empirical studies were conducted aimed at identifying the level of awareness of students at Russian universities regarding modern approaches to the use of artificial intelligence in the educational environment. These data allow us to form a clear idea of the prospects for further development of the education system with an emphasis on the formation of the necessary competencies in future researchers. The research tasks include:

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– analysis of the current state of research in the field of AI application in education;
– study of the opinions of students and teachers of Russian universities regarding the effectiveness of using AI technologies in the process of writing and defending scientific papers;
– assessment of the impact of artificial intelligence on the quality and speed of student projects;
– development of recommendations for improving interaction between students and artificial intelligence technologies.

2 Methodology

The study was conducted using a questionnaire survey that covered more than 200 undergraduate and graduate students from two Russian universities in Samara and Krasnodar. To assess the level of competence of the participants, specially designed questionnaires containing closed and open questions were used. Data was collected online using the Google Forms platform. The main areas of study were focused on the following aspects:

– the level of proficiency in modern digital services using AI technologies;
– the degree of satisfaction with the quality of the proposed solutions and service;
– the use of specialized applications and software for data processing, automation of analytical work, and improvement of the structure of the text of publications;
– possible difficulties and limitations that arise when working with artificial intelligence.

In addition, a content analysis of students' written reports on their research projects was conducted, identifying the most common cases of using AI assistants and the impact of these tools on the final research product.

3 Results

The survey showed that most students actively use various AI-based tools to simplify the process of completing assignments. The most common applications were programs for automatic translation of texts, grammar and style checkers, as well as services that help analyze large amounts of data and create graphs and tables.

The survey revealed the following distribution of students' preferences for AI tools:

– automatic translation (used by about 70% of respondents);
– spelling and style checkers (about 65%);
– data analysis and processing (about 50%).

Students noted the following positive aspects of using AI:

– increased speed of completing individual stages of a project;
– improved accuracy of calculations and analytics;
– the ability to quickly compare and contrast a large volume of literature sources.

However, many respondents emphasized the difficulties that arise when interacting with AI services:

– insufficient accuracy of automatic interpretation of complex terms and concepts;
– limited capabilities of free versions of popular programs;
– the need for constant monitoring and manual correction of automatically generated documents. It is also important to note the problem of understanding the principles of operation of artificial assistants, especially among junior students. Students are often unaware of the potential risks and errors that arise due to incorrect input of initial data or the selection of inappropriate model settings.

The analysis of the collected data allowed us to draw a number of important conclusions about the nature of the use of artificial intelligence (AI) technologies in the educational and research activities of students at Russian universities. The survey demonstrated significant interest in the implementation of innovative solutions in everyday work, and also identified specific barriers and difficulties that prevent the full potential of these technologies. The main trends noted by the respondents include the following:

1. Wide availability of AI resources.

The majority of the students surveyed (more than 70%) indicated that they regularly use the services of AI applications for various purposes. They noted the ease of access to such resources, the ability to quickly obtain results and reduce the time spent on processing the material. The introduction of such services has been especially significant for humanities students who have to work with large arrays of literary and historical sources. Machine learning technologies have made it possible to automate the procedures for extracting key terms, classifying sources, and generating a thematically structured report.

2. Automation of repetitive actions.

A significant proportion of respondents noted the benefits of automatic solutions when performing standard scientific research procedures. For example, almost half of the students (48%) said that it is thanks to such tools that they can save a significant amount of time at the preparatory stages of research (for example, collecting statistics, systematizing bibliographic references, preliminary analysis of the publication text).

This trend is especially important in the context of the growing volume of requirements for scientific publications imposed by leading journals and conferences. Here, mechanisms for rapid citation analysis, identifying similarities with previously published materials, and checking the originality of the text are important. Such services have become the standard of the modern academic environment, allowing young scientists to concentrate directly on the substantive part of their work.

3. Innovative approaches to creating presentation materials.

One of the striking examples of the active use of AI are visualization tools that provide users with convenient interfaces for creating graphs, charts, and tables. Many respondents admitted that such resources help present complex scientific concepts more clearly and understandably to a wide audience. About a third of students (31%) used specialized infographic generators that allow you to create high-quality presentations with minimal effort. The same respondents highlighted positive changes in the perception of their own research after starting to use such tools. In their opinion, improving the visual design

increases the attractiveness of the published material and encourages more readers to get acquainted with the final research product.

Despite the positive dynamics of AI implementation, the study participants identified some important difficulties that users face:

1. Low reliability of some solutions.

Almost a quarter of the students surveyed (23%) expressed dissatisfaction with the level of accuracy of the results provided. Some tools make mistakes when processing special terms or do not deeply understand the context of the data presented. This shortcoming is especially evident when translating specialized terminology, where the exact meaning of the term plays a key role.

2. High dependence on high-quality input data.

Another problem is the sensitivity of most AI models to the quality of the input data. If the initial conditions contain distorted or incomplete information, the obtained result turns out to be unreliable. Only a third of students confidently stated that they know how to properly prepare data before sending it for processing by algorithms.

3. Risk of overreliance on automated decisions.

Some respondents expressed concern about the danger of completely transferring responsibility for decision-making to machines. Such a practice reduces the student's motivation to independently study the material and leads to the loss of critical understanding of the results of their work. It is necessary to create a system of measures to avoid such a situation, maintaining a balance between the capabilities of artificial intelligence and the human contribution to the scientific process.

4. Limited integration with existing educational systems.

Students faced problems with the compatibility of the proposed products with the information resources used within the university. Even the most advanced services are rarely integrated with traditional content management systems (LMS), which complicates the process.

4 Discussion

The obtained results indicate a high demand for artificial intelligence technologies among university students. However, there are significant differences in the level of mastering these tools by different groups of students. Thus, students of technical fields more often use specialized applications for modeling and simulating processes, while humanities students prefer to use automatic translation and text editing tools. Thus, there is a need to develop differentiated training programs that take into account the specifics of disciplines and features of the educational process of different faculties. This will increase the efficiency of using AI technologies and minimize possible negative consequences. In addition, an important factor remains raising the level of information culture of students, since a correct understanding of the mechanisms of functioning of artificial intelligence helps to increase confidence in its conclusions and solve problems of dependence on

automated assistants. It is necessary to pay attention to the training of teachers who must have sufficient knowledge of the capabilities and limitations of existing AI tools in order to competently advise students on their use in specific situations [4, 5].

5 Conclusion

The use of artificial intelligence technologies in students' research activities is a promising direction for the development of higher education. Modern tools can significantly speed up the execution of individual tasks, ensure a high level of reliability and clarity of the presented results, but require a careful approach to user training and strict adherence to ethical standards when using such solutions.

The study showed a high degree of interest among students in the use of artificial intelligence technologies, but the presence of significant gaps in understanding the principles of operation of the relevant tools creates obstacles to the effective implementation of all the advantages of these technologies. It is important to develop the competencies of teachers, improve curricula and methodological materials that contribute to the formation of the correct attitude to the use of AI.

In the future, it is planned to continue studying this topic, expand the range of institutions studied and thoroughly analyze the role of artificial intelligence in the formation of professional qualities of young scientists.

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Innovations in Digital Education

Choice of Educational Trajectories of Students of Secondary Vocational Educational Institutions

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Abstract. Professional self-determination of students should begin as early as in the secondary school block. The process of professional self-determination is influenced by some factors. First of all, it is the social prestige of a profession and the level of labor remuneration. The main moment of professional orientation of schoolchildren is the creation of professional intentions and their motivation. Competently organized career guidance work of secondary vocational education, employers and school representatives helps choose the future profession correctly. Vocational guidance activities should be carried out on a regular basis. They include: talking to schoolchildren about the directions and profiles of training, online Olympiads, scientific conferences, various competitions, employers' talks about existing professions, their demand at specific enterprises. The methods used help high school students with their professional self-determination. For effective management of the process of professional formation it is necessary to monitor factors that favorably and negatively affect this process, with subsequent analysis of the results and taking measures to stimulate favorable and eliminate or weaken the impact of negative. According to the research results, the student's path, needs and expectations of students, channels and sources of information, groups of reference persons that can influence the student's professional self-determination were determined. The conditions for professional self-realization of students in the chosen profession as a result of the study were formed.

Keywords: Career Guidance Work · Educational Trajectory · Professional Self-Determination · Schoolchildren · Secondary School · Secondary Vocational Education · Student

1 Introduction

At present, the structure of employment of the population depends on the demand of the labor market. But the main problem of eliminating the imbalance between professions is that even specialists cannot always give accurate forecasts on the demand for professions. That is why it is difficult for today's ninth-grader to make the right choice. Help in professional self-determination of secondary school students falls on the shoulders of parents and educational institution. However, not all teachers perceive vocational guidance as a significant area of activity. Due to the fact that the quality of teaching began to be assessed in relation to the results of the mandatory state exam, teachers need much

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more time to prepare their students to get good results. And they simply do not have enough time to master such professional activity as career guidance. Therefore, this type of activity in some schools was assigned to a psychologist or an external specialist. The absence of stakeholders in this situation could not give a positive result. As a consequence, the neglect of vocational guidance work led to the fact that 40% of students in colleges and technical schools were disappointed in their choice of profession during the first year of study. It should be noted that in most schools career guidance work is still carried out in the absence of administrative centralization. Often we see a situation when vocational guidance work is carried out sporadically and depends on the enthusiasm of an individual teacher. In addition, most schools create obstacles to vocational guidance work by representatives of secondary vocational and higher education institutions. The lack of qualitatively structured work on vocational guidance activities has led to the fact that graduates who passed successfully their final exams and had a high average certificate score were unable to make a correct choice of their future professional activity.

2 Methodology

The authors used the following methods: theoretical review of scientific publications, analysis of educational and methodological literature, the own teaching experience, survey. We surveyed 123 students of Kazan Technological College of the 1–4 academic years. We used random sampling according to the direction of training. 67 female and 56 male students were interviewed. The main purpose of the study is to determine the complexity and the main reference groups of persons influencing the choice of educational trajectory.

3 Literature Review

There are few scientific publications specifically devoted to the results of career guidance work with students and their assessment. Among them, we can mention such issues: models for assessing the results of career guidance work with students [1], approaches to assessing schoolchildren's readiness for professional self-determination [2], children's career guidance activities in additional education [3], educational vocational guidance [4]. The question about the results of vocational guidance is solved in one way or another in various studies, based on the evidence base in the experimental part of the work. Of particular interest is the research work by A.R. Usmanov [5] where one of the scientific results is presented – the development and justification of the regional environment of professional self-determination, including the assessment of its quality. Thus, the literature review confirms the importance of the variety of methods used in career guidance work, the need to assess the effectiveness of activities and the relevance of their adaptation to the interests and needs of high school students.

4 Results

In the Russian education system, a child and his/her parents face a choice in 9th grade. In this grade, a compulsory state exam is taken. Often people think that children and parents determine their further educational trajectory based on the results of this exam.

The same opinion exists about 11th grade graduates, when passing the unified state exam becomes a starting point for the development of further educational steps. However, our research in both groups of respondents, conducted since 2021, shows that the majority of schoolchildren initially understand the possibilities of their educational trajectory.

In this study, we also found that schoolchildren initially plan for themselves. More than half of all respondents indicated that they initially realized that they would leave school after 9th grade. At that point, the main challenge is figuring out where to go. And if 30 years ago a student of secondary vocational education had a portrait of a person who was not very smart and aspiring to something in life, today the portrait has changed a lot [6]. Changes have occurred thanks to the policy of the Russian Federation in the field of popularization of such education, good employability and high salaries in the field of such work. For this purpose, the federal project «Professionalitet» [7] is being implemented. It is designed to radically transform the sphere of secondary vocational education. This is achieved through the introduction of new approaches to training, which are practice-oriented and take into account the actual needs and requirements of employers, as well as by shortening the period of specialist training. A special priority is the use of digital technologies in professional activities in order to reduce monotony and boredom. Thanks to the implementation of this project, graduates are guaranteed employment.

Returning to the results of our research, we emphasize that 15% of respondents were waiting for the results of the compulsory state exam. Based on the results of passing the exam, they chose the educational trajectory in the form of special professional education. It can be assumed that these 15% did not decide on their educational trajectory and could have stayed in school and then entered a higher education institution if they passed the exam successfully. However, the results of the exam did not give these children the opportunity to stay in school for the next two years before university.

The next stage in professional development is the choice of educational institution. In our case, 35% of all respondents said that they planned to enroll only in Kazan Technological College. We can notice the following correlation: more than half of all pupils knew initially that they would leave after 9th grade, more than half of them chose only Kazan Technological College. From this we can conclude that more than a quarter of all surveyed schoolchildren purposefully built their educational trajectory within the framework of this particular college.

Important results for educational institutions themselves are the search for information about the institution and reference groups of persons who influenced the choice of schoolchildren. We have identified the top-3 sources of information that influenced the choice of schoolchildren (Fig. 1).

The diagram shows the most popular answers. Moreover, if in our other studies among students, there is no reference group of parents, then here in ninth-graders almost 20% of respondents listen to the opinion of their parents when choosing an educational institution. However, since 2022 we see a trend among students of secondary vocational educational institutions and university students to increase the role and importance of the Internet in choosing an educational path. This trend has formed the necessity of positioning for educational institutions not only on the Internet, but also in social media [8].

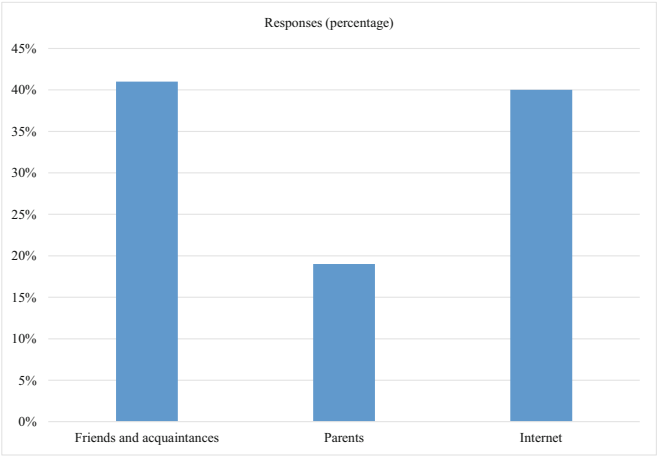


Fig. 1. Distribution of answers to the question «How did you learn about this college?» (Source: authors).

Of particular interest is the distribution of answers to the question about the motivation to study in a particular field in which students are currently studying. The most popular answer options were «they recommended it», «I wanted to go to this particular direction» and «I had enough points» (Fig. 2).

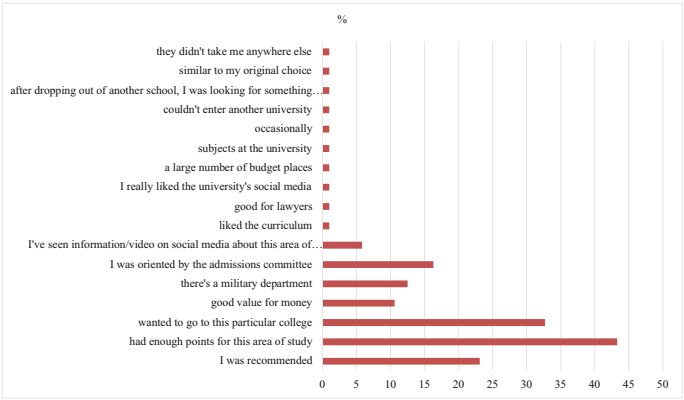


Fig. 2. Distribution of answers to the question «Why did you choose this particular area of training?» (Source: authors).

The choice of a certain training direction becomes another stage in the formation of the educational trajectory. Any educational institution should analyze what these areas of training are and why children want to enter them. In the case of this college, the principal has implemented a workable bundle to shape the brand identity. The principal handed over the social media management of the college to a group of students. And then these students took documents from the applicants during the admission campaign.

Many of the applicants tended to approach these students because they were already familiar with them. That is why in our study we use videos from social networks as a reason for choosing a certain direction.

The study paid attention to the emotional component in the construction of the educational trajectory. We identified certain factors that applicants thought about and worried about when choosing a training direction. We have identified the top 3 most popular factors: «after training the salary level will be low», «there will be little free time during training», «it will not be possible to study and work at the same time». Any educational institution should respond to the concerns and fears of applicants, so it is possible to address these concerns in the admissions office or through social media. Social media becomes the best option, as there is an opportunity to communicate with real students, not with the teaching staff.

As the results of the research have shown, parents' opinion is important for applicants when choosing an educational institution. We decided to determine what parents were concerned about when choosing a training direction. However, more than half of the respondents indicated that they themselves chose the direction of training. The remaining part of respondents noted that parents themselves recommended this direction. About 20% of respondents indicated that parents were concerned about the financial aspect of training (this applies only to paid education).

We asked the respondents to note what was the most important factor in choosing an educational institution and training direction. The most popular factor was the possibility to continue studying at the university where the college operates. Moreover, more than half of all respondents plan to continue their studies. The next two factors also took the leading positions: the availability of a state diploma and the availability of interesting disciplines.

Studying in any institution is not only about competences and diploma. There is also social life. We asked students what are their expectations from their studies? The top 4 expectations are: to make friends, to get general development, to learn skills, to get a profession. These factors indirectly influence the professional self-determination of students, but can be a great tool in shaping the trajectory of the institution itself.

5 Conclusion

On the basis of the conducted research it is possible to define clusters in the process of building educational trajectory by students of secondary vocational education. First, it is a motivational cluster, which includes a close circle of schoolchildren. Next, these are the factors of choosing a profession, which in fact schoolchildren do not have. They do not see the real activity in the future profession, do not understand options of the salary. In the cluster of professional choice the continuation of education is a leader. Students consider secondary vocational education as a starting point in their educational trajectory. Therefore, they choose those educational institutions where there is an opportunity to continue their studies at the bachelor's or specialty level. Vocational guidance work with high school students gives them the opportunity to learn about the training areas and profiles implemented in the presented university, passing scores, crediting of individual achievements, etc. Higher education institutions learn about the

opportunities and preferences of students at school, further higher education institutions adjust not only activities to attract applicants, but also educational programs in demand among young people. The effectiveness of career guidance work is determined by the number of applicants, and later students who came to the university, which carried out well-organized work to attract them. In the future, the study is planned to expand by introducing the labor market and employers in the self-determination of students.

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Professional Standard vs Federal State Educational Standard: Contradictions and Ways to Overcome Them

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Abstract. This work is devoted to the state and problems of training managers in the system of secondary and higher vocational education in Russia. The work analyzes the federal state educational standards of secondary vocational education and professional standards. According to the results of the analysis the problems preventing the full-fledged training of financial managers in colleges and institutions of secondary and vocational and higher education are revealed. The novelty of the obtained results lies in the substantiation of a new solution to the problem of continuity of education in the field of financial management. On the basis of the principle of continuity, the prospect of professional development of managers in the directions of training of secondary vocational education «Banking» and «Finance» and higher education «Management» is investigated. The practical significance lies in the use of the obtained results in the training of financial specialists – middle managers in Russian colleges and technical schools, and further in universities. As a result of the analysis of federal educational standards of secondary vocational and higher education and professional standards, problems were identified and ways to solve them were proposed. Recommendations are proposed in the field of revision of education levels in professional standards, introduction of federal educational standards of secondary vocational education in the direction of training «Management», as well as the use of standards 38.02.06 «Finance» and 38.02.07 «Banking» for the training of middle-level financial managers.

Keywords: Employers · Federal State Educational Standard (FSES) · Financial Managers · Graduates · Labor Market · Professional Standards

1 Introduction

Nowadays the activity of any organizations with financial departments is associated with a high degree of uncertainty and risk. Risks depend on many factors (instability of the world and domestic market, introduction of restrictions, loss of foreign economic relations). Such risks have an impact on the company's activities. Maintaining the competitiveness of financial services is the main activity of the organization. Competitiveness of rendered services is primarily influenced by high qualification of financial managers. In order to train such specialists, secondary specialized educational institutions and higher

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educational institutions, employers have a difficult task to prepare qualified personnel. The professional activity of financial managers is related to the provision of financial services. Therefore, it is necessary that theoretical knowledge is supported by practical skills. Employers can help to consolidate the acquired competencies. We should consider the requirements of the Federal Educational Standard (FES) and professional standards when studying the peculiarities of training financial managers. However, there are a number of contradictions and inaccuracies in their content, which hinder the training of highly qualified specialists. At the same time, there is a problem – the Russian secondary vocational education does not have a federal state educational standard in the direction of training «Management».

2 Methodology

Educational research requires a comprehensive approach that includes both quantitative and qualitative methods. The choice of methods depends on the objectives of the research, the issues being investigated and the resources available. The study is based on the analysis of the regulatory and legal framework of education: Federal Law «On Education in the Russian Federation» dated 29.12.2012 N 273-FZ [1], Federal State Educational Standards of Higher Education in the direction of training 38.03.02 «Management» [2], 38.02.06 «Finance» [3] and 38.02.07 «Banking» [4]. Along with this, the authors relied on their long-term experience, the opinion of colleagues, and used methods of generalization and synthesis.

3 Literature Review

M.M. Bezrukikh and N.V. Zhdanko [5] believe that the characteristic feature of recent decades is not so much the emergence of new professions as the change in the boundaries of old ones, associated with new tasks of activity, new technologies and methods of work, new requirements for the results and performance evaluation. It is not about the emergence of new professions or new positions, but about the saturation of already established professions with better professional competencies. It is possible to do this by involving employers-practitioners in the process of improving the educational process in colleges and universities.

One of the main problems in the sphere of training financial managers is the deviation of the content of educational programs from the conditions of the labor market development. Educational programs remain unclaimed in terms of their competencies, and graduates cannot find a job upon college completion because of this. This transforms individual educational and career trajectories – a graduate either goes for retraining or changes profession completely. Another problem is the lack of practical training for students. Theoretical knowledge is important, but without practice it is of little use. Students should be able to apply their knowledge in practice to become qualified specialists [6]. To solve these problems, the authors suggest a number of measures: updating the content of educational programs, introducing new teaching methods and technologies, improving the qualifications of teachers and creating conditions for student motivation. The implementation of these measures will improve the quality of education in regional

colleges and prepare qualified specialists in demand in the labor market. Scientific studies emphasize that in the training of modern personnel in the system of secondary vocational education, along with teachers, the most active and equal participation in training should be taken by specialists of the enterprise.

4 Results

A lot of years of experience in teaching, development and implementation of basic educational programs for training financial managers have allowed us to identify a number of contradictions and problems of conjugation of educational and professional standards. One of the contradictions is the legislative inconsistency between the definitions of higher education graduate qualifications and professional standards and the definition of employee qualifications given in Article 195.1 of the Labor Code of the Russian Federation [7]. Qualifications of working specialists or generalized labor functions in professional standards should correlate with graduate competencies in educational programs. This means that when implementing the same educational program in different educational organizations, the formulation of professional competencies should be identical. As a recommendation, it can be suggested to use the wording fixed in the labor function [8].

The FSES of higher education should regulate the number of professional standards implemented in one educational program. It would be optimal to specify 2–3 professional standards for one type of activity and formulate 2–3 competencies for each professional standard. Thus, the number of credits for one competence will be approximately the same in different educational organizations. This will give the possibility of painless transfer of a student from one HEI to another within the framework of implementation of one educational program, as the difference in the transfer will be minimal [9]. Let us give examples of disagreements on the above-mentioned contradictions. Thus, when implementing the bachelor's program «Management» at Kazan Federal University, it was revealed that three types of professional activity were chosen as the tasks of professional activity: information and analytical, organizational and managerial and financial. When implementing a similar program in the Russian Presidential Academy of National Economy and Public Administration, only two types of activity were selected: organizational and managerial and information-analytical. In the Financial University under the Government of the Russian Federation, the following are chosen as the same tasks in the implementation of the program: organizational and managerial, information-analytical and research. This confirms our thesis about the contradictions in the training of specialists of the same bachelor's degree profile «Financial Management» in different universities of the country [10].

The analysis showed differences in the selected professional standards. It is necessary to understand that these professional standards guide the educational organization in the implementation of the basic educational program. Professional competencies are formulated on these standards [11]. Professional standards in the field of management play a key role in developing the competencies and qualifications of specialists working in various areas of management. They determine the requirements for knowledge, skills and abilities necessary for the successful performance of professional duties. The number

of professional standards is not regulated by the FSES 3++. Therefore, each organization chooses professional standards independently. As a result, the number and formulation of professional competencies will also differ from each other. Implementation of the main educational program «Financial Management» (Bachelor's degree) in Kazan Federal University is based on the following professional standards: 08.036 «Specialist in working with investment projects» and 08.008 «Specialist in financial consulting». In the Financial University, the same educational program is implemented on the basis of four professional standards: 08.008 «Specialist in financial consulting», 08.015 «Specialist in corporate lending», 08.018 «Specialist in risk management», 08.004 «Specialist in securities market» [12].

In the Russian Academy of National Economy and Public Administration, in the process of implementing a similar educational program 12 professional standards are used for two types of activities: 08.004 «Securities market specialist», 08.008 «Specialist in financial consulting», 08.009 «Specialist in factoring operations», 08.010 «Internal auditor», 08. 018 «Specialist in risk management», 40.033 «Specialist in strategic and tactical planning and production organization», 08.002 «Accountant», 08.022 «Statistician», 08.025 «Specialist in evaluation activity», 07.003 «Specialist in personnel management», 07.002 «Specialist in organizational and documentary sup-port of organization management», 08.023 «Auditor» [13].

The FSES of higher education 3++ bachelor's degree level states that from each selected professional standard, the organization allocates one or more generalized labor functions. These functions correspond to the professional activities of graduates based on the established professional standard. Professional standards 08.008 «Specialist in financial consulting» and 08.015 «Specialist in corporate lending» stipulate only one labor function of level 6 (Bachelor's degree level) «Advising clients on the use of financial products and services» and «Ensuring the conduct of lending transactions for corporate borrowers» [14].

Our proposal for the interface between the FSES of higher education and professional standards: to introduce information in the federal standards – for which groups of professional standards one labor function is allocated. Based on this, only one professional competence can be allocated.

One of the ways to eliminate the contradictions of the FSES of higher education and professional standard can be the addition of the professional standard with a section that reflects labor functions and actions in accordance with the professional competencies of the federal standard of higher education for the profile «Financial management». Such approach will allow employers to lay down their requirements to training of future managers. And universities will allow preparing specialists in accordance with the requirements of employers. In the implementation of this approach, there is another positive moment: employers and developers of basic educational programs will have to communicate closely, thereby identifying contradictions between different standards. They will jointly take measures to eliminate these contradictions, taking into account the needs of the labor market. The quality of specialist training will increase due to the improvement of the quality of the educational process. In addition, in accordance with part 7 of paper 11 of the Federal Law «On Education in the Russian Federation» [1], the formation of

requirements of the federal standard of professional education to the results of mastering the basic educational programs of professional education in terms of professional competence is implemented on the basis of relevant professional standards (if any).

Another contradiction lies in the inconsistency in the FSES of higher education 3++ of the field of education «Management» with the areas and types of professional activities. The FSES of higher education (bachelor's degree) in the direction of training 38.03.02 «Management» as areas of professional activity of graduates indicates:

-organization of internal and external financial control, and audit; financial consulting; risk management; organization of procurement; research and market analysis of products, services and technologies; promotion and organization of sales of products, services and technologies; project management; controlling and information-analytical support of management decisions; consulting);
-the field of education and scientific research;
-the sphere of strategic and tactical planning and production organization; logistics; organization of supply networks.

As types of professional activities are specified: informational and analytical, organizational and managerial, financial, entrepreneurial, pedagogical, research. In the system of secondary vocational education, as in the system of higher education, when drawing up curricula and basic educational programs, they are guided by the requirements of federal state educational standards of secondary vocational education and professional standards. For continuous professional education of managers the federal standard provides two levels of training: bachelor's and master's degree, at the level of secondary professional education of this direction the standard is not provided. There are similar directions of training of 38.00.00 group, which could be applied for training of financial managers. These include 38.02.06 «Finance» and 38.02.07 «Banking». Federal standard 38.02.06 «Finance» contains a list of pro-professional standards corresponding to the professional activities of graduates of the educational program of secondary vocational education. These are professional standards 08.006 «Specialist in internal control» and 08.026 «Specialist in procurement». All these professional standards assume the presence of three levels of training: specialists of middle level, specialists with higher education (bachelors and masters). Here the principle of continuity of professional education is observed. In the case of the FSES of secondary professional education 38.02.07 «Banking», the situation is different. The list of professional standards of this direction is much wider than the previous one: 08.020 «Specialist in work with collateral» has one level of training – bachelor's degree, 08.011 «Specialist in mortgage lending» – have bachelor's and master's degree, 08.19 «Specialist in consumer loans» and 08.014 «Specialist in work with overdue accounts payable», 08.027 «Specialist in payment services» – level of secondary vocational education and higher (bachelor's degree). And only one professional standard «Specialist in operations in the interbank market» has three levels of continuing professional education [15].

It can be concluded that the system of continuing education lacks the necessary levels (either secondary vocational education, which in recent years is considered very relevant among young people, or the master's level, which is necessary for specialists to improve their professional skills). Employers need to revise professional standards,

divide generalized labor functions between the three levels of education, fix the rights, duties and distribute responsibilities.

The student's role in mastering the program should be spelled out. Since the student is disengaged from the partnership, standards. In turn, it reduces his responsibility for mastering the material, for the quality of practical skills.

If we consider the FSES of higher education 3++, then in the direction of training «Management», the program «Financial management» the developer of the program has the opportunity to choose a professional standard. Thus, the Kazan National Research Technological University implements the training program «Financial management». The following were chosen as the main professional standards: 08.008 «Specialist in financial consulting» and 08.045 «Specialist in the field of innovative financial technologies». But the developers of the standard did not provide for the level of secondary vocational education, which violated the principle of continuity of professional education for the training program «Financial management».

5 Conclusion

The specification of inconsistency and difficulties in the formation and implementation of training programs became the basis for our attention to the process of developing competencies for training directions «Management» 38.03.02 and 38.04.02. In addition, at the level of secondary vocational education there is no opportunity to get a profession of financial manager. This is due to the fact that there is no federal state standard in the direction of training «Management». This violates the principle of continuity of education in this area of training. The exchange of experience with colleagues highlighted the existing problem, which should be solved at the level of development of federal state educational standards and standards of professional sphere. Professional standards should meet the requirements of the labor market. Federal educational standards should be responsible for the overall vision of the program and the relation between levels of education. Consolidation and competency-based approach enable to form a unified field for partnership between educational institutions, employers and students.

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Digital Technologies for Automating Communication in the Activities of a State University

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Abstract. The work investigates digital technologies for automating communication in the activities of a state university. The main attention is paid to the use of information systems and platforms to improve the interaction between students, teachers and university administration. Theoretical and methodological grounds for the study of digital technologies in the educational sphere are proposed. The advantages and perspectives of the application of such technologies are described, as well as possible problems and ways of their solution. Automation of messages and answers to frequently asked questions will reduce the time resources of the university staff. For applicants or students, automation of communication becomes the most comfortable option for solving bureaucratic problems in the university. This contribution presents a case study of chatbot implementation for the activities of the Institute of Innovation Management of Kazan National Research Technological University. The chatbot is realized as an example of solving problems faced by students.

Keywords: Chatbot · Digital Environment of Higher Education Institutions · Digitalization of Education · Information and Communication Technologies · Modeling · Network Social Services · Web 2.0

1 Introduction

Digitalization of the educational process creates prerequisites for flexibility and openness of learning, creation of innovative learning environment, formation of new role functions. To organize the management system of a new educational space, it is necessary to create an innovative methodological base with the inclusion of modern digital technologies [1, 2]. The scientific community is at the stage of systematization of the results of the introduction of digital technologies in the educational process, the stage of research, trial development and implementation of digital educational innovations.

Digitalization of education is aimed at improving the quality of education and increasing its accessibility. It allows adapting the educational process to the individual needs of students. Digital technologies contribute to the development of critical thinking skills and creativity among students. Some modern pedagogical scholars believe that the introduction of digital technologies in education helps to increase students' motivation

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and improve their performance. Digitalization of education opens new opportunities for international cooperation and exchange of experience.

2 Methodology

The purpose of the work is to analyze the methodological foundations for the application of automated messages in education. The objectives of the study are:

- to analyze the existing theoretical and methodological basis for the application of digital technologies of automated communication;
- to determine peculiarities of digital communication in the sphere of education;
- to analyze the effectiveness of the realized chain of automated messages.

The study allows us to identify the potential of information technologies and e-learning tools, in particular chat-bots, as an effective communication tool in the Innovation Management Institute of Kazan National Research Technological University. This helps to improve the quality of education, increase the level of service and contributes to the achievement of the goals of development of the innovation environment of the university. The study is based on theoretical methods that include analyzing the literature on digital communication. Classical approaches to the study of digital environment can be analyzed on the basis of Digital Humanities. This becomes an opportunity to correlate social processes with digital technologies.

3 Literature Review

The review of scientific literature on the automation of communication in higher education shows various directions of scientific research. Most scientists describe the advantages of automation of communication processes in higher education institution, the prospects of digital technology implementation. Automated systems make it possible to significantly simplify and automate a large number of internal processes, which leads to increased efficiency of various structures of a higher education institution. The tasks of load distribution or combining documents in a digital environment allow structuring the educational process with high accuracy [3]. The automation of educational processes should be based on the use of a high-quality and high-tech integrated educational system (platform), which should be a basis for the automation system of university management [4, 5]. This reflects the implementation of a comprehensive approach to higher education institution (HEI) management, allows integrating educational and educational activities, organizing the knowledge control system on the platform [4–6]. V.N. Minina [7] identifies four trends related to the introduction of digital technologies and tools into the educational process: the formation of blended learning model; transition to online learning; creation of virtual (digital) educational environment; change in the approach to the management of educational organizations.

The scientific literature presents the experience of Russian universities in the field of automation of communications in higher education. The case of Immanuel Kant Baltic Federal University reflects a comprehensive approach to the automation of HEI. It uses

the program «1C: University PROF» due to which the university is able to automatically transfer data on students, contracts and payments between different departments.

On the basis of the conducted surveys [8], relevant conclusions are drawn about the creation of a unified information space of a higher education institution and the interaction of information systems. It should be noted that the peculiarities of the organization of the educational process primarily affect the development and selection of automated educational platforms.

Researchers note that the digital modernization of education in Russia is non-systemic. This is expressed in the absence of a common value and meaning. Much attention is paid to technologies and tools, to the accumulation of new technical means in the absence of a systemic vision of the need, ways and consequences of their application for culture [9]. Another direction of research is the development of information educational technologies, in particular, chat-bot and automated systems of educational activity management. Chat-bot is an important factor in optimizing the delivery of information to students. N.G. Novgorodova and B.A. Redjkina [10] reveal stages of chatbots application in the educational process. The researchers pay special attention to the role of a teacher and a separate department in the organization of information space for students, transparent interface, availability of educational information. The direction of introducing chatbots using voice interaction with the bot in messengers is promising. The use of a voice dialog in the web version on the website of the university implies that students receive up-to-date information. This will increase the prestige of the university among the target audience and remove some of the burden from the university departments. The area of research on the introduction of chatbots includes issues of providing reference information oriented to students and applicants, the possibility of launching an electronic assistant using messengers and social networks [11, 12]. Another advantage of chatbots application in educational activities is personalization of learning [13]. It consists in analyzing by a chatbot the peculiarities of the individual learning process, based on the analysis, personal recommendations are issued to improve the performance. Chatbots become a tool for organizing interactive classes, assignments and testing. There are examples of creating chatbots in accordance with the requests of a certain university [14].

Foreign research on the education digitalization provide results of implementation of digital technologies in the educational process of universities and school education system, experience of digital transformation of higher education through the introduction of computer technologies [15, 16]. Special attention is paid to the use of chatbots as an element of learning activities in higher education, in project-based learning, the impact of sharing chatbots on teamwork [17]. For higher education institutions, a model of cognitive framework for chatbots as support for students in higher education is presented [18]. Current sources on digitalization and automation of communication in education are complemented by research on the implementation of artificial intelligence technology in higher education. Y. Sun [19] studies the implementation of artificial intelligence technologies in the process of English language teaching in higher education institutions in China in order to provide recommendations to improve the quality of teaching and promote the informatization of language education.

Foreign research investigates the application of chatbots in higher education using artificial intelligence. It justifies the use of SQL database to store questions and answers by using artificial intelligence markup language metadata, and the content of the database is formed by «extracting» information from library websites and analyzing chat logs [20]. Research on social media as a communicative learning environment show that social media contributes significantly to students' academic life [21]. Digital technology opens up opportunities for blended, online and mobile learning. Ultimately, a model is formed that contains external constructs: student access, student awareness, student ability, and faculty characteristics [22].

4 Results

Research shows that there is a problem of communication in Russian language for foreign students in some universities, not all incoming students can express themselves clearly and understand the Russian language. Chatbot in their native language could contribute to solving the problem of adaptation in the educational environment of the university. It also contributes to raising the image of the university, increases the value of communication with the educational environment [1, 2]. Designing the communicative space includes a number of stages.

At the first stage of our project implementation, we conducted a survey to find out the demand for an electronic resource in the form of a chatbot to organize the learning process for both international students and students – citizens of the Russian Federation, as well as a survey of the directorate staff about the problems of communicative interaction with students.

Our respondents were students of the Institute of Innovation Management of Kazan National Research Technological University (hereinafter – IIM KNRTU). Several questions were asked in the form of a questionnaire survey, which allowed to identify problem areas according to students, and to determine how promptly and qualitatively students receive feedback from the work of the directorate of IUI KNRTU.

To the first question «How often do you contact the directorate of the institute to solve your issues?», the following answers were received: the number of requests per month varies from 2–4 times.

The second question concerned the quality of communications («Were the employees of the directorate able to help you with your questions?». The majority of respondents stated that the directorate was able to help them with the question they were interested in, but it was frustrating to wait for a long time and they didn't like the human attitude to them.

The third question was «Are you satisfied with the work of the institute directorate?». In general, students evaluate the work of the directorate on 3 out of 5 points. In our opinion, the average score is determined by the average completeness of the information provided, attitude to students and waiting in line.

The fourth question was «What changes, improvements would you suggest for the work of the directorate in the future?». A lot of students would like to have an application in the form of a chatbot or a separate e-mail to communicate with the staff of the directorate on pressing questions about the learning process. At the same time, they expressed a desire to ask a question remotely and receive an answer online.

Thus, the survey of students confirmed the need for the realization of a modern communicative model in the form of a chatbot. The proposed chatbot will help both students and employees of the directorate of IIM KNRTU to improve the process of communication, consultation and assistance on various issues, which in turn will improve the efficiency of the educational process.

The advantages of the proposed chatbot include the following:

- saving time and resources: the chatbot saves time for both staff and students by providing quick answers to frequently asked questions;
- availability 24/7: through automation, the chatbot is available for communication around the clock, allowing information to be retrieved at any convenient time;
- increased efficiency: the chatbot helps to optimize communication in the institute, speeding up the processes of receiving information, reducing the burden on the staff;
- integration with existing systems: possibility of integration with information and educational systems of the institute for automatic updating of data and prompt provision of information.

The target audience includes students (who are looking for up-to-date information about class schedules, exam deadlines, instructor contacts and schedules, as well as information about the dormitory, the extended education department, and questions related to off-budget study), teaching staff, employees of the institute directorate who are interested in prompt receipt of information and effective communication system.

Our chatbot was created in the BotHelp service. This service is used to create autofunnels in the sphere of services, goods and online schools. The clear interface allows you to create minilandings, widgets, automations, multi-step chatbots on your own, without involving additional specialists. With BotHelp, you can set up atowebinars that will run independently. It enables to solve tasks in marketing, sales, customer service. Previously, the service was called WhatsHelp. The platform was based on the whatshelp.io domain. In December 2019, the brand was renamed BotHelp, and all tools were moved to bothelp.io. BotHelp is a unified platform for communicating with audiences in popular messengers, including VKontakte, Telegram, Viber.

New messages from all connected channels are displayed in the BotHelp cabinet. Every user who writes to any messenger is automatically entered into the database and becomes a subscriber. The collected contact list can be used to increase sales, end-to-end analytics and marketing purposes. For example, in BotHelp you can segment your audience and make automatic mailings. A separate tool of the platform is the chatbot builder. In it, you can create virtual consultants for Telegram, VK and other channels. Creation is understood as the formation of a script, according to which the program should work. Technical skills and the ability to write a code are not required. The platform allows you to track statistics: how many people clicked on buttons, went to the next step. This allows you to understand conversion rates and take further steps.

Chatbots combine two important elements: they are multitasking, as they allow to automate a number of processes (consultations, conducting control activities and exams, checking test results, conducting surveys of students to identify weaknesses in educational programs), and they are convenient for interaction with the user due to the comfortable format of communication, imitating a conversation with an interlocutor.

These qualities of chatbots make them an indispensable tool for conducting educational programs and bring the quality of learning to a new level.

In the Russian education system, chatbots are becoming part of the educational process. For example, in 2021 Mari State University launched its chatbot first for university applicants. Its functionality included actual questions for those wishing to enroll in their educational institution. A year later, in 2022, they launched a chatbot for students studying at the university. During the first month of operation, the chatbot sent 2373 messages and users wrote 431 messages to it. The chat bot has helped save time for both staff and students. Although this technology is not widespread due to its difficulty in implementation, it is in demand by both students and staff at the university.

5 Conclusion

The development of chat-bot as a communication space for the Institute of Innovation Management of KNRTU is an innovative step in ensuring effective interaction of participants of the educational process. In relation to the rapid development of digital technologies, the institute faces the need to improve communication processes, providing rapid transfer of information, support for students and teachers, as well as facilitating access to various services and resources. Currently, the only communication channel for working with students in the institute is the directorate of IIM KNRTU. The bot was created for Telegram users. Telegram was not chosen by chance – most students use this messenger due to its popularity, rich functionality, high speed of message delivery and data privacy protection.

The communicative space includes managers, staff, heads of departments, faculty. Communicative space depends on the coherence of all elements of the system. The problem space concerns all types of interactions. The main reasons often include organizational communications, when students cannot get a quick answer to urgent questions, to which we refer questions of organizational nature. The employees of the directorate have to answer questions that become typical for specific groups, semester and academic period. We see the solution of the problem in the organization of an automated resource that will help to optimize the activities of the directorate and create a harmonious communicative space within the university. Introducing innovations such as automated messaging into the learning environment reduces the power distance between students and university staff, reduces stress for applicants and the effects of cross-cultural shock for international students.

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Some Experience of Using Design Thinking in Teaching English to Students – Future Engineers

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Abstract. The research topic «engineering education» has always attracted and is attracting a lot of attention from specialists. As part of the discussion of this topic, one can observe the vector of discussion from humanization and humanitarization to the transformation of the educational landscape and the training of engineering personnel. The modern development of society, driven by automation, digitalization, and the spread of artificial intelligence, places great demands on engineers as specialists who create our environment. It is obvious that the marker of the quality of the educational process is the demand for graduates, their compliance with the requirements of the market situation and the satisfaction of employers. However, modern graduates-future engineers often have with them insufficiently developed engineering thinking, including systems thinking, creative thinking, innovative thinking, critical thinking, responsible and ethical thinking. Building learning based on design thinking can make the educational process more practice-oriented, as close as possible to professional activity, which contributes to the development of engineering thinking, including systems, creative, critical, responsible and ethical, promotes thinking in a voluminous and non-standard manner.

Keywords: Design Thinking · Engineering Education · Engineering Thinking · Higher Education · Students-Future Engineers · 21st Century Skills

1 Introduction

Recently, the correspondence of engineering education to the modern paradigm, the availability of competencies among engineering specialists and the change in engineering thinking have been actively discussed. The trigger of this agenda is significant changes in the engineering field:

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- automation and digitalization (new generation robotics, which allows automating more technically complex processes; Industry 4.0: Internet of Things (IoT), smart factories, cloud networks and «cloud twins» that allow modeling scenarios for the development of technology and making forecasts, cyber-physical systems; mixed/augmented/virtual reality (AR/VR); artificial intelligence (AI) and machine learning);
- cybersecurity and biosecurity (data and infrastructure protection; blockchain, RFID and GPS technologies contribute to the digitization of supplies and make this ecosystem more transparent; security of the Internet of Things (IoT));
- globalization (remote work: the work of specialists in international projects on regional platforms; flexible teams: distributed teams, outsourcing; engineering as a service: provision of engineering services by subscription);
- environmental friendliness and sustainable development (application of 3-D printing, development of energy efficient products, circular economy based on the recycling of materials, the growing interest in renewable energy sources);
- bionics (introduction of innovative materials (composites, alloys), nanotechnology, bioengineering that uses natural mechanisms to create new products);
- customization (focus on mass uniqueness, personalized engineering solutions; flexible production systems that adapt to constantly changing market demands; cooperation with the consumer based on the «partner with partner» format, rather than as a counterparty) [1, 2].

Thus, these trends and, to a greater extent, artificial intelligence are changing the specifics of engineering, making certain demands on professional (hard skills) and «soft» skills, and require the development of engineering thinking.

2 Methodology

The theoretical and methodological basis of the research consists of works studying the trends in the development of modern society in the context of Industry 4.0, the active spread of artificial intelligence, cloud twins, Internet of Things, mixed, augmented and virtual reality. The researchers are convinced that these trends significantly affect all areas of activity, including engineering [3, 4]. So, there is a demand for advanced engineering thinking, since engineering activities are carried out today in completely new conditions. These trends are dynamically reshaping society, human relationships, work, and all areas of human activity. Engineering thinking should take into account the format of changes, predict and create solutions that will be relevant in changing realities and help people adapt to them. In addition, engineers need to take into account the risks of the impact of digitalization and artificial intelligence and minimize them [5]. Moreover, the great impact of engineering on humans and society, as well as the development of artificial intelligence products, requires responsible and ethical thinking. An engineer needs to create technologies that will be trusted and benefit society [6].

Working with digital twins, advanced modeling techniques, as well as the use of effective testing and verification methods requires systematic thinking. It is important for an engineer to be aware of which system of activity he is in and what the purpose of this system is [7]. Systems thinking does not consider individual components, but thinks

voluminously, on a large scale, taking into account interrelated aspects [8]. Systems thinking requires an analysis of cause-and-effect relationships, presupposes a vision of possible risks of erroneous decisions, which also contributes to the formation of responsible and ethical thinking [9]. Therefore, today there is a demand for engineers to work in unified environments open to multidisciplinary design and interdepartmental cooperation.

Solving a professional engineering problem involves not only analyzing it, but also «reasonable reflective thinking focused on deciding what to believe or how to act» [10], i.e. using critical thinking. Critical thinking is the technical equipment of a solution [11], which presupposes the ability to navigate a large information flow, the ability to take into account biases, the ability to critically use digital technologies, i.e. increases the likelihood of overcoming difficult situations and justifies the choice for its further solution [12]. Engineering has a lot in common with scientific activity, in which the activity of developing knowledge is integrated directly into the processes of creating, debugging, developing and replicating new technologies [13]. At the same time, engineering transforms not only the world of technology, but also social relations. A key aspect of engineering is the acquisition of new knowledge to solve human and social problems, as well as the satisfaction of the human need for knowledge, which requires the development of scientific thinking.

According to V.G. Gorokhov, an engineer must be able to do something that cannot be described by the word «knows», he must also have a special type of thinking that differs from both ordinary and scientific [14]. Innovative and creative thinking is of paramount importance. This is especially true for the modern situation, when the world is unstable and dynamic [15]. At the same time, we are talking not only about creating a new product, but also about constantly improving existing technologies by increasing efficiency and safety, and reducing costs [16]. Obviously, an engineer needs to have the ability to produce ideas or products that are both original and adapted to the context and limitations of specific tasks.

Engineering trends such as customization, demand for mass uniqueness, flexible production systems, and building relationships with customers in the «partner with partner» format focus on the interests of consumers, understanding requests, and creating products subject to continued collaboration with stakeholders. Today, consumers want to invest in customized, affordable, ecological, safe, and effective products that work throughout their entire life cycle. This means a huge level of complexity, on the one hand, and adaptive thinking, an open and flexible mind, on the other hand [17].

A survey conducted by Tech-Clarity showed that more than 80% of employees claim that having the «right» mindset among engineers is crucial for enterprises, business and the prosperity of the country. However, there is currently an imbalance between the skills of employees and the demands of companies. Engineering thinking is one of the top 10 skills that educational organizations do not prepare well enough for [18]. This fact requires education to be able to quickly adapt to the challenges of the time. One of the possible solutions is to apply the design thinking method. The analysis of different works on design thinking considers it as a way to solve intricate problems, allowing to find non-standard solutions more effectively, based on the creative and interdisciplinary component.

3 Results

The stages of design thinking (empathy, problem definition, idea generation, prototyping, testing) can be actively involved in the educational scenarios of higher education when teaching students – future engineers. Design thinking is a system approach to problem solving that allows you to think about a problem from multiple perspectives and thus creates the basis for a consistent and logical transition to decision-making. Design thinking is based on the generation of ideas, their implementation and evaluation of the result. Design thinking is a rather laborious and complicated process that is consistently implemented through the analysis of the initial situation, the generation of ideas, the development of a plan and the direct implementation of the idea. The use of this method in an educational scenario allows students to develop systems, analytical and creative thinking [19]. In addition, design thinking, being teamwork, involves not only generating ideas when all participants try to express their point of view, prove the correctness of their judgment, but also actively listen and hear what others are saying, and therefore show empathy [20]. Design thinking allows us to rethink the process of working with such a valuable resource as information. Information that is obtained, analyzed, and processed based on people's opinions, feelings, and behaviors is valuable. The basis of design thinking is empathy, the ability to deeply understand people's feelings and thoughts, and focus on personal behavioral scenarios.

The introduction of design thinking stages is focused on students' independent familiarization with the functioning of their professional environment, teaches them to pay attention to the needs of consumers, the ability to calculate risks, as well as details that can make the product more competitive [21]. There is also an awareness of the real significance of the product for users, a new vision of how information can be obtained for effective solution implementation [22]. Consequently, the pedagogical potential of using design thinking for the development of engineering thinking is high.

Regarding the application of design thinking methods in the educational process of higher education, its successful implementation requires teamwork, collaboration, the ability to work with information and discuss material in a dialogue, visualization skills and discussions of the work done. The Foreign Language subject best meets these requirements. In addition, the use of the design thinking method within the framework of this subject makes it possible to increase the motivation of students to learn English, as it shows a roadmap for the practical application of knowledge.

The authors have experience working with engineering specialties and are well aware of the problems associated with the training of future specialists. For example, in English classes, the phrase is often heard: «Why do we engineers need English?» In general, the audience very often has little motivation to master the subject due to the fact that they do not understand where and how they can apply this language knowledge in practice. Unfortunately, very often teachers themselves focus on the assimilation of some specific knowledge, rather than the ability to apply the acquired knowledge to solve specific problems. However, the analysis of employers' requests indicates the importance of learning English due to the emphasis on cooperation, work on international projects, the possibility of popularizing their product and production, participation in international exhibitions and scientific conferences.

A large number of potential possibilities of design thinking gave rise to the implementation of this method in the process of working with 46 students – future engineers in Samara State Transport University and Samara State Technical University. In order to implement the design thinking method, the students were first divided into groups of 5–7 people, in this way all the stages were completed (Empathize, Define, Ideate, Prototype, Test).

1. Empathize. This stage is supposed to find the answer to the question: «Who to study?». The team had to understand the target audience, i.e. whether it was narrow specialists, customers or stakeholders. It was necessary to take into account the experiences and needs of different users, i.e. to look at the situation through their eyes and put their interests in the center of attention.

2. Define. This stage formulates a problem, finds a niche that is relevant today and requires a solution. The correct formulation of the problem is the key to its successful solution in the subsequent stages of design thinking.

These two stages (Empathize and Define) show the importance of mastering the skills of both convergent and divergent thinking. These types of thinking are interrelated units of the intellectual development process, which are formed not sequentially, but in parallel, taking into account the age characteristics of the development of intelligence and personality of the student as a whole. Convergent thinking is necessary to make ideas logically complete, contributes to the formation of a solution to the problem. It moves towards the goal linearly, based on logic, laws, algorithms, learned ideas, generally accepted norms and principles. Divergent thinking plays a key role in the search for ideas, the direction of thought.

Taking into account the importance of convergent thinking, future engineering students had to find authentic literature about the future project, see how ideas are being implemented in other countries, analyze the strengths and weaknesses of the problem being studied and present reports in the form of presentations in English. This stage also showed the importance of working with information, the ability to find and isolate details that are extremely important for the project, and to think about how they can implement the project. This stage was accompanied by a discussion of the problem using the following techniques:

3. Ideate is the next stage. This stage involves going beyond the limits of habitual thinking. It's a time of inspiration and freedom. Sometimes ideas may seem impossible, but it is the randomness that allows us to consider the most innovative and unusual solutions. The successful techniques at this stage were the following:

- reverse brainstorming (it makes you think about the task from the perspective of how you can make the problem worse; participants needed to focus on the causes of failures, difficulties, and undesirable outcomes, for example, insufficient calculation accuracy or design errors, non-compliance of materials or components with technical requirements, difficulties in integrating new technologies with existing systems, unforeseen technical limitations or equipment failures; then it was necessary to transform negative ideas into positive actions;
- a role-playing game (the teams had to act out situations in English on behalf of different characters (an expert, a child, a mother with many children, a skeptic), presenting how they use a particular product).

Therefore, this stage is not just creativity for the sake of creativity. Idea generation is a structured process that aims to find inspiring and viable ideas. Moreover, this stage helps to unlock the potential of both individual participants and the entire team and lays the foundation for subsequent stages of prototyping and testing.

4. Prototype. This stage is a way of «rehearsing» with a proposed idea, in which each iteration contributes to an ideal solution. The teams' tasks were to create simple, visible versions of ideas or products so that they could try and discuss. The most effective techniques were the following: 1) digital prototyping (the teams had to create interactive models using various programs that could be «played» by «clicking» on buttons), 2) service prototyping (the teams played out scenarios of stakeholder interaction and key processes, identified weaknesses and strengths). Thus, this stage was a significant step, contributing to the improvement of team concepts through feedback received during discussions and avoiding the development of what would not be required.

5. Test. The last stage in design thinking is testing. This is a very important stage, and the teams needed to check whether their product or concept was working.

4 Discussion

Modern trends in the functioning of engineering activities, i.e. digitalization, automation, and the active introduction of artificial intelligence, have led to the need to revise the concept of «engineering thinking». The traditional form of teaching from the lecturer to the trainees contributes to the formation of many patterns and standard models of behavior, methods of decision-making and working with information. The method of design thinking allows you to make the learning process of students easier (motivating, practice-oriented, interdisciplinary), it creates positive attitude to possible mistakes and failures, contributes to the development of engineering thinking (systems, scientific, creative, critical, responsible, ethical, innovative), emotional intelligence and communication skills in both Russian and English.

A survey of students regarding the benefits of using design thinking in foreign language classes demonstrated the following data, shown in Fig. 1:

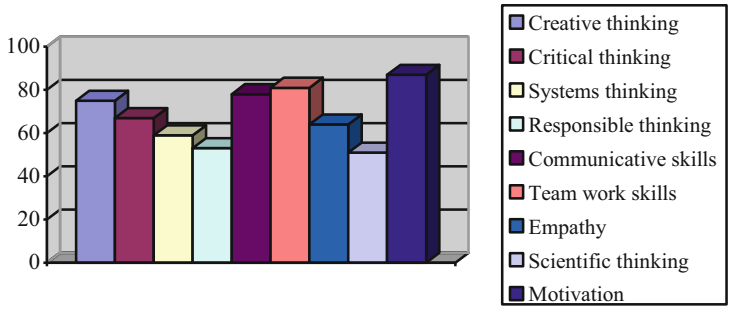


Fig. 1. The most useful aspects of using design thinking in English classes (Source: authors).

However, in the process of working with students, some disadvantages were noticed:

– some key points, such as deep immersion in working with stakeholders, rapid prototyping and storytelling, were considered superficially, which ignored the role of craftsmanship and blocked the way to new ideas;
– no tools or techniques are a panacea for solving complex problems; on the contrary, sometimes a set of tools relevant to one team served as a Pandora's box for another, generating false confidence and creating problems;
– low English language proficiency, which made it difficult to develop design thinking.

The fear of «losing face», that is, offering is not the best option. Often, the wrong decision in the traditional education system or professional field is interpreted as incompetence, insufficient knowledge, skills and experience. Developing creative skills requires a change in thinking about mistakes. After all, it is a mistake that can lead to the right decision. The solution may be to «reduce the degree of tension» by presenting the most improbable or ridiculous solution. This trick causes laughter, reduces discomfort, jokes and looseness appear. Despite some difficulties, in general, we can say that design thinking is an effective method of developing engineering thinking.

5 Conclusion

Engineers represent a fundamental part of our society, as they are called upon to solve problems from construction to medicine, build our lives now and have a significant impact on our future. The field of engineering is of great importance for the progress and well-being of people. A high-quality education is the key to an engineer's success and ability to meet the challenges of the time. Design thinking reveals the well-known thesis: what we should do, having learned, we learn by doing it. By acting, the student learns to solve problems systematically, creatively, innovatively, taking into account the demand for mass uniqueness and customization, approach the project responsibly and ethically. Design thinking promotes the ability to generate ideas and adapt to non-standard solutions. Teamwork allows improving the skills of collaboration and collaboration. Do not forget about such an important component as interdisciplinarity and a practice-oriented approach, which also has a positive effect on learning English, giving a clear understanding of where and how to apply your language skills.

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A Study of Customer Loyalty in Private Schools

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Abstract. Customer loyalty is a key aspect of successful business, especially in the education sector. Private schools, like other educational institutions, face a challenge of attracting and retaining students and their families. The research objective is to determine the level of customer loyalty and draw conclusions to optimize the quality of educational services. The target audience of this study includes clients and staff of private Russian schools. The methodological basis consists of tools for assessing customer satisfaction and loyalty, methods for collecting primary data through telephone and personal interviews. The sample size was 4,200 people. The study showed that consumer loyalty decreases if the problems voiced by clients are not resolved for a long time. In addition, the loyalty of external clients depends on the loyalty of internal clients. The results obtained made it possible to increase the number of clients, control the level of customer satisfaction and staff attrition, and introduce new methods for child development. Studying customer loyalty in private schools helps us understand what factors influence the choice of an educational institution and how the quality of services provided can be improved. It also helps us understand what factors influence the choice of an educational institution.

Keywords: Customer Development · Customer Loyalty · Education · Private Schools

1 Introduction

One of the tasks solved by businesses in terms of managing relationships with consumers is the desire to win customer loyalty. For the educational services sector, the task is relevant due to the increasing demands of consumers for service and the characteristics of the target audience. The users of services are children, and their parents are the decision makers. Thus, it is necessary to understand needs of each group and identify problems in communications. In addition, in the context of growing competition, it is necessary to form unique brand features that support the consumer loyalty.

Studying consumer loyalty in private schools is an important tool for improving the quality of educational services and ensuring sustainable growth. Understanding the factors that influence loyalty allows schools to adapt to customer needs and remain competitive in the market.

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2 Methodology

The research objective is to determine the level of customer loyalty and draw conclusions to optimize the quality of educational services. The scientific significance of this research lies in the need to examine the impact of loyalty on customer retention and the development of the institution.

The research methodology includes the following aspects:

- frequency (the study was conducted twice a year – beginning of the school year, October, and the end of the school year, May – this allows us to identify the dynamics and changes in the behavior of clients and employees);
- questionnaire for clients was developed (the task is to evaluate the educational process, its quality, satisfaction);
- questionnaire for staff is aimed at the evaluation of clients, identification of conflict and difficult situations;
- data collection methods are telephone calls, qualitative interviews (customer development), online questionnaires;
- duration of the study is 3 years.

The target audience of this study consists of clients and staff of private Russian schools. 21 Russian schools formed the sample of the study. During the study, 3,500 client questionnaires and 700 school staff questionnaires were processed.

3 Literature Review

In scientific works, consumer loyalty is considered taking into account several aspects. Firstly, aspects of consumer experience relate to consumer satisfaction. Researchers study components of satisfaction and its impact on consumers. T.A. Khoironi, H. Syah and P. Dongoran [1] define three components of this satisfaction: emotional or cognitive reaction, reaction to the product or consumption experience, reaction to action (after consumption, after choice, based on accumulated experience). Particular attention is paid to the positive relationship between employees' satisfaction and customer satisfaction [2]. However, the results show that employees' satisfaction does not have a significant, direct impact on customer loyalty, but showed an indirect influence via customer satisfaction. According to E. Cengiz [3], customer satisfaction is a personal assessment that is largely influenced by customer expectations, their impressions of contact with the organization, and personal results. Consumer satisfaction depends on the characteristics of a product or service, and the assessment is based on the buyer's expectations before purchase, which, together with the perception of the product, are the determining factors of customer satisfaction [4]. Since consumer experience is determined by the characteristics of a product or service, its quality has a positive effect on customer loyalty [5]. As a result, customers will be willing to pay more for high quality products and services [1, 6].

Secondly, the relationship aspects relate to brand image and customer loyalty. Brand image and customer trust have a positive and significant impact on customer satisfaction and loyalty [7]. Customers must trust the seller or product, and the relationship must have

a positive perceived value. In this case, companies can create emotional attachment. A study of Samsung smartphone buyers [7] revealed the existence of dependencies between the level of trust, customer satisfaction and loyalty: trust has a positive and significant impact on customer satisfaction, i.e. the higher the trust is, the higher the customer satisfaction is. Satisfaction has a positive and significant impact on customer loyalty, i.e. the higher the satisfaction is, the higher the customer loyalty is.

Thirdly, the behavioral aspects determine consumer actions to disseminate information, recommendations and repeat purchases. Conformity to customer expectations can lead to satisfaction, recommendation and intention to make a repeat purchase [4]. On the one hand, customer loyalty is the customer's commitment to the brand, based on a positive attitude and expressed in constant repeat purchases [8]. On the other hand, loyalty includes the use of a product or brand as the first choice over other products or brands, regular mentions in social networks and recommendations [6]. Previous studies have shown the need to improve the quality of goods and services, increase consumer satisfaction and build emotional attachment in order to increase consumer loyalty [9].

4 Results

The first research question that was interesting for us was to form an understanding of why consumer loyalty should be studied. Answering it, we considered the following aspects significant for private educational institutions:

1. Understand customer needs. Studying loyalty helps identify what parents and students value in an educational experience. This may include the quality of teaching, infrastructure, additional services and the atmosphere of the school.
2. Improve service quality. Analyzing loyalty allows schools to identify weaknesses in their offerings and make necessary changes to improve the customer satisfaction.
3. Increase student retention. Loyal customers are more likely to stay with the school for a long time, which reduces the cost of attracting new students and ensures stable income.
4. Create a positive image. High levels of loyalty contribute to the creation of a positive image of the school, which can attract new students through recommendations and reviews.
5. Competitive advantage. In an increasingly competitive private education market, understanding the factors that contribute to loyalty can become an important competitive advantage.

Besides, the consumer loyalty provides business with:

- financial stability: an increase in loyal customers leads to a steady stream of income, which allows a school to plan its expenses and investments;
- reduced marketing costs: loyal customers often become brand advocates, which reduces the need for expensive advertising campaigns;
- innovations and development: understanding customer needs and expectations allows schools to innovate and develop new programs, which can increase their appeal;
- long-term relationships: loyalty helps build long-term relationships with customers, which is important for building community and support for the school.

The following evaluation criteria were applied:

1. For clients: level of satisfaction with education, changes in educational practices (new methods), feedback on safety and social aspects (no bullying, team building).
2. For staff: definition of client types (difficult, conflict-prone), frequency of requests and description of problem situations (how their solutions affect satisfaction).

The study collected data and identified certain patterns:

1. Feedback quality: Loyal customers, both internal and external, always provide quality feedback. They give clear recommendations for work, notice changes and actively respond to any innovations.
2. The impact of unresolved problems: if the respondents' voiced problems are not resolved for a long time, this leads to a decrease in the number of loyal customers by 10%. At the same time, the number of neutral customers increases (5–10%), and the number of respondents reporting problems increases sharply (15–20% per quarter).
3. The loyalty of external customers depends on the loyalty of internal customers. Over the period of the study, a direct dependence can be seen in the dynamics of the indicators: if the Net Promoter Score (NPS) indicator decreases by 3–5 units for internal customers, then the decrease for external customers is the same.

Based on the conducted research, we could:

– formulate detailed recommendations on HR and recruitment, which helped improve the quality of service;
– introduce new positions to improve the quality of feedback;
– develop expert recommendations for marketing based on collected data;
– increase in the customer base and retention of current customers.
– It is worth noting that our recommendations include among other things:
– to provide clear instructions to improve customer loyalty and enhance the quality of education;
– continuously to monitor results to adapt a strategy based on changes in the market;
– to use CRM systems to collect and analyze data on the customer base;
– to conduct seminars and trainings for employees based on customer feedback to improve the quality of service.

It is also recommended to implement regular events for parents and students to strengthen the school community and increase loyalty. Next steps of this research were determined: to expand the research to other aspects of education and to develop a long-term strategy to maintain and improve customer loyalty.

5 Conclusion

In the framework of this research we were able to provide detailed recommendations to HR on personnel search, introduced additional positions, which increased the indicators for providing feedback. The authors developed clear recommendations on the target audience for the marketing strategy. The growth in the number of clients in the considered private educational institution increased 3 times over 2.5 years. We identified

key unique features of the brand. The study allows keeping the level of customer satisfaction, staff outflow under control, identify urgent problems, and also recognize trends and demand in the market in a timely manner. Due to the study, it was possible to introduce new methods for the development of children, to identify problems in children's communication (bullying) at the very first stage of their appearance.

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Education Quality Assessment System in the Context of Competitive Environment

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Abstract. The present research is devoted to issues of strengthening the competitiveness of educational organizations from the position of availability and functioning of the internal system of education quality assessment. The authors consider relationship between the system of education quality assessment and the strategic goal of university development on the example of Samara State University of Economics. The work presents a methodology for calculating the competitiveness index of the educational organization. The research purpose is to comprehensively assess the quality of education at the university as a basis for operational management and a reference point for the development of its strategy, adjustment of goals and objectives. Objectives of the study are: to determine a set of indicators that demonstrate the achievement of strategic objectives by types of policies and the university development program, to formulate measures aimed at ensuring a high level of educational process within the university, taking into account the factors that ensure the quality of education, to formulate a methodology for calculating the non-linear relationship between the competitiveness of the university and internal and external assessment of the quality of education. The main methods of work in this study are situation analysis, which allowed us to determine the attributes and properties of the research object, identify strengths and weaknesses; quantitative statistical methods, which provided the identification of cause-and-effect relationships and patterns; economic and mathematical modelling, which allowed us to create a model of competitiveness of an educational organization in the market of educational services.

Keywords: Competitiveness of Educational Organization · Education Quality Assessment System · Strategic Development of Educational Organization

1 Introduction

Educational institutions, guided by the requirements of the Federal Law «On Education in the Russian Federation», Federal State Educational Standards (hereinafter – FSES) and recommendations of the European Association for Quality Assurance in Higher Education (ENQA), develop and carefully follow a quality policy. This policy includes

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procedures for assessing and maintaining the quality of education, methods of its measurement, as well as mechanisms and processes for quality control of educational programs and awarded qualifications. In addition, it is necessary to utilize assessment tools that allow for an objective evaluation of the quality of education provided.

The policy, methods and procedures of assessment build the internal system of education quality assessment in the educational organization. This system helps the university management to control and manage the quality of education and conditions of its implementation. All this contributes to the competitiveness of the educational organization, strengthening its independence and improving its reputation in the society. The educational quality policy establishes the mission of the educational organization, goals and objectives to ensure the quality of education, as well as the resources necessary for their implementation. The procedures describe methods and tools that are used to implement the policy, monitor it and make changes if necessary.

Quality education is directly related to a clear definition of the goals and results of educational programs at each level of the educational process. To ensure the high quality of education, an educational organization develops its development strategy, defines its mission and specific goals.

2 Methodology

Samara State University of Economics (SSUE) has defined its mission as the training of personnel with a high level of entrepreneurial competencies for the development of the digital economy and the application of advanced methods in making socio-economic decisions. The university development program 2023–2032 sets long-term goals through 2032. The strategic goal of SSUE is to take a leading position among entrepreneurial universities in the Volga Federal District (VFD) by 2032, focusing on research projects, continuing education and development of innovative solutions aimed at commercialization. The strategic goal is achievable through the realization of tasks within the framework of various activities: education, science and innovations, youth policy, human capital development, infrastructure development, digital transformation. The target model of the university development is predicted by the method of expert assessments. It is assumed that the university development program is fulfilled, including solving the tasks of campus expansion, increasing the state assignment for education and research, attracting more students and teachers. The target model of the university is defined by a set of indicators demonstrating the achievement of strategic goals by types of policies and development program. The indicators that allow measuring the progress in achieving the university's development goals until 2032 are reflected in Table1.

All the mentioned policies are aimed at achieving the set goals by solving specific tasks using a project approach. The university's mission focuses on two interrelated areas: intellectual services and entrepreneurship. Specialized projects are developed in these areas, as well as initiatives for internal university transformation. The human capital of scientific, pedagogical and teaching staff of the university, their knowledge, skills and experience are the foundation for the creation of intellectual services and the formation of innovative educational offerings. SSUE concentrates its efforts on training professionals, focusing on interdisciplinary practical research in the field of intellectual services. Implementation of the projects included in the goals of the university's

Table 1. Key indicators of success in the realization of SSUE strategy until 2032.

Strategic Indicators	Actual State	Forecast 2032
Total contingent of students, people	8538	12000
Area of rooms for independent work of students, sq.m	650	900
Provision of students with dormitories, %	33	50
Digital maturity, %	76	88
Share of employees under 39 years of age in the total number of teaching staff, %	17,5	32
Volume of income from income-generating activities per 1 teacher, thousand rubles	3186	4557
Volume of income from income-generating activities per 1 teacher, thousand rubles	398	960
Volume of funds from research, development, scientific and technical services under contracts with organizations of the real sector of economy and at the expense of the Russian budget and local budgets per 1 teacher, thousand rubles	48,4	65

Source: authors.

educational policy enables the university to take leading positions in the VFD in the sphere of education, scientific research and innovations ready for implementation and monetization. The projects of the university are oriented on the priorities of scientific and technological progress of the Russian Federation and world trends for the next 10–15 years. They are aimed at the effective solution of urgent problems concerning the interaction of man with the natural environment and technology, as well as the development of social structures in the era of global change. The approaches of humanities and social sciences are used for this purpose. The fulfillment of the mission, realization of the strategic goal and objectives by types of policies is not possible without continuous monitoring of the quality of education and the quality of conditions for the implementation of educational services.

3 Literature Review

Educational organizations should develop goals and strategies based on the demands of their customers. T.I. Mikushina [1] considers the definition of 'competitiveness of an educational organization' in the interpretation of various researchers. The scientist emphasizes the dynamism and ambiguity of this concept in modern conditions of educational services market development. Currently, the problem of the relationship between the quality of education and competitiveness of educational organization is reflected in the studies of a large number of scientists. So A.V. Verkhovtseva [2] offers a model for assessing the competitiveness of educational organization taking into account factors of recruitment and retention of competitiveness, market conditions. It is a basis for comprehensive competitiveness management. A.A. Lubsky [3] believes that the competitiveness

of an educational organization is based on a comprehensive assessment in relationship with the external environment. According to N.V. Kuznetsova [4], competitiveness is ensured by innovative activity and orientation to the quality of social order of society. A.V. Mikheev [5] draws attention to the influence of innovative factors of educational organization development on the dynamics of indicators of its competitiveness assessment. In his opinion, innovations influence the formation of competitive advantages. Y.K. Migalko [6] studies features of brand formation of an educational organization and substantiates the necessity of brand formation as a condition of its competitiveness in modern socio-economic conditions. According to [7], an educational organization needs to 'clearly plan its image, form and promote it'. The scientist emphasizes the importance of creative thinking of teaching staff, their desire for self-improvement and improvement of pedagogical level, etc. B.A. Temerkhanova [7] believes that the image of an educational organization in the consumer's mind allows ensuring success and increasing competitiveness. V.V. Fokin [8] considers problems of creating a brand of educational organizations. The researcher is sure that the increase of competitiveness is achieved through corporate identity, image and logo of educational organizations, which increases the loyalty of customers, i.e. parents and students. Y.A. Mishina [9] analyses factors of assessing the competitiveness of educational organizations in the market of educational services on the example of educational organizations of higher professional education in Donetsk region. A.V. Solovyova and L.A. Kolyvanova [10] point out that it is possible to achieve the goal through improving the competitiveness of teachers. A number of researchers link the competitiveness of an educational organization with the results of training, i.e. with the competitiveness of graduates. F.M. Tokova and R.M. Batchaev [11] note the importance of interaction between an educational organization and employers during the training of qualified specialists, which ultimately increases the competitiveness of an educational organization. Thus, it can be stated that modern Russian scientists actively conduct research in the field of competitiveness of educational organizations at all levels of education. The authors of this study are based on the assertion that a significant impact on the competitiveness of higher education institution is influenced by the factors that ensure the quality assurance of education, which will be discussed below.

4 Results

Comprehensive assessment of the quality of education is the basis for the operational management of the university, a reference point for the development of its strategy, adjustment of goals and objectives. Continuous quality monitoring (quality assurance policies and procedures), evaluation and analysis of activities at all levels of educational service delivery are also important. This helps to understand the position of the university in relation to others, as well as to determine the ways of further development. Competitiveness of an educational organization (CE) in the market of educational services is the most important indicator of external quality assessment, presented as a complex, non-linear relationship (Eq. (1)):

$$CE = f(Cmb, Cssp, Ctq, Cra, Ccg) \quad (1)$$

where: *Cmb* is criterion of the state of material and technical base that meets the requirements of Federal State University Standard, *Cssp* – quality criterion for scientific and pedagogical staff, *Ctq* – training quality criterion, *Cra* – quality criterion of the university's research activities, *Ccg* –employment criterion for graduates.

The criterion of the state of material and technical base is determined by the requirements of FSUS of higher and secondary vocational education (Eq. (2)):

$$Cmb = \sum_{i=1}^{n} (Ei * Yi) + (Ei * i) \tag{2}$$

where: *Ei* – elasticity coefficient, determined by the method of correlation and regression analysis, showing the change in the *Cmb* in percentages of increase *Yi* and *Xi* by 1%.

In simple linear regression – Eq. (3):

$$E = \text{Cmb} * \frac{\text{Yav}}{\text{Xav}} \tag{3}$$

where: *Yav* and *Xav* – average values of quality criteria for higher and secondary vocational education programs. For different levels of education, this indicator is calculated as follows:

Kmbhe – the criterion of the state of the material and technical base for educational programs of higher education takes into account the availability of:

- facilities, including for independent work, equipped with modern technology and learning materials, such as computers with internet connection and access to e-learning platforms (*Y1*);
- licensed software (*Y2*);
- books and other printed materials that are part of the library collection (*Y3*);
- access, including remote access, to up-to-date professional databases and information reference systems (*Y4*);
- access for students with disabilities and disabilities to printed and electronic educational materials presented in formats adapted for them (*Y5*);
- unlimited access to electronic information and education environment (*Y6*);
- access to material, technical and other resources of organizations that jointly implement the educational program within the framework of network interaction (*Y7*).

Kmbsve – the criterion of the state of the material and technical base for educational programs of secondary vocational education takes into account the availability of:

- classrooms for all types of classes, spaces for independent work, workshops and laboratories equipped with the necessary equipment, teaching materials, computer devices with Internet access and access to the electronic information and education system (*X1*);
- licensed software (*X2*);
- printed and/or electronic publications for each subject (module) (*X3*);
- access, including remote access (when using e-learning and distance technologies), to modern professional databases and information reference systems (*X4*);
- access for students with disabilities to printed and electronic educational materials presented in formats adapted for them (*X5*);
- unlimited access to electronic information and education environment (*X6*);
- access to material, technical and other resources of organizations that jointly implement the educational program within the framework of network interaction (*Y7*).

Cssp is determined by Eqs. (4) and (5):

$$Cssp = \frac{\Sigma}{\mathrm{N}} \tag{4}$$

where: *P* – rating assessment of a scientific-pedagogical worker's activity measured on the basis of a 10-point scale; *N* – number of scientific-pedagogical workers.

$$P = Pa + Pe \tag{5}$$

where: *Pa* – academic rating of a scientific and pedagogical employee, calculated on the basis of questionnaire survey (18 indicators in the questionnaire survey) of students «Teacher of SSUE through the eyes of students» based on the results of training for the semester; *Pe* – performance of indicators of an effective contract, assessed on a 5-point scale as a proportion of the set of performance criteria (Eq. (6)).

$$Pa = \sum_{i=1}^{18} xi * wi \tag{6}$$

where: *xi*– average score obtained by a scientific and pedagogical worker on the *i*-th question for the whole reference group; *wi* – weight coefficient determined by the method of expert evaluations and approved in the methodology for processing the results of the questionnaire.

Training quality criterion (*Ctq*) is determined by the degree of possession of competencies of graduates for each educational program, based on the assessment of the results of the final state attestation (Eq. (7)):

$$Ctg = \sum_{i=1}^{L} yi/L \tag{7}$$

where: *y* – percentage ratio of the level of mastery of competencies by graduates in each educational program, which is defined as a share of the maximum possible score obtained in the process of passing the state final attestation; *L* – number of educational programs that have a contingent of graduates in the analyzed academic year.

University research activity quality criterion (*Cra*) is an indicator of educational institution activity in the volume of research works (published textbooks, monographs, participation in conferences, grants) per 1 scientific and pedagogical employee. In SSUE, it is calculated, among other things, for teachers-practitioners involved in the implementation of educational programs from among employees and managers of other organizations and institutions, whose professional activity corresponds to the profile of the educational program.

Graduate employment criterion (*Ccg*) is determined on the basis of an annual survey of graduates, calculated as the number of employed in the total number of graduates of the current academic year. It is important to consider the competitiveness of an educational organization not only as a quantitative indicator of the current academic year. The dynamics of this indicator over a number of years and its comparison with the indicators of other universities is of great importance.

5 Conclusion

Calculating the competitiveness of an educational organization helps to create a system for forming and maintaining its positive image. A favorable image can also be strengthened through recognition and good reputation, quick adaptation to changes in the needs of the population and employers, introduction of innovative solutions, popularity of the specialties offered, effective advertising policy and international relations. Thus, to strengthen the competitive position of the educational institution it is necessary to have an effective system of education quality assessment. Such a system allows regularly monitoring the compliance of educational programs and processes with the established standards and requirements, identify weaknesses and quickly make adjustments. This helps to maintain a high level of teaching, improve teaching materials and methods, and meet the needs of students and employers. In addition, transparent and objective quality assessment helps to increase the trust of students, parents and partners, which in turn has a positive impact on the reputation of the university. A well-organized quality assessment system becomes an important tool for increasing competitiveness and attracting new students and partners.

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Digital Strategies of Russian Higher Education: A Legal Aspect

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Abstract. In the modern world, knowledge is gaining an increasingly dominant role, overshadowing traditional factors of production and natural resources. In this new reality, higher education, as a key stage of the educational system, is becoming a fundamental engine of progress and human development. It is the accumulation and dissemination of knowledge, as well as the ability to innovate, that determine the competitiveness of nations, the well-being of individuals, and the trajectory of the world's development. Investments in higher education are therefore a strategic priority aimed at creating the intellectual capital needed to address global challenges and build a sustainable future. The educational process has always been sensitive to economic and technical trans-formations. Today, in the era of the fourth technological revolution, the widespread introduction of digital technologies and AI into all spheres is taking place. Higher education could not stay away from these processes. All levels of education are undergoing a digital transformation. And here the question is not so much about the «survival» of educational organizations in the market, but about the level of competencies trained by specialists for all fields of professional activity in the digital world. Undoubtedly, problematic aspects arise in this regard. The relevance of this study lies in the fact that the problems of education affect almost all members of society in one way or another.

Keywords: Artificial Intelligence · Development Strategy · Digitalization · Education · Higher Education · Innovative Technologies

1 Introduction

Digitalization has become an integral part of the life of modern man and society. This process cannot be stopped. It's only picking up speed every year [1]. This process affects educational services too. It should be noted that the educational process is always sensitive to industrial revolutions and economic transformation. Modern higher education

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is characterized by the penetration of digitalization into the learning process and the management process of educational organizations. Digitalization of higher education should be considered as «a process of transformation of educational and administrative processes, as well as everyday social practices in the higher education system» [2]. It is due to the introduction of technologies for creating, processing, exchanging and transmitting large amounts of information on media other than paper. This process involves the integration of educational and information resources. Digitalization of education, including higher education, is divided into three stages:

The first stage began in the mid-1980s of the last century and ended in the early 1990s. A special feature of this stage was the appearance of computers in higher education institutions. However, they were used exclusively at the faculties of computer science and programming. It was during this period that there was an urgent need to improve computer literacy not only among students, but also among the scientific and teaching staff.

The duration of the second stage was 10 years, starting in 2000. It is characterized by the widespread use of computer technology and a variety of techniques in the learning process. This applies to all subjects, regardless of their relation to information technology. In particular, documentaries are actively shown during lectures and seminars, interactive whiteboards are used, and online tests are used to assess the level of knowledge.

The third stage begins in the middle of the 21st century and continues today. It is important to emphasize that this period is characterized by the comprehensive introduction of information technology into the educational environment. Traditional textbooks are giving way to online platforms, paper attendance logs are gradually being replaced by electronic counterparts, and paper credit books are being trans-formed into electronic versions. It is the stage of IT development that radically transformed the structure and objectives of the educational process.

2 Methodology

During the research, a combination of various scientific methods was used to ensure the validity, validity and relevance of the results. Empirical methods were applied, such as the analysis of statistical data on the digital infrastructure of universities, the level of digital literacy of teachers and students, as well as the use of digital educational resources, which made it possible to assess the current state of digitalization. A case study analysis of individual universities that have achieved significant success in digitalization has revealed the best practices. Finally, modeling and forecasting scenarios for the development of digitalization based on the identified trends and factors allowed us to identify the most promising strategic vectors. The combination of these methods provided a comprehensive and in-depth study.

3 Results

The advantages of digitalization are indisputable, but there are also disadvantages of this process. In the scientific and pedagogical environment, there are concerns about negative consequences such as a decrease in the quality of education, a decrease in the cognitive

abilities of students, a lack of social skills, and a negative impact on the health of students, scientific and pedagogical staff. We must not forget about the digital divide here either [3]. In addition, the process of digital transformation for universities is a costly process in terms of financing. In our opinion, special attention should be paid to the need for scientific and pedagogical staff to possess digital competencies and implement them in the educational process. In our opinion, the implementation of the educational process in a mixed format should be a priority. An ecosystem association of universities would be advisable and even more important for educational institutions. It is necessary to take care of not only the pressing problems, but also the problems of the future – the increasingly extensive penetration of artificial intelligence into educational and administrative processes, which causes a mixed reaction in the scientific and pedagogical community. The range of its use is quite wide. So, AI can be used to train «soft skills», for example, practicing communication skills, blockchain is already being implemented today to store certificates, diplomas, exam papers, and creative works, providing access to them and at the same time protecting authorship.

It is already indisputable that the use of digital tools in the learning process in higher education is an urgent need. A lot of experts express the opinion that in modern realities education is no longer possible to imagine without digitalization. And this is directly related to the fact that the digital environment has become an integral part of the life of every individual and society as a whole.

According to [4], the question of using digital technologies in education is no longer worth it. According to [5], today, digitalization is no longer the future, but an inevitable reality and there is no alternative to it, therefore universities need to rebuild and achieve digital maturity. This process does not remain without attention from the state. So, in 2021 The Government of the Russian Federation has developed and approved a strategic direction in the field of digital transformation of higher education and science [6]. It is based on a number of regulatory documents adopted earlier [7–10]. As for higher education, the strategy is aimed at achieving a high level of «digital maturity» of higher education institutions. The Russian Government has consolidated a number of tasks of the digital transformation process in:

- improving the quality of higher education and scientific research;
- implementation of tools that allow the use of forecasting and analytical methods in making strategic decisions;
- improving the efficiency of the Ministry of Science and Higher Education and universities through the introduction of digital tools in management, scientific and educational processes;
- the formation of mechanisms for involving business entities, government agencies and corporations in solving the most important problems of transformation of the Russian military.

The Ministry of Education and Science of the Russian Federation has developed a concept for the digital transformation of higher education, which consists in the transition of education and science to management, in which decisions are made based on the analysis of numbers, rather than intuitively based on personal experience [11]. A number of trends can be identified that are characteristic of the process of digitalization

of Russian higher education: building a mixed learning model, introducing online education, creating a virtual digital educational environment, transformational approaches in the management of higher education institutions.

It would be wrong to equate the process of digitalization of education with online distance education [12]. Digitalization of education involves the use of various programs, applications, and digital resources for learning both online and in the classroom. For example, when students complete assignments on a computer or tablet in an educational institution. This concept is broader than online distance education, as it covers all aspects of learning, including technological tools and resources necessary for effective learning. As a result of the digitalization of education, students have the opportunity to study more efficiently and conveniently, and teachers can use the latest teaching methods to improve the quality of education. The process of digitalization of the educational process in higher education also involves a complete transformation of the organization's business processes using digital technologies. The pace of this process is undoubtedly set by the speed of digitalization of the national and global economy.

4 Discussion

As for the digitalization of administrative processes in higher education institutions, first of all, it is the creation of departments for digital transformation. The Department of Digital and Information Technologies was established at Samara State University (SSU) in 2021. Its responsibilities include the implementation of a digital transformation strategy and the formation of a high information culture. By implementing its competencies, it manages and coordinates the activities of structural divisions in the field of digitalization. In addition, the department manages and coordinates the implementation of corporate projects, develops and implements new information technologies in the educational and scientific activities of the university. It also solves a lot of practical problems related to the digitalization of information processes at SSU:

- ensuring the operability of the university's information and communication network;
- development and maintenance of its functioning as a regional segment of the National Research Computer Network (NRCN) and the unified global Internet;
- automation of the information processing procedures in the educational institution;
- protection of confidential information;
- carrying out design and research work in the field of development, implementation and maintenance of software products, maintenance of computing equipment.

The Samara Polytechnic University also has the Digital Transformation Department, the Department for Technical Information Protection, which is an independent structural unit of the educational organization. Back in 2021, the university developed a digital transformation strategy in order to implement an effective digital environment at the university. This strategy has been submitted to the academic council of the university for discussion and approval. This discussion testifies to the significance of the strategy for the educational organization. The key priority in the strategy is the educational process, the ability to analyze the digital footprint, as well as the digital transformation of basic processes that make it possible to quickly cope with the increasing volume of incoming

information. The strategy is aimed at introducing modern information systems to create an individual learning trajectory for each individual student, expand distance learning opportunities, and build a dialogue with the organization's target audiences – students, employees, partners, the media, etc.

One of the sections of the Samara University development strategy is devoted to the policy of digitalization in the field of educational process and administration. Several vectors of digitalization are fixed in the policy: digitalization of educational and scientific activities, digitalization and transformation of the management system, digitalization of the campus and IT infrastructure. The following priority areas are recognized: «digitalization of business processes, development of services of the unified digital platform of the university, development of the infrastructure of digital services, filling the organization's digital platform with scientific and educational electronic resources and databases» [13].

The main objectives of the digitalization policy of Kabardino-Balkarian State University named after Kh. M. Berbekov (KBSU) include: in-depth analysis and up-grade of IT infrastructure, introduction of end-to-end technologies and digital services, creation of a digital twin of KBSU based on big data technologies, artificial intelligence and neural networks, which will optimize and predict the main development tracks and the life of the university. In 2022, KBSU participated in the project «Code of the Future» as part of the national program «Digital Economy of the Russian Federation». As part of the project, students in grades 8–11 could take a two-year course in modern programming languages. Since September 1, 2023, the digital department project has been implemented at KBSU. It aims to provide students with additional qualifications in parallel with their studies in the main professional educational program. Students of specialties that are not related to the IT field can receive additional qualifications. For example, future economists, lawyers, managers, doctors will be able to receive competencies in creating algorithms and computer programs, as well as working with databases at digital departments [14].

In 2021, students of the Grozny State Oil Technical University named after Academician M. D. Millionshchikov created the first blockchain platform in the Chechen Republic with control of publicity. Digital document management and a voting system are deployed on the basis of this platform. The educational institution pays special attention to the creation of a digital educational environment, the development of information educational technologies in certain areas of economics, management and law, development of simulation educational simulators in the field of economics, public administration, management and law [15].

5 Conclusion

It should be noted that higher education institutions have realized that the process of digitalization is a real necessity for their survival, attracting an increasing number of students, including foreign citizens. Today, this process in higher education is not spontaneous, but strategic in nature: roadmaps have been developed until the end of the 21st century. The introduction of AI into the educational process carries significant potential, but it also comes with certain risks. The main one is the risk of increasing digital inequality, thereby exacerbating educational inequality. It is important to take into account the

possibility of excessive dependence of students on AI in the educational process. Equally important is the risk of bias in AI algorithms, which can lead to discrimination in the educational field. The leakage of confidential information cannot be ruled out. Therefore, the introduction of AI in education requires a thorough risk analysis and the development of strategies to minimize them.

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Innovations and Quality of Learning in the Higher Education System

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Abstract. Processes of digital transformation and implementation of innovative technologies in the higher education system have been actively taking place. Digital tools and platforms that contain various opportunities for organizing the educational process are actively applied: creation of electronic courses, interactive educational materials, test databases, tools for communication and interaction between students and teachers, monitoring academic performance. Among the key areas of innovation development in digital education, one can highlight the introduction of an individual learning path using artificial intelligence, mentoring in virtual reality, immersive learning, etc. Active use of innovative technologies and digital learning increases the share of independent types of work of students, reduces traditional forms of training and modifies the role of the teacher in the educational process. At the transformation stage, the key role belongs to the tools for assessing and monitoring the level and quality of assimilation of educational material by students. This work reveals a technology for identifying the risk of potential discrepancy in mastering an academic discipline.

Keywords: Digital Technologies · Educational Process · Innovations in Education · Mastering the Discipline · Quality of Education

1 Introduction

In modern society, the quality of education is a key characteristic of the development of the higher education system. The transition to an innovative path of development is based on the improvement of human capital. The ability to perceive knowledge and skills, the possibility of successful implementation of acquired skills determine the potential of a future employee.

The state considers the following strategic areas and priorities of digital transformation:

– preservation and strengthening of traditional forms of education using IT technologies;
– introduction of electronic products of Russian origin (data storage systems and server equipment, communication equipment, etc.);

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– creation of an electronic educational environment, including electronic information resources and technologies that allow obtaining knowledge on educational programs in full [1].

Digital technologies currently play a key role in education. Digital tools and platforms are actively used, which contain a variety of opportunities for organizing the educational process: creation of electronic courses, interactive educational materials, test databases, tools for communication and interaction between students and teachers, monitoring academic performance, etc.

2 Methodology

Based on the calculation of the priority number of risk (PNR) indicator using the expert assessment method, it is possible to identify the topics of the academic discipline, which may cause problems in mastering the material by students. Identification of potential discrepancies allows us to develop a number of preventive measures that help eliminate the most significant problems and exert control over the educational process. The purpose of the study is to identify potential discrepancies with the requirements for the content and level of assimilation of educational material based on the application of the PNR methodology. Research objectives include: to determine key areas of development and state priorities in the field of digital education transformation, to calculate the PCR indicator using the expert assessment method, to provide recommendations for reducing the number of potential discrepancies in the level and quality of assimilation of educational material. The study is based on the application of scientific and systemic approaches using quantitative and qualitative methods.

3 Literature Review

Currently, a large number of works are devoted to the study of innovative approaches and methods in education. Some authors consider individual areas of higher education development, such as distance learning [2, 3], practice-oriented education [4], immersive education [5]. Most authors consider general areas of digital transformation and innovation in the field of education [6–10]. There are several key areas for the development of innovations in digital education: 1) individual learning path based on the use of artificial intelligence: based on the student's preferences and past experience, the neural network creates a learning plan taking into account the needs and capabilities of the student; 2) mentoring in virtual reality: virtual assistants can consult students, answer questions, and explain complex issues; 3) immersive learning: the use of game-based teaching methods based on the use of virtual and augmented reality; 4) assessment of skills and abilities using augmented reality technologies: the recreation of real conditions allows students to demonstrate professional competencies in practice.

The key task of the higher education system is to ensure a high level of mastery of educational programs using various methods and technologies based on the management and control of the educational process. The active use of innovative teaching methods and digital technologies is based on the individualization of learning, an increase in the

share of independent types of work. This reduces the number of active communications between students and a teacher, and reduces the role of the latter in learning. Therefore, the problem of assessing the quality and degree of assimilation of the educational material by the student, assessing the accessibility of the latter comes to the fore. The basis of the curriculum is a working program of a discipline. Its compilation involves planning, organizing and managing the educational process in a specific discipline. In the process of implementing the curriculum, discrepancies in the quality of its assimilation may arise. In this case, it is necessary to adjust the order of studying the academic discipline, taking into account the characteristics of the learning process, the contingent of students. The goal of the educational process is to reduce discrepancies in the assimilation of the educational program, and it is desirable not to identify, but to prevent these discrepancies.

4 Results

Effective regulatory impact on the educational process is based on obtaining complete, timely and reliable information on the quality of the educational process and involves: analyzing the work program, its individual topics and sections from the point of view of their significance for practical activities, their complexity from the standpoint of mastering; identifying types of discrepancies in the quality of mastering the educational process, determining the possibility of identifying discrepancies; developing and implementing corrective and preventive actions in case of detection of this discrepancy (incomplete or incorrect mastering of educational material).

Let's analyze the work program for the discipline «Risk Management». Data analysis shows that the share of lectures in the total volume of the discipline is 12.5%, the share of practical classes is 12.5%. More than half (62.3%) of the academic hours allocated to this discipline are allocated to the student's independent work.

Analysis of the work program of the studied discipline is necessary to establish types and consequences of potential discrepancies in mastering the educational program for the future economic activity of university graduates. For each topic of the academic discipline, it is possible to find the priority number of risk (PNR) – Eq. (1):

$$PNR = S * O * D \tag{1}$$

S – significance as an assessment of losses due to non-mastering of the material (non-compliance with requirements) for economic activity, O – the possibility of non-compliance, D – the ability to detect non-compliance.

We determine the indicators S, O and D using the expert assessment method. The expert assessment method is a type of research in which the respondents are experts – specialists in a certain field of activity. The teachers of the department were involved as experts. The experts assessed the indicators in points from 1 to 10. The results of the expert survey are presented in Tables 1, 2, and 3.

According to the experts' opinions (Table 1), the most significant topics are «Risk factors», «Strategies for making risk decisions» and «Basic risk management tools. Risk management techniques and methods».

According to the data in Table 2, a relatively high probability of the occurrence of a discrepancy in the assimilation of the material is characteristic of the topics «Risk measurement and criteria for making risk decisions» and «Risk assessment methods».

Table 1. Possibility of occurrence of non-conformity, in points.

Indicator	Topic number								
S	1	2	3	4	5	6	7	8	9
	3,3	6,3	7	3,3	5	4	6,7	3,3	3

Source: authors

Table 2. Possibility of discrepancy in material acquisition, in points.

Indicator	Topic number								
O	1	2	3	4	5	6	7	8	9
	3,3	4	4	3,7	5,3	5,3	4	3,3	3,7

Source: authors

Table 3. Ability to detect discrepancies in the assimilation of material, in points.

Indicator	Topic number								
D	1	2	3	4	5	6	7	8	9
	2,3	1,7	2	1,3	2	1,7	2	1,7	2,3

Source: authors

In Table 3, the detection capability varies from 1 to 10. One point is given when the discrepancy is reliably detected, ten when the discrepancy is practically not detected. Based on the data in Tables 1, 2 and 3, we will calculate the PNR indicator, rounding it to whole values (Table 4).

Table 4. Priority number of risks, in points.

Indicator	Topic number								
PNR	1	2	3	4	5	6	7	8	9
	25	43	56	16	53	36	54	19	26

Source: authors

The analysis of Table 4 shows that for the topics «Risk factors», «Strategies for making risk decisions», «Risk measurement and criteria for making risk decisions» and «Basic risk management tools. Risk management techniques and methods» the indicator is relatively high.

5 Conclusion

When analyzing the indicator of the PNR, it is necessary to emphasize that the significance of the topic is more important when determining the degree of non-compliance and deciding on the need for controlled impact on the educational process. In these topics, the value of S is estimated at 5 points or higher, so it is necessary to take measures to eliminate the possibility of non-compliance. Reducing and minimizing the factors leading to the emergence of non-compliance in the mastery of the academic discipline is one of the key types of control impact on the educational process. The latter involves the implementation of preventive and corrective actions. They should be aimed at eliminating the most significant non-compliance in the quality of mastering the academic discipline, its individual topics and sections. The end result in this case, naturally, is to consider the trends of positive change in the level of knowledge and professional skills of students.

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Digital Technologies in the Personnel Management System in Conditions of Personnel Shortage

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Abstract. Due to the current shortage of personnel on the Russian labor market, manufacturing companies are facing a critical challenge in finding ways to improve the production efficiency. One of the key approaches is to implement a set of methods aimed at increasing the labor productivity. To address this issue, innovative approaches and unconventional solutions are needed, including the widespread use of digital technologies. In this context, an imitative model of how extensive production growth affects the efficiency in the face of personnel shortages is considered. This model demonstrates the limited potential of traditional methods in achieving the desired level of economic growth in the current environment. In this context, a simulation model is proposed to investigate the impact of intensified production methods on the efficiency growth, considering the current shortage of personnel on the labor market. This model aims to examine challenges and benefits of implementing these methods within the economic development strategies of companies, as well as their potential to achieve strategic objectives. Special attention is given to the transformation in the professional workforce structure due to the evolving technological landscape in modern ecosystems. In light of this stage of innovative economic development, opportunities for enhancing the potential of digital transformation are explored in terms of strategically managing the professional composition of personnel within local ecosystems and various sectors of the national economy.

Keywords: Approach · Efficiency · Extensive Human Capital · Intensive Approach · Labor Productivity · Profession

1 Introduction

The Russian economy is faced with a serious shortage of personnel in the labor market, which has led to the need to find innovative approaches and non-standard solutions to increase the productivity at enterprises. A federal project approved by the Government to increase the labor productivity, which provides targeted support to individual companies, was adopted as a key approach. The project will affect 40% of non-resource industries and all social organizations. It is planned to spend 30.5 billion rubles on the project over six years. The labor productivity is expected to grow by 21% in six years,

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which is a significant improvement over the previous period, when growth was 8% [1]. It should be emphasized that labor productivity in various sectors of the economy is currently showing significant fluctuations. In particular, in the field of mining, the labor productivity reaches almost 300 thousand US dollars per year per employee. At the same time, in the petrochemical and metallurgy industries, this figure ranges from 118 to 135 thousand US dollars [2]. The woodworking and light industry sectors show a significant lag in the labor productivity [3]. In conditions of a shortage of personnel, the problems associated with the growth and equalization of labor productivity levels in the economy are becoming more complex. The situation is aggravated by sanctions restrictions on the supply of new equipment, which leads to its rise in price. In this regard, there is a need to activate factors related to human activity.

2 Methodology

In this regard, the issue of extending the limit of overtime hours for employees of Russian enterprises from 120 to 240 h per year is being discussed. According to [4], about a third of Russians (29%) already overwork every day or almost every day. About a quarter (23%) work overtime 2–3 times a week. 12% do this at least once a week. 17% work overtime a couple of times a month [4]. The most overloaded age group is people aged 45–54, among them 88% of the respondent's overwork. In other age groups, the percentage of those affected by overworking is approximately the same, 79–80%, which indirectly confirms the shortage of personnel in the labor market [5]. By the end of 2024, the unemployment rate in the country has updated the historical minimum of 2.5%, which, in fact, became the basis for the emergence of the concept of «personnel shortage». An equally relevant approach to solving the problem of labor shortage has become the so-called «quiet hiring», which has become widespread in companies with more than 1,000 employees, mainly in the banking, financial and construction sectors, where competition for qualified specialists is particularly high. The essence of this approach is to appeal to the company's key employees in order to combine professional competencies by redistributing tasks and expanding functionality. Quiet hiring allows companies not only to solve the problem of staff shortages, but also to increase the level of labor productivity by increasing the intensity of staff work. In addition, this approach reduces the cost of hiring and adapting staff. The extent of the spread of quiet hiring varies widely. Every fourth company closes from 5% to 15% of vacancies due to the redistribution of responsibilities. However, in a number of companies, this figure is significantly higher – from 40% to 60%, and in some cases reaches 80%. It is expected that in 2025, the share of quiet hiring will continue to grow as a result of the growing shortage of personnel [6].

For all the obvious financial advantages of quiet hiring, it has its own significant risks of application. Special studies have shown that 54% of respondents employed in the organization's quiet hiring system noted the risk of increased staff workload and employee burnout [7]. The latter circumstance is compounded by the fact that a lot of respondents noted the unwillingness of employees to perform new duties.

3 Results

In the context of a significant increase in prices for new equipment, as well as the expected difficulties with its development, models related to extensive methods of increasing production volumes have gained some relevance [8]. First of all, the issue of expanding production through the widespread use of traditional technology was considered. The latter implied an increase in the number of jobs and, consequently, an increase in the number of staff. The advantages were seen in the relatively low price of previous-generation equipment and the relatively low cost of attracting staff capable of servicing it. However, in the context of a situation of «personnel starvation», unexpected consequences of using this approach arose. Figure 1 shows a model that characterizes the negative consequences of such decisions.

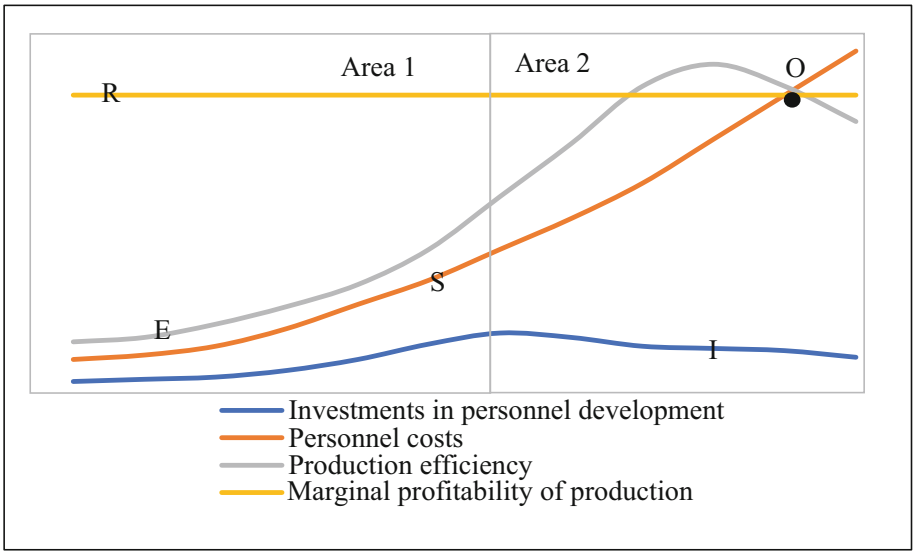


Fig. 1. Simulation model of the impact of extensive production development on the growth of its efficiency in conditions of personnel shortage (Source: authors).

In the process of implementing the tasks to increase the number of staff, certain problems have arisen. In the context of a shortage of personnel in the labor market, the cost of hiring staff has increased sharply. At the same time, the level of remuneration for workers in traditional professions has also increased significantly. In this regard, it was necessary to significantly increase the salaries of existing staff and, accordingly, new employees who were accepted for vacant positions. Expectations of a change in the labor market situation towards an increase in the supply of labor resources have not been fulfilled. The salary level for the main professional groups of staff continued to grow, which negatively affected the profitability of production (Fig. 1, Area 2). The advantages associated with relatively small investments in personnel development did not lead to the expected cost reduction. In addition, the company faced a critical decline

in profits (point O), which deprived it of the opportunity to use additional forms of staff motivation. Due to the shortage of personnel, the company faced the problem of staff turnover, including highly qualified specialists. This puts enterprises on the brink of survival as independent subjects of economic activity. Thus, the use of extensive methods to increase production efficiency did not lead to the expected results, but, on the contrary, aggravated the problems of the organization's development in conditions of personnel shortage.

There is a need for a qualitative change in approaches to achieving sustainable growth in production efficiency, which implies a transition to intensive forms of development. This includes the activation of factors determining the technical development of production, as well as improving the level of qualifications and professional training of personnel. Unfortunately, nowadays heads of organizations tend to save not only on hiring and adapting staff, but also on their professional development. This is reflected in the fact that the training of new professional competencies is often replaced by limited professional training. This problem has acquired national importance. In the future there will be a lot of work with the educational unit to coordinate the list of professions and training areas in educational institutions. Currently, a paradoxical situation has developed: 56 groups of professions are allocated in the vocational education system, 435 groups of occupations are allocated in the Ministry of Labor and Social Protection of the Russian Federation, and employers already have 3 million job titles [9]. This is a consequence of the development of the scientific and technological revolution. In the context of the active development of technologies in the production and management spheres, especially in the context of the introduction of digital technologies and artificial intelligence, new competencies are emerging that differ significantly from traditional professional skills [10]. At the current stage, each new competence acquires the status of a profession, which leads to the paradox of the demand for practice of about 3 million job titles. In fact, each such profession is a hybrid education that includes both new professional skills and traditional methods of work. Each of these «hybrid professions» gets a name associated with the dominant new competence. Due to the uniqueness of such professions related to specific technologies in production and management, it is difficult to classify them into groups.

As new technologies diffuse, these competencies become more important than acquired skills that can be applied to different industries and management areas [11]. Consequently, the number of hybrid professions decreases, and they become approved professions in state classifications. However, mastering new skills in the context of using innovative technology requires significant investment in the development of personnel. Developing new skills through trial and error involves high risks of technical failure and emergency systems, which seem incompatible with effective innovations in production methods (Fig. 2). This model considers the situation related to the choice of intensive production development methods. The intensification of production involves the introduction of new technology [12]. Despite the difficulties associated with the implementation of innovation policy, its implementation creates strategic prospects for the development of production. For the successful implementation of innovations, it is necessary to solve a number of financial issues as well as to develop an investment program for personnel development. This will allow you to master new competencies

necessary to manage new technologies and ensure stable performance of the technical system. In addition, it is necessary to pay attention to modern digital management technologies, which play a key role in activating factors of sustainable dynamic production growth. Area 1 of the simulation model describes the process of mastering a new technical system and, as a result, acquiring new professional competencies, including digital management techniques. In this area, there is a high level of investment in developing human capital of employees, which is essential for achieving high levels of professionalism and increased labor productivity [13]. Together, these factors make it possible to achieve the desired level of efficiency for the technical system, reflected in significant increases in economic indicators that characterize its profitability.

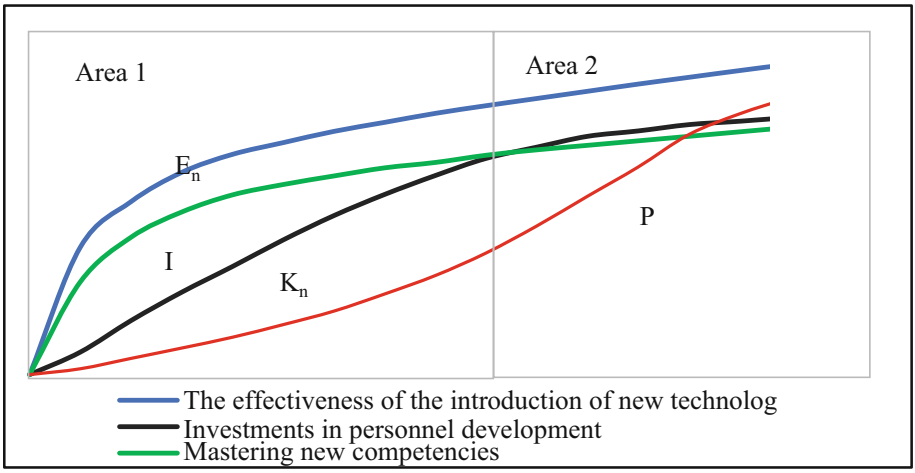


Fig. 2. Simulation model of the impact of intensive production development methods on the growth of efficiency under conditions of personnel shortage (Source: authors).

Area 2 of the model under consideration demonstrates a situation in which previously made investments in human capital lead to a high level of mastering of new technology by employees of the organization. This, in turn, contributes to a significant increase in labor productivity and wages, which makes the organization competitive in the labor market. Thanks to this, the company can attract highly qualified technical and IT specialists, thereby creating conditions for further development. At the same time, the growth rate of production costs and personnel development is decreasing compared with the dynamics of labor productivity growth and production efficiency of new technical systems (Fig. 2, Area 2).

4 Discussion

Currently, there is a systematic consolidation of many new skills in Area 2, which leads to the emergence of new professions. It should be noted that the Russian Federation has a state information resource – the Directory of Professions – which provides citizens

and organizations with information on sought-after and promising jobs. The meaningful filling of job descriptions takes place in stages [14]. Most jobs are presented in short descriptions and consist of three blocks: the first block contains information relevant to professionals (state executive authorities, employer's associations and organizations, employment services, trade unions). The second block includes analytical and statistical information on approximate salaries of specialists in each profession, as well as information on the relevance and prospects of development of a profession. The third block contains a detailed description of the professions aimed at a wide range of users, including people of different ages, and is intended to form an idea of the nature of the profession and help with professional self-determination. Rules for creation, maintenance, and updating of directories of professions are established by the Government of the Russian Federation. The Ministry of Labor website contains only verified data from experts, so many professions have brief descriptions. However, it is likely that every year as digital technology develops, the content and functionality of the directory's information and reference resources will improve. It can be expected that the trend of using digital technologies to create and define new professions and professional groups will increase, as it has become a noticeable phenomenon in the modern economy. For example, in 2016, about 600 new jobs were created. In 2023, Ministry of Education of the Russian Federation approved 5,110 new job titles and positions for employees [15].

5 Conclusion

In the context of the worsening personnel shortage in the Russian economy, the need for a transition from extensive to intensive methods of production development is becoming obvious. While not denying the possibility of using extensive methods of development in general, it is important to note that their application in modern conditions has limited opportunities for economic growth. Analysis has shown that traditional approaches to increasing labor productivity are no longer providing the required level of efficiency. Extensive models of development based on increasing staff numbers, in conditions with limited human resources, lead to increased costs and reduced profitability. On the other hand, intensive methods based on digitization, introduction of new technologies, and development of human capital show sustained effectiveness. Introduction of digital technologies into management and production creates conditions for formation of new professional skills. These competencies are often hybrid forms that combine traditional and innovative elements. Systematic development of new competencies requires government and business investment support. Vocational training, retraining, and the formation of new qualifications standards play a special role in this process. Strategic regulation of employment structures should take into account technological diffusion and adaptation of vocational education systems. An analysis of intensive development models has shown that investment in staff training contributes directly to productivity growth and long-term cost reduction. The use of digital technologies provides prospects for building flexible human resource management systems. In these circumstances, quiet hiring can only be a supporting role without solving systemic issues. Long-term competitive advantages are gained by organizations that build their own personnel development programs integrating digital management methods. This innovation can become an important tool for

synchronizing processes in the labor market. Using digital technologies to form a state directory of professions becomes important in implementing this approach. Developing it in a digital format is a significant step toward building a modern professional guidance system. It is also important to consider the diversity of new professions and their need for prompt reflection in regulatory frameworks. Digitalizing the Directory of Professions and synchronizing it with labor market data allows us to create an objective picture of economic needs. This, in turn, helps to establish a qualified and balanced workforce in various sectors of the national economy. The successful development of new technologies requires not only technical modernization, but also a profound transformation of management culture. Staff should be prepared to work with new equipment and for continuous training and self-improvement. In this case, digital transformation will lead to increased productivity and quality of work. The future of effective personnel management lies in digital engineering and strategic human capital planning. Digitalization and development of hybrid competences are key factors for enterprise competitiveness. A modern human resource model requires an integrated approach and strategic planning, with digital technologies as the core of sustainable economic growth strategy.

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Lean Approach to Inventory Management of a Machine-Building Enterprise

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Abstract. At modern engineering enterprises, within the framework of lean manufacturing technologies, not only material resources, quality, time and productivity have become valuable, but also safety, delivery, inventory and capacity. To achieve maximum results and effective process management, it is necessary to eliminate any type of activity that consumes resources but does not create value for the consumer. Among the known seven types of losses in production, we will highlight excess inventories. Inventories are not just tangible assets in the warehouses of an enterprise; they are a critical element that ensures the continuity and efficiency of its operation. They serve as a buffer that mitigates market fluctuations and production risks. It is proper inventory management that allows enterprises to quickly respond to changing conditions of supply and demand, optimizing their costs and accelerating the turnover of assets. From the point of view of lean manufacturing, storing excess inventory in a warehouse is a type of waste that can lead to increased storage costs and reduce the turnover of the company's working capital.

Keywords: ABC-XYZ–Analysis · Capacity · Delivery · Excess Inventory · Inventory · Inventory Management Methods · Lean Production · Losses · Safety · Value

1 Introduction

The use of the ABC method means that the majority of inventory value is made up of a small number of product items. The ABC analysis procedure includes the following steps [1]: data collection, calculation of product consumption, product ranking and segmentation. After segmenting products into categories, inventory management for each category is carried out differently: category A uses strict inventory control, frequent inspections and precise planning to avoid excess inventory or shortages, as these have the greatest impact on the financial condition of the company; category B products require a balanced approach, with a moderate level of control; for category C, more free management is allowed, since these goods are less important to the total value of inventories.

The XYZ analysis method is focused on assessing the variability of demand and predictability of product items [2]. Unlike ABC analysis, which focuses on the financial significance of goods, XYZ analysis is aimed at determining the stability of demand.

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The XYZ analysis process involves the following steps: 1) collecting data on actual consumption of products over a given period, 2) analyzing the stability of demand for each item, 3) calculating the coefficient of variation (the lower the coefficient is, the more predictable the demand for the product is), 4) classifying products. XYZ analysis involves classifying products based on their consumption variability into three categories: X – the most predictable demand with a low level of variation, Y – moderate demand variability requiring more careful planning and analysis, Z–: high variability with unpredictable demand, products in this category require a special approach to inventory management, often using risk-reducing solutions such as higher safety stocks or more frequent orders in smaller batches.

2 Methodology

The assembly shop program of a machine-building enterprise is 12000 items per month (25 working days per month). The shop works in two shifts for 8 h. The maximum stock is 50% more than the safety stock. The auxiliary area is 30% of the main area. The first line parts are stored in boxes of 10 pieces. The box size is 0.8 × 0.5 m. The boxes with the first line parts do not take up additional space, but are located under the racks. The second line parts are stored on carts in special nests (10 pieces on each cart). The area occupied by one cart is 1.2 sq.m. The third line parts are stored on the racks in cells. The number of cells in one rack is 16. The area of one rack is 2 sq.m. For subsequent warehouse operation, inventory control methods are used to possibly free up warehouse space, as well as cash in excess inventory using ABC-XYZ analysis. Average annual inventories and quarterly volumes of demand for parts by item are presented in Table 1.

The interval boundaries for dividing parts into groups for ABC-XYZ analysis are presented in Tables 2 and 3.

In most manufacturing systems, a small percentage of purchased parts account for a large percentage of purchasing costs. Therefore, to have the greatest impact, management attention must be focused on these parts. To achieve this, a lot of manufacturing companies use an ABC classification for purchased parts and materials. In a typical ABC category definition, we rank purchased parts according to annual cost and define. Group A – 20% of the nomenclature of parts, the stocks of which occupy a significant share in the total cost of stocks – 80%; group B – 30% of the nomenclature of parts, the stocks of which occupy a smaller, but still significant share – 15%; group C – 50% of the remaining nomenclature of parts (about half of the quantity), the stocks of which occupy an insignificant share in the total cost of stocks – 5%.

From the distribution presented above, it can be seen that the number of A parts is relatively small and their cost is high, so it makes sense to use complex, labor-intensive methods to closely coordinate the flow of A parts with their use in the production process. Such efforts are generally not warranted for Type C parts, as the cost of storing a small amount of excess inventory is low. Parts B are in the middle, so they deserve more attention than parts C, but not as much as parts A. Approaches may vary from system to system, but the basic idea of classifying ABC remains the same: inventorying different classes of parts should be handled differently.

Table 1. Average annual reserves and quarterly sales volumes details by position.

Item number	Average annual stock by items, thousand rubles	Realization			
		1 quarter	2 quarter	3 quarter	4 quarter
1	2280	590	610	690	670
2	720	200	130	180	120
3	3550	500	1300	400	690
4	850	170	190	200	190
5	90	20	0	50	40
6	1580	520	540	410	430
7	220	40	50	50	70
8	16750	4400	4500	4300	4200
9	310	50	60	110	40
10	5280	1010	1030	1060	960
11	8750	2210	2180	2280	2240
12	1950	520	550	530	560
13	930	240	270	280	250
14	480	70	110	80	60
15	400	100	80	60	80
16	290	90	60	80	50
17	190	60	30	60	50
18	130	60	20	40	10
19	770	190	100	130	50
20	80	30	50	0	30
21	250	60	50	50	70
22	800	190	200	200	180
23	30	0	40	5	10
24	170	40	60	40	70
25	3000	590	700	660	800
26	110	40	40	50	30
27	23470	5180	5500	5490	5850
28	40	10	0	20	10
29	280	50	30	70	50
30	960	240	320	420	240

(*continued*)

Table 1. (*continued*)

Item number	Average annual stock by items, thousand rubles	Realization			
		1 quarter	2 quarter	3 quarter	4 quarter
31	20	5	10	15	10
32	70	10	70	20	10
33	370	80	40	50	70
34	13590	2900	3140	3300	3200
35	630	90	130	170	140
36	50	15	30	30	15
37	520	90	80	100	90
38	6050	1770	850	560	2280
39	140	20	30	80	40
40	9870	2600	2500	2700	2350
41	450	90	80	60	90
42	990	310	330	300	320
43	1310	300	550	390	570
44	580	100	110	90	100
45	690	130	180	150	190
46	890	150	240	240	210
47	1700	530	580	420	470
48	60	25	25	40	20
49	7270	1500	2200	1600	1800
50	1170	290	340	350	390

Source: author based on [2].

Table 2. Interval boundaries for dividing positions into groups for ABC analysis.

Group	% of parts positions in the total assortment volume	Share of stock by item in total stock, %
A	20	80
B	30	15
C	50	5

Source: author based on [3].

Table 3. Interval boundaries for dividing positions into groups for XYZ analysis.

Group	Interval (coefficient of variation, v) (%, positions of parts in the total range)
X	$0 \leq v < 10$
Y	$10 \leq v < 25$
Z	$25 \leq v < \infty$

Source: author based on [3].

3 Results

It is necessary to determine the zoning in the warehouse and the area of the selection and storage zones that should be occupied by certain positions of parts. Let's calculate the warehouse area for storing parts:

- single-shift needs of the assembly shop for parts: 12000 products / 25 working days * 2 shifts = 240 pieces;
- maximum stock of each part in the warehouse: 1.5 * 240 = 360 pieces;
- number of drawers and usable area occupied by the first line parts: 360 / 10 = 36 pieces; 36 * 0.8 * 0.5 = 14.4 sq.m.;
- number of trolleys and useful area occupied by parts of the second line: 360 / 10 = 36 pieces; 36 * 1.2 = 43.2 sq.m.;
- number of racks and useful area occupied by parts of the third line: 360 / 16 = 22,5 pieces; 22,5 * 2 = 45 sq.m.

Considering that the boxes with parts of the first line do not take up additional space, but are located under the racks, we determine the total area of the warehouse: 1,3 * (43,2 + 45) = 114,66 sq.m.

Table 4 presents the summary matrix of ABC-XYZ analysis.

Table 4. ABC-XYZ Matrix.

	X	Y	Z
A	27, 8, 34, 40, 11, 10	49, 25	38, 3
B	1, 12, 42, 13, 4, 22	47, 6, 43, 50, 30, 46, 2, 45	19
C	44, 37	35, 14, 41, 15, 16, 21, 7, 17, 24, 26	33, 9, 29, 39, 18, 5, 20, 32, 48, 36, 28, 23, 31

Source: author.

AX, AY, BX, BY, CX, CY – these items of the assortment of parts required for the assembly of products constitute a significant share of the total cost of inventories and are in predictable demand over time.

AZ, BZ – these items of the assortment of parts, the sales volumes of which change unpredictably over time, are subject to special analysis.

CZ – these items of the assortment of parts should be controlled with the aim of possibly freeing up warehouse space, as well as funds in excess stocks, since sales volumes for them change over time in a practically unpredictable way and they occupy an insignificant share of the total cost of stocks.

Therefore, it is necessary to take these features into account when placing parts in a warehouse with a total area of 114,66 sq.m. Thus, the cross ABC-XYZ analysis method combines two approaches to inventory classification [3]: ABC analysis is focused on the value component, XYZ analysis focuses on the stability of demand. Combining these methods allows for a more comprehensive and multifaceted understanding of inventory and its management. This helps to create a more balanced inventory planning and control system, combining the priority of goods by the cost of their impact on business with the variability and predictability of demand for them.

The combination of results – the goods are classified according to their belonging to the ABC and XYZ categories, as a result a matrix of 9 groups of goods is formed: AX (high-value goods with predictable demand), AY (high-value goods with average predictability of demand), AZ (high-value goods with unpredictable demand), BX, BY, BZ (similarly for goods with average value), CX, CY, CZ (similarly for goods with low value).

Inventory plays a key role in the operational behavior of virtually all manufacturing systems. These classic results of inventory analysis are central to more modern manufacturing management methods such as material requirements planning (MRP), just-in-time (JIT), time-based competition, lean manufacturing, and flexible manufacturing. Inventory management is an important process for ensuring the operational activities of an enterprise, which is aimed at optimizing the size of inventories, timely replenishment and minimizing the costs of storage and disposal [4]. The use of various inventory management techniques helps businesses determine credible inventory levels, reduce the risk of overstocking or stockouts, and improve purchasing and logistics efficiency [5]. For lean inventory management, another method recommended is «Just-in-Time» (JIT), the main principles of which are: minimization of inventories [6], continuous improvement of all processes; reduction of the production cycle [7], continuity of production processes; prevention of defects at all stages of production to prevent defects [8], minimization of downtime of production lines, purchases in small batches as needed in the production process [9], management of logistics processes to ensure timely delivery of raw materials and materials [10].

4 Discussion

To calculate batch formation, two fractions of the production system must be considered: 1) production is instantaneous (there are no constraints on production, and each stage is developed simultaneously), 2) delivery is immediate (there is no time lag between production and availability), 3) demand is certain (there is no uncertainty about quantity or timing), 4) demand is constant over time (thus, it can be represented as a straight line, so if the annual demand is 365 units, this means a daily demand of one unit), 5) the production cycle fixes a fixed cost setup (regardless of the batch size or the cost of the work, the cost is calculated separately), 6) products can be analyzed separately (either

there is only one product, or there is no interaction (such as shared equipment) between the products). All the models discussed so far have assumed that demand is known in advance. If demand is uncertain, there are two basic approaches: 1) model demand as deterministic for modeling purposes, and then modify the solution to account for the uncertainty; 2) explicitly represent the uncertainty in the model. Neither approach is right or wrong in an absolute sense. In general, the answer depends on the circumstances. When planning for a sufficiently long period, a deterministic model can work well. The most common deterministic model for production planning is material requirements planning. The most common probabilistic models are statistical approaches to the reorder point. Statistical modeling of production and inventory control problems is not new.

To select the appropriate output, we must consider the following important information: expected demand and the cost of producing too much or too little. To develop a formal model, we make the following assumptions: 1) products are separable (we can consider products one at a time because there are no interactions, e.g., shared production resources or correlated demand), 2) planning is done on a single period basis (we can neglect future periods because the impact of the current decision on them is small, e.g., because inventory is not carried forward across periods), 3) demand is random (we can characterize demand using a known probability distribution) 4) deliveries occur ahead of demand (all inventory ordered or produced is available to meet demand), 5) the costs of overstocking or understocking are linear (the costs of overstocking or understocking are proportional to the amount of the overstock or understock).

As space is limited, the manufacturer has a system that automatically places purchase orders with every sale. But as the manufacturer is slow to fill replenishment orders, the warehouse must hold some inventory to quickly meet customer demand. In this setting, the key question is how much inventory to hold. We need a model, and to develop it we use a continuous time structure and the following assumptions: 1) the products can be analyzed separately (there are no product interactions, e.g., shared resources), 2) demand occurs one at a time (there are no batch orders), 3) unmet demand is deferred (there are no lost sales), 4) replenishment dates are fixed and known (there is no randomness in delivery dates), 5) replenishments are ordered one at a time (there are no setup costs or limits on the number of orders that can be placed per year that would motivate batch replenishment), 6) demand can be approximated by a continuous distribution (that is, we ignore integrity and act as if the product can be purchased in any positive quantity).

5 Conclusion

The JIT objectives for achieving zero inventory can be expressed as follows:

1. To avoid disruptions to the production process in a JIT environment, where parts are purchased by work stations only as needed, it is important that parts be of good quality. Since there is no excess inventory with which to compensate for a defective part, a defect will cause delay. Therefore, it is important that every part be made right the first time. The only acceptable level of defects is zero, and it is not possible to wait for checkpoints to check quality. Quality must be at the source.

2. In a JIT system, the objective is to replenish the stock taken by the previous operation. Since subsequent operations may accept many types of parts, maximum responsiveness is maintained if each operation can replace parts one at a time. If, instead, the operation can only produce parts in large batches, it may not be possible to replenish all parts quickly enough to avoid delays. Most often, this goal is expressed as a lot size of one piece.
3. The most common reason for large lot sizes in manufacturing systems is the presence of significant setup times. If it takes several hours to change a die on a machine to produce a different type of part, it makes sense to run large lots of each part between setups. Small lot sizes result in frequent setups and thus severely reduce productivity. Eliminating setups is a prerequisite for achieving a lot size of one piece.
4. Without excess work in progress in the system to protect the machines from downtime, breakdowns will quickly lead to a stoppage of production along the entire line. Therefore, an ideal JIT environment cannot tolerate unplanned equipment failures (or operator unavailability, for that matter).
5. If parts are produced exactly in the required quantities and at the required time, then no more material should be handled than is absolutely necessary. No additional movements in and out of the warehouse are allowed. The ideal is to feed material directly from operation to operation without any intermediate pauses. Any additional processing moves the system away from JIT operation, since parts have to be produced in advance to compensate for the extra time spent processing.
6. When ideal JIT parts flow occurs, the preceding worker requests parts, and they are immediately available. This requires zero lead time on the part of the following work operation. One-unit lot sizes greatly reduce the effective lead time required to produce parts, but the actual processing time per part is just as important as the waiting (queue) time. The goal of zero lead time is very close to the essence of the goal of zero inventory.
7. In a JIT environment, where parts are produced only as needed, the flow of materials through the plant will be smooth. If there are sudden changes in quantities or product mix in the production schedule, since the excess work in progress in the system cannot be used to smooth out these changes, the system will be forced to react. Unless there is significant excess capacity in the system, this will not be possible, and disruptions and delays will result.

Thus, a uniform production schedule and a homogeneous product mix are important inputs to a JIT system. Zero lead time without inventory literally means instant production, which is physically impossible. The goal of JIT is to ensure that the environment is constantly improving. No matter how well a production system works, there is always room for improvement.

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Managing the Lean Production Flow of Energy Company

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Abstract. In modern conditions, the process of managing lean production flow in energy sector organizations is becoming increasingly important. Currently, all modern improvement trends, such as lean, are addressing productivity issues in both manufacturing and services, as well as in other sectors such as the energy industry. The resulting competition between different approaches contributes to these methods being applied and not producing any effective results. The division of modern concepts into competing systems prevents the spread of good ideas, which is another sign of the problem. There is currently no universally accepted definition of the productivity improvement problem and no single standard for evaluating competing technologies. There is little understanding of the relationship between financial metrics (such as cost, profit, and return on investment) and operational metrics (such as work in progress, cycle time, throughput, capacity, variability, inventory, delivery). There is little understanding of how operational metrics relate to each other. Therefore, there is no system to distinguish good from bad in terms of concepts, methods and tools. Energy companies inevitably resort to management of proven methods and tools.

Keywords: Capacity · Cycle Time · Delivery · Effect · Efficiency · Inventory · Lean Manufacturing · Losses · Throughput · Value Stream · Variability

1 Introduction

In manufacturing, the lack of a generally accepted set of principles for effective organization has opened up a possibility of starting improvements by drawing a rudimentary value stream map to identify losses in the system, then projecting where the system might go by preparing a future state map, and finally attempting to bridge the gap by applying a set of fairly standard Kaizen activities. If the situations are sufficiently similar to one another, the practices will be successful. But in new situations, such an experience-based approach will probably not be innovative enough to provide a useful solution. Lean practitioners have developed a version of systems analysis called value stream mapping (VSM). Value stream mapping is actually a variation on an older procedure known as «process flow mapping», which provides a visual representation of the process to be studied or improved. VSM begins by creating a «current state map», which identifies the characteristic flow of parts through the process, and then compares «value-added» time

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to overall cycle time. The results are often impressive, with value-added time accounting for less than 1 percent of the total. Then it moves on to creating a «future state map», showing what the system will look like after all the improvements have been implemented. However, while VSM is a useful first step, it is not a fully developed systems analysis paradigm for the following reasons:

1. There is no precise definition of «value-added». An omission that often leads to a lot of wasted time arguing about what is and is not value-added.
2. The value-added time is often so short that it does not provide a reasonable target for cycle time.
3. VSM does not provide a means to diagnose causes of long cycle times.
4. Although VSM collects capacity and demand data, it does not calculate utilisation and therefore never detects when a process is experiencing demand that exceeds its capacity.
5. There is no feasibility test for the 'future state'.

This does not mean that VSM is useless – it is useful. Any improvement project must begin with an assessment of the current state. A lot of companies have discovered significant opportunities simply by using VSM to closely examine their current processes. However, once all the steps have been completed, VSM does not provide a means to identify further improvements. Taking that next step requires a model that systematically links policy to performance.

2 Methodology

Lean manufacturing methods and tools have an impact on such indicators as quality, cost, and time. Moreover, it is important not to implement isolated tools, but to form a system in such a way that the need for the implementation of tools and their relationship are quickly determined (Table 1).

Mapping the value stream is an effective tool for organizing activities related to electricity transmission and technological connection to power distribution networks. Mapping involves the use of a process approach, the main advantage of which is the prompt solution of emerging problems and issues, which makes it possible to increase the efficiency and effectiveness of production processes [1].

Let's highlight the main types of losses in the production process of a grid company:

– overproduction (excessive condensing capacity, which sells poorly on the market and leads to a decrease in the efficiency of stations);
– excessive expectations (work producers and team members have to sit idle while work permits or work orders are being issued);
– excessive transportation (partial application of standards and regulations for certain operations leads to additional staff movements and reduces work productivity);
– excessive processing (inefficient processing due to poor tool quality or an ill-conceived design solution);
– excess inventory (unbalanced warehouse logistics);
– excessive movements (all unnecessary movements that employees have to make during the work process);

Table 1. Matrix of mutual application of lean manufacturing tools in energy companies.

Lean Manufacturing Tools	Standard working (SW)	Workplace organization 5S	Value Stream Mapping (VSM)	Visual control (VC)	Single Minute Exchange of Dies (SMED)	Poka-yoke	Total Productive Maintenance (TPM)
Standard working, (SW)		+	+	+	+	+	+
Workplace organization 5S	+			+			+
Value Stream Mapping, (VSM)	+	+		+	+		
Visual control, (VC)	+	+	+				+
Single Minute Exchange of Dies, (SMED)	+	+					+
Poka-yoke	+			+			+
Total Productive Maintenance, (TPM)	+	+			+		

Source: author

– defects;
– unrealized potential of employees (partial application of the standard for submitting and implementing innovation proposals).

All types of activities in an energy company can be divided into three categories: energy production, repair and maintenance, and auxiliary production. As part of the mapping, we analyzed the processes associated with the repair and maintenance of equipment, since it is in these processes that a large number of losses are observed [2]. We have analyzed the maintenance process of equipment for partitioned tires of 6 kV power plants. Maintenance of this category of equipment is an important area for managing the lean production flow of a network company.

3 Results

Let's calculate the flow efficiency coefficient according to Eq. (1).

$$\text{Cef} = \frac{\sum \text{TCV}}{\left(\sum \text{TCV} + \sum \text{TDL} + \sum \text{TnCV}\right)} * 100\% \quad (1)$$

where Cef – flow efficiency coefficient, %; $\sum$TCV – total time to create value, min.; $\sum$TDL – total time of direct losses, min.; $\sum$TnCV – total time of non-value-added operations, or accompanying operations, min.

The time of value-adding operations is 210 min, the time of supporting operations (non-value-adding operations) is 493 min, the time of direct losses is 85 min. Thus, the efficiency coefficient was 26.65%.

$$\text{Cef} = (210\,\text{min.}/(210\,\text{min.} + 85\,\text{min.} + 493\,\text{min.}) * 100\% = 210\,\text{min.}/788\,\text{min.} * 100\%)$$
$$= 26.65\%.$$

The following types of losses had an impact on the decrease in flow efficiency: due to waiting, excessive movements, defects in operations. It is possible to reduce the waiting time during application registration due to the active use of electronic document management between structural divisions. To eliminate downtime, implement an automatic guided vehicle (AGV) workplace support system. As a result of the measures carried out, the efficiency coefficient of the value stream of the equipment maintenance process for partitioned tires of 6 kV power plants was 34.65%.

$$\text{Cef} = (210\,\text{min.}/(210\,\text{min.} + 41\text{min.} + 375\,\text{min.}) * 100\% = 210\,\text{min.}/606\,\text{min.} * 100\%)$$
$$= 34.65\%.$$

Table 2 shows the total time for the maintenance of busbars of 6 kV distribution generator voltage and the efficiency of the flow before and after the events.

Table 2. Total operation time and flow efficiency.

Operation	Before			After			Deviation (±)		
	∑TCV	∑TnCV	∑TDL	∑TCV	∑TnCV	∑TDL	∑TCV	∑TnCV	∑TDL
1	0	158	10	0	110	2	0	−48	−8
2	0	60	0	0	60	0	0	0	0
3	0	15	0	0	15	0	0	0	0
4	0	30	0	0	30	0	0	0	0
5	0	80	50	0	30	10	0	−50	−40
6	90	0	0	90	0	0	0	0	0
7	30	0	5	30	0	2	0	0	−3
8	60	0	5	60	0	2	0	0	−3
9	30	0	0	30	0	0	0	0	0
10	0	60	15	0	40	5	0	−20	−10
11	0	30	0	0	30	0	0	0	0
12	0	60	0	0	60	0	0	0	0
Flow efficiency, %	26,65			34,65			+8,00		

Source: author

Table 3 shows the calculation of the efficiency of auxiliary equipment.

The economic effect was 12599.50 rubles. The economic efficiency index was 46% or 0.46. The practical significance of the issue under study is determined by the high role of lean production flow management in energy sector organizations [3]. Shop Floor Control (SFC) is where planning meets process. It is therefore the core of a production planning and control system. Because of its proximity to the actual production process, SFC is also a natural vehicle for collecting data for use in other planning and control modules. A well-designed SFC module both manages the flow of materials and simplifies the design and control of the rest of the production planning system.

Table 3. Calculation of the efficiency of auxiliary equipment.

No in order	Evaluation parameter	Before	After	Deviation (±)
1	Busbar operation 6 kV, MV	54,00	63,00	9,00
2	Number of consumables, conventional units	68,24	43,04	−25,20
3	The standard, conventional units	63,00	63,00	-
4	Saving (−)/Overspending (+), conventional units, (line 3 – line 2)	5,24	−19,96	25,20
5	The cost of consumables for 1 conventional units, rubles'	500,00	500,00	-
6	The cost of consumables, rubles, (line 2 * line 5)	34118,00	21518,50	-12599,50
7	Economic effect (savings), rubles, (line 4 * line 5)	−2618,00	9981,50	12599,50
8	Economic efficiency indicator, coefficient, (line 7/line 6)	−0,08	0,46	0,54

Source: author

Despite its logical importance in the production planning hierarchy, SFC is often given little attention in practice. This is partly because it is perceived, in our opinion, too narrowly, as purely material flow management. This view creates the impression that once you have a good schedule, the SFC function can be accomplished by routing sheets attached to parts and specifying the sequence of machining centers to visit. No planning system can anticipate random failures, but the SFC module should take them into account anyway. In addition, SFC can and should play a larger role than just material flow management.

4 Discussion

A set of results from the operations management literature shows that decisions affecting material flows are less important to a company's performance than decisions affecting the manufacturing environment [4–8]. Evidence shows that the benefits of improving the manufacturing environment through reduced setup times, increased productivity, and increased worker flexibility were much greater than the benefits of switching to the Kanban system from the reorder point. If a company improves the environment sufficiently, it does not matter much what type of manufacturing control system it uses. Smoothing the master production schedule is likely to have a greater positive impact than sophisticated dispatching techniques for controlling work within the line.

If SFC is narrowly interpreted as scheduling or flow control, then such studies do tend to downplay its importance. However, if we take the broader view that SFC controls flow and establishes links between other functions, then the design of the SFC module serves to shape the entire production environment. Moreover, the pull system automatically

adjusts the speed, thereby achieving key benefits. Kanban is needed to apply the necessary pressure to achieve greater improvements. Without an SFC module that facilitates flow improvements by collecting data and documenting their effectiveness, it is extremely difficult to identify areas of influence and to consolidate changes. The goal of the SFC module is to bring the actual production environment as close as possible to the ideal environments. The SFC tool must be relatively easy to use, integrate well with other planning functions, and be flexible enough to adapt to the changes that the utility is likely to face. Thus, we can talk about the expediency of the proposed measures within the framework of lean production flow management in future periods, which will allow grid companies to achieve positive results in the energy services market and provide consumers with high-quality services.

5 Conclusion

Lean manufacturing implies fundamentally new approaches to the organization of the production process in energy companies. The organization and tracking of all specific actions performed within the material and information flows of value creation from the customer to the consumer, and the careful compilation of a visual representation of each process (operation) in the flow is the main task of mapping. Studying the map helps you focus on the flow, display the sequence of operations, and see its ideal and improved state. No matter how precise and sophisticated a lean tool is, the actual sequence of operations never follows the schedule exactly. A shop floor control (SFC) tool uses the schedule as a source of general guidance, adhering to it when possible, but also making adjustments when necessary. For example, if the equipment needed to transmit electrical energy fails, the SFC tool must determine how the sequence of operations should be changed. In theory, this can be an extremely complex problem, since the number of options is enormous. But in practice, we must make decisions quickly, in real time, and therefore cannot hope to consider all possibilities. An SFC tool must limit attention to reasonable actions and help the user make effective and reliable choices. Each of the lean production tools solves a certain part of the problems, and only their combined use will allow solving the problem completely, or minimizing it to acceptable values. As practice shows, energy companies take the very idea of the tool as a basis, transform and adapt it to their production characteristics. In our opinion, this approach is more meaningful and effective from a practical point of view.

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Standard Model of Quality Assurance at the Educational Organization

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Abstract. This work is the result of the research of theoretical and methodical aspects of building an internal system of education quality assessment. The typical model of quality assurance and its main components are considered, the structural and logical scheme of the model is presented. The authors analyze the main models of quality assurance of education that are currently used, list their advantages and disadvantages. The review of modern scientific literature on pedagogy and the topic of the study is carried out. The purpose of this study is to design a model for ensuring the quality of education at the university in modern conditions. The authors consider the main models of education quality assurance, based on the software product proposed by the National Foundation for Support of Innovations in Education module «VIKON. VSOKO». The considered models have their features and advantages. The model presented in this study takes into account the dependence on many factors, including the goals of educational policy, resources and needs. Objectives of this study are: to identify the key components of the model structure, to consider different approaches in forming a model of quality assurance in an educational organization, indicating their advantages and disadvantages. The main elements of the model of education quality assurance, providing the competitiveness of the educational organization, are the development strategy, educational process management system, continuous monitoring and quality assessment, development of scientific and pedagogical staff and personnel, availability of feedback from consumers of educational services, infrastructure and resources, social responsibility.

Keywords: Education Quality Assessment System · International Standards of Education Quality · Standard Model of Quality Assurance

1 Introduction

A standard model of quality assurance in an educational organization is a system that helps to manage educational processes in order to maintain a high level of training of students and meet the needs of all participants of the educational process (students, teachers, employers, society). The model includes various mechanisms for controlling and improving the quality of educational programs, teaching methods and other aspects of the educational organization.

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The main objectives of the model of quality assurance in the educational organization are:

- forming of quality criteria, which must be met by the educational organization to achieve a high level of education;
- monitoring of existing practices in the field of achieving the quality of education, identification of strengths and weaknesses of the educational process on the basis of continuous assessment of the current state;
- determination of vectors of development of the strategy of improving the quality of education and introduction of actual directions of quality improvement;
- continuous monitoring of the effectiveness of the implemented changes and compliance of the quality of education with the established standards;
- maintaining feedback and adjusting changes to meet customer satisfaction;
- formation of quality culture oriented to continuous improvement and striving for high results.

The main methods of scientific research used in the work: systematization as a way of combining knowledge by characteristic features; comparison as an opportunity to compare the advantages and disadvantages of selected models; expert method as a basis for conclusions about the effectiveness of the model of quality assurance in an educational organization.

2 Methodology

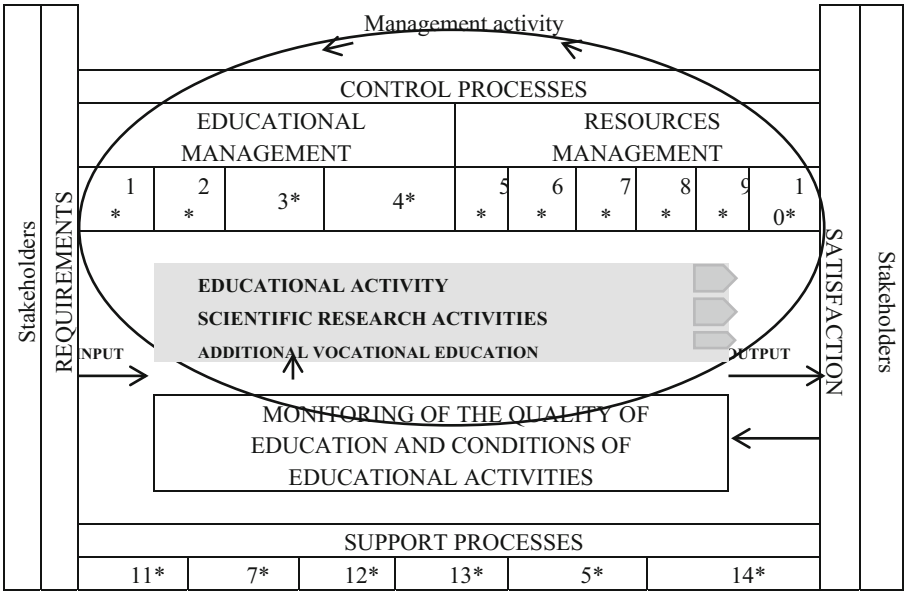
The structure of the quality assurance model includes the following key components:

1. Quality policy and strategy involves formation of the mission, vision and goals of the educational organization, developing a strategy to achieve a high level of quality education, prioritizing and setting development directions. This component is an important aspect of organizational management aimed at providing a high level of educational services and satisfying the needs for quality education, ensuring competitiveness and sustainable development.
2. Planning and design of educational programs implies analysis of the labor market and employers' requirements to graduates, design of curricula and programs taking into account modern trends and requirements, introduction of innovative teaching methods and technologies. Planning and design of educational programs is a complex and dynamic process that requires constant analysis and adaptation to changing conditions. It is important to remember that a successful educational program should be flexible and oriented to the real needs of students and society.
3. Implementation of educational programs contains organization of the educational process in accordance with the approved standards, ensuring accessibility and efficiency of educational resources, control over the implementation of curricula. Implementation of educational programs requires a comprehensive approach, including organizational, methodological and technical components. The success of an educational program is determined by the harmonious combination of its components and constant readiness for improvement and change.

4. Assessment and control of the quality of education involves regular inspections within the organization and self-inspection, analyzing its work, as well as collecting opinions of students, teachers and other participants of the process, analyzing the results of quality assessment and taking corrective measures. Assessment and control of the quality of education play a key role in ensuring a high level of educational services. An integrated approach, including goal setting, data collection, analysis, development of recommendations and implementation of improvement measures, allows to continuously improve the educational process and achieve high results.
5. Staff training and development is designed to professional development of faculty and staff, supporting professional growth and career advancement, creating conditions for sharing experience and knowledge within the team. Staff training and development is a strategically important process aimed at improving the qualifications of employees of the educational organization, improving their professional skills and personal growth, which contributes to increasing competitiveness and achieving long-term goals.
6. Information support and data management in the educational organization implies using information systems to collect, store and analyze data on the quality of the educational process, providing access to relevant information to all stakeholders, automation of quality management processes. Information support and data management in an educational organization are key elements of modern educational process. They contribute to the effective management of the educational process, data security and decision-making support. The use of modern information technologies and systems allows educational organizations to remain competitive and meet the requirements of the time.
7. External assessment and accreditation of educational programs implies participation in independent evaluations and state accreditation procedures, comparing its results with world and national ratings, obtaining quality confirmations. External assessment and accreditation of educational programs are an important tool to ensure the quality of education. They contribute to improving their quality of education, attracting new students, establishing partnerships and developing cooperation.
8. Continuous improvement of the quality of education involves regular analysis of achieved results and identification of opportunities for improvement and unused resources, coordinating activities based on the data obtained, introducing innovations and monitoring the results of the actions taken. Continuous improvement of the quality of education is a cooperative work of all participants using different methods and tools. Continuous improvement of education quality helps educational organizations to increase the level of competitiveness, improve learning outcomes and increase the satisfaction of participants in the educational process. Thus, the quality assurance model is a comprehensive approach covering all activities of an educational organization and aimed at continuous improvement of the educational process and increasing its efficiency.

3 Results

Schematically, a standard model of quality assurance in an educational organization is presented in Fig. 1.



1* – development, design
2* – marketing
3* – planning
4* – measurement, analysis, improvement
5* – financial
6* – human
7* – logistical
8* – informational
9 * – educational
10* – regulatory
11* – system-wide
12* – educational
13* – personnel
14* – mechanisms of accessing the quality of educational activities and training of students

Fig. 1. Standard model of quality assurance in an educational organization (Source: authors).

At the moment, there are various approaches to the formation of quality assurance model in an educational organization. They represent complex approaches to quality management of the educational process and learning outcomes and are aimed at creating conditions for continuous improvement of the quality of education and its compliance with modern requirements. When forming their own quality model, educational organizations are guided by the International Standards of Education Quality presented in Table 1.

It is worth noting that according to the data of the Educational Law Laboratory of the Institute of Education of the Higher School of Economics, in the year of the first accreditation monitoring one out of three universities did not conduct and/or did not record procedures related to internal independent assessment of the quality of education [1]. 34% of universities in the Russian Federation do not have internal systems of education quality assessment. The remaining 66% are distributed by type of education quality system as follows: 50,5% education quality system based on methodological recommendations [2], 32.8% use quality management system (ISO 9000); 16.7% author's models of quality assurance.

Table 1. International standards for quality education.

International networks of quality assurance agencies	Year of creation	Number of member countries	Quality assurance standards
International Network of Quality Assurance Agencies in Higher Education (INQAAHE)	1991	93 countries	INQAAHE International Standards and Guidelines of Quality Assurance in Tertiary Education (ISGs)
European Association for Quality Assurance in Higher Education (ENQA)	2000	51 countries	Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG)
Asia-Pacific Quality Assurance Network (APQN)	2003	45 countries	APQN-Chiba Principles

Source: authors.

4 Discussion

The review of modern scientific literature on pedagogy offers various approaches to the problem under discussion. U.K. Babansky [3] emphasizes the importance of a systematic approach to education quality management. He believed that the quality of education is determined by the interaction of many factors, including the content of education, teaching methods, the level of teacher training and the material and technical base of educational organizations. V.A. Slastenin, I.F. Isaev and E.N. Shiyanov [4] note the importance of pedagogical skills and professionalism of teachers in ensuring the quality of education. In his opinion, a teacher should not only transfer knowledge, but also form students' ability to self-education and self-realization. L.S. Vygotsky [5] emphasizes the significance of taking into account the zone of proximal development in teaching. This principle implies that learning should be oriented to the current level of development of the learner, but at the same time stimulate his/her further development.

These examples show that scientists pay great attention to various aspects of ensuring the quality of education, from the professional development of teachers to the use of modern methods and technologies. Each educational organization chooses its own way of building a quality assurance model. However, a number of the most characteristic ones can be noted. The main models of education quality assurance, their advantages and disadvantages are presented in Table 2.

Currently, the National Foundation for Support of Innovations in Education, the developer of the VIKON Module, offers the program product module «VIKON. VSOKO». This is a tool for conducting surveys of students on their satisfaction with the quality of educational activities. The advantage of this tool is that the questionnaire is

Table 2. Models of quality assurance in education.

Model	Essence	Advantages	Disadvantatges
TQM model	The approach is based on principles of total quality management. The emphasis is on the continuous improvement of all aspects of the educational organization through the involvement of all participants of the educational process (teachers, students, administration)	Improved quality of educational services, more efficient processes, flexibility and adaptability, cost reduction, transparency and accountability, long-term sustainability	High initial costs, long implementation period, risk of overloading staff, dependence on management, limited flexibility for change, problems with measurability of results, lack of immediate results, need for continuous monitoring
EFQM model	This model is focused on assessment and improvement of the organization management system taking into account the interests of all stakeholders (students, teachers, employers). It includes nine evaluation criteria that cover all aspects of the educational organization's work	Integrated approach, focus on results, international recognition, stimulates innovations, transparency and accountability, supports strategic planning, motivates employees, continuous improvement, recognizes achievements	High complexity, significant time and resource costs, ambiguity of criteria interpretation, risks of formalization, dependence on external experts, difficulties in adapting to specifics, lack of immediate effect, need for continuous updating
ISO 9000 model	The ISO 9000 series of standards describes requirements for a quality management system that can be applied in any organization, including educational institutions. The main objective is to ensure a stable level of quality of services provided and to meet the needs of students	Increasing the trust of customers of educational services, improving internal processes, reducing the number of errors and defects, ensuring stability and predictability, simplifying interaction with partners, developing corporate culture	High certification costs, bureaucracy and paperwork, slow implementation, risk of formalization, lack of attention to innovations inability to fully comply with all requirements, regular inspections and updates, no guarantee of success
SWOT-analysis model	This tool allows to analyze the strengths and weaknesses of the educational organization, as well as to identify opportunities and threats of the external environment. Based on this analysis, strategies are developed to improve the quality of education	Ease of use, versatility, objectivity, in-depth perspective, decision aids, effective resource allocation; integration with other methods, teamwork-friendly	Subjectivity in assessing factors, limited information, insufficiently in-depth analysis, ignoring dynamics, lack of priorities; uncertain category boundaries, risk of superficiality, time and resource consuming
PDSA model	The Deming cycle, which is used for continuous process improvement. It consists of four stages: planning changes, implementing them, studying the results and implementing improvements	Cyclical and iterative, rapid feedback, minimal risk, adaptation to changing conditions, team participation; cost-effective, practical, easy to understand and apply	Slow progress, lack of systematic approach, dependence on team motivation, need for regular revisions, limited applicability in some situations, difficulty in measuring results, tendency to conservatism

(*continued*)

Table 2. (*continued*)

Model	Essence	Advantages	Disadvantatges
Balanced Scorecard Model	A balanced scorecard that helps educational organizations to evaluate their performance not only in terms of financial results, but also taking into account other important factors such as student satisfaction, quality of teaching, etc	Integrated approach, clarity and clarity of strategy, balanced view of results, improved communication and coordination, focus on key success factors, innovative capacity, support for strategic flexibility	Complexity of implementation and support, dependency on subjective assessments, risk of indicator overload, requires constant updating, limited applicability, does not address operational management issues, potential for data distortion, incomplete integration with other management systems
Six Sigma model	An approach aimed at minimizing defects and improving the efficiency of processes. In education, it can be used to optimize curricula, teaching methods and administrative procedures	Systematic approach to defect elimination, focus on the customer of educational services, economic benefit, increased discipline and organization, culture of continuous improvement, wide applicability, development of employees, international recognition	High initial costs, long implementation time, over-reliance on statistics, risk of excessive formalism, lack of attention to creative thinking, limited applicability in creative industries, undesirable effects on morale
KPI model	Use of key performance indicators to monitor and evaluate the achievement of the educational organization's goals. These indicators may include student performance, employment rate of graduates, satisfaction of teachers and students, etc	Clarity and transparency of objectives, measurability of results, focus on critical aspects, motivation of employees, performance management, comparison and benchmarking, informed decision-making, adaptability	Limited coverage, risk of manipulation, inflated expectations, one-sidedness, inconsistency with reality, high implementation and support costs, lack of flexibility in crisis situations, overestimation of the role of KPIs
Self-assessment and external audit model	Regular self-assessment and external audits to identify areas for improvement and confirm compliance with quality standards	Active employee involvement, deep understanding of internal processes, resource savings, regularity and responsiveness, fostering a culture of continuous improvement, personal growth of employees, strengths of the external audit model, independent expertise, professional competencies, market recognition, broad overview, compliance with standards, feedback	Subjectivity, lack of independent expertise, limited competencies, risk of formalism, lack of external recognition, high costs, infrequent, potential resistance, short-term effect

Source: authors.

assembled as a constructor and allows expanding the range of questions, the results are automatically processed.

5 Conclusion

Each of these models has its own features and advantages, and the choice of a particular model depends on the specifics of the educational organization, its goals and objectives. It is important to remember that the success of the implementation of any quality assurance model depends largely on the involvement and motivation of all participants of the educational process. The issues of ensuring the quality of education and building a model of its provision remain relevant. The choice of a particular model depends on many factors, including educational policy goals, resources and needs. It is important to remember that the quality of education is a dynamic process that requires constant analysis, adaptation and improvement.

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Innovations in Digital Postgraduate Education

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Abstract. The contribution presents a comprehensive analysis of modern trends in the digitalization of postgraduate education, based on the latest scientific research. The work investigates in detail innovative technologies that are radically transforming the system of additional professional training: adaptive online platforms, intelligent AI-based systems, immersive VR/AR simulators, blockchain certification and modular microlearning formats. Particular attention is paid to benefits of digital transformation, including possibilities of an individual approach to learning, the elimination of geographical barriers and the formation of practice-oriented competencies. The analysis reveals significant implementation problems: low motivation of students, the risk of superficial assimilation of knowledge, technological difficulties among representatives of older age groups, as well as skepticism of employers towards alternative forms of certification. Based on the analysis of six relevant studies, strategic development directions are proposed: creation of blended educational models, implementation of digital adaptation programs, development of generally recognized standards for assessing digital competencies. This work is of interest to heads of educational institutions, developers and researchers of the digital transformation of education. The authors substantiate the need for a balanced approach that combines technological innovations with the preservation of fundamental principles of pedagogy.

Keywords: Artificial Intelligence · Blockchain · Digitalization of Education · Micro-Education · Postgraduate Education · VR/AR

1 Introduction

In the modern world, digital innovations in postgraduate education play an important role in the development of professional skills. The significance of this topic is associated with rapid technological changes that require continuous training and adaptation of specialists [1]. Online platforms, virtual laboratories and artificial intelligence-based systems make learning more flexible and individual. Modern technologies erase geographical boundaries, allowing us to gain knowledge from the best experts without being tied to a place. Short programs and modular courses have become especially popular, providing an opportunity to master new skills without interruption from work [2]. Big data and analytical tools help to build personal learning paths in accordance with the needs of each student. Virtual and augmented reality technologies open up new opportunities for practical training, for example, in medicine or technical specialties. In addition, the blockchain

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system ensures transparency and reliability of accounting for educational achievements [3]. However, the implementation of innovations requires solving problems of digital inequality and increasing the motivation of students. Thus, digital postgraduate education not only meets contemporary challenges, but also forms a culture of lifelong learning. Further development of this direction will increase the competitiveness of specialists in the global market. In the future, the integration of neurotechnologies and immersive learning can revolutionize professional training.

2 Methodology

The methods of studying digitalization of postgraduate education include both quantitative and qualitative approaches, allowing to obtain a comprehensive view of this process. At the first stage, a systemic analysis of scientific literature and regulatory documents was applied to identify key trends and the regulatory framework. Then, sociological methods (questionnaires, interviews with teachers and students) are used to assess the effectiveness of digital tools and identify problem areas. An important role is played by a comparative analysis of successful cases of implementation of digital platforms in Russian and foreign universities. The final stage is a pedagogical experiment to test new digital teaching technologies with subsequent statistical processing of the results.

3 Results

Digitalization of postgraduate education is developing in several key areas, each of which is aimed at improving the availability, quality and effectiveness of training [4]. Firstly, this is the introduction of online platforms and distance learning systems that allow specialists to gain new knowledge without interrupting their professional activities. Secondly, adaptive learning technologies are actively developing, which, using data analysis, adjust educational programs to individual needs and level of training of students. The third area is associated with the use of virtual and augmented reality to create realistic learning environments, which are especially in demand in medicine, engineering and other practice-oriented fields. The fourth important aspect is the use of artificial intelligence to automate the verification of work, personalize training and predict educational results.

Special attention is paid to digital systems for recording achievements based on blockchain technologies, which ensure transparency and reliability of recording qualifications. In addition, network forms of interaction between educational organizations and employers are actively developing, which allows promptly updating of programs in accordance with the changing requirements of the labor market. The creation of digital libraries and open educational resources that provide free access to relevant knowledge plays a special role. In the future, the development of these areas will contribute to the formation of a flexible system of continuous professional education that meets challenges of the digital economy. Let us consider the main examples of innovations in the digitalization of postgraduate education (Table 1).

These innovations are transforming postgraduate education, making it more flexible, personalized and practice-oriented.

Table 1. Examples of innovations in the digitalization of postgraduate education.

Example	Opportunities
Online academies	Allows you to obtain additional qualifications or master new disciplines through massive open online courses with the possibility of obtaining certificates
Virtual and augmented realities	They are used in medicine (operation simulators), engineering (3D modeling of equipment) and other areas to practice practical skills without the risk of errors
Gamification and simulators	Interactive simulators (for example, for pilots, programmers, managers), where training is based on solving real cases in a game format
Artificial intelligence	Chatbot assistants, adaptive learning systems (platforms that adjust the program to the student's level), automatic work checking
Digital twins and big data	Big data analysis helps universities and corporations predict in-demand skills and adjust advanced training programs
Blockchain for accounting of achievements	Distributed ledger technologies (e.g. digital diplomas on the blockchain) provide protection against counterfeiting and convenient access to verified qualifications
Microlearning and nano-degrees	Short modular courses (from Google, IBM, Yandex) that allow you to master specific skills in a few weeks with the issuance of digital badges
Blended learning	Hybrid programs that combine online lectures with face-to-face master classes and workshops in virtual classrooms
Digital mentors and tutoring systems	Platforms with recommendation algorithms that select a personalized learning path based on the user's goals
Neurotechnology and biometrics	Experiments with tracking student engagement through eye movement analysis, EEG, and other metrics to adapt the learning process

Source: authors

4 Discussion

Modern studies of digitalization of postgraduate education reveal both significant prospects and serious challenges of this process. The work by D.M. Anderson and S. Staub [5] confirms that digital platforms significantly increase the availability of additional professional education, but they face the problem of low student engagement – less

than 15% of students complete courses without strict deadlines. This factor requires the development of new motivation mechanisms.

Personalization of training through artificial intelligence technologies, as shown in the study by M. Csernoch [6], demonstrates high efficiency in technical disciplines, but is inferior to traditional tutoring in the development of soft skills. A hybrid model combining 70% adaptive AI systems and 30% interaction with a teacher is recognized as optimal. An important area of digitalization is the introduction of blockchain technologies to record educational achievements. As revealed in the study by L. Norden and T. Ribeiro [7], the use of distributed ledgers allows reducing bureaucratic costs by 40%, but requires the development of uniform standards for digital diplomas and overcoming mistrust on the part of employers.

In practice-oriented areas, such as medicine, VR/AR technologies are of particular value. According to H.M. Al-Hattami [8], virtual simulators reduce the time for mastering practical skills by 30% compared to traditional methods. However, their widespread implementation is constrained by the high cost of equipment and a decrease in efficiency after repeated use («novelty effect»).

An alternative to classical formats is microlearning. K.V. Isaeva and A.S. Vantyaeva [9] note that short modules up to 15 min long increase the engagement of corporate students by 62%. However, this form provides fragmented knowledge and requires mandatory supplementation with mentoring systems. The problem of inequality remains a serious barrier to digitalization. As shown in [10], 37% of specialists over 45 years of age experience significant difficulties in using digital educational tools. This highlights the need to develop digital literacy programs and maintain hybrid (face-to-face and distance) learning formats.

5 Conclusion

In conclusion, it can be stated that digitalization of postgraduate education is a complex, multifaceted process that requires a balanced approach. Modern research demonstrates the significant potential of digital technologies in increasing the accessibility, personalization and practical orientation of training. However, the identified problems (low student engagement, knowledge fragmentation, technological barriers and digital inequality) indicate the need for systemic solutions. The development of hybrid models that combine advantages of digital formats with traditional educational practices is of particular importance. The main task is to create effective mechanisms for motivating and supporting students. At the same time, it is necessary to resolve issues of standardizing digital certificates and overcoming employer skepticism. A promising direction is further development of immersive technologies, provided that their cost is reduced. Maintaining a balance between technological innovations and fundamental educational values is no less important [11, 12]. The implementation of these tasks will create a flexible, inclusive system of continuous professional education that meets the challenges of the digital age. Thus, digitalization of postgraduate education requires a comprehensive approach that takes into account both technological capabilities and human-oriented principles of learning.

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Digital Innovations in the Educational Process at the Present Stage

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Abstract. The acceleration of scientific and technological progress, the development of information technology and globalization processes significantly affect modern society and the economy. In the context of the digital economy, there is a need to train a new type of specialists with modern professional competencies. Of particular importance is the problem of innovative development of the digital education sphere, which is becoming a key factor in the success of reforming educational systems. The purpose of the study is to analyze modern trends and prospects for integrating innovative approaches into the digital education system, assessing the advantages and risks of using the latest digital tools in education. To achieve this goal, the following research tasks were formulated: to study the basic concepts and definitions related to innovations in the field of digital education, to analyze foreign and domestic experience in applying innovative methods and technologies in educational work, to identify positive consequences and possible threats arising from the transition to new forms of digital learning, to form practical recommendations and proposals for the effective implementation of innovative solutions in Russian educational practice.

Keywords: Additional Reality (AD) · Educational Technologies · E-Learning Aids · Gamification · Gamified Learning · Innovative Technologies · Virtual Reality (VR)

1 Introduction

Innovations play a significant role in the development of digital education, acting as a key factor in the positive effects for the development of new forms of digital learning. Analysis of this area requires a comprehensive approach that takes into account various factors. In the context of the digital economy, there is a need to train a new type of specialists with modern professional competencies. Of particular importance is the problem of innovative development of the digital education sphere, which is becoming a key factor in the success of reforming educational systems. Issues related to the role of innovations in digital education, their impact on the development of digital forms of learning are of interest to specialists from different countries [1–9].

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2 Methodology

Innovations in education are processes of introducing new methods, approaches, formats and teaching methods aimed at improving the quality of the educational process, adapting the education system to the modern requirements of society and the economy, and improving the academic results of students. Innovative approaches include the introduction of digital technologies, the development of innovative teaching materials and courses, the use of interactive teaching methods, and the development of an individual approach to teaching each student. The main characteristics of innovations in education are novelty, efficiency, appropriateness and uniqueness.

3 Results

We have identified the following trends in the development of digital innovations in education:

-use of digital platforms and cloud technologies (modern platforms provide distance learning, availability of educational resources regardless of the location of users, the ability to personalize education);
-use of virtual and augmented reality (VR and AR open up opportunities for interactive immersion in the material being studied, increasing student motivation and improving learning outcomes);
-artificial intelligence and machine learning (ML): ML technologies analyze student behavior, identifying patterns and optimizing the learning process (intelligent assistants automate knowledge assessment, offer personalized recommendations and conduct dialogues with students);
-massive open online courses (MOOCs): the scale, quantity and flexibility of MOOCs increase the availability of quality education, providing a wide choice of courses and formats for delivering material.

The transition from traditional learning formats to digital technologies can significantly improve the efficiency of the educational process, making learning accessible and attractive to the general population [4–6]. Let's consider the main advantages of introducing innovative technologies into the digital education system:

1. Increasing the availability and scalability of the educational process.
   Innovative technologies help to eliminate a barrier to access to quality educational resources, providing the opportunity to gain knowledge regardless of geographic location, social status or income level of students, the opportunity to study at a convenient time and place. Quality education for different segments of the population is available thanks to digital tools.
2. Interactivity and involvement of participants.
   Involvement, increased interest and concentration of students is achieved through the use of multimedia content, simulations, game elements, as well as through active interaction of students with each other and the teacher through specialized tools (video conferences, forums, chats).

3. Individualization of the educational path.
   Adaptation of the training program to the personal needs of each student is achieved by analyzing data on the student's progress, forming individual learning paths and providing personalized recommendations for improving results. Creating an individual learning path increases the motivation and academic success of the student.
4. Improving the quality of education.
   Digital innovations help to increase the educational quality by stimulating the development of in-demand competencies, such as critical thinking, working with information, teamwork, developing the ability to independently find solutions to complex problems and adapt to changing living and working conditions.
5. Saving resources of educational institutions.
   Digital tools help reduce costs of maintaining physical classrooms, paying for utilities and technical equipment of classrooms. Access of teachers to open sources of educational literature and methodological materials reduces the financial burden on educational institutions.

Thus, the introduction of innovations in digital education opens up broad prospects for increasing the efficiency of the educational system, improving the quality of training specialists and adapting education to the requirements of the modern economy. Modern information technologies help to overcome traditional limitations, ensure equal access to quality education and prepare competitive professionals of the new generation. Along with the obvious advantages of integrating innovative approaches into the digital education system, serious problems and risks arise that can negatively affect the quality of the educational process. First of all, issues of ethics and security are raised, namely: the need to protect personal data, combat plagiarism and falsification of results.

4 Discussion

While it is clear that innovations are being increasingly introduced into the field of education in modern conditions, there are some difficulties along the way. Let's consider the main obstacles and threats associated with the introduction of innovations into the field of digital education.

1. Insufficient training of teachers. A significant risk is the insufficient level of competence of teachers in the field of modern information technologies. A lot of teachers face difficulties in mastering new methods and platforms, which reduces the effectiveness of their work and worsens the perception of the material by students. The problem is aggravated by the lack of specialized retraining courses and professional training for university and school staff.
2. Technical difficulties and dependence on infrastructure. The effectiveness of digital education directly depends on the availability of stable access to information and communication networks and the quality of the equipment used. The problem of unstable access to the Internet and low quality of technical resources is especially acute in remote regions and rural areas. There is a need for large public and private investments to improve infrastructure and ensure equal access to educational services.

3. Risk of losing personal contacts and emotional support. The transition to electronic distance learning is often accompanied by the loss of personal contact between a teacher and a student, which negatively affects the level of assimilation of the material and social adaptation of young people. Psychological support for students, especially younger age groups, is reduced, since students lose the opportunity to directly contact the teacher for advice or consultation.
4. Increase in the costs of maintaining the digital environment. Constant software updates, the purchase of licenses for specialized programs, and server maintenance require significant financial investments. For most regional universities, such expenses are an unbearable burden, forcing them to abandon promising projects or save on the quality of the services offered. Financial sustainability and transparency of funding processes remain key factors in the success of reforms in the field of electronic education.
5. Loss of control over the quality of knowledge gained and reduced objectivity in assessing academic achievements. The lack of clear criteria for assessing the competencies formed in the course of studying disciplines using electronic means makes it difficult to determine the real level of a specialist's training. It is more difficult to track student motivation, the lack of regular feedback and reduced responsibility lead to superficial mastery of the material. The effectiveness of digital learning remains a subject of debate among experts, but it is necessary to improve the assessment mechanisms and control the quality of the educational services provided.
6. Substitution of real skills with virtual practice. Another danger is associated with the replacement of real practice and practical tasks with virtual analogues. The formation of exclusively theoretical knowledge can lead to the lack of necessary practical skills that will be in demand in the labor market. Virtual laboratories and simulators are certainly useful, but they are not always able to replace real manual work, participation in scientific experiments, and the experience of independent decision-making. Therefore, it is important to combine virtual training with practical classes and internships in real organizations.
7. Increased dependence on technical failures and cyber attacks. The dependence of digital education on external factors increases the risk of disruption of the educational process as a result of technical failure of equipment or unauthorized interference by third parties. Frequent cases of hacking of educational portals, hacker attacks on university databases indicate a threat to the security of personal data of students and teachers. To minimize the risk, it is necessary to invest in strengthening the protection of information systems, conducting regular network security checks and strengthening measures to counter cyber threats.

Analyzing the problems and risks considered, we can conclude that the introduction of innovations in digital education is associated with a number of difficulties, the solution of which will require an integrated approach and coordinated efforts of all participants in the educational process [1, 4, 8]. The success of the reform is possible only with the active involvement of government agencies, the scientific and pedagogical community, the business community and the students themselves in discussing ways to overcome existing barriers. Only through joint efforts is it possible to create an effective and

sustainable system of high-quality higher and secondary vocational education that meets the challenges of our time.

5 Conclusion

The development of digital education is one of the most important areas of the Russian state policy aimed at modernizing the educational system. Modern Russia is at the stage of active implementation of the latest information technologies in the educational process, which opens up great prospects for further growth and progress of the entire industry. The main objectives of the development of digital education in Russia are:

-accessibility: to increase the number of Russians with access to high-quality digital educational resources (online platforms and MOOCs allow citizens to master modern professions and improve their qualifications);
-reliable infrastructure: to develop broadband Internet access, a single digital educational ecosystem and ensure the availability of high-quality education for all regions of the country;
-integration of new technologies: to actively introduce mobile devices, cloud storage and intelligent assistants into school and university education.
-regulatory framework and certification: to regulate the use of IT technologies in the educational process, to introduce mandatory certification of teachers in the use of digital tools, and to organize special advanced training courses;
-development of domestic software: to provide competitive educational services and applications focused on Russian cultural specifics;
-international cooperation: to develop relations with international partners, to intensify the exchange of experience and knowledge, which contributes to the integration of the best world practices;
-comprehensive support measures: joint efforts of the state, business and society are needed for the successful implementation of innovative projects in the field of education.

Innovations in the field of digital education are a prerequisite for maintaining the competitiveness of Russian universities and colleges in the international arena. Competent implementation of projects to modernize the educational environment will improve the quality of training specialists, strengthen the position of domestic science and ensure sustainable development of the country's economy. Active use of advanced digital technologies is creating a new paradigm of education focused on individualization of learning, increasing student engagement and ensuring equal opportunities for different categories of students. Innovations in digital education play a key role in improving the quality and accessibility of educational services in Russia. Their implementation provides a new level of interactivity, an individual approach to learning and effective management of educational resources. At the same time, there is a need to overcome a number of challenges, such as adapting the traditional education system to new technological standards, professional training of teachers and the formation of an adequate regulatory framework. The key condition for the successful implementation of innovations is the unification of efforts of government agencies, educational institutions and commercial enterprises, which will create a holistic digital educational environment that meets the challenges of the new era.

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Digital Technologies in Corporate Education

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Abstract. This scientific work investigates current trends in the corporate education through the prism of leading experts in knowledge management and personnel development. The views and opinions of various researchers who highlight key areas of training transformation in organizations are analyzed. Particular attention is paid to the transition from traditional formats to flexible, technology-rich models, including micro-learning, VR/AR simulators, and AI-based systems. The balance between digitalization and maintaining human-centered approaches, such as mentoring and social learning, is considered. Cases of Amazon, Walmart, IBM, and other companies are used to show how corporate education is becoming a strategic tool that directly affects business results. The authors examine in detail the contradiction between the technologization of training and the need to maintain a human-centered approach. The research results could be useful for HR specialists, heads of training centers, and anyone interested in the evolution of approaches to professional personnel development in the digital age.

Keywords: Adaptive Learning · Corporate Training · Digitalization · Learning Organization · Micro-Learning

1 Introduction

The introduction of digital technologies into corporate education allows employees to gain knowledge at a convenient time and in any place, increasing the flexibility of training. Digital platforms make it possible to personalize training, adapting content to the level and needs of each employee. Online courses and webinars reduce the company's costs for organizing face-to-face training, including rental of premises and travel expenses. Gamification and interactive modules increase employee engagement, making the learning process more exciting and effective.

The use of artificial intelligence allows you to analyze employee progress and automatically adjust the training program. VR and AR technologies help to practice practical skills in a safe virtual environment, which is especially important for dangerous or complex professions. Digital simulators and trainers speed up the adaptation of new employees, reducing the time to get into office. Big Data and analytics allow you to evaluate the effectiveness of training, identifying weaknesses in programs and improving them. Mobile applications and micro-learning make it possible to master knowledge in small portions, which increases the digestibility of the material. Cloud technologies

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provide access to educational materials from any device, which is especially important for remote employees. Social networks and corporate chats facilitate the exchange of knowledge between colleagues, creating a culture of continuous learning. In the context of digital transformation of business, corporate education using modern technologies is becoming a key factor in the competitiveness of a company.

2 Methodology

This study used a set of complementary methods that allowed for a comprehensive analysis of modern trends in corporate education:

1. Analysis of secondary sources (study of scientific publications, books and articles by leading experts in the field of corporate training).
2. Comparative analysis (systematization and comparison of various concepts and approaches to corporate education, identification of common trends and fundamental differences in the views of experts).
3. Case study (consideration of specific examples of the implementation of innovative educational practices in large companies – Tesla, Coca-Cola, Walmart, etc.).
4. Synthesis of theoretical approaches (integration of various concepts into a single system of views on modern corporate education).

The use of these methods allowed for the creation of a comprehensive understanding of modern approaches to corporate education, identification of key trends and development of substantiated conclusions on the development prospects of this area. Particular attention was paid to the balance between theoretical concepts and practical examples of their implementation in the business environment.

3 Results

Corporate education is a specialized system of professional training aimed at developing employee competencies in accordance with the current business tasks of the company. Unlike academic education, it has a number of unique characteristics that make it a key tool for personnel development in modern organizations. First of all, corporate training is distinguished by a pronounced practice-oriented approach. Instead of abstract theories, employees master specific skills necessary to perform work tasks. For example, at Tesla, new employees undergo training directly in production, practicing operations with equipment under the guidance of experienced mentors [1]. This approach ensures the immediate application of knowledge in practice. An important feature is the flexibility and adaptability of educational programs. In the context of rapidly changing technologies and market requirements, companies promptly update the content of courses. Microsoft, for example, uses artificial intelligence-based systems to analyze current IT trends and automatically adjust training materials for its specialists.

All corporate training programs are closely integrated with the organization's business strategy. At Coca-Cola, sales manager training includes negotiation simulators, which directly contributes to revenue growth [2]. This targeted approach distinguishes

corporate education from traditional education, where the connection between training and specific business results is often indirect. Modern corporate training actively uses digital technologies. Companies such as Walmart are introducing VR simulators to practice interactions with customers [3], and Google is developing personalized development trajectories on the Grow platform [4]. Micro-learning, gamification, mobile applications – all these tools make the learning process more effective and relevant to the digital age.

Personalization is another key feature of corporate education. Instead of standardized programs, employees receive individual development trajectories that take into account their current level, job responsibilities, and career aspirations. This approach significantly increases motivation and learning effectiveness.

The effectiveness of corporate educational programs is assessed through the prism of their impact on business indicators. McKinsey, for example, analyzes how manager training affects the success of projects [5]. This approach to assessing profitability fundamentally distinguishes corporate training from traditional training, where exam grades are the main measure of success.

An important characteristic is the continuity of training. At IBM, employees have constant access to courses on the SkillsBuild platform, which supports the concept of lifelong learning [6]. This is especially important in the context of rapid technological progress, when professional knowledge becomes obsolete within a few years.

Thus, modern corporate education is a dynamic, technologically rich system that combines a practical focus with an individual approach. It enables companies to quickly adapt to changes, improve staff qualifications and maintain competitive advantages in the context of digital business transformation.

4 Discussion

Modern experts in the field of knowledge management and corporate training offer different, but in many ways complementary, views on the evolution of the professional development system. P.F. Drucker, the founder of management theory, laid the philosophical foundation, considering knowledge as a key production resource in the modern economy [7]. His ideas about continuous learning integrated into business processes were developed in the works of subsequent researchers.

J. Bersin [8] develops the concept of «experience-oriented» learning, emphasizing the transition from formal courses to the learning in the flow of work model. His approach combines microlearning, coaching and digital platforms with deep skills analytics. In contrast to technology-oriented views, A. Capatina, D. Juarez-Varon, A. Micu, A.E. Micu [9] criticize «boxed solutions», defending the value of informal learning through mentoring and natural knowledge sharing.

A technological revolution in corporate training is predicted by such visionaries as Y.-F. Wang, Y.-F. Hsu and K. Fang [10]. They predict the dominance of adaptive AI systems and immersive technologies, arguing that VR/AR simulators will soon replace a significant part of traditional programs. V.M. Howard, J. Barber and S. Kardong-Edgren [11] complement this perspective, considering digitalization as a disruptive innovation that is radically changing the corporate development industry.

A practice-oriented approach is presented in the work of H. Kimiloglu, M. Ozturan and B. Kutlu [12] who focus on the connection between training and career growth. Their research shows that modern employees expect personalized development trajectories, and effective systems should provide clear paths for professional growth.

Synthesizing these views, we can state that the modern paradigm of corporate education is moving towards hybrid models that combine technological innovations with a deep understanding of the human factor. As most experts note, the future belongs to adaptive systems that organically integrate digital tools with business strategies and individual employee needs, creating an ecosystem of continuous professional development in the context of digital transformation.

5 Conclusion

In conclusion, it can be said that modern corporate education is going through a period of transformation, combining technological innovations with traditional approaches to training. Experts agree that the future belongs to flexible, personalized development systems that take into account both the strategic goals of the company and the individual needs of employees. Key trends are the integration of training into work processes, the use of adaptive technologies and the creation of a culture of continuous professional growth. At the same time, the importance of the human factor – mentoring, knowledge sharing and the formation of a learning organizational environment – remains. Successful companies will combine digital tools with a well-thought-out motivation system, ensuring a close connection between personnel development and business results. The ability of organizations to quickly adapt educational programs to changing market conditions and technological challenges is of particular importance. Ultimately, effective corporate training becomes a strategic asset that determines the competitiveness of a company in the digital era.

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Strategies for Quality Management in an Educational Institution

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Abstract. The work investigates applied aspects of development and construction of quality management strategy in educational institution. The interrelation of quality management strategy and competitiveness of educational institution is presented. A typical model of quality assurance and its main components are considered, the structural and logical scheme of the model is presented. The work presents the main stages of building a quality management strategy with step-by-step tasks and activities. The review of the main studies on the subject is carried out. The research purpose is to create a quality management strategy in an educational organization that can ensure effective management on the basis of an integrated approach. The following tasks were solved: determination of the main prerequisites for the development of the strategy of education quality management; formulating the important directions of the strategy of education quality management, allowing the university to hold competitive positions; step-by-step consideration of the process of building a strategy of quality management in an educational institution; consideration and formulation of the essence of the main modern concepts of quality management in education.

Keywords: Concept · Educational Institution · Education Quality Management · Strategy

1 Introduction

The process of quality management in educational institutions is a complex process that ensures a high level of education and satisfaction of the needs of all participants of the educational process. To achieve this goal, various quality management strategies are used. The development of quality management strategies in educational institutions becomes necessary due to changes in the modern world and increased expectations from all participants of the educational process. In the conditions of global socio-economic relations and rapidly developing technological progress, the requirements for the quality of education are significantly increasing. All participants of the educational process – students, their parents, university management, teachers and employers expect that the educational institution will provide a high level of training of graduates that meets the

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educational standards and labor market requirements. Increasing competition in the market of educational services requires effective mechanisms for assessing, controlling and improving the quality of services provided. The formation and implementation of quality management strategy allows educational institutions to adapt to new challenges, improve competitiveness and meet the needs of all stakeholders. Let us list the main prerequisites for developing a quality management strategy for education: increasing competitiveness and creating unique advantages, compliance with modern requirements; the need to improve learning outcomes, ensuring the satisfaction of students, parents, teachers, compliance with the requirements of educational standards and state accreditation of training areas / specialties, effective use of resources; development of corporate culture, preparation for future challenges.

2 Methodology

In the conditions of increasing competition between educational institutions, the success and efficiency of a higher education institution is determined by its ability to offer quality, unique education. Formation and implementation of the strategy of education quality management will allow the university to acquire distinctive features in the market of educational services and attract the best applicants and teachers. The modern labor market requires graduates to have not only in-depth knowledge but also practical skills. Graduates are expected to have competencies in critical thinking, teamwork, creativity and self-education. Quality management strategies help educational institutions to adapt their educational programs and methods to these requirements. The development and implementation of quality management strategies is aimed at improving the level of cognitive and applied competencies of students. This is achieved by optimizing curricula, using modern teaching methods and regular monitoring of students' progress.

The quality of education directly affects the level of satisfaction of students, parents, teachers and employers. Established quality management strategies help to take into account the interests and wishes of all participants of the educational process, contributing to the strengthening of interaction and improving the atmosphere in the educational institution. In order to receive state accreditation and successfully pass accreditation monitoring, educational institutions are obliged to fulfill the requirements of educational standards. The development and implementation of a quality management strategy will ensure this compliance and efficient use of available resources – time, finances and human resources. The implementation of quality management strategy in the educational institution also contributes to the formation and maintenance of corporate culture, which provides a favorable atmosphere for creativity and innovation among the teaching staff and students.

The dynamics of changes in society and socio-economic relations oblige educational institutions to be ready for new challenges – development of digital technologies, globalization and changing requirements of the labor market. The implementation of quality management strategies in education will allow to prepare for these changes and successfully adapt to them. Thus, quality management strategies in the educational institution allow providing a high level of education and prepare for the labor market qualified specialists who can successfully cope with the challenges of the future.

3 Results

Building a quality management strategy in an educational institution is a complex and multilevel process that requires a systematic approach and involvement of all participants of the educational process. Let us consider the main stages of building (Table 1).

Passing these stages allows forming a comprehensive system of quality management in the educational institution, aimed at continuous improvement of the educational process and achievement of excellent performance.

4 Discussion

The concept of quality management proposed by V.V. Okrepilov [1] is important for the design and implementation of quality management systems in various spheres, including education. Quality is considered as a result of activity, where quality is considered not only as a characteristic of educational service, but also as a process of achieving the desired result. The system approach to quality management implies that education quality management should be integrated into all aspects of the educational process, from planning to evaluation of results. The integrity of the system of education quality management implies that all elements of the system should work in a coordinated and interdependent manner to ensure a high level of quality. Continuous improvement means that the system should be constantly improved in order to increase the efficiency and satisfaction of all stakeholders (students, teachers, employers). Customer orientation implies that educational institutions should take into account the needs and expectations of their students and other consumers of educational services. Active participation of teachers in the quality improvement process is a key success factor. The use of statistical methods of quality control allows assessing results objectively and identifying areas for improvement. These principles are a basis for the development and implementation of effective quality management systems in the educational sector, contributing to the improvement of the level of training of specialists and improvement of educational processes.

The concept of quality management in education was also developed by other scientists. W.E. Deming is a founder of the philosophy of quality management. His idea of PDCA cycle is widely used in education quality management. W.E. Deming emphasized the importance of continuous learning and improvement [2]. J.M. Juran [3] made a significant contribution to the development of quality management concepts, including those related to education. He proposed the idea of the «quality triad» (planning, control and improvement) and emphasized the importance of involving management in quality management processes. Ph.B. Crosby [4] developed the concept of «zero defects», which involves striving for absolute quality without errors. Although this concept was originally developed for industry, it has also found its application in the educational environment, where it is important to strive to minimize errors and mistakes. A.V. Feigenbaum [4] introduced the concept of Total Quality Management (TQM). This concept implies the involvement of all participants in the educational process in achieving high quality standards. TQM is actively used in educational institutions to improve curricula, teaching methods and knowledge assessment. Yu.P. Adler [6] contributed to the development of approaches to quality management in education. He emphasized the need to

Table 1. The main stages of building a quality management strategy in an educational institution.

Stages	Stage goals	Stage processes
1. Analyzing the current situation	Assessment of current status	Analyzing current indicators of the quality of education (academic performance, satisfaction of students, parents and teachers, level of graduates)
	Identification of problem areas	Identification of system weaknesses such as insufficient teacher motivation, outdated teaching methods, lack of resources
	Data collection	Using various methods of information gathering (surveys, interviews, document analysis and statistical data)
2. Formulation of goals and objectives	Defining strategic goals	Formation of long-term goals to improve the quality of education (increasing the level of knowledge of students, introduction of new learning technologies, improving interaction with employers)
	Setting specific objectives	Development of short- and medium-term objectives to achieve strategic goals, such as developing new educational programs, conducting trainings for teachers, and modernizing infrastructure
3. Development of an action plan	Selection of approaches and methods	Determination of the most effective methods and tools to achieve the set goals, such as the use of modern educational technologies, implementation of monitoring and quality assessment system, creation of conditions for professional growth of teachers

(*continued*)

Table 1. (*continued*)

Stages	Stage goals	Stage processes
	Assignment of responsibility	Assigning responsibility for each stage of the plan, setting deadlines for tasks and milestones
4. Implementation of the plan	Implementing changes	Implementation of planned activities (updating of educational material, training of personnel in new methods of work, attraction of additional resources, etc.)
	Progress monitoring	Continuous monitoring of the plan implementation progress, collecting feedback from all stakeholders, adjusting plans if necessary
5. Evaluation of results	Evaluation of the outcomes obtained	Analyzing the performance of implemented activities and comparing achievements with the planned objectives
	Adjusting the action plan and strategy	Correcting strategy based on new information, adjusting to changing circumstances
6. Continuous improvement	Feedback and participation of all stakeholders	Regular feedback from students, parents, teachers, employers and other participants of the educational process
	Continuous learning and development	Continuous professional development of teaching staff, introduction of new teaching methods and technologies

Source: authors

apply modern methods of statistics and mathematical data processing to monitor and improve the quality of educational processes. V.A. Lapidus [7] was an active popularizer of the concept of Total Quality Management (TQM) in Russia. He explored possibilities of applying Western quality management models to Russian realities, including the education system. A.D. Shadrin [8] worked on the issues of quality management in the higher education system. He proposed approaches to the creation of quality management systems that take into account the specifics of Russian universities.

These scientists have made important contributions to the formation of the modern concept of quality management in education, and their work continues to influence the management practices of educational institutions around the world.

5 Conclusion

Effective quality management in an educational institution requires a comprehensive approach, including the introduction of various strategies and methods. It is important to remember that the quality of education depends not only on teaching staff, but also on the interaction with all participants of the educational process, including students, parents of teachers, employers and society as a whole. Thus, in order to strengthen the competitive position of an educational organization, it is necessary to have an effective system of management and evaluation of the quality of education in the educational institution. Such a system allows to regularly monitor the compliance of educational programs and processes with the established standards and requirements, identify weaknesses and immediately make adjustments. This helps to maintain a high level of teaching, improve teaching materials and methods, and meet the needs of students and employers. In addition, transparent and objective quality assessment helps to increase the trust of students, parents and partners, which in turn has a positive impact on the reputation of the university. A well-organized quality assessment system based on a quality management strategy becomes an important tool for increasing competitiveness and attracting new students and partners.

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Neural Network Tools in Developing Project Activity Competencies Among University Graduates

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Abstract. The contribution investigates the potential of neural network-based tools in developing project competencies in university students. Rapid integration of generative artificial intelligence models such as ChatGPT, YandexGPT, Gamma, and DeepSeek opens up new prospects for improving the formation and development of competencies of competitive university graduates. A mixed-methods study was conducted at Surgut State University to assess the impact of artificial intelligence based tools on student project work. The study determines how neural network tool technologies can optimize various stages of project activities – from idea generation and planning to information analysis and presentation development. Based on the results of the study and a literature review, the authors present benefits and risks of integrating neural networks into the process of preparing university graduates to make them competitive in the labor market. The results of the study convincingly showed that responsible and controlled use of AI tools contributes to the formation and development of students' project-based competencies (creativity, self-efficacy, critical thinking and teamwork), and also emphasizes the need for digital literacy and ethical awareness.

Keywords: Artificial Intelligence · Competencies · Digital Literacy · Education · Higher Education · Generative AI · Neural Networks · Project-Based Learning

1 Introduction

In the framework of the rapid development of artificial intelligence (AI) and its penetration into various fields, the emergence of powerful generative models of AI (GPT-3.5/4, YandexGPT 5 Pro, DeepSeek) attracted the attention of society: in just two months, the ChatGPT audience reached 100 million users [1]. These technologies open up new opportunities for education, but also set a task for universities to effectively integrate AI tools into the training of competitive university graduates. One of the current areas is the use of neural networks to develop students' project work competencies, which are understood as the ability to plan and implement projects: from generating ideas and finding solutions to teamwork and presenting results. The formation of such competencies is enshrined in educational standards and is in demand by employers in the conditions of the modern economy. At the same time, the question remains open: how can neural

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network-based tools help students master project work skills and improve the effectiveness of training without compromising the quality of knowledge acquisition, prepare highly qualified specialists capable of solving problems of the regional and national economy. Project-oriented learning has long established itself as an effective method for developing key professional competencies of graduates. Research shows that involving students in project activities contributes to the development of teamwork competencies and problem-solving skills [2, 3].

The experience of Surgut State University in implementing project-based learning confirms that the success of project-based training largely depends on the coordinated actions of all participants in the educational process – teachers, students and representatives of customer organizations who are ready for dialogue, joint design and implementation of innovations in the real sector of the economy. Such cooperation enables the formation of professional competencies in students that meet the modern requirements of the labor market, including in the field of medicine, education, oil and gas industry, culture and public administration, although it has also revealed gaps in the acquisition of some disciplinary knowledge. This indicates the need to find means to complement project-based learning for the formation and development of the required level of competence, including with the application of AI technologies.

Currently, experience in using neural network tools is emerging in the higher education. In particular, generative neural networks (text and multimodal ones) are considered as a promising tool for supporting the learning process. Foreign and domestic studies note a predominantly positive attitude of the teaching staff to the integration of neural network tools into project-based learning [4]. A survey of teachers conducting project activities showed that most of them perceive AI tools as a useful assistant that increases the efficiency of project implementation and allows personalizing training to the students' needs. The use of AI in projects contributes to the growth of independence and motivation of students, as well as the development of key competencies and soft skills. Experiments by Spain teachers also demonstrate specific educational effects: when introducing AI systems into project assignments in engineering, the effectiveness of training, students' motivation and their ability to learn collectively increased [5]. At the international level, AI tools are increasingly considered as a means of enriching project-based learning and developing the 21st century competencies [6].

Domestic researchers are also studying the potential of neural networks in education. M.P. Prokhorova and L.I. Kutepova [7] summarized the possibilities of using generative neural networks in preparing students for project activities, showing that AI can be effectively used to generate project ideas, work with texts and presentations, create images, and record the results of teamwork. The researchers emphasized that the implementation of this potential requires the fulfillment of a number of pedagogical conditions: compliance with the rules for working with a neural network, checking the quality of generated content and requests, and maintaining students' motivation and interest. Another example is the use of text generative networks (such as MashaGPT) in educational and research activities. As noted by L.E. Osipenko and A.V. Korotkov [8], the emergence of such models has demonstrated to students fundamentally new resources for preparing academic work – essays, term papers, and even final qualification papers. On the one hand, this opens up access to powerful text generation tools,

and on the other, it has sparked discussions about academic integrity and the need to teach students how to properly use artificial intelligence tools. Image generation can be cited as a positive example of the creative use of neural networks. Neural networks for creating visual content have potential in higher education, allowing teachers and students to more quickly prototype artistic concepts and develop their imagination [7]. International organizations also pay attention to the impact of generative AI on education. UNESCO emphasizes that new approaches to preparing teachers and teaching students how to work with generative artificial intelligence are needed for the effective and ethical implementation of such tools [9]. It is recommended to start working with a neural network by asking the right questions and critically evaluating its answers. In general, an analysis of the literature shows that neural network tools are considered a promising means of enhancing project-based learning. At the same time, researchers agree on the need for methodologically competent, controlled use of them so that AI technologies truly contribute to the development of competencies, and do not replace the creative and intellectual activity of students.

2 Methodology

The study was conducted using a combination of methods: theoretical analysis, design of pedagogical intervention and pedagogical experiment. At the preparatory stage, an analysis of educational standards and literature was performed to determine the key competencies of project activities of university graduates. Such competencies include the ability to generate and justify project ideas, conduct information search and data analysis, plan work and distribute tasks in a team, carry out interpersonal communication in a project team, solve problems, present and document results. At the same time, a review of modern neural network tools was conducted that are potentially suitable for supporting these types of activities. Particular attention was paid to generative models: large language models for working with text (ChatGPT, YandexGPT, DeepSeek, MashaGPT), image creation tools (Gamma, Midjourney), as well as applied AI services for data and code analysis (for example, GitHub Copilot for programming). At the design stage, a methodology for integrating AI tools into the educational process in a discipline related to project activities was developed. Typical educational situations/project stages were formulated where the use of a neural network could bring the greatest benefit. For each case, examples of tasks and recommendations for working with a specific tool were prepared. In addition, instructions for students on the ethical and effective use of AI were developed (including rules for citing generated content, the need to critically evaluate neural network responses, etc.). Next, as part of the experiment, the proposed methodology was tested on a group of students studying the course «Fundamentals of Project Activities». Students completed a project on a selected case over the course of one term, having the opportunity to use the recommended neural network tools at different stages of their work. The teacher monitored the progress of the projects, recorded examples of students' interaction with AI and intermediate results. Upon completion of the project, the participants were offered a survey to assess the perceived impact of AI tools on various aspects of their work and their own learning. The questionnaire included both closed and open questions to collect qualitative feedback.

At the stage of results analysis, questionnaire data were processed and the quality of project work was compared with previous streams. The obtained data were compared with the findings known from the scientific literature, which made it possible to identify general trends and characteristics of the experimental group. The reliability of the results was ensured by combining quantitative and qualitative data and expert assessment of the final projects by two independent teachers. During the experiment, the main stages of project activities and the corresponding tasks were identified, for the solution of which the participants successfully used tools based on AI tools. These stages and examples of the use of neural networks are given in Table 1.

Table 1. Project stages and examples of using neural network tools.

Project stage	Example of AI Application
Generation and selection of ideas	Using ChatGPT, YandexGPT, DeepSeek, MashaGPT for brainstorming and generating ideas based on a description of a topic or problem
Search and analysis of information	Querying a language model to summarize scientific articles, analyze data, find arguments
Work planning	Formation of a draft project plan using ChatGPT, YandexGPT (stages, timeframes, distribution of roles)
Implementation (technical and creative)	Using GitHub Copilot for code autocompletion, Midjourney, Gamma – for visualization, graphics
Preparation of documentation and presentation	Editing the text of reports and presentations using ChatGPT, YandexGPT, DeepSeek, MashaGPT; generating infographics and diagrams using AI

Source: authors.

Modern generative models are capable of supporting students at most key stages of project work. The capabilities of neural networks to generate new ideas and content (texts, images), as well as to speed up routine operations (searching for information, rough planning, checking finished materials) turned out to be especially in demand. It is important to emphasize that in all cases, students did not blindly rely on the answers of neural network tools, but considered them critically and selectively. For example, when generating ideas, the group could reject most of the options proposed by the neural network, but one or two of them prompted the team to original solutions, which were eventually implemented. Similarly, plans or texts prepared by the neural network were considered only as a starting point for further development.

3 Results

An analysis of student feedback and expert assessment of their projects showed positive dynamics in a number of indicators. Participants in the experiment noted that the integration of neural network assistants had a positive effect on creativity and the quality of their work results. According to the final survey:

- 90% of students indicated that the use of AI tools helped them generate more original ideas for the project, go beyond obvious approaches;
- 85% of respondents noted an improvement in the quality of project documentation due to the use of AI for editing text and creating illustrative materials;
- about 80% indicated an increase in work efficiency: neural networks made it possible to significantly save time when searching for information and rough planning, which freed up resources for in-depth development of the substantive part of the project;
- approximately 60% noted that interaction with the neural network stimulated their critical thinking: they learned to formulate clear queries and thoughtfully evaluate the reliability of the answers received from the AI;
- at the same time, almost 30% of students expressed some concern that easily accessible help from the neural network could lead to excessive dependence on it in the future, reducing their own initiative.

The obtained quantitative data are also supported by qualitative observations. Teachers who compared the work of the experimental group with projects from previous years noted a higher average level of elaboration of topics and presentation of results. Student projects began to contain more creative elements, non-standard solutions, and presentations – more convincing visual demonstrations. Participants in the experiment reported in open comments that AI tools increased their confidence in completing complex tasks: knowing that they can quickly get a hint or help from the neural network, students took on difficult aspects of the project more confident. Some students noted that they learned to formulate their thoughts better due to the need to ask clear questions to the model and analyze its answers. At the same time, potential risks were also identified. Some groups at the beginning of the experiment tried to rely excessively on the answers of ChatGPT, YandexGPT, DeepSeek, MashaGPT without sufficient verification. For example, one project report contained entire paragraphs generated by the neural network, which, as it turned out, included factual inaccuracies. After comments from the teacher, the students reworked these fragments, admitting that they initially «trusted too much» in the neural network tools. This case served as a lesson for the entire group about the need to verify information. In the final interviews, a lot of participants emphasized that they understand the limitations and possible fallibility of artificial intelligence, so they consider it important to critically reflect on the results of its work.

Overall, the results of the experiment demonstrate that, with proper guidance from the teacher, neural network tools can enhance the development of students' project competencies by stimulating their creativity, independence, and reflection. The data obtained indicate a significant educational potential of neural network technologies in developing project skills, which is consistent with the findings of other studies. Our experiment showed an increase in creativity, speed, and quality of project implementation with the

support of AI, as well as an increase in students' confidence. These observations are consistent with the results of work in foreign universities, where the introduction of AI into project assignments in engineering increased the effectiveness of learning, motivation, and the quality of students' collaboration [4]. The teachers who participated in our study noted an increase in students' independence – this aspect also coincides with the opinion of the teachers from the survey, who saw AI as a tool that increases students' autonomy and motivation in project-based learning. Thus, the integration of neural networks can really enhance the value of the project-based methodology, providing more personalized and active work for students.

4 Discussion

An important result of the discussion is that neural networks become a catalyst for the development of cross-disciplinary competencies, and not just facilitate the execution of individual operations. In our experiment, students were forced to formulate clear queries and critically evaluate the model's responses – these processes contribute to the development of analytical thinking and communication skills. According to the observations of other researchers, generative AI can stimulate deep learning and critical thinking in students, encouraging them to check the compliance of the received answers with their learning needs. In other words, when used correctly, a neural network does not make students passive consumers of knowledge, but, on the contrary, acts as an interlocutor, requiring them to meaningfully set tasks and evaluate alternative points of view. This is especially valuable in the context of project activities, where the ability to independently find and select optimal solutions from a variety of options is important. However, the results also highlighted a number of risks and limitations. The fears of some students about possible dependence on AI require the most serious attention. There is a risk that with prolonged work with the «smart assistant» some students will lose the desire to overcome difficulties on their own. A similar trend was noted in [10]: in the second half of the experiment, students began to pay less attention to the content of the AI's answers and checked them less often, which indicates the formation of excessive trust in the system. To avoid this, it is important for the teacher to build a framework for the use of artificial intelligence tools. Our experience shows that it is necessary to focus students on the role of the neural network as an auxiliary tool. It is useful to introduce restrictions, for example, to require each student to justify why he/she accepts or rejects a proposal formulated by the neural network. It is also worth diversifying the tasks, including those that cannot be done without live creativity and experimentation. In this case, neural network tools will perform an auxiliary function without reducing the intellectual effort of students.

Another challenge is issues of credibility and ethics. Generative models sometimes provide convincing-looking but incorrect information. In an educational context, this can lead to the propagation of errors if a student is not attentive enough. In addition, the ability to obtain a ready-made text or code actually invites some students to dishonest behavior (cheating). In this regard, a number of universities and even entire countries were forced to temporarily ban the use of AI tools in assignments, fearing the loss of academic integrity [9]. In our opinion, a ban is an extreme measure, it is more productive

to teach its correct use. International guidelines emphasize the importance of explaining to students consequences of thoughtless use of AI. Therefore, during the experiment, we paid special attention to forming an attitude towards responsible use of neural networks in participants. Students were explained that AI should be used to enhance their own understanding, not to imitate knowledge. The projects encouraged the students to reveal own creative contribution with the support of AI, and mindless copying of neural network answers was strictly prohibited.

The role of a teacher in the integration of neural network tools should be discussed separately. The success of using neural networks in education largely depends on the preparedness of the teachers themselves. The teacher must have sufficient digital competence to be able to customize students' work with AI and integrate it into the pedagogical design of a lesson. Otherwise, there is a risk of either formally using the technology without an educational effect, or losing control over the learning process. In the experiment, the teacher acted as a moderator, that is, helped to formulate correct requests to the model, pointed out inaccuracies in its responses, shared experience (for example, how to rephrase a request to obtain a more relevant result). Such support turned out to be critically important at the initial stage, without it, some students experienced frustration when interacting with the neural network (in the case of an unformulated answer or misunderstanding how to clarify the question). Thus, the methodological conditions mentioned earlier include not only rules for students, but also advanced training for teachers in the field of the AI application.

The experiment was a pilot and covered a relatively small sample of students from one university. Its results, although consistent with global trends, need to be verified on a broader statistical base. Not all types of projects and specialties were represented in the sample – the effects of AI may vary depending on the subject area. Further development of the methodology for assessing the educational effect of AI is also required. In the future, it is important to develop metrics such as, for example, the increase in certain competencies measured through testing before and after using AI. These issues constitute prospects for further research.

Generative neural network tools have significant potential in the context of higher education, allowing us to modernize the approach to developing students' project work competencies. The study demonstrated that, with proper integration, AI tools can enhance the main stages of project work – from the emergence of an idea to the presentation of results. Students using neural networks demonstrate higher creativity, awareness, and confidence in solving complex problems. Neural networks can act as a kind of thinking simulator, offering a variety of ideas and information, they stimulate students to analyze, select, and justify their decisions, which develops critical thinking and problem-solving skills. The results obtained are consistent with the findings of other studies indicating a positive impact of AI on students' motivation and cooperation, as well as their general and specific competencies. At the same time, the use of neural network technologies for educational purposes requires compliance with a number of conditions. To avoid negative consequences (such as loss of independence or dissemination of false information), it is necessary to create a methodological framework and standards for working with AI. Teachers should actively participate in this process: we need to teach students effective strategies for interacting with a neural network, monitor

the correctness of the use of sources, encourage reflection on the quality of recommendations received from AI. An important conclusion of our work is that the neural network does not replace a teacher, but enhances pedagogical functions (mentoring, organizational, expert). If this balance is maintained, AI technologies can become a valuable assistant in education, allowing to improve the quality of training.

5 Conclusion

The introduction of neural network tools into education is currently an objective necessity dictated by the digital transformation of professional activity. Graduates who know how to work with modern AI systems gain a competitive advantage in the labor market. Therefore, it is advisable for universities to experimentally and gradually introduce such tools into the educational process, accompanying this with scientific and methodological research. Prospects for further work are seen in the development of standard models of project-based learning with AI support for different areas of training, the creation of educational and methodological materials on the ethical and effective use of neural networks, as well as in a systematic assessment of the impact of such innovations on the quality of education. Higher education, relying on the potential of AI, is able to more effectively solve the problem of forming high-level competencies in graduates necessary for successful professional activity in the 21st century.

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Digital Technologies in Student Entrepreneurship

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Abstract. Digital technologies transform student entrepreneurship and open new opportunities for project implementation. This work analyses the data of a survey among students of Samara State University of Economics regarding the use of digital technologies in the creation of entrepreneurial projects. The study of the role of artificial intelligence in project development allowed the authors to identify problems faced by students at different stages of work: from conceptualization to forecasting economic results. The findings indicate that along with analyzing the legal and regulatory framework and developing a financial plan, the process of developing an idea is the most difficult stage of project activity. To what extent are students able to neutralizing problematic stages of work using digital technology? Assuming that artificial intelligence is designed to optimize each stage of project work, the results of a questionnaire among 2nd-4th year students showed which internet platforms and neural networks are most preferable for project work. Analysis of the data from the survey of teachers supervising student projects allows us to conclude that the majority of teachers approve of the use of neural networks at certain stages, in particular, visualization, organization and structuring of information. So, in the context of the analysis, universities are able to act as key stakeholders in the implementation of entrepreneurial projects, creating conditions for the generation of ideas and the launch of student business projects.

Keywords: Artificial Intelligence · Digital Technologies · Entrepreneurial Project · Neural Network · Student Entrepreneurship

1 Introduction

If we take a close look at the opportunities currently available for modernizing the Russian economy, we should pay special attention to student entrepreneurship. It is 'nurtured' in a completely new environment, which provides us with artificial intelligence technologies. The transition or 'peak' of the fourth industrial revolution occurred in 2020–2022, a pandemic period. Agreeing with A Auzan's opinion, we note that a new institution has emerged that has connected not only entrepreneurs, but also millions of people [1]. It seems that a type of institution has now emerged that has never existed before, based on artificial intelligence technologies. It relates to digital platforms with aggregators and ratings.

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Is there hope that we can use this new trend for economic progress? Let us turn to the sphere of education and see what prospects there are here. The university environment plays an important role in the formation of entrepreneurial competences, forming basic and professional skills necessary for the creation of projects in the process of education [2]. The theory of human capital suggests that it will take about ten years to realize the effect of ideas, but it is worth it.

The interest of the scientific community to the problems of student entrepreneurship is quite high. A number of works are devoted to the study of students' attitudes towards entrepreneurship [3]. Attempts are made to assess the economic contribution of student entrepreneurship [4]. In some cases, such analyses are given in the context of studying the publication and patent activity of students [5].

The focus of our attention is on the problems arising in students when developing their own projects and analyzing the attitude of students and teachers to the use of artificial intelligence in the process of idea implementation. We conducted a questionnaire survey of 2nd-4th year students of Samara State University of Economics studying the disciplines 'Entrepreneurial Business' and 'Fundamentals of Project Activity'. In addition, the questionnaire survey was offered to the teachers of the profile disciplines mentioned above.

The aim of this study is to explore challenges associated with developing student entrepreneurial projects using digital technologies. The main research tasks include:

– identifying problematic issues at the stages of entrepreneurial project development;
– analyzing the findings regarding the use of digital technologies in the development of student projects.

2 Methodology

The methodological basis of the study was: methods of collecting primary sociological information, in particular, questionnaire survey and interpretation of the obtained data, including analytical research. The questionnaire form was presented in the form of an online address to respondents with pre-prepared questions on the problem under study. The information obtained was subject to interpretation where the results of the study were obtained and conclusions were drawn.

3 Results

3.1 Stages of Development of Student Entrepreneurial Projects

Creating an entrepreneurial project is a multi-stage process. It includes such blocks as concept, legal and regulatory framework, list of products and/or services, marketing, financial block, organizational structure, funding sources, economic results. Each block is important because it determines the functionality of the project in a practical sense. It can be seen that each block implies certain knowledge and skills of the student. At the same time, some of them are given in the process of studying at the university, while others are acquired by the student on his/her own, studying either book literature or, mainly, data on the Internet.

In fact, digital technologies are primarily designed to optimize and speed up work processes at every stage. However, before analyzing students' use of digital technologies, it is necessary to determine at which stages in the development of an entrepreneurial project they encounter problems and difficulties.

Within the framework of the survey, the following question was addressed to 2nd-4th year students of Samara State University of Economics 'at what stage(s) in the development of your project(s) in the disciplines «Entrepreneurial Business» and «Fundamentals of Project Activity» or outside of them did you encounter problems?'. The results of the survey are presented in Fig. 1.

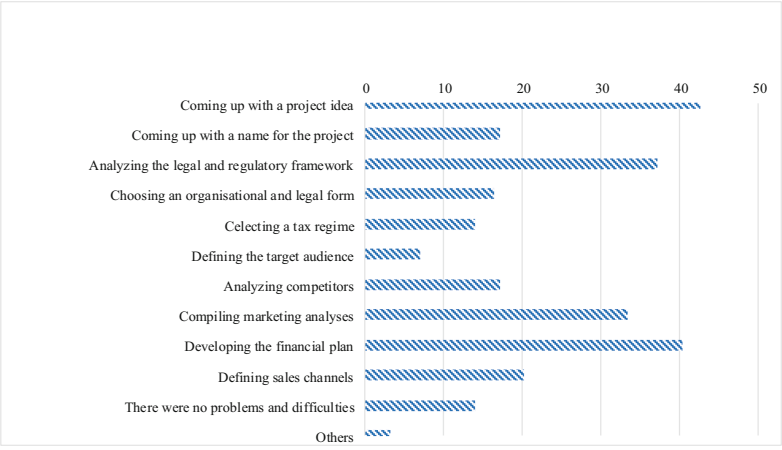


Fig. 1. Problems in developing an entrepreneurial project among students (% of respondents) (Source: authors).

As can be seen from the data above, the most common problems students have are coming up with a project idea (indicated by 42.6% of respondents), developing a financial plan (40.3% of respondents), analysing the legal and regulatory framework (37.2% of respondents) and compiling marketing analyses (33.3% of respondents). The data analysis allowed us to draw the following conclusions.

The problem with generating a project idea is that the process itself is not easy, as the results of the survey confirm. The fact is that within the entrepreneurial disciplines, the project idea must be original, with a unique selling proposition, as well as viable and realisable. Moreover, already at this stage it is necessary to consider competitors in order to understand how to differ from them (originality of the project) and how easy it will be to enter the market in the chosen field of activity in today's business realities.

The financial plan is an estimate of projected income and expenses, determination of projected profit and break-even point. The difficulty for students at this stage is that they need to make a financial plan so that it is realistic and profitable. Analyzing the legal framework is necessary to understand what laws and state standards regulate the project's activities. Students get lost in this huge array of legal data, because, as a rule, business regulation is not limited to one or two legal acts.

Marketing analysis refers to the study of internal and external environmental factors on a business in order to make an informed decision. As a minimum, when developing a project, students conduct a SWOT analysis, where factors are divided into four categories: strengths, weaknesses, opportunities and threats. Lack of experience and certain knowledge leads to the fact that students often encounter problems with its compilation, for example, incorrectly interpreting data under these four categories or incorrectly formulating conclusions. In the 'Other' response option field, some students indicated that they also faced such problems as lack of time for project development, difficulties in conducting activities, questionnaires, interviews, etc.

3.2 Application of Digital Technologies in the Development of Entrepreneurial Projects

After identifying the main problem points of students, the main question of this study arises, what digital technologies do students use in the development of an entrepreneurial project to neutralize these and other problems? First of all, it is necessary to mention neural networks which are very popular nowadays among people from different spheres of activity, including students.

A neural network is a specific technology within artificial intelligence (AI), which is a program that, using a mathematical model that mimics the neural connections of the human brain, receives and processes data and then produces a result.

The first theoretical foundations of artificial intelligence, modeling the human brain at a primitive level, were laid by American scientists W. McCulloch and W. Pitts back in 1943 [6]. Subsequently, every 10–20 years, research was conducted in this area in the world, new models and methods for improving artificial intelligence appeared, and as a result, nowadays neural networks have been developed, which can not only print any text information, but also create realistic images, videos, computer codes, solve mathematical problems of different complexity and much more. Since the field of application of neural networks is vast and the development of an entrepreneurial project, as it was mentioned earlier, includes many stages, it is reasonable to ask where exactly the student has used a neural network. So, in the course of the study, students were asked whether they had used neural networks in developing an entrepreneurial project, and if so, at what stages. Their answers are presented in the diagram below (Fig. 2).

According to the survey results, just over two-thirds of respondents have used neural networks when developing an entrepreneurial project, with the most common purposes being to compile marketing analyses (noted by 27.9% of respondents), come up with a name for the project (26.4% of respondents), and create a logo (24.8% of respondents).

After determining what students use artificial intelligence for, another equally important subject of research arises – what kind of neural networks do students use? Especially, a neural network can serve for several stages of project development – it all depends on what the functionality of the neural network is.

Therefore, in the course of the research the students were asked the question: 'what neural networks did they use when developing an entrepreneurial project?', and they were also offered to rate their satisfaction with a particular neural network from 1 to 5, where 1 – extremely unsatisfied, 5 – extremely satisfied.

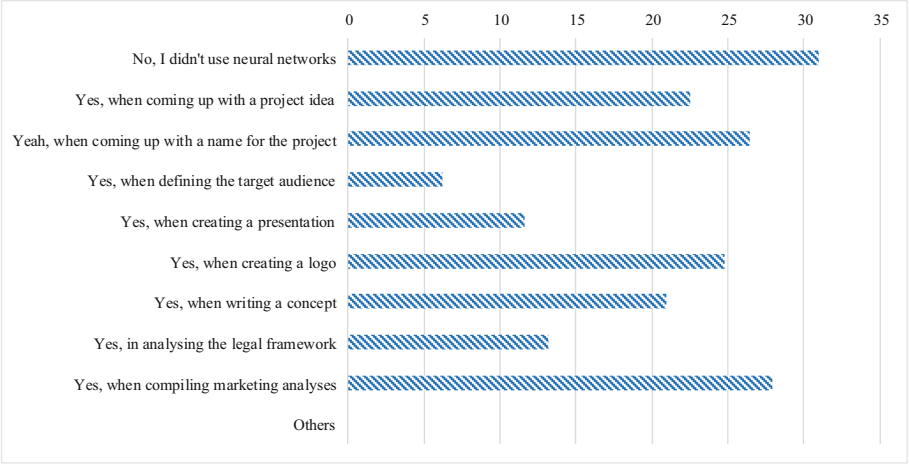


Fig. 2. Purposes of students' use of neural networks (% of respondents) (Source: authors).

4 Discussion

According to the survey results, the majority of students used a neural network such as ChatGPT for entrepreneurial design. ChatGPT is an artificial intelligence chatbot based on the GPT Transformer Architecture, which allows it to analyze and contextualize words, phrases and sentences to generate text in natural human language. This model was developed by the American company OpenAI in 2018 and is still being improved.

Students use ChatGPT to develop project ideas and concepts, to analyze the legal and regulatory framework (when the neural network provides a detailed list of regulations, GOSTs regulating this or that sphere of business), to determine the target audience of the project, and to conduct marketing analyses.

Students generally rated their experience with ChatGPT positively, respondents mostly gave it ratings of 4 and 5, less often 3, but there were no negative ratings of 2 or 1.One of the students, who gave this neural network 3 grade, explains it by the fact that ChatGPT did not give a clear answer, but gave a direction for further work.

It is worth noting that students also specified GPT-based artificial intelligence chat rooms, which are integrated into the social network 'Telegram'. In fact, it is the same ChatGPT, but functioning in this messenger, which is quite convenient for students, because the neural network is at hand if necessary.

Another but no less popular answer among students was 'Shedevrum'. This is an application that allows generating images, videos and text based on the YandexART and YandexGPT neural networks created by the Russian company Yandex. The neural network generates images and videos by the method of cascade diffusion: the artificial intelligence creates a picture based on a prompt – a text description consisting of several keywords. Then it gradually increases its resolution, saturating it with various details, shapes and textures.

In the field of image and video generation, students also pointed out the domestic neural network 'Kandinsky'. It was developed by Sber with the support of scientists

from the AIRI Institute of Artificial Intelligence. This neural network creates images in several stages. First, Kandinsky generates a certain number of images specified by the user based on the prompt. Then, a special ruCLIP Large algorithm selects the images that best match the description and then scales them using Real-ESRGAN technology or the same cascade diffusion method.

Both Shedevrum and Kandinsky are used by students to create a logo and (or) images for the project presentation slides when developing an entrepreneurial project. The respondents evaluated the work with these services very positively, no one gave a grade lower than '4'.

Speaking of creating presentations, it is worth mentioning the Gamma neural network that does this. It works on the basis of machine learning algorithms, the user enters text: sets a general topic, description, and then Gamma transforms this textual information into presentation slides. Thanks to adaptive algorithms, the neural network is able to select appropriate graphs, images and diagrams depending on the material being presented [7]. This neural network can suggest an outline of the text that can be edited. The layout of the slides changes according to their content without being uniform on each slide. Various GIFs, videos, diagrams can be added [8]. In general, neural networks generating presentations are very rare in the survey results, which suggests that students most often use artificial intelligence to create images or text for slides in a presentation, rather than trusting it to make the presentation itself for the project in full. The following neural networks were also mentioned by the students: DeepSeek, Perplexity AI, Claude AI, Midjourney.

Since the development of an entrepreneurial project by students in the relevant academic disciplines is carried out under the guidance of a teacher, the question arises, how do they feel about the use of artificial intelligence by students in the development of an entrepreneurial project? This question was posed to them as part of the research. According to the results of the questionnaire it turned out that 9 out of 10 teachers who teach entrepreneurship do not mind students use neural networks at certain stages, only one teacher chose the option that students should not use artificial intelligence in the development of the project.

Another digital technology that can be used by students is online platforms, which are interactive online boards designed for collaboration among the project team. In essence, they allow students to visualize, organize and structure information while developing an entrepreneurial project. This gives them the opportunity to plan the project process, find new connections between existing data and stimulate discovery. Interestingly, the process of making connections and generating insights often takes place already during the design of the online board. One well-known platform is the Miro workspace. This platform contains specialized toolkits for all stages of innovation creation, from diagramming to code analysis, in a single integrated workspace where all team members involved in the project process can be brought together [9].

It can be seen that the above examples of digital technologies are developed by private individuals and companies. However, there are digital services related to entrepreneurship that are created with the support of the state. In Russia, for example, such a service is the Digital Platform for Small and Medium Entrepreneurship (hereinafter referred to as

the SME Digital Platform), developed by the SME Corporation and the Ministry of Economic Development of Russia. The SME Digital Platform is an online portal designed to support small and medium-sized enterprises in various areas. Thus, the SME Digital Platform offers such online services as applying for state support for business, market assessment and business plan calculation, checking counterparties, trademark registration, business insurance and many others. The full list of online services is presented on the official website of the platform [10]. It is noticeable that this platform is mainly intended for those who are planning to start an entrepreneurial project or who are already implementing it. By the way, this also applies to students who have started or want to start their own business. But even for students who are at the project development stage, the SME Digital Platform can also be useful. For example, there is such an online service as Business Learning, which includes tests to check professional and personal competencies, a personalized selection of video lectures, courses and skills development programs based on competency assessment, and other tools.

5 Conclusion

Analyzing the data obtained from the student questionnaire allows us to draw the following conclusions regarding the use of digital technologies in the creation of entrepreneurial projects, as well as to identify which stages of work most often cause difficulties. The problem of generating a viable idea on the market is one of the most difficult. Here it is important for a student to have a set of knowledge of economic and legal disciplines and to be able to update them. In addition, developing a financial plan, analyzing the regulatory framework often leads to misinterpretation of data. These and other problematic points that follow from the survey results (choice of tax regime, marketing analysis, competitors' analysis) can be «neutralized» with the help of artificial intelligence. To what extent can this tool allow students to effectively create projects, interact with the target audience and build their brand, better understand the market, work from anywhere in the world, which is especially important for those who combine or intend to combine their studies with entrepreneurial activity?

The results of the survey showed that students are most interested in using AI in the marketing analysis, ideation and logo creation phases. Which technologies are favoured by students? The answer to this question showed a rather large range of used platforms, neural networks of both domestic and foreign developers. In addition to private developers, there are digital services developed by the state to promote entrepreneurship [10]. What is interesting is that the process of creating connections and generating insights often takes place already during the design of the online board, in the joint work of students and the teacher-mentor. The interaction between the university and the state with regard to the development of student entrepreneurship is currently gaining significant advantages due to the possibilities of artificial intelligence and digital technologies. The authors of this work do not pretend to analyze the problem. The research directions concerning the monitoring of student entrepreneurship in the context of regional universities to understand the prospects for the development of small and medium-sized businesses seem promising.

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Digitalization of Socio-economic Systems

Labor Market Trends in the Age of Transformation

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Abstract. Each stage of economic development corresponds to a certain employment structure. Digital transformation plays a crucial role in improving living standards, optimizing production cycles, accelerating economic activity, and generating new job opportunities. Digitalization and automation present significant opportunities for the development of the Russian labor market. The research focuses on six regions of the Russian Federation from different federal districts, analyzing data over a ten-year period from 2013 to 2022. The authors used cointegration analysis, which helped identify non-random relationships between socio-demographic characteristics of unemployment and regional digitalization indicators. The findings highlight key challenges and opportunities for developing regional labor markets in the context of the digital transformation of the economy. These insights are valuable for managers and academics engaged in evaluating the effectiveness of regional human potential and enhancing the digital skills of the workforce. The study concluded with practical recommendations for state regional administrations.

Keywords: Cointegration Analysis · Digital Transformation · Labour Market · Socio-Demographic Characteristics of Unemployment

1 Introduction

Digital technologies not only reduce costs but also enhance communication between individuals and organizations, broaden access to services and goods, and alter the types and structures of labor relations [1, 3]. Notably, this transformation has led to the rise of new employment forms, such as remote work, freelancing, and platform-based jobs [4, 5]. As a result, the modern labor market is characterized by increased flexibility and mobility of labor resources, the emergence of new development trends. Analyzing and understanding these trends is essential for effective regulatory measures [6, 7]. There are two opposing perspectives on the impact of digital transformation on the labor market. Some researchers argue that the rapid implementation of digital processes will lead to structural and technological unemployment [8–10], while others contend that advancements in artificial intelligence, automation, and robotics can foster the creation of new professions, enhance entrepreneurial opportunities, boost labor productivity, increase competition, and lower transaction costs [11–13].

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Digitalization has undeniably transformed the organization of labor, giving rise to new specialties while rendering others obsolete. It has reduced routine tasks, automated various professions, and intensified control over labor efficiency [14–16]. In this evolving landscape, there is a growing demand for specific competencies, particularly digital skills. Consequently, labor market mechanisms must be designed to promote flexibility and adaptability, facilitating rapid retraining and the development of a workforce capable of thriving in new conditions. Understanding the regional dynamics of these labor market changes is crucial for formulating effective regulatory policies. This study aims to assess the changes in individual behavior within Russian regional labor markets concerning socio-demographic characteristics amid the ongoing digitalization of the economy. The research focuses on six regions of the Russian Federation. The analysis covers a decade, from 2013 to 2022.

2 Methodology

The research hypothesis is that digitalization contributes to reducing the gender gap in employment, unemployment among older generations and highly educated workers, and the duration of unemployment for individuals seeking work for over a year. Initially, an analysis of socio-demographic characteristics and digitalization indicators was conducted for each study object, covering the period from 2013 to 2022. The statistical digest from Rosstat served as the primary information source. Subsequently, descriptive statistics were calculated for all indicators using the SPSS Statistics program for data processing, with a confidence level set at 95%. A comparative analysis was performed on the socio-demographic characteristics and digitalization indicators across the regions for the same period, focusing on their average and median values, as well as standard deviations, minimum, and maximum values. The parameters selected for labor market analysis included: the number of unemployed individuals by gender, the number of unemployed individuals by age group, the number of unemployed individuals by education level, the number of unemployed individuals seeking work for 12 + months. To evaluate the level of digitalization in the regions, the following indicators were selected: the proportion of households with a PC and Internet access (%), the number of active mobile broadband Internet subscribers per 100 people, the percentage of organizations utilizing the Internet, the number of connected mobile subscriber devices per 1,000 people. The cointegration analysis allows us to identify long-term relationships between two or more time series that may be non-stationary when considered individually. Unlike correlation, cointegrated series exhibit identical stochastic trends. To eliminate false correlations, the Dickey-Fuller and Engle-Granger tests were employed (Table 1).

If the results of the Engle-Granger test indicate that the residual series is stationary, then the pair of indicators is considered cointegrated, confirming a non-random relationship between them.

Table 1. Critical values of the ADF statistic of the Engle–Granger test.

Number of variables	Test type	Confidence level (p)		
		0.01	0.05	0.10
2	Constant and trend	−4.32	−3.78	−3.50

Source: authors.

3 Results

Using the method described above, we calculated descriptive statistics for the socio-demographic characteristics of unemployment and digitalization indicators for six regions of Russia. On the example of data for the Republic of Tatarstan we illustrate and clarify the calculation process (Table 2).

The average and median values of most indicators in the Republic of Tatarstan are closely aligned, suggesting a normal distribution of the data series from 2013 to 2022. This study presents a comparative analysis of socio-demographic characteristics and digitalization indicators across regions, highlighting trends and dynamics over the same period (Table 3).

In 2022, the Republics of Tatarstan and Chechnya led in the percentage of households with PCs and Internet access. The Krasnoyarsk Krai and the Zabaikalsky Krai showed average results, while the Novgorod region and the Chuvash Republic were the laggards. Notably, the Chechen Republic recorded the largest growth in this indicator, with an impressive increase of 727.29%, moving from being an outsider in 2013 to a leader a decade later. In terms of active mobile Internet subscribers, Tatarstan ranked first in 2022, with 113.27 users per 100 people. The Krasnoyarsk Krai, the Novgorod region, and the Chuvash Republic followed closely in second, third, and fourth places. The Zabaikalsky Krai placed fifth with 95.3 users per 100 people, while the Chechen Republic closed the ranking with 65.4 users per 100 people.

Regarding the share of organizations using the Internet, the Chuvash Republic and the Novgorod region led in 2022, despite a declining trend in this indicator. The Krasnoyarsk Krai and the Zabaikalsky Krai showed average results, with 74.7% and 73.8%, respectively. The lowest results were seen in the Republics of Tatarstan and Chechnya. Tatarstan, in particular, experienced the largest decrease in Internet usage among organizations, which caused it to lose its leadership position. Although Chechnya was the only region where the share of organizations using the Internet increased over the decade, it still failed to achieve significant results compared to other regions.

In terms of connected mobile devices per capita, the Novgorod region ranked first, with over 200 devices per 100 people. Tatarstan came in second with 190.9 devices per 100 people, followed by the Krasnoyarsk Krai and the Chuvash Republic. The Zabaikalsky Krai was second to last with 158.2 devices per 100 people, while Chechnya was in last place, being the only region to see a decrease in the number of mobile devices by 12.49% over ten years. Summing up the analysis of digital services, the Republic of Tatarstan emerged as a leader, while Chechnya was the overall laggard. The remaining regions exhibited varied dynamics, making it difficult to categorize them definitively.

Table 2. Descriptive analysis of socio-demographic unemployment trends and economic digitalization indicators in the Republic of Tatarstan (2013–2022).

Indicator	Average value	Median value	Standard deviation	Minimum value	Maximum value
The number of unemployed by gender (thousand persons)					
Male	35.96	36.03	7.03	22.76	44.39
Female	34.15	36.32	5.33	25.25	39.53
The number of unemployed individuals by age group (thousand persons)					
up to 30 year olds	20.34	18.45	6.36	14.48	32.77
30 – 59 year olds	46.54	50.64	13.16	21.89	58.07
60 + year olds	2.92	3.01	0.94	1.07	4.36
The number of unemployed individuals by education level (thousand persons)					
Higher education	16.16	17.96	4.32	9.27	22.05
Secondary vocational education	23.04	24.51	6.99	13.19	31.74
Secondary general education	27.45	26.91	4.56	19.59	34.27
The number of unemployed individuals seeking work for 12 + months					
12 + months	10.97	9.81	5.40	3.26	20.34
Digitalization indicators					
The proportion of households with a PC with Internet access, %	82.08	83.00	8.02	66.10	97.80
The number of active mobile broadband Internet subscribers per 100 people	87.93	88.30	22.68	55.00	117.30

(*continued*)

Table 2. (*continued*)

Indicator	Average value	Median value	Standard deviation	Minimum value	Maximum value
Share of organizations using the Internet, %	82.13	84.40	10.98	60.10	97.70
Number of connected mobile subscriber devices per 1000 people	1861.07	1860.40	93.70	1728.20	2013.10

Source: authors based on [17].

However, all regions demonstrated improvement in the development of digital services and products over the past decade. This analysis allows examining how the digitalization of the economy has impacted individual behavior in the labor market.

Cointegration analysis was conducted to explore the relationship between digitalization indicators and unemployment across different regions. In Tatarstan, all the considered digitalization indicators affected unemployment among individuals with secondary vocational education. Interestingly, one digitalization indicator – the share of organizations using the Internet – had a direct positive correlation with the number of unemployed with secondary vocational education, suggesting that an increase in the share of such organizations led to more unemployed in this group. Other indicators, such as the proportion of households with PCs and Internet access, the number of active mobile broadband Internet subscribers per 100 people, and the number of connected mobile devices per 1,000 people, showed an inverse relationship with unemployment. The Engle-Granger test revealed that increased household Internet access and decreased organizational Internet use contributed to the reduction in male unemployment. Furthermore, the rise in mobile Internet subscribers and connected devices reduced the number of people seeking work for more than a year. Thus, the hypothesis was partially confirmed: digitalization helped reduce the gender gap in employment by lowering male unemployment and reducing long-term unemployment. However, the assumption that digitalization would also reduce unemployment among older individuals and those with higher education was not confirmed.

Although the Engle-Granger test calculated regression coefficients between digitalization and socio-demographic unemployment characteristics in the Krasnoyarsk Krai, the residuals of the series were non-stationary. This suggests that the relationships may be random, and the hypothesis was not confirmed for this region.

In the Chuvash Republic, the test results showed, with 99% confidence that the increase in connected mobile devices among the population from 2013 to 2022 led to

Table 3. Changes in digital services and products by regions of Russia.

	Republic of Tatarstan	Krasnoyarsk Krai	Chuvashia Republic	Novgorod Region	Zabaikalsky Krai	Chechen Republic
The proportion of households with a PC with Internet access, %						
2013	66.1	72.6	58.8	63.2	61.4	11.6
2022	97.8	82.8	75.2	75.9	84.3	96
Growth, %	47.96	14.05	27.89	20.09	37.30	727.59
Number of active mobile broadband Internet subscribers per 100 people						
2013	55.0	75.2	58.7	40.4	50.3	50.7
2022	117.3	103.8	102.5	103.2	95.3	65.4
Growth, %	113.27	38.03	74.62	155.45	89.46	28.99
Share of organizations using the Internet, %						
2013	85.6	76.5	81.6	82.3	76.7	65.6
2022	70.1	74.7	79.9	79.6	73.8	69.7
Growth, %	−18.11	−2.35	−2.08	−3.28	−3.78	6.25
Number of connected mobile subscriber devices per 1000 people						
2013	175.6	172.3	182.1	197.1	142.9	133.7
2022	190.9	187.2	186.3	225.9	158.2	117.0
Growth, %	8.71	8.65	2.31	14.61	10.71	−12.49

Source: authors based on [17].

a slight decrease in unemployment among individuals with secondary general education. However, the influence of digital indicators on other unemployment characteristics appeared to be random, meaning that the hypothesis was not confirmed.

In the Novgorod region, one digital indicator demonstrated a statistically significant relationship with certain socio-demographic characteristics of unemployment. The increase in connected mobile devices from 2013 to 2022 contributed to a decrease in unemployment among males and individuals with secondary general education. Therefore, the hypothesis was partially confirmed in Novgorod: digitalization played a role in reducing the gender gap in employment by decreasing male unemployment, but it did not have a guaranteed effect on reducing unemployment among individuals aged 60 and over, those with higher education, or those looking for work for more than a year.

In the Zabaikalsky Krai, an increase in mobile Internet subscribers and mobile devices among the population, along with a decrease in the share of organizations using the Internet, contributed to a slight reduction in unemployment among individuals with

secondary vocational education. Additionally, the rise in mobile devices and mobile Internet users led to a decrease in unemployment among those aged from 30 to 60. There was also a partial decrease in the number of unemployed individuals over 60 years old attributed to the same increase in connected mobile devices. Thus, the study's hypothesis was partially confirmed: the advancement of digital technologies helps to lower unemployment among the older generation and those who have been seeking work for over a year. However, the results do not support the assertion that the digitalization of the economy effectively reduces the gender gap in employment or decreases the number of unemployed individuals with higher education.

In the Chechen Republic, the Engle-Granger test revealed a different dynamic. There was an inverse relationship between the share of organizations using the Internet and unemployment among individuals under 30 years of age. Specifically, an increase in the share of organizations utilizing the Internet, coupled with a decrease in the number of mobile communication devices among the population, resulted in a decline in unemployment in this age group. Furthermore, the analysis indicated that an increase in the number of mobile Internet users significantly contributed to a reduction in unemployment among individuals with secondary general education, with a 99% confidence level. Notably, a 1% increase in mobile Internet users correlates with a decrease in the number of unemployed individuals with secondary general education by approximately 4.086%. However, for other socio-demographic characteristics, the digitalization indicators did not demonstrate a statistically significant relationship, indicating that the study's hypothesis was not confirmed in those instances.

4 Discussion

The advancement of new technologies has led to the gradual automation of many routine tasks, particularly those involving physical labor [16]. Artificial intelligence systems increasingly threaten the employment of mid-skilled professionals, including drivers, sales consultants, and technologists. One of the primary risks associated with the acceleration of digital transformation and production automation is the challenge of rapid adaptation, which will be difficult for the workforce. Historically, Russia has experienced a slower pace of digital technology development compared to leading countries. Despite a relatively smooth transition to automation and the absence of widespread technological unemployment, the need for adaptation to a digital economy remains critical. This adaptation encompasses training in new business methods, household organization, and effective application of public services.

Moreover, the disparity in digitalization levels and adaptability among Russian regions is significant. In recent years, a continuous decline in the working-age population has prompted an increase in the retirement age to address economic and social challenges. If this trend persists, it could result in profound transformations within the labor market. While the development of the digital economy may mitigate the issue of a shrinking labor force and contribute to economic growth, it could also lead to substantial job losses and increased unemployment, particularly among less skilled workers. For instance, the introduction of industrial robots in the United States has notably reduced employment and wages for certain worker groups. The experiences of European countries offer valuable insights for addressing the challenges posed by digitalization in

the labor market. European policymakers recognize that reforming the education and training system is essential for preparing the workforce for new jobs created by digitalization. Consequently, EU employment policies focus on equipping the workforce with the necessary skills to tackle emerging challenges and occupations that demand new competencies, particularly digital skills. Strengthening the capabilities and competencies of the workforce and developing human capital are vital for promoting labor force employment.

5 Conclusion

The analysis indicates that the transformation of regional labor markets, driven by the digitalization of the economy, necessitates adjustments in personnel qualification requirements, stimulates demand for new competencies, and promotes the development of distance and digital learning methods. However, the rapid changes in the labor market due to dynamic digitalization also bring significant challenges, including the increased risk of job losses and a growing mismatch between workers' skills and employers' requirements. Thus, the following key conclusions can be drawn:

- regions most vulnerable to the challenges of adapting their labor markets to digital transformation include those that are less developed;
- there is a significant risk that the pace of digital technology adoption may outstrip the ability to retrain workers and create new jobs in various regions, this imbalance could lead to the emergence of an «economy of ignorance», where individuals engage in low-demand activities (subsistence farming or shadow employment), new technologies are not implemented, and continuous training is not prioritized;
- the technological exclusion of citizens from the modern economy can significantly increase the burden on regional budgets, as there will be a pressing need for active social support systems;
- the level of human capital development within a region is a critical determinant of its adaptive capacity in the digital age;
- retraining initiatives can mitigate the social risks associated with digital transformation; regions with higher levels of education among their populations will likely experience fewer negative impacts.

Regulating regional labor markets in the context of economic digitalization necessitates a comprehensive approach that considers various factors, including the sectoral structure of the economy, the dynamics of labor relations, technological innovations, and the needs of both employers and employees. Key initiatives that regional authorities could implement include:

- establishing specialized digital platforms that connect employers, employees, and regional educational institutions, such platforms can enhance communication among stakeholders, facilitating quicker adaptation to labor market changes;
- implementing state support programs for small and medium enterprises that actively leverage digital technologies, this could include tax incentives or grants for employee training, thereby encouraging businesses to invest in their workforce;

– organizing programs aimed at improving digital literacy among the population, particularly in regions with lower education quality, such initiatives will help bridge the gap between labor market supply and demand, ensuring that the workforce possesses the skills needed in a digital economy.

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Use of Information Accounting Systems in Medical Institutions

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Abstract. The authors analyze the need to use information systems for data accounting in medical institutions. The significance and relevance of this issue is determined by the task of rapid processing and transmission of data between departments and medical institutions as a whole. An acute question arises about the design of a medical information system for working with large volumes of data. The authors used methods of analysis (analysis of the organizational structure of a medical institution), systematization and graphical display of information, as well as personalization when determining access to automated functions of the information system. The analysis of domestic and foreign sources conducted by the authors confirmed the interest of scientists in the issues of digitalization and automation of management systems in healthcare institutions. Conclusions were made that when building a specific information system for data accounting for a medical institution, one should focus on its organizational structure and the functionality of each person involved.

Keywords: Accounting · Data · Digitalization · Healthcare · Information Systems · Medical Institutions

1 Introduction

A significant role in our time is played by the problem of processing the flow of large volumes of data on patient admission to the hospital, as well as the impossibility of maintaining consolidated management accounting and personalized accounting of medical care in electronic form using databases, which is why there are limited opportunities for transferring information from one medical institution to another. A huge amount of information that is unique to each patient must be filled in within the certain framework of the medical standard to which the medical institution refers to fill out outpatient and statistical coupons, medical records and information about the counterparty. All this has a negative impact on the speed of work of medical personnel and increases the costs of the medical institution, since it is necessary to create new coupon sheets, add information to them, sort and store them in paper form, and this takes a huge amount of time, accordingly affecting the number of appointments and the workload of the staff.

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Thus, there is an urgent issue of designing a medical information system to work with large volumes of data to improve the quality and availability of medical care in public health institutions, reduce inaccuracies and loss of information, save resources, reduce the workload on personnel, free up space in rooms intended for storing documentation, and reduce the time it takes to fill in information about contractors. To create such conditions, it is necessary to develop a system for processing patient flows: speed up the processing of incoming patient flows, partially automate the filling in of data in the documents being created that are linked to the contractor, and use simple and intuitive forms and types of information presentation.

2 Methodology

An important task of designing an information system is not only the processes of collecting and storing information, but also its systematization, exchange and distribution. Here, the use of modern computer technologies shows that the use of high and low-level languages is not the most effective way to create a system, compared to specialized languages for creating database management systems. The purpose of the study is the primary analytics of the information system «Medical Information System». To achieve the goal, it is necessary to complete a number of tasks: to formulate the task of the project, to explore the subject area, to perform business modeling of the subject area.

3 Results

Analysis of the subject area is one of the most important stages of the project, development of an automated system, the purpose of which is to identify, classify and formalize information about all aspects of the subject area that affect the final result. Let's conduct a preliminary analysis of the subject area of the design of the developed system. Medical and preventive institutions are located in almost every populated area. At the moment, there are more than 8 thousand state medical institutions in Russia. The population of Russia exceeds 147 million people. Thus, on average, one hospital accounts for about 18.5 thousand people. From the statistics it is clear that the average number of visits per inhabitant per year is 8.4 [1]. From this it follows that the average attendance of one hospital per day is about 450 people. However, these statistics are averaged, which means that in large cities this value can exceed a thousand people per day, while in small towns this value is below 50 people per day. The volume of flows of one institution can also be judged by different seasons of the year.

The task is to reduce the workload of the personnel of medical and preventive institutions. The first step is to determine the circle of users for whom the information system is being created. To do this, it is necessary to describe the organizational component. Analyzing the typical organizational structure of a medical and preventive institution, we determined the main persons participating in the activities of the institution: chief physician, administrator, operator, accounting and economic department, doctors, mid-level medical personnel, registrars, statisticians, laboratory assistants. To correctly determine the requirements for personnel access rights to automated functions of the information

Table 1. Personnel access rights to automated functions of the information system.

Chief physician	Management of the activities of a medical and preventive institution Organization of the work of the outpatient, therapeutic and surgical departments
Administrator	Issuance of access rights to the database Technical and software maintenance of equipment
Operator	Filling in the database
Accounting and economic department	An auxiliary department for the operation of the hospital
Doctor	Filling in prescriptions
Mid-level medical personnel	Fulfillment of prescriptions by doctors
Registrars	Maintaining an electronic medical record; Creating referrals
Statisticians	Compiling various reports
Laboratory assistants	Carrying out laboratory tests

Source: authors.

system, an organizational and staffing structure of positions (personnel roles) is set for each division (Table 1).

As can be seen from Table 1, depending on the functionality of a particular employee, the functions of the information system that are necessary for the implementation of activities also change. At the same time, it should be noted that the main management of the information system is carried out by the administrator of the IT department. His/Her competence also includes granting access rights to the database. Accordingly, an important point in the further design of the system is a clear delineation of the functions available to users and the organization of their interrelations between departments.

When designing information systems for healthcare institutions, the following key aspects should be taken into account: functional requirements to ensure the implementation of key processes for diagnosis, treatment and resource management; security of patient and staff data through reliable authentication and encryption mechanisms; scalability of the architecture to adapt to the growth in the volume of processed information; integration with external healthcare systems to exchange information between different organizations; user-friendly interfaces to improve the efficiency of interaction between doctors and medical personnel with the system.

Integration of the medical institution information system with other systems is necessary to ensure effective exchange of medical information and coordination of actions of various organizations. This allows the data exchange between medical institutions of different levels (e.g., clinics, hospitals, diagnostic centers), enables access to research results, patient medical records from other sources, provides integration with state health information systems for reporting and analysis of the epidemiological situation, improves the quality of medical care through an integrated approach to patient treatment. Thus,

integration helps improve the level of public service and optimize the work of medical institutions.

User-friendly interfaces play a key role in the design of healthcare information systems for the following reasons:

- increased productivity: intuitive interfaces allow healthcare workers to find the necessary information and enter data faster, reducing the time spent working with the system;
- minimizing data entry errors: well-designed interfaces reduce the likelihood of accidental errors when entering information, which increases the accuracy of electronic medical records and reports;
- improved patient care: quick access to up-to-date information helps doctors make prompt decisions, improving diagnostics and treatment of patients;
- user training: a user-friendly interface reduces the need for lengthy training of employees to work with the system, accelerating the process of implementing new technologies.

4 Discussion

Considering modern research related to the automation of business processes in the field of healthcare, it can be noted that issues related to the problems of introducing digital technologies into the management system of medical institutions are especially relevant nowadays in Russia. The issue of personnel readiness for the expected changes is questioned [2]. Researchers emphasize the need for reengineering business processes in domestic healthcare and the introduction of artificial intelligence [3]. It is noted that the introduction of innovative digital technologies into the management system in healthcare will allow it to be brought to a higher level [4]. The importance of finding new concepts and approaches to modernizing this management system is substantiated [5], and the role of digitalization of business processes in ensuring quality control of medical activities is shown [6]. Foreign scientists are also actively researching issues of informatization of management systems of medical institutions. Analysis of technical equipment and functionality of the healthcare system is regularly carried out [7]. Specific difficulties and problems of automation of business processes in this industry are highlighted [8]. The opinion of medical institution personnel regarding automation processes is studied [9], as well as the processes of transferring all existing documentation to digital format using healthcare as an example [10].

5 Conclusion

Summing up the specifics of working with data in medical institutions, we can conclude that personnel at various levels are faced with huge flows of information daily, concerning incoming and outgoing patients. The inability to promptly process this information leads to significant delays in resolving emerging issues. Speaking about medical institutions, it can be noted that in their activities, delays can significantly affect the results of the services provided. In this regard, there is a need for prompt transfer of information both within a medical institution and between them. When building a specific

information system for data accounting for a medical institution, one should focus on its organizational structure and the functionality of each person involved. These factors will be decisive when granting access rights and building connections in the information system.

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Transformation of Consumer Expectations in Industrial Production: Impact of Personalization and New Technologies

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Abstract. The work explores the evolution of consumer expectations in industrial production in the context of the growing role of personalization and the widespread implementation of new digital technologies. The authors sequentially analyze theoretical and practical aspects related to the industry's transition to flexible production systems focused on individual customer preferences, and evaluate the impact of this transformation on the demand structure and the competitive environment. The main factors contributing to the growth of mass customization are identified, including the application of big data, the development of robotic lines and the use of artificial intelligence to predict consumer behavior. The work also highlights the significance of after-sales service and environmental aspect in implementing personalized solutions. The authors consider how the interaction of technological innovations and market demands are shaping new business models and supply chain management approaches, and formulate directions for further research in this area. The research purpose is to analyze how personalization and new technologies influence the transformation of consumer expectations, and to show what changes take place in the structure of demand and industrial production strategies.

Keywords: Consumer Behavior · Consumer Expectations · Digitalization. Industry · Mass Customization · Personalization · Technological Innovations

1 Introduction

In recent years, the industrial sector has evolved significantly due to a variety of factors ranging from globalization and digitalization to changing demand trends. Consumer behavior, driven by new social, economic and technological realities, plays an increasingly important role in shaping market trends. An example of this shift in preferences is the growing interest in personalized products and services, as well as rising expectations of innovative technologies that can meet individual customer needs. One factor

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driving this change is the rapid development of Industry 4.0, which combines elements of artificial intelligence, the Internet of Things, cloud technology and intelligent manufacturing systems. All of these have a direct impact on the way companies design, manufacture and promote their products. Consumers expect more than just a quality product at a reasonable price – they increasingly seek unique ownership experiences, enhanced functionality and personalized product features. Modern businesses are forced to integrate personalization into their business models to maintain a competitive advantage. Personalization is no longer a luxury and is becoming a basic expectation in many areas – from electronics and automobiles to home appliances and furniture. The introduction of advanced digital services is shaping a new level of communication between the manufacturer and the end user.

2 Methodology

The first step in the research was to study the scientific literature and industry reports on the development of modern technologies and their impact on consumer behavior. The main focus was on publications from the last 5–7 years, as this was the period of the most intensive growth of technologies and the massive transition of companies to more flexible and customized production processes. For more complete understanding of the industry context, we collected and analyzed statistical data, reports of consulting agencies, as well as cases of implementation of personalized solutions in various industries. Successful examples of customer data collection systems, the use of big data, and mass customization practices were particularly interesting. To complete the theoretical data, qualitative interviews were conducted with 15 middle and senior managers of manufacturing companies operating in mechanical engineering, light industry and food industry. A comparative-historical approach was used to understand the transformation of demand and consumer behavior. It allowed us to compare how consumers reacted to the emergence of new technologies in the past and in the present.

3 Literature Review

The issue of transforming consumer expectations in the industrial production has been actively discussed in scientific research in recent decades. Technological developments, the transition to flexible production systems and the increasing role of customer experience are creating new paradigms in the field of demand management.

One of the basic theoretical approaches to personalization is the concept of mass customization. Its main statements were formed in the works of B.J. Pine [1], J.H. Gilmore and J. Pine [2], where the researchers justified the transition from mass production to a more flexible format oriented to individual customer needs. According to these studies, mass customization is based on combining the advantages of conveyor systems (economies of scale) with the ability to customize a product for a specific customer (economies of scope). This concept has further developed in the context of Industry 4.0, where robotic and modular production lines with a high degree of adaptability come to the center of attention [3]. Digital tools such as cloud platforms, the Internet of Things (IoT), and predictive analytics systems have enabled companies to obtain and process

information about end-customer preferences more quickly, making the customization process cost-effective [4].

The second area of research closely related to the personalization in the industrial production is the analysis of the impact of digital technologies and Big Data on supply chain management, marketing policy and production processes [5]. Modern companies are actively applying machine learning algorithms to predict demand and identify hidden patterns in the consumer behavior [6]. The use of digital platforms (e.g., online configurators) facilitates customer engagement in the early stages of product development, and makes it easier to collect the feedback needed for continuous improvement of the production cycle [7]. At the same time, customer preference data can act as a resource that allows companies to effectively segment the market and offer a wide range of options for specific customer groups.

Research on the evolution of consumer behavior has a long history in marketing and behavioral economics [8, 9]. In the context of industrial personalization, particular attention has been paid to the concept of 'escalating expectations', according to which, once consumers become accustomed to a certain level of customization, they begin to perceive it as the 'new normal' [10]. In addition, the theory of 'desired attributes' emphasizes that consumers evaluate a product not only on functional parameters (quality, price), but also on emotional, aesthetic and social qualities [11]. With active digitalization, these additional parameters are becoming increasingly important, especially among the younger generation focused on unique customer experiences.

In recent years, there has been an increasing interest in investigating the impact of personalized solutions on the environmental and social sustainability of industry [12]. On the one hand, flexible manufacturing facilities and online tools for product customization contribute to better meet consumer demand and thus reduce surplus and waste [13]. On the other hand, increasing variability can lead to increased logistics complexity, additional transport costs, and a larger total carbon footprint if supply chains are not properly customized [14]. Researchers point to the need to develop comprehensive models that take into account not only the economic effects of personalization but also its impact on the socio-ecological context. Such approaches are increasingly used in Life Cycle Assessment (LCA), where special attention is paid to optimizing resource consumption and implementing circular economy principles [15].

Supporting the trend towards personalization, the industry is evolving in parallel towards service-oriented business models [16]. Subscriptions-based services, sharing platforms and co-creation, where the consumer is involved in the product design process, are becoming increasingly relevant [17]. Academic discussions show growing importance of 'ecosystems' around a product, where services, additional content and software play an important role [18]. Personalization is seen as one of the mechanisms to increase value for the customer and competitiveness for the company, as it allows to satisfy not only basic but also 'emotional-symbolic' needs of consumers [19].

The widespread use of data of customer behavior and preferences generates serious privacy and information security risks [20]. In the digital economy, personal data security becomes a critical element of trust between producer and consumer [21]. Legal compliance issues (e.g. GDPR in the European Union) and protection against cyber-attacks are key aspects when deploying personalized services. Careful consideration of legal and

ethical standards in dealing with big data is becoming essential to maintain sustainable customer relationships and company reputation [22]. However, there are still a number of unresolved issues that require further analysis: first of all, these are the long-term consequences of mass customization on the environment, as well as the socio-ethical aspects of using big data. In addition, many authors point out the importance of integrating new business models with traditional forms of production and logistics in order to avoid rising costs and ensure a balanced realization of the potential of personalization in different industries. The further development of research in this area will directly determine how effectively and sustainably the industry will be able to respond to the continued growth of consumer expectations on a global scale.

4 Results

Based on the analysis of the collected data and interviews with company representatives, it's possible to identify a number of trends indicating the transformation of the industry under the influence of personalization and technological innovations. The main findings of the research are summarized below.

1. Trend of increasing demand for personalized products.

Consumers expect increasingly unique product configurations tailored to their personal tastes, needs and lifestyles. In the automotive industry, for example, this translates into a wide range of options and additional features that can be selected when buying a car (interior color, type of infotainment system, etc.). In the field of household appliances, companies offer models that allow customizing design and functionality to meet specific user requirements. Table 1 presents a conceptual periodization of the evolution of consumer expectations in industry, indicating approximate timeframes and briefly describing the features of each stage. These periods reflect major shifts in the socio-economic context, production structure and technological capabilities that together influenced the way consumers perceived and selected products.

The early industrialization period was a period of the early emergence of the factory production system, with the first mechanized machine tools and steam engines. The growth of urban populations and developing trade networks stimulated the first forms of mass production, but customization was minimal. It was more important for customers to simply purchase the goods they needed in a rapidly growing market. The period of mass production saw the further development of steam engines and metallurgy, the introduction of conveyor systems (towards the end of the period), and the intensification of railway transport. People begin to value the reliability and availability of products, and manufacturers try to secure a lower price through higher output volumes. Product personalization is not yet seen as a priority.

During the heyday of the 'conveyor' industry there is a widespread introduction of conveyor production, the emergence and development of electric motors, and the intensive use of assembly lines (especially in the automotive industry). Goods become even more standardized. Mass production (as exemplified by Ford cars) shows that a standardized model in large volumes can significantly reduce the final price. Personalization remains a rarity, available to a very narrow circle of wealthy customers. In the period of

Table 1. Periodization of the evolution of consumer expectations in industry.

No	Period	Consumer expectations
1	Early industrialization (late XVIII – middle of XIX century)	Consumers experienced shortages of goods and basic products. Essential needs dominated over the desire for 'uniqueness'
2	Formation of mass production (middle of XIX – early XX)	The demand for relatively 'standard' goods with more predictable quality and stability of characteristics is forming. There is a gradually growing interest in 'factory-made' goods, which are becoming a symbol of progress
3	The rise of the 'conveyor line' industry (early XX to the 1930s)	Availability and low cost of goods are important for consumers. Brand identity is just beginning to take shape. Customers are mainly focused on functionality
4	Transition to a consumer society (1940s – 1970s)	For consumers convenience and design becomes important in addition to basic qualities of goods (reliability, price). The prestige of owning 'modern' goods becomes an important social marker
5	The rise of the brand role and the onset of globalization (1970s – 1980s)	The market is becoming increasingly saturated and consumers are beginning to pay attention to brand, quality, functionality and appearance. The idea of 'lifestyle products' is emerging
6	Digitalization and early customization (1990s – 2000s)	Consumers understand that goods can be 'customized', primarily in the IT sector (computers, mobile devices). There is a shift towards clearer market segmentation
7	Industry 4.0 and mass personalization (2010s – present time)	Consumers expect a product or service to be a 'constructor', allowing the customer to choose from a wide range of parameters (color, size, functionality)

Source: authors.

transition to a consumer society (1940s-1970s) there is economic recovery after World War II, the active development of electronics, the appearance of televisions, refrigerators and other household appliances. The 'consumer boom' gives rise to standardization, but already taking into account marketing approaches: advertising and the brand component stimulate the mass desire to 'be like everyone else', to have 'trendy' things. Customized orders are still rare, and mass-produced products accessible to the middle class come to the fore.

In the period from around 1970s to 1980s, we can note the trend of the increasing role of the brand and the beginning of globalization. At this time there is the spread of

automation in factories, the first robots and computerized production control systems, and the growth of international trade. Competition among global brands intensifies, marketing becomes more sophisticated and targeted. Personalization is not yet widespread, but 'premium segments' are already appearing, where customers are offered to choose the color, material and individual modifications. In parallel, mass production for the bulk of consumers continues to dominate. In the period 1990s-2000s we can observe the beginning of digitalization and the first steps towards customization. In the period of digitalization, computer technology comes to the fore, the spread of the Internet forms a global communication network, and ERP systems and CAD/CAE design tools are introduced into production. Customers have a growing need for variety. Customers want products with functional options that reflect their personal lifestyles. Manufacturers are starting to use online catalogues where the customer can choose a specific configuration or color. However, mass customization is still limited by technological barriers.

The period of Industry 4.0 and mass customization (2010s-present) is characterized by the development of digital platforms, big data, artificial intelligence, the Internet of Things (IoT), robotic modular lines and 3D printing. Customization is moving from the category of 'premium options' to 'conditionally standard': users expect a company to be able to offer flexible solutions for their individual needs. Marketing approaches are also strengthening: brands are actively implementing online configurators, using social networks to gather feedback, and focusing on post-sales support.

There is a stable trend towards personalized products, which is expressed in several aspects of companies' activities at once. Analysis of interviews with managers of industrial enterprises indicates that customers are more often demand not only the functional characteristics of the product, but also its design, compatibility with existing systems, availability of customization options for personal preferences. This shift is linked to a general increase in consumer awareness, which now has access to an extensive database of comparative product characteristics in digital channels. This leads to the phenomenon of 'escalating expectations', where once given the opportunity to choose a unique configuration, people begin to see customization as a natural element of their next purchase. This is supported by a number of marketing studies, which show that more than 65% of consumers in developed countries would like to be able to personally influence the appearance and functionality of the products they purchase, whereas a decade ago this percentage was much lower [10].

2. Developing the integration of digital platforms.

Manufacturers actively use digital solutions to communicate with customers and gather feedback at all stages of the product lifecycle. Online configurators and virtual showrooms allow the customer to 'build' the product of their dreams, while companies can quickly obtain information on the most popular features and designs. With digital tools, the time gap between identifying a new trend and launching the corresponding product on the market is shortened. Another important aspect is the integration of digital platforms into production processes and interaction with final customers. It is expressed in the creation of online configurators, interactive showrooms, and the widespread use of mobile applications that not only allow the user to select a product, but also to evaluate in real time whether the new configuration meets the user's expectations. Thus, in contrast

to the classical models, where the purchase process was separated as much as possible from production, today's digital tools make it possible to virtually 'link' the order to the production chain. On the one hand, this simplifies the collection of information on preferences and adjusts production plans. On the other hand, such platforms provide continuous feedback between consumer and manufacturer, creating additional incentives for product improvement at the design stage. PwC's study notes that the active digitalization of industry is accelerating the time-to-market cycle of product development, which is critical in highly competitive markets where innovation leadership provides direct competitive advantage [23].

3. Application of Artificial Intelligence (AI) and Big Data technologies.

AI and Big Data are used for automated analysis of consumer preferences and demand forecasting. Companies are implementing recommendation algorithms and machine learning systems to predict which personalized options will be in demand among different customer groups. The result is more accurate production planning and lower costs associated with unpopular models. The use of AI and Big Data technologies further strengthens this trend, as it allows for detailed analysis of preferences and demand forecasts taking into account a variety of factors: seasonality, regional characteristics, socio-demographic characteristics of the audience, etc. Automated algorithms can reveal hidden correlations and patterns of behavior that are inaccessible during manual data processing. In addition, Machine Learning systems provide adaptability of recommendations, helping companies to create targeted offers for different audience segments. For example, the results of a study conducted as part of the PwC consulting project [24] show that 78% of surveyed companies from the engineering and automotive industries actively use big data analytics to optimize production processes and develop new models. Predicting failures and improving product quality by analyzing telemetry from products already in operation is also becoming a significant innovation. Thus, automotive concerns can adjust design decisions based on information about the actual wear of units in different operating conditions.

4. Flexible manufacturing systems.

Mass customization has become possible due to the development of flexible production lines that can be quickly adapted to new models and configurations. Robotic manufacturing assembly lines and modular production control systems make it possible to produce both large and small quantities of products in the shortest possible time. An important conclusion from this analysis is that this digital transformation is structurally changing the very logic of industrial production, leading to the widespread adoption of flexible and repositionable production systems. The cycle illustrates how data about customer behavior and preferences are sequentially processed and transformed into concrete solutions for flexible production facilities and personalized products (Fig. 1). Throughout this process, end-to-end digitalization and the close connection between customer and manufacturer at all stages of the product cycle are central to this process.

The first stage of customer demand analysis involves collecting data on customer preferences. Sources may include reviews on websites, survey results, sales statistics, social networks and other digital channels. The manufacturer should identify the main trends in consumer behavior and determine the demanded features and functions of

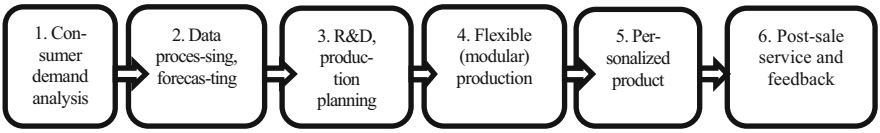


Fig. 1. Personalized production cycle (Source: authors).

future products. At the second stage, the collected information is analyzed using Big Data methods, etc. The result of this stage is a forecast of demand for different customization options and the identification of potential market niches where personalization can have the greatest effect. At the third stage, the research and development (R&D) departments form technical requirements for the new product based on the obtained analytical data. The manufacturing department determines what process lines, materials and processes are needed to enable personalization and mass customization. In the fourth stage, robotic lines, adaptive CNC machines, 3D printers and other modern technologies are introduced to enable rapid switching between different assembly options. During the production process, real-time data on the production progress is collected, which makes it possible to adjust product configurations, avoid defects and save resources. At the fifth stage, the customer receives a product or service customized to their individual preferences: color, feature set, additional services or unique design. This approach increases customer satisfaction and loyalty, and helps strengthen the brand's image as an innovative brand. At the sixth stage after purchase, the consumer continues to interact with the company through service centers, mobile applications, and online support. At this stage, the manufacturer collects additional information from customers about operational problems and new wishes, which forms a continuous cycle of data for future product modifications.

The principles of mass customization are being taken to a new level with the development of modular production lines, robotic assembly plants and real-time production control systems. Under traditional assembly line schemes, oriented towards the production of large, uniform production batches, the implementation of customized solutions was extremely difficult economically. However, modern technologies – robotics, adaptive CNC machines, 3D printing – allow for a quick switch to production of modified models or small batches without significant additional costs, satisfying the most diverse tastes of end users. In the aircraft industry, for example, flexible systems are appearing that allow changes to be made to the aircraft design at the assembly stage to meet specific customer requirements, while in electronics, manufacturers are increasingly offering configurable platforms for smartphones or laptops. This not only increases customer satisfaction, but also stimulates innovation, as each improvement can serve as the basis for more extensive changes in the future.

5. Growing importance of experience and service after purchase.

Consumers perceive the product not only through the prism of its characteristics, but also through the accompanying service: warranty service, software updates, additional delivery and installation services, personalized loyalty programs. According to

the results of interviews with managers, it is the after-sales service that largely determines the customer's loyalty and affects the decision to re-purchase. Similarly, the very understanding of the quality of industrial goods is being transformed, moving from purely technical characteristics to an integrated approach that includes emotional and social components. Interviews with senior managers of companies engaged in the production of high-tech household appliances showed that more and more attention is paid to after-sales service, software updates and additional service options.

The consumer is no longer ready to consider the product only as a «physical thing»; it expects enhanced functionality, rapid repair or replacement, 24/7 information support. This means that the success of the product begins to depend not only on the correct choice of materials and reliable components, but also on the completeness of the ecosystem that is created around it. So, many large manufacturers are introducing mobile applications that allow you to remotely control equipment, receive notifications about prevention or possible breakdowns. Some companies go even further by offering personalized service programs that are linked to the user's account and take into account his individual consumption history, equipment usage schedule or personal service preferences [12].

Another significant result of the study is the realization that personalization and digitalization in industry are closely related to the growing role of cross-functional interaction within companies. In particular, the successful organization of personalized production requires the coordination of marketing, research and development (R&D), production units and logistics. Marketing should quickly collect data on customer needs, R&D should embody these needs in design solutions and intelligent systems, and production should provide the technical ability to release customized batches without losing quality and increasing costs. This integration is further complicated by the fact that companies often work with a wide network of suppliers, each of which contributes to the overall technological process. Therefore, the introduction of new technologies and personalization strategies requires not only reliable data exchange, but also building partnerships in which suppliers participate in product development in the early stages. Close coordination of all links in the supply chain increases the adaptability and speed of launching new products on the market, which is especially important in the production of goods designed for high variability [12, 25].

Combining all of the above factors, we can see that product personalization, supported by digital technologies, is radically changing the very nature of demand. Where once manufacturers sought to find 'standard solutions' for the masses and minimize production costs through economies of scale, now flexibility, responsiveness to changing expectations and variability of offerings are at the forefront. Under these conditions, large enterprises are increasingly resorting to the strategy of 'hybrid' approach, combining mass production of basic platforms with the possibility of further development and customization. In essence, this is a rejection of rigid specialization in favor of more versatile production facilities with modern equipment. This has a direct impact on R&D investments, as well as on the quality of the workforce: employees are expected to possess complex skills ranging from IT competences to the ability to quickly learn to work with new automation systems [26].

The transformation of demand under the influence of personalization and technological shifts is driving the emergence of new business models. Some companies start to provide the product in the format of 'as-a-service', when the consumer actually pays not for the possession of the product, but for the opportunity to use its functions. Under such conditions, the structure of costs and revenues changes fundamentally, as the manufacturer takes over the service component, and the customer receives a more flexible and convenient format of use. On the other hand, opportunities for 'co-creation' – co-designing products together with the user – are increasing [27]. A number of industries (e.g., sports equipment, luxury goods, furniture) are adopting platforms where consumers, designers, and manufacturers work closely together to create truly unique solutions. This practice not only strengthens customer loyalty, but also gives a strong impetus to innovation, as ideas come directly from the target audience [28].

Finally, within the framework of the topic under discussion, the question of the long-term social and environmental implications of such industrial transformation is of particular interest. Product personalization can help to reduce overproduction and inventory, which has a positive impact on resource intensity and reduces unsold goods. However, as companies strive to meet increasingly sophisticated customer demands, there is a risk of 'modification overproduction' and increased pressure on logistics infrastructure. These contradictory effects demonstrate the need to develop more subtle mechanisms for assessing the effectiveness of customization, taking into account not only financial indicators, but also environmental impact and social and ethical aspects. The challenge arises to form new standards of environmentally responsible and socially oriented production, where customization and new technologies will be used in a balanced way, without excessive exploitation of resources and without infringing on the interests of local communities. The results of the research confirm that consumer behavior in industry is changing rapidly under the influence of the development of new technologies and the growing orientation towards personalization. Previously, manufacturing was predominantly focused on mass production of goods with minimal variation to achieve economies of scale. Now, economies of scale are being complemented by economies of scope, where flexible production capacity can serve many narrow market segments to meet individual customer needs.

One of the main challenges identified during the interviews is the integration of new technologies without significant disruption to existing business processes. Many companies face difficulties in the transition to personalized production, as it requires revising the supply chain, optimizing logistics, and investing in staff retraining. In addition, the processing of big customer data (Big Data) is linked to privacy and cyber security issues, which requires special attention to legal aspects and data protection. An additional challenge is the need to research and predict consumer behavior over the long term, as innovative solutions require large capital investments. A poor understanding of what demand will be like in 5–10 years' time can lead to erroneous investments and losses. Nevertheless, the data collected in this study shows that the trend towards personalization will continue to gain momentum as the cost of technology continues to fall and consumers become more aware of the options available.

From an environmental and sustainability perspective, personalization can work in two opposite directions. On the one hand, personalized production can reduce waste

and losses by producing exactly what the end consumer needs. On the other hand, if the personalization process is not organized in a sustainable way, it can lead to excessive consumption of resources and increased environmental impact (e.g. when using complex packaging materials or delivering small quantities of goods over long distances).

5 Conclusion

Modern industry is undergoing a major transformation due to changing consumer expectations and the rapid development of digital technologies. The personalization of goods and services is becoming not just a competitive advantage, but actually a basic market requirement. New technologies (from artificial intelligence to flexible manufacturing systems) are enabling companies to rapidly re-engineer and fulfill a wide range of individual needs. The main findings of this study suggest that personalization is an important growth driver, enabling businesses implementing mass customization solutions to expand the range of market niches covered while building customer loyalty. The digital transformation of communications is reflected in the use of online configurators, virtual showrooms and comprehensive big data analytics systems, which simplify the interpretation of information on customer preferences and facilitate faster adaptation of products to changing market needs.

The next aspect concerns the development of flexible manufacturing facilities: in a context of rapid technological evolution, investments in robotization and modular assembly lines are becoming a strategic priority for companies seeking to offer the most varied product range possible while maintaining competitive lead times and costs. In addition, there are increasing demands on after-sales service, which increasingly has a direct impact on brand reputation, warranty claims and repeat purchases, ultimately forming the long-term basis for sustainable business growth. Finally, the environmental component is of particular importance: with intelligent planning and optimized processes, personalization can reduce waste and surplus production, but with errors in the organization of supply chains and resource management, the risk of excessive use of materials and, consequently, an increased negative impact on the environment increases. In view of the dynamism of modern markets and technological developments, it seems appropriate to focus further research on a number of areas. More detailed analysis of the impact of new consumption patterns – in particular sharing platforms and subscriptions – on the prospects for personalized production is needed, as these formats may fundamentally change customer behavior. Attention should be paid to assessing the risks arising from the processing and storage of personal data, as any security failure compromises consumer trust and leads to reputational losses. The environmental impact of mass customization remains an important area of research.

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Comparative Analysis of the Information Potential of Different Countries

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Abstract. In the modern contexts, social and economic progress depends on more than just the deployment of predictive data models, additive manufacturing, or online resources. Equally important is a rising tide of digital data concerning economic actors, taking place in an environment marked by uneven growth in traditional sectors, cross-pollination across interconnected industries, and the emergence of entirely new domains of activity with novel business models. This progression of information transformation is both complicated and multi-faceted, influenced by many discrete elements whose differentiation, evaluation, and measurement help direct strategic choices, ensure well-aligned planning, and facilitate adaptive measures by means of feedback. The global techniques for assessing the extent of ICT adoption and usage have not always kept pace with swiftly evolving technologies and the processes that shape economic progress, creating a need to modernize existing global guidelines for tracking and interpreting diverse aspects of the information economy.

Keywords: Digital Transformation · E-Government · E-Participation · Human Capital · Indicators · Information Potential · Telecommunications Infrastructure

1 Introduction

The large-scale use of information and communication technology (including Internet) led to the development and globalization of the information society, based on a profound transformation of social and economic spheres in the digital direction to ensure the accelerated pace of economic development, including at the global level, the increase in labor productivity, the formation of new economic and industrial fields, as well as achieving sustainable economic growth [1]. It should be noted that in the current conditions, digitalization of the social sphere leads to increased inclusivity by increasing the speed and efficiency of communication between various communities, information exchange, and the results of material and non-material activities.

Measures that depict the advancement of the information society come from several global bodies, each publishing comprehensive analysis on the digital economy at large. For instance, the International Telecommunication Union – functioning under

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the umbrella of the United Nations – has, since the late 1990s, undertaken methodical examinations of digital evolution [2]. This has refined the conceptual basis of ongoing monitoring and given rise to indicators such as the ICT Development Index, an ICT Services Price Index, and the Global Cybersecurity Index [3]. Similarly, the Organization for Economic Cooperation and Development (OECD) provides reviews detailing trends and future scenarios for digital economy advancement. Additionally, the annual Global Information Technology Report, a product of collaboration between the World Economic Forum and INSEAD [4], includes an illustrative gauge known as the «Networked Readiness Index». Since 2004, the United Nations' structural divisions, alongside Eurostat and the OECD, in coordination with authorities in multiple countries, have developed an agreed-upon core set of metrics for tracing ICT progress. Today, numerous standardized systems, consistent with recognized practices for monitoring the information society and its economic elements, include indicators related to the availability and use of ICT [3]. The outcomes from these globally coordinated methodological efforts enable valid comparative analysis of how the information economy evolves in Russia and other parts of the world. They also clarify principal elements of the information potential, which directs strategic initiatives aimed at optimizing and consolidating that potential.

2 Methodology

This work adopts a mixed-method qualitative and quantitative approach. The primary goal is to compare multiple international rankings and indices that gauge the level of information potential across countries, with a particular emphasis on Russia's standing. The research began with a survey of internationally recognized metrics that capture ICT penetration, e-government performance, human capital, and telecommunication infrastructure. Among the primary sources, there were the E-Government Development Index (EGDI) published by the United Nations, the OECD's Digital Economy Outlook, analysis by the International Telecommunication Union (ITU), and the Global Information Technology Report by the World Economic Forum. From these indices, we choose several elements relevant to the concept of «information potential», beginning with infrastructure, which encompasses penetration rates of mobile subscriptions, broadband usage, and the overall quality of telecommunication systems. Another essential element is human capital, comprising factors such as literacy rates, levels of educational attainment, training programs in information technology, and the average years of formal education. In addition, e-government performance encompasses aspects like online public service provision, e-participation mechanisms, digital portals designed to engage citizens, cybersecurity policies, and the maturity of official government websites. Numerical data were gathered from reports and datasets maintained by the United Nations (particularly the UN E-Government Surveys), the ITU, and the OECD. Where relevant, we used the official documents from these organizations to obtain indicators for Russia and selected comparator countries. In some cases, regional averages were considered (e.g., Europe and Central Asia) to benchmark Russia's performance against regional norms.

3 Literature Review

The institutional discourse on information potential, digital transformation, and e-government intersects with multiple fields, from economics and sociology to public policy and information science. A brief review of key sources is provided below.

A set of frequent contributions to the field emerges from international organizations, which collectively supply a corpus of data and analytical frameworks. The G20 Digital Economy Development and Cooperation Initiative [1] underscores the vital links between macroeconomic policies and national ICT strategies, emphasizing how collaborative efforts among major economies can promote best practices and shared standards. Documents by the International Telecommunication Union [2] regularly publish statistics on broadband availability, pricing, and emerging trends such as 5G coverage, providing a baseline for cross-country comparisons of technological progress.

The OECD Digital Economy Outlook [3] represents another flagship publication that consolidates evidence on how the digital sector influences productivity and job growth. Meanwhile, the World Economic Forum's Global Information Technology Report [4] highlights the importance of network readiness and the role of policymakers in fostering sustainable and inclusive digital expansion. The Partnership on Measuring ICT for Development [5] is similarly concerned with harmonizing definitions, indicators, and methodologies, recognizing that comparability is crucial for robust global assessments.

Central to this study are the UN's review of e-government [6] and subsequent updates. These surveys frequently measure the development of e-services, telecommunication infrastructure, and human capital, culminating in the E-Government Development Index (EGDI) and its sub-components. Additionally, the «Internet economy in the G20» [7] has been featured by the Boston Consulting Group as a locus of pioneering digital policies, linking technological innovation to increased global GDP share. K. Schwab [8] elaborates this view by describing the Fourth Industrial Revolution as an epoch of rapidly converging technologies, such as artificial intelligence and the Internet of Things, which require new regulatory approaches and governance structures.

Publications that investigate the aftermath of the COVID-19 pandemic – for example, statements by Antonio Guterres, Secretary-General of the United Nations [9] –highlight the shift to more digitally anchored frameworks of governance, commerce, and education. In parallel, works by [10, 11] address behavioral and market-structure questions, exploring how new technologies can alter consumer preferences, business competition, and satisfaction paradigms. R.L. Oliver' work [12] on consumer satisfaction theories, while more specific to marketing, provides insights into how online service provision might be evaluated from a user perspective, thereby intersecting with e-government strategies.

4 Results

One of the principal metrics used worldwide to evaluate a nation's progress in digital governance is the UN's E-Government Development Index (EGDI). This composite index aggregates data on three sub-indices: telecommunication infrastructure, human capital, online service provision. Each sub-index includes several components. Telecommunication infrastructure might consist of mobile and fixed broadband subscriptions, while

human capital relates to literacy rates, school enrollment figures, and average years of education. Meanwhile, online service provision measures the availability, sophistication, and effectiveness of national e-government websites.

The sub-index of services provided by online (OSI) EGDI is a composite index that measures the performance of the application by governments of information and communication technologies in order to provide public services to users at the national level, incorporating many aspects of their presence on the Internet and assesses national websites from the standpoint of technical characteristics, political and strategic solutions for e-government development in special sectors of service provision. These estimates are tabular data of a set of standardized indicators in accordance with the scale [0; 1], where 0 is the lowest, and 1 is the highest indicators of online service provision. Indicators of the sub-index of services provided online are not absolute measurements, but reflect the presence of the governments of countries participating in the rating in the electronic environment in relation to each other at a certain point in time. Due to the fact that the sub-index of services provided online a composite tool, the interpretation of its high score determines the current best practices for developing services provided on-line, and not the level of excellence. Also, the low rate is not a reflection of the lack of progress in the development of services provided by online e-government.

Russia placed 36th in the 2020 EGDI with a value of 0.8274, signifying a «very high» level of e-government development. This rating, while commendable, showed a decline from the country's performance in 2018, attributable in part to slower-than-expected improvements in the «Index of services provided online» sub-component. Even though the telecommunication infrastructure sub-index continued to rise, the partial reversal in the sub-index capturing online services influenced Russia's overall EGDI score. The sub-index for Telecommunications Infrastructure displayed stable upward movement over the past four years. A minor drawback emerged in the number of mobile phone subscribers per 100 inhabitants, which declined slightly during the same period. Some analysts interpret this decrease as a consequence of the proliferation of social networks, messaging applications, and VoIP services, which reduce the demand for direct phone calls. Another possibility is that an increasing number of subscribers use a single SIM card with advanced data plans, obviating the necessity for multiple subscriptions.

It is essential to place these trends in a broader context. Many nations that had lagged in e-government initiatives have rapidly improved their position by adopting updated UN guidelines for digital government, including expansions in e-participation, mobile-friendly portals, and integrated platforms providing one-stop services. By 2020, states worldwide have accelerated their online presence due to immediate needs imposed by the COVID-19 crisis, forcing Russia to compete in a more dynamic global environment.

A subset of EGDI is the E-Participation Index (EPI), which gauges citizens' ability to use online tools for obtaining information, voicing opinions, and influencing public decision-making. In 2020, Russia's E-Participation Index stood at 81.76 percent, placing the country at 29th in the global rankings. This represented a somewhat volatile pattern, as Russia was 23rd in 2018 and 32nd in 2016. The fluctuations can be traced to how quickly other nations are enhancing their e-consultation and e-decision-making facilities, as well as changes in the UN's methodology that places greater emphasis on user engagement, transparency, and social inclusion.

Despite the fluctuations, the trajectory for Russia over roughly the past decade indicates generally increasing adoption of e-participation mechanisms, such as electronic petitions, public consultation platforms, and digital polling. Government agencies have also expanded their social media presence and introduced interactive portals for services ranging from tax filings to healthcare appointments. Within that scope, the Index of Services Provided Online captures whether citizens are able to complete 20 key transactions through official government sites, including obtaining business permits, applying for social benefits, or registering job vacancies.

The Human Capital Index (HCI), as employed in multiple UN and World Bank frameworks, demonstrates the extent to which educational and health standards equip citizens to become productive participants in a digital economy. For Russia, the UN's broader measures of educational involvement (including literacy rates and gross enrollment) have revealed consistent improvement over recent years. While one specific iteration of the HCI suggests that a child born in Russia today can achieve about 68% of the maximum potential education and health levels by the age of 18, the UN E-Government Surveys place this figure significantly higher (0.8833 for 2020) due to a different mix of criteria. Because these methodological approaches vary, direct comparisons should be made cautiously. It remains clear, though, that Russia's performance on education-related metrics is comparatively strong within the Europe and Central Asia region.

A significant contributor to these positive results is Russia's emphasis on maintaining near-universal literacy rates and ongoing government efforts to increase tertiary enrollment in science, technology, engineering, and mathematics (STEM) disciplines. However, challenges remain, including a mismatch between the specialized skills needed in cutting-edge ICT fields and the competencies traditionally developed in universities. Rapidly changing labor market requirements force educators and policymakers to continuously adapt curricula, underscoring that educational achievements must be continuously updated to maintain competitiveness.

Beyond e-government, the broader information potential of a nation is reflected in how effectively Internet technologies translate into economic growth. The Boston Consulting Group [7], cited in various G20 discussions and UN reviews, estimated that the contribution of the Internet to global GDP accounted for roughly 21 percent of overall growth in the preceding five years. Scholars such as K. Schwab [8] have termed this phenomenon part of the Fourth Industrial Revolution, wherein information technologies, artificial intelligence, and the Internet of Things converge to drive large-scale structural shifts in production, communication, and service delivery.

For Russia, the formation of new e-business ventures, platforms, and entrepreneurial start-ups is notable at the regional level, but the domestic digital sector has not yet ascended to truly global leadership in the same way that multinational technology giants in the United States or parts of Asia have. Russian tech companies do show strong performance in localized markets – particularly in social media platforms, search engines, and e-commerce – but they often face significant competition beyond the country's borders. This limits their impact in shaping world digital standards or establishing global market dominance.

The onset of COVID-19, often cited by the United Nations and other observers, has propelled many governments worldwide to strengthen online service capabilities. Russia

was no exception, as digital technologies were rapidly harnessed to manage lockdowns, provide remote healthcare services, and continue delivering various government benefits. Surveys suggest that emergency measures, such as expanding remote identification processes for social benefits and speeding up online platforms for business registrations, accounted for much of the uptick in Russia's 2020 e-government metrics.

5 Conclusion

The comparative perspective presented in this work illuminates the multifaceted nature of information potential and e-government development. Russia's position in global indices such as the E-Government Development Index (EGDI) and the E-Participation Index (EPI) demonstrates that the country has achieved considerable progress in digitalizing public services, expanding telecommunication infrastructures, and investing in human capital. The overall trend is one of advancement, even though the precise numerical rankings reveal fluctuations in specific sub-indices. Indeed, the global field is highly competitive and dynamic: as Russia upgrades its online service provision, other countries concurrently enhance their own strategies and surpass earlier achievements.

While it is tempting to focus solely on technology upgrades or purely on human capital, the evidence suggests a convergence of factors is necessary. Education, health, and robust digital services must function in tandem. This is particularly evident in the sub-indices of the UN's EGDI, where a shortfall in one dimension can curtail a nation's overall ranking. The telecommunication infrastructure in metropolitan regions of Russia has improved markedly, but rural and remote areas frequently trail behind. Russia has carved out strong regional leadership in certain aspects of the Internet economy, yet it faces stiff challenges on the global stage. Domestic technology companies thrive regionally but do not necessarily redefine global markets. Greater international collaboration, along with an emphasis on innovation-driven entrepreneurship, could potentially help Russian companies expand internationally.

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Adaptation of Russian Business to Global Challenges

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Abstract. Russian business is currently operating in unique conditions characterized by a high degree of uncertainty in the external economic environment, caused by changes in global value chains, economic and financial sanctions, and shifts in technological paradigms. The contribution investigates the key challenges faced by Russian companies, as well as the mechanisms for adapting to these challenges. The aim of the research is to identify the main factors influencing the sustainability of Russian enterprises and determine the most effective development strategies in the current conditions. The methodological framework of the study includes methods of economic-statistical analysis, comparative analysis, and a structural-functional approach. The work presents an analysis of statistical data reflecting macroeconomic trends in the market, the dynamics of innovative activities, and the digital transformation of Russian enterprises. Changes in business strategies related to digitalization, automation of business processes, restructuring of supply chains, and the creation and development of platform technologies are also considered. The study concludes that a comprehensive approach is necessary to support the development of Russian business, combining government support, the development of digital infrastructure, and the integration of Russian enterprises into new international cooperation networks.

Keywords: Adaptation · Digitalization · Economic Challenges · Russian Business · Sanctions

1 Introduction

In recent years, Russian businesses have faced numerous challenges driven by both internal and external factors. Among the most influential factors are the COVID-19 pandemic, sanctions pressure, changes in the global economic structure, digitalization, and the transformation of business models. One of the priority adaptation strategies recognized in the academic community is the development of digital business ecosystems. The authors of the study [1] analyze trends in the integration of digital services into complex ecosystems based on interactions between various market participants. The researchers conclude that the use of such models enhances business resilience and creates additional competitive advantages. Under conditions of economic turbulence, digital platform solutions provide companies with access to new sales channels, facilitate the automation of business processes, and improve the enterprise efficiency.

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Small and medium-sized enterprises (SMEs) are particularly vulnerable to crisis phenomena. Considering the impact of the pandemic and sanctions pressure on companies specializing in foreign economic activities, the study [2] finds that the negative effects include increased costs for imported components, disruptions in supply chains, and a decline in consumer purchasing power. At the same time, crisis phenomena have accelerated the development of digital solutions. Researchers explore the transformation of business models through digitalization. It is highlighted that platform-based solutions in marketing, accounting, auditing, and financial and operational activities help mitigate some of the negative consequences of global challenges, reduce current business costs, and automate certain internal processes [3].

Beyond digitalization, structural shifts in the global economic and financial system, as well as transformations in global value chains, significantly impact the Russian economy [4]. The economy faces rising transaction costs, changes in the cost structure of production, and, consequently, shifts in pricing mechanisms and the balance of global power [5, 6]. The consequences of the COVID-19 pandemic should not be overlooked, as it became a powerful external factor triggering large-scale changes in both macroeconomic and microeconomic environments. In addition to a short-term decline in business activity, the pandemic led to long-term shifts in employment structures, consumption patterns, and business process organization. Research indicates that the most severe negative consequences were experienced by enterprises in the service, logistics, and international trade sectors [7, 8]. Simultaneously, the pandemic stimulated the development of remote work, digital platforms, and e-commerce, increasing the significance of technological factors in ensuring business competitiveness.

2 Methodology

The study applies both quantitative and qualitative analysis methods. Statistical data on GDP dynamics, industrial production, innovative activity, and business digitalization were obtained from official sources. A content analysis of scientific publications and analytical reports on the impact of global challenges on Russian business was conducted. A comparative analysis of empirical studies was used to identify corporate adaptation strategies. Structural-functional analysis methods were applied to assess the role of digital ecosystems in ensuring business resilience.

3 Results

Table 1 presents some statistical data reflecting the decline in GDP, the industrial production index, and total (capital and current) expenditures on innovation activities in the post-pandemic year (2020) and in 2022.

As the data show, GDP at current prices demonstrates significant growth from 109,608.3 billion rubles in 2019 to 172,148.3 billion rubles in 2023, indicating an increase in the nominal volume of the economy. However, real economic growth was not as significant as it might seem from the nominal figures, due to active inflationary processes and overall economic instability. Industrial production exhibits considerable volatility. After a decline in 2020 (to 97.9% compared to the previous year), production

Table 1. Dynamics of GDP, industrial production, total expenditures on innovative activities, the share of innovative goods, and organizations using digital technologies, 2019–2023.

Indicator	2019	2020	2021	2022	2023
Gross domestic product at current prices, billion rubles	109,608.3	107,658.1	135,773.8	155,188.9	172,148.3
Gross domestic product at 2019 prices, billion rubles	109,608.3	106,699.68	112,982.96	111,615.45	115,713.15
Industrial production (as % of the corresponding period of the previous year)	103.4	97.9	106.3	100.7	103.5
Share of innovative goods, works, and services in total shipped goods, completed works, and services, %	5.3	5.7	5.0	5.1	5.1
Total (capital and current) expenditures on innovative activities, million rubles	1,954,133.32	2,134,038.42	2,379,709.88	2,662,571.14	2,982,079.67
Total (capital and current) expenditures on innovative activities at 2019 prices, billion rubles	1,954,133.3	1,056,97.79	1,980,254.85	1,914,983.04	2,004,468.23
Share of organizations using digital technologies in the Russian Federation	n/a	80.7	81.8	79.6	78.6

Source: authors based on [9–11].

rebounded to 106.3% in 2021. However, in 2022, growth slowed to 100.7%. The share of innovative goods, works, and services in total shipped goods remains low, fluctuating

between 5% and 5.7% over the analyzed period. This indicates that despite significant investments in innovation, their integration into the real economy remains limited.

The share of organizations using digital technologies shows a slight decline from 81.8% in 2021 to 78.6% in 2023. While the overall level of digitalization remains high, this decrease may indicate certain challenges companies face in the process of digital transformation. Digital transformation means that enterprises fully utilize digital technologies and tools, such as big data, the Internet of Things, and blockchain, to optimize business processes and enhance managerial and innovation capabilities [12].

The decline in GDP and industrial production in 2020 and 2022 led to a reduction in expenditures on innovation activities, which ultimately affected the decrease in the share of organizations using digital technologies in their operations, as well as the decline in the share of innovative goods, works, and services in total shipped goods and completed services. Despite significant efforts to stimulate innovations and digitalization, their contribution to the real sector of the economy remains limited. GDP in constant prices demonstrates only moderate growth, highlighting the need for continued efforts to enhance real efficiency and economic resilience in the context of sanctions and digital transformation.

4 Discussion

The threat and imposition of economic sanctions continue to be a widely used tool of foreign policy. Although the 1990s were dubbed the «decade of sanctions», in recent years, there has been a surge in the use of this tool globally. For example, current U.S. sanctions target Russia, Iran, Eritrea, Uzbekistan, and Sri Lanka, while the EU has imposed sanctions on Russia, Madagascar, Fiji, and Honduras. The UN has also imposed sanctions on North Korea, among others. Rising tensions between major global powers, economic sanctions, and retaliatory measures have created new challenges for businesses. Sanctions have restricted access to foreign markets, advanced technologies, and financial resources, forcing companies to seek new suppliers, engage in total import substitution and localize production, diversify export destinations, and develop alternative sources of financing. Sanctions have exacerbated the problem of import substitution, primarily through production localization, while simultaneously opening up new opportunities for the long-term development of the Russian economy-provided the principle of technological independence is ensured [13]. The negative consequences of the pandemic are now less impactful on businesses. However, other aspects that cannot be classified as negative-such as the acceleration of digitalization processes, the emergence of new professions, and new employment formats-have transformed and continue to reshape business processes. These changes contribute to cost optimization and enable enterprises to attract highly skilled remote workers from distant regions that were previously inaccessible.

5 Conclusion

The modern challenges facing Russian businesses require an active search for new sustainable development strategies. The study shows that digitalization, platform-based business models, diversification of economic activities and supply chains are becoming

priority tools for companies to adapt to new market conditions. At the same time, digital solutions not only mitigate the negative effects of external constraints but also create new opportunities for expanding product markets and increasing corporate competitiveness. However, structural barriers remain that limit the pace of transformation and growth of Russian business, these include the high capital intensity of high-tech projects, a shortage of qualified personnel, and the ongoing dependence on certain imported technologies. To ensure the long-term sustainability of Russian businesses, a comprehensive approach is needed. This should include government support for innovative industries, the development of digital economy infrastructure, and integration into new international cooperation networks.

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Ensuring Economic Security of Pharmaceutical Industry Enterprises

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Abstract. This contribution investigates the critical issue of ensuring the economic security of pharmaceutical companies, a sector that plays a key role in public health and the national economy. It examines the unique challenges faced by pharmaceutical companies, including regulatory pressure, market volatility, intellectual property protection, and supply chain vulnerabilities. By analyzing key risk factors and proposing practical solutions, the author provides insights into how pharmaceutical companies can improve their resilience, ensure sustainable growth, and remain competitive in a rapidly changing global market. Efficient use of resources, cost management and strengthening partnerships with stakeholders are also key components of ensuring economic security. The work concludes that ensuring economic security for pharmaceutical enterprises requires a multifaceted approach balancing innovation, compliance, financial stability and strategic risk management. By addressing these aspects, pharmaceutical companies can overcome challenges, protect their market position and contribute effectively to health systems while maintaining long-term viability. The results are intended to support industry leaders and stakeholders in developing frameworks that protect the economic interests of the pharmaceutical sector while promoting innovation and public health outcomes.

Keywords: Economic Security · Generic · Pharmaceutical Industry · Risk · Threat

1 Introduction

The pharmaceutical industry, being one of the areas of the chemical industry, involves the development and study of a huge number of scientific works related to the creation of medicines and life support of the population. The Russian Federation, being a social state, assumes the provision of a decent standard of living. For which the development of the pharmaceutical industry is necessary, providing the population with certain medicines. The Russian pharmaceutical industry has a long path of development, which actively began during the First World War. It was its beginning and the cessation of import of medicines that allowed the development of the domestic pharmaceutical industry. In 1914–1918, research centers were created to study and develop medicines, methods of production and influence on living organisms. A lot of research centers were opened

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to study and train personnel to work in chemical and pharmaceutical enterprises. The Second World War also made its own adjustments to the development of the pharmaceutical industry, which affected not only work in harsh conditions, but also the closure of many factories to produce drugs. During the military actions, about 50 pharmaceutical enterprises were destroyed, more than 4,000 pharmacies were closed. After the end of military actions, it was decided to restore all previously existing factories and build new ones which led to the further development of the domestic pharmaceutical industry. By the 50s of the twentieth century, there were about 3,000 pharmacies in Russia, the production of drugs increased to 600 million. After the transition to a market economy, the pharmaceutical industry faced several problems. Pharmaceutical enterprises received the right to carry out their activities independently, which led to a sharp increase in prices for many drugs, a reduction in benefits for the provision of free treatment, and a major drawback was the lack of state regulation of the activities of pharmaceutical enterprises.

2 Methodology

The objective of the study is to assess the effectiveness of the economic security system of pharmaceutical companies, which is necessary for stable functioning and countering various challenges and threats. The study emphasizes the need for comprehensive strategies that combine financial stability, risk management, innovation, and regulatory compliance to protect the economic security of these enterprises. The following research methods were used during the study: analysis, comparison of indicators of different periods, balance and graphical methods of summarizing information, as well as systematization and abstraction.

3 Discussion

A lot of studies have been devoted to economic security in various sectors of the economy [1–6]. The Russian Federation, being a social state, prioritizes the creation of conditions for the protection of rights and satisfaction of the life of the population. Article 41 of the Constitution of the Russian Federation [7] states that every person has the right to receive medical care and health protection which is directly carried out with the help of the pharmaceutical industry. Pharmaceutical activity, being one of the areas of development of both national and economic security, allows us to assess the level of well-being and social protection of the country. The pharmaceutical industry is one of the sectors of the economy that is directly involved in research, development, production, release, and distribution of drugs that have received certification. One of the main tasks of the pharmaceutical industry is the uninterrupted provision of the population of the country with drugs. Absolute fulfillment of the tasks enables the state to fulfill its constitutional duties to fully ensure social well-being among the population. Thus, pharmaceutical activity can be represented in two aspects:

1. Manufacturing and distribution of medicines.
2. Wholesale and retail trade in medicines, medical devices for various purposes, biological supplements and other permitted products.

In accordance with Article 4 of the Federal Law № 61-FZ [8], medicines are usually understood to be substances or their combinations obtained using biological technologies or by synthesis, which, after meeting a person or other living organism, enter the body or tissues and are used for the diagnosis, prevention and treatment of various diseases.

The pharmaceutical industry, being one of the high-tech industries, occupies a special place in the world market. Maintaining positions and further stable development requires proper regulatory and state regulation. The issue of state regulation of the pharmaceutical industry has been open and requiring attention for many years. When considering the regulation of the pharmaceutical industry by the state, the following levels can be distinguished (Fig. 1).

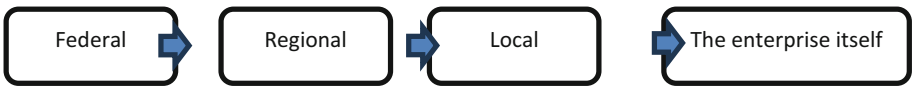


Fig. 1. Levels of state regulation of pharmaceutical activity (Source: author.)

State regulation of pharmaceutical activity is carried out in several areas:

-regulation at the time of patenting, manufacturing and putting into circulation of medicinal products for medical and veterinary purposes;
-issuance of a license to carry out activities in the field of medicinal products, which is regulated by the Government Resolution «On Approval of the Regulation on Licensing the Pharmaceutical Industry» [9];
-issuance of certificates to employees engaged in the creation, production and sale of drugs;
-regulation of prices for medicines, carried out by developing and approving a list of vital drugs, calculating maximum prices for medicines included in the list of vital drugs, introducing a state register of prices for medicines, as well as monitoring and supervising the circulation of medicines.

4 Results

Currently, a strategy for the development of the pharmaceutical industry for the period up to 2030 has been developed, which implies the development of many domestic companies, an increase in demand for medicines produced in the Russian Federation, the development of import substitution and an improvement in the quality of manufactured products.

The pharmaceutical industry, being one of the innovative, technical and labor-intensive industries, has its own key features.

The volume of pharmaceutical products manufactured in 2022 amounted to 2,500 billion rubles, which exceeds last year's value by 11%.

According to statistics [10], in 2022, the bulk of drug sales came from the commercial sector and amounted to 4.5 billion packages or 1,350 billion rubles. For the first half of 2023, the volume of the commercial market amounted to 108 billion rubles, which corresponds to an increase in sales of almost 20% compared to the first half of 2022.

The activities of pharmaceutical enterprises, like any other commercial organization, are aimed at making a profit.

At the same time, the pharmaceutical market is divided into two groups: original drugs, generic drugs.

An original drug is usually understood as a substance that has undergone synthesis and a full research cycle for the first time, and has received a patent for the production, release and sale of a drug. A generic drug is a drug that is a substitute for the original, has a similar composition of active ingredients and release form. Considering the distinctive features of these categories, the following can be highlighted:

1. Original drugs, synthesized for the first time, undergo a full production cycle, including preclinical and clinical trials, which determines not only the price of the product, but also the period of its development.

   Usually, the creation of one new drug takes from 10 to 20 years. Generic drugs, in turn, already have a developed form of the active substance, which simplifies the task of entering the market with a new drug. That is why this type of drugs is cheaper and appears on pharmacy shelves faster.
2. According to statistics, a lot of generics are less effective and safe. This is since original drugs are required to undergo and provide the results of all clinical and preclinical trials before entering the pharmaceutical market. Copies of originals, in turn, have access to the market without testing and compliance with GMP rules.
3. Side effects in these categories can be completely different. This is since manufacturers of generic drugs have the right to add those auxiliary substances, dyes, flavors that they consider necessary. The dynamics of changes in sales of original and generic drugs can be seen in the diagram below (Fig. 2).

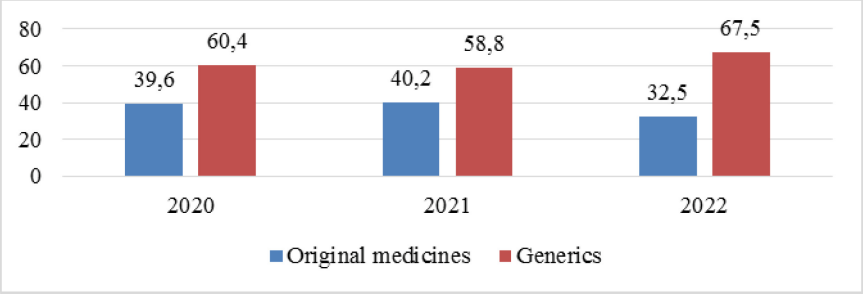


Fig. 2. Ratio of sales of original and generic drugs (Source: author).

Today, the task of pharmaceutical production is to move from import substitution of generic drugs to innovative development of domestic enterprises and increasing the production of their own medicines. Modern trends in the development of the pharmaceutical market also include:

-oversaturation of the pharmaceutical market;
-increasing state interest in the development and maintenance of the pharmaceutical industry;

-creation of links between different pharmaceutical manufacturers to improve the quality of their products;
-an increase in the number of generic drugs, which, due to their technological features, does not provide the opportunity for their precise control in production and release.

The restructuring taking place in the world market in modern conditions increases interest in ensuring the economic security of both the state and the enterprise. A sustainable system of economic security at the enterprise allows it to function stably even in the conditions of the global crisis with the least losses. Ensuring sustainable development is possible with the use of economic security tools. These are usually understood as a certain list of principles, levels and rules with the help of which the set goals and objectives of the enterprise will be achieved.

One of the tools of economic security at pharmaceutical enterprises is the «Strategy for the Development of the Pharmaceutical Industry» until 2030 [11] which includes the goals and objectives of state regulation in the field of the pharmaceutical industry. The main goal of the strategy is to ensure high-quality, safe and affordable production of domestic drugs that meet the needs of the population, as well as their competitiveness in both the domestic and foreign markets. The main objectives of this strategy are: stimulation and increase in the volume of production of domestic drugs, increasing the level of competitiveness of domestic manufacturers, increasing the number of enterprises engaged in innovative development in the pharmaceutical industry. The results of this strategy vary depending on the selected scenario.

The conservative scenario assumes the preservation of current positions, the absence of state support and investment projects in the pharmaceutical industry. The task of the pharmaceutical industry in ensuring this scenario is the production of medicines, at the level of partial supply of the population with medicines, as well as to maintain a stable level of national security. The conservative scenario is not aimed at building a communication system between interconnected industries to ensure further relations in the field of development, creation, release, promotion and distribution of medicines. Using the conservative scenario will lead to the following results (Table 1).

Table 1. Results of the pharmaceutical industry under the conservative development scenario.

Indicator	Period			
	2023	2025	2027	2030
Volume of the market of medicines for medical purposes, million rubles	2461	2817	3018	3298
Volume of production of medicines in the territory of the Russian Federation, billion rubles	696	842	1001	1261
Share of medicines for medical purposes, produced in the territory of the Russian Federation, in the total volume of consumption, %	37.0	39.1	41.4	42.6

Source: author

The basic development scenario is aimed at creating and developing many scientific projects, attracting investment funds for the development of the pharmaceutical industry which in turn will allow:

-to achieve the level of production of medicines that will enable all segments of the population to obtain medicines;
-to create and develop the potential of domestic drugs that meet international quality standards and release to international markets;
-to develop and improve government support measures for the pharmaceutical industry.

The indicators of the basic scenario are as follows (Table 2):

Table 2. Results of the pharmaceutical industry under the basic scenario.

Indicator	Period			
	2023	2025	2027	2030
Volume of the market of medicines for medical purposes, million rubles	2550	3030	3340	3757
Volume of production of medicines in the territory of the Russian Federation, billion rubles	721	904	1085	1385
Share of medicines for medical purposes, produced in the territory of the Russian Federation, in the total volume of consumption, %	37.3	39.3	41.5	42.7

Source: author

As a result of considering the two scenarios, the following conclusions can be drawn. When choosing the baseline scenario, the state will achieve better results in all three analyzed parameters by 2030, which in turn will lead to an increase in the output of pharmaceutical products, the emergence of new and development of domestic enterprises, and an increase in the life of the population. A large amount of investment is needed to achieve these goals.

The attractive funds will make it possible to develop many pharmaceutical enterprises, create new jobs, which will affect the further level of employment of the country's population. To achieve the objectives set by [11], the state stimulates the development of domestic manufacturers of medicines, which in turn ensures the development of scientific technologies in the field of drug production. A significant share is given to the issue of exporting medicines abroad. New programs for state preferential provision of medicines to needy segments of the population are being developed, and pricing limits are being determined. There is a gradual development of import substitution and improvement of logistics supplies within the country.

5 Conclusion

Therefore, pharmaceutical companies need strategic planning and continuous investment in research and development (R&D) to maintain economic security. Innovative business models and digital transformation strategies [12] must be implemented to remain competitive and secure. Efficient use of resources, cost management, and strengthening

partnerships are key components of ensuring economic security. Ensuring the economic security of pharmaceutical enterprises requires a multifaceted approach that balances innovation, compliance, financial stability, and strategic risk management. By addressing these aspects, pharmaceutical companies can overcome challenges, protect their market position, and effectively contribute to healthcare systems while maintaining long-term viability.

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Economic Security of Functioning and Development of Gold Mining Enterprises

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Abstract. This work investigates the role of economic security in the gold mining industry, its significance for national security and economic stability, particularly in Russia. It highlights how gold serves as a vital resource in various sectors, including banking, medicine and other industries, and how it underpins Russia's gold and foreign exchange reserves, which provide financial stability and protection against foreign exchange risks. Considering the current geopolitical climate, the author discusses the impact of international sanctions on Russia, which have forced the country to refocus on new markets. This shift has accelerated industrial growth which is critical for generating tax revenues and supporting the country's budget due to gold's unique liquidity. The author identifies several challenges faced by gold mining companies, including high costs associated with developing and extracting mines, as well as volatility in global gold prices, which can negatively impact their profitability. The contribution highlights the need to assess the economic security of the gold mining industry to ensure its sustainable development. It underlines the importance of conducting risk assessments and implementing preventive measures to ensure economic security. The author considers the methodology for determining the level of economic security of an enterprise. The focus of the work is on PJSC Polyus, the largest gold mining company in Russia, one of the three leaders in the world in terms of gold reserves. In conclusion, the author emphasizes the critical role of the industry in ensuring the financial and economic security of both enterprises and the Russian state.

Keywords: Economic Security · Financial Stability · Gold · Gold Mining Industry · Risk Management · Safety · Threats

1 Introduction

All companies face problems related to enterprise security, one of the key aspects of which is economic security, which is of crucial importance for all their activities. Currently, the issue of national security is especially relevant. The sanctions imposed on Russia prompted the country to quickly switch its attention to new markets. As a result, all industries, especially manufacturing ones, in the Russian Federation are experiencing rapid growth. Gold is an essential resource for various sectors, including the banking sector, medicine and other industries. It plays an important role in Russia's gold and foreign exchange reserves, helping to ensure financial stability and reduce currency risks.

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The Central Bank of the Russian Federation influences gold prices through its purchases, which has a positive effect on companies' income. Given this, the development of the gold mining industry is becoming a key component of national security. Gold mining makes a significant contribution to the state budget due to its liquidity and the billions it brings in tax revenues. However, the industry faces high operating costs in mining operations. In addition, the current volatility of gold prices negatively affects companies. Thus, assessing the economic security and risks in the gold mining sector is crucial for the growth of various parts of the country's economy. Gold remains a significant resource in the modern economy, retaining some of its monetary functions. Russia is the world leader in gold mining, and PJSC Polyus is the largest representative of this sector and is among the three largest holders of gold reserves in the world. The purpose of this work is to assess the economic security of the gold mining industry with an emphasis on the activities and development of PJSC Polyus, the largest gold miner in Russia.

2 Methodology

The paper uses a range of analytical and research methods focusing on the financial, social and environmental aspects that affect gold mining operations. Commonly used methods in such studies include risk assessment frameworks, financial modeling and value chain analysis to assess the economic security and profitability of the gold mining industry. Environmental, social and governance (ESG) frameworks are becoming increasingly relevant and applied in this area. Many gold mining operations now integrate ESG metrics to assess social impact, ecological footprint and management effectiveness to balance economic growth with sustainability. The integration of ESG data not only helps us to understand financial risks but also meets global sustainability standards. Methods such as digital tracking and data verification are used to generate accurate and reliable information.

3 Results

In recent years, research in the field of risk assessment and economic security of enterprises has been actively developing [1–10]. The importance of studying the issue of economic security appeared at the beginning of the last century, which was associated with the active growth of industry in Russia. Currently, the concept of «economic security of an enterprise» has become especially relevant due to the increased number of threats. Each economic entity strives for internal and external security, which will ensure its stable and efficient operation. The purpose of economic security is to prevent threats and minimize the risks of their occurrence, as well as reduce the consequences of risks that have occurred. To do this, it is necessary to develop a set of measures to counter internal and external threats, which will be implemented and refined throughout the organization's activities.

To assess the economic security of a particular enterprise, it is necessary to understand the methodology for determining the level of economic security. The methodology for assessing the level of economic security is based on an assessment of the environment in which the company is located. To do this, the market in which the organization operates

is analyzed, the impact of territorial conditions and the density of population of the area is determined. In addition, the impact of the organization itself on the environment is considered, for example, on ecology or on the development of territories. These factors must be considered in a certain time range, which may change depending on the goals set, but will mainly be short-term to obtain more accurate data. Thus, to determine the level of economic security, we recommend using the action plan presented in Fig. 1.

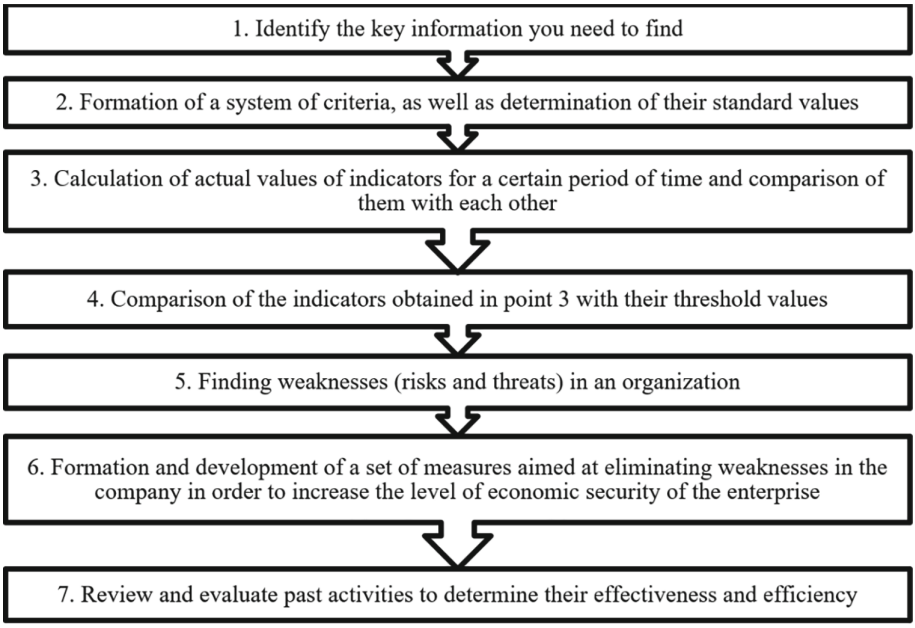


Fig. 1. Algorithm for determining the level of economic security (Source: author).

It is important for an organization to maintain a certain level of economic security, since its decrease can negatively affect the efficiency of the company. The best way to assess the state of security is a comprehensive approach containing a system of indicators and criteria. The criteria can be divided into groups, since they determine the ability of an enterprise to withstand various threats. They will be determined depending on the specifics of the activity, and the indicators will serve as a quantitative assessment of the criteria.

The main parameters that must be started when determining the level of economic security are the coefficients of liquidity, solvency, financial stability and efficiency of the organization. These are indicators that help to assess the financial condition of the organization and draw the main conclusions. But for a more detailed analysis, we suggest using a system of indicators divided into certain groups of coefficients: economic, social, environmental, institutional. If the calculated value of the indicator is greater than 0, then this indicator is taken as equal to 1, otherwise – 0 (Table 1).

The resulting indicator can be an assessment of the level of sustainable development, which will be determined as a sum of products of the indicator's value by the specific

Table 1. System of indicators for determining the level of economic security.

Indicators	Indicator weight
1. Economic indicators	
1.1 Increase in capital-labor ratio, %	0.07
1.2 Increase in reserves due to geological exploration, %	0.06
1.3 Increase in the organization's profit due to the introduction of R&D and other innovations, %	0.07
1.4 Reduction in the resource intensity coefficient of mined gold	0.05
2. Social indicators	
2.1 Increase in the level of qualification of labor resources, %	0.05
2.2 Increase in the number of employees of the organization, %	0.05
2.3 Increase in the level of the payroll, %	0.05
2.4 Reduction in the rate of injuries with loss of working capacity	0.05
2.5 Increase in the amount of funds invested to improve the standard of living of the population in adjacent territories, %	0.05
3. Environmental indicators	
3.1 Reduction in pollutant emissions, %	0.08
3.2 Reduction in environmental payments, million rubles	0.08
3.3 Increase in recovery factor, %	0.09
4. Institutional indicators	
4.1 Increase in the number of regulatory legal acts regulating the activities of this industry, %	0.13
4.2 Increase in local regulatory acts regulating the activities of this industry, %	0.12
Total	1

Source: author

weight of the indicator (Eq. (1))

$$R_y p = \sum\nolimits_{(t=1)}^{n} (VP(t) * sp.gravity(t)) \quad (1)$$

Calculating according to the proposed formula, we will obtain an indicator, the interpretation of which will be based on the system of criteria presented below (Table 2).

One of the most important representatives of the gold mining industry in Russia is PJSC Polyus. The main deposits of the group of companies are in Siberia and the Far East. PJSC Polyus includes various projects both at the construction and production stages, as well as 5 largest mines and gold placers. The main areas of deposits are the Krasnoyarsk Krai, the Magadan and Irkutsk regions, as well as the Republic of Sakha (Yakutia). In recent years, the Russian economy has faced various challenges, from the pandemic to the sanctions policy pursued by foreign states against our country. All these

Table 2. Criteria for assessing the level of sustainable development.

Criterion	Description
from 0 to 0.5	Low level of sustainable development. The company does not meet most of the main criteria and conducts ineffective economic activity
from 0.5 to 0.75	Average level. The company meets more than half of the criteria, which indicates its ability to increase the pace of development and improve the efficiency of its activities
0.75 to 1	High level. The company meets almost all the criteria, tries to increase the pace of development and successfully conducts its economic activity

Source: author

events have affected all sectors of the economy, and gold mining was no exception. To assess the level of economic security, it is worth considering the main indicators of the company's activities.

4 Discussion

To determine the level of economic security of PJSC Polyus, we will turn to the methodology described above and present the calculation results in Table 3.

Table 3. Calculation of the system of indicators for determining the level of economic security.

Indicators	Indicator value	Total value
1. Economic indicators		
1.1 Increase in capital-labor ratio, %	6.31	0.07
1.2 Increase in reserves due to geological exploration, %	17.23	0.06
1.3 Increase in the organization's profit due to the introduction of R&D and other innovations, %	36.16	0.07
1.4 Reduction in the resource intensity coefficient of mined gold	-0.04	0.05
2. Social indicators		
2.1 Increase in the level of qualification of labor resources, %	9.88	0.05
2.2 Increase in the number of employees of the organization, %	4.39	0.05
2.3 Increase in the level of the payroll, %	200	0.05
2.4 Reduction in the rate of injuries with loss of working capacity	-0.01	0.05

(*continued*)

Table 3. (*continued*)

Indicators	Indicator value	Total value
2.5 Increase in the amount of funds invested to improve the standard of living of the population in adjacent territories, %	4.84	0.05
3. Environmental indicators		
3.1 Reduction in pollutant emissions, %	-28	0.08
3.2 Reduction in environmental payments, million rubles	-0.45	0.08
3.3 Increase in recovery factor, %	1.47	0.09
4. Institutional indicators		
4.1 Increase in the number of regulatory legal acts regulating the activities of this industry, %	100	0.13
4.2 Increase in local regulatory acts regulating the activities of this industry, %	0	0
Total (P_{yp})		0.88

Source: author

Assessing the data presented, we can conclude that PJSC Polyus has a high level of sustainable development. The company has improved its results in almost all the above indicators, which indicates the effective operation of the company despite the current global situation. Even though the company has a high level of economic security, it is necessary to consider the main risks that may affect the activities of PJSC Polyus.

5 Conclusion

When gold is mined, a lot of poor ore is extracted, the processing cost of which is significantly higher and the labor intensity is higher. The consequence is the closure of deposits, and at existing deposits, the processing of poor ore occurs last and in smaller quantities. It is not profitable for large companies to mine gold at small deposits, since they are unprofitable. However, a new method of extracting gold from poor ore is currently being finalized and tested in practice. This method can revolutionize the gold mining industry. A lot of deposits that were considered low-profitable will become highly profitable due to processing of slag and poor ore. The new technology is based on the use of magnetic liquid separation to obtain high-quality concentration which will be sent for enrichment and gold smelting. This method also reduces the cost of hydrometallurgical processing of enriched concentrate by 25%. Using the new method, there is a reduction in the number of ore processed to obtain 1 g of gold by 10–20%.

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Development of Stock Market Functions in the Context of Economy Digitalization

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Abstract. The contribution presents the evolution of the basic functions of the stock market that have changed to the greatest extent under the influence of digitalization (the functions of pricing, ensuring liquidity and reducing information asymmetry). Particular attention is paid to the impact of such digital technologies as high-frequency and algorithmic trading, big data analysis on the functioning of the stock market. The research methodology is based on an interdisciplinary approach and includes system, comparative and content analysis. As a result, the key aspects of the influence of digitalization processes on the functions of the stock market, the transformation of the mechanisms for their implementation are presented. Recommendations are developed for adapting the institutional regulation of the stock market to the new challenges of digital transformation. Approaches to regulating digital assets, ensuring equal access of participants to information and managing the risks associated with the use of algorithmic trading are proposed. The results of the study can be used in the development of regulations for stock market participants, regulatory authorities and financial institutions in order to ensure the efficiency of the stock market.

Keywords: Digitalization · Information Asymmetry · Liquidity · Pricing · Stock Market

1 Introduction

The relevance of this research topic is determined by the fact that the digitalization of the stock market creates both new opportunities and challenges. First, as noted in the work of G.D. Kravtsov [1], it stimulates the development of financial technologies (FinTech), which change the nature of interactions between market participants. Second, according to E.V. Rozhkov [2], digitalization requires the adaptation of traditional stock market institutions to new realities, including the integration of smart contracts, blockchain, and high-frequency trading.

A review of scientific literature shows that the transformation of stock market functions has been the subject of attention. For instance, the pricing function is examined in terms of its impact on automated trading systems used in high-frequency trading. E.A. Batraeva and A.O. Kazachenok [3] highlight that algorithms enable faster market responses to information changes, while G.V. Kolesnik [4] emphasizes the risk of instability due to the nonlinear nature of price movements. Some researchers, including M.S.

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Kshnyakina [5], consider this as a shift from traditional pricing models to dynamic ones based on big data analysis. The liquidity provision function is mainly discussed in terms of its enhancement through the ability to conduct round-the-clock operations. However, experts such as Zh.V. Fedorova, Z.S. Sadaeva, and R.S.A. Gatsaeva [6], point out the issue of liquidity concentration in decentralized systems, which complicates the work of market makers. The function of reducing information asymmetry has gained a new perspective in the digital economy. K.I. Galynis [7] emphasizes that the development of big data and artificial intelligence intensifies the imbalance in information access between large and small participants.

Nevertheless, the author identifies insufficient exploration of issues related to the transformation of fundamental functions in the context of digitalization. The aim of this contribution is to analyze the impact of digitalization processes on the basic functions of the stock market and identify new patterns in their development.

2 Methodology

The system analysis method is used to study the functions of the stock market. Comparative analysis of traditional and modern principles of pricing, ensuring liquidity and reducing information asymmetry allows us to substantiate the main directions of their transformation. Content analysis of scientific literature was conducted to systematize views on the transformation of the stock market in the context of digitalization. The basis for this study is formed by articles and monographs devoted to theories of the stock market, the evolution of its functions, digital assets and regulatory mechanisms.

3 Results

The study focuses on the pricing, liquidity provision, and information asymmetry reduction functions due to their central role in the stock market's operation and their high sensitivity to digitalization.

The pricing function is crucial for the stock market, as its efficiency determines the allocation of capital in the economy. Liquidity provision is essential for the normal functioning of the stock market since it ensures the possibility of quick and low-cost asset exchanges [8]. The stock market has traditionally served as a mechanism for reducing information gaps between participants, but the application of digital technologies has introduced new challenges.

These aspects most clearly reflect the structural changes occurring in the market under the influence of digital technologies. Table 1 presents the key aspects of the evolution of stock market functions in the context of digitalization.

According to the author, the selected functions are at the center of the stock market's digital transformation. Their analysis allows us not only to understand current changes but also to predict how digitalization will continue to impact the market in the future.

Technologies in the digital age are no longer merely infrastructure but active participants in market processes. For instance, artificial intelligence algorithms are replacing humans in investment decision-making; blockchain technology is reshaping the issuance and circulation processes of financial instruments, enabling decentralized exchanges and

Table 1. Evolution of key aspects of stock market functioning in the context of digitalization.

Function Aspect	Traditional Model	Changes in the Context of Digitalization
Pricing	Based on the uniform distribution of information among participants	Information access speed has become a key factor; temporal asymmetry-based arbitrage has emerged; algorithms play a significant role
Liquidity	Dependent on trading volumes, limited by trading sessions	Liquidity is driven by high-frequency strategies; digital assets allow 24/7 trading, expanding the concept of liquidity
Reducing Information Asymmetry	Stock markets reduce information gaps between investors and issuers	Dominant participants with access to big data and analytical technologies gain significant advantages, exacerbating new asymmetries

Source: author.

digital assets; cloud computing and big data integrate massive datasets into market processes that were previously inaccessible for analysis [9]. The digitalization of the economy is not just an external factor but a new stage in the evolution of the stock market [10].

The pricing function is a fundamental one, ensuring the determination of the market value of assets. In the classical paradigm, prices responded to macroeconomic factors, news, and corporate financial reports. Price changes had a time lag due to the limited speed of data processing. Key pricing influencers included participants' orders, corporate events, and market makers' interventions in case of insufficient liquidity. The development of digital platforms has led to a significant reduction in the time lag between events and price changes. Modern technologies enable real-time consideration of vast datasets, including participant behavior and news trends. High-frequency trading strategies exploit price changes to generate arbitrage profits, resulting in nonlinear effects associated with mass transactions, where price changes trigger avalanche-like reactions. Market competitiveness is now defined by the ability to process big data (Table 2). Access to «exclusive» information has become a valuable asset, intensifying asymmetry [11].

Liquidity of the stock market, traditionally understood as the ability to quickly convert assets into cash with minimal costs, has undergone significant transformations due to digitalization. To understand the nature of these changes, it is essential to analyze the interrelation of key factors determining liquidity and the mechanisms of their implementation in the digital stock market. In traditional economic theories, liquidity was characterized by indicators such as trading volumes, bid-ask spreads, market depth. These

Table 2. Transformation of the stock market pricing mechanism.

Aspect	Traditional Model	Digital Model	Traditional Tools	Digital Tools
Information Access	Uniform distribution of data	Segmented access, advantages for Big Data owners	Financial statements, macroeconomic statistics	Big Data, algorithmic platforms
Time Lag	Significant: from minutes to days	Minimal: milliseconds	Manual order execution, human data analysis	High-frequency trading, machine learning
Algorithms	No automatic impact on price	Algorithms dominate, managing 70%. + operations on digital markets	Market makers, limit orders	High-frequency strategies, smart contracts
Pricing	Balance of supply and demand manually regulated	Automated, based on liquidity and data dynamics	Manual balancing, market makers' reports	AMM formulas, machine learning algorithms
Influence Factors	News, economic reports, fundamental analysis	Nonlinear factors, including algorithms, social trends, online data	Financial reports, corporate events	Algorithmic triggers, social network behavior

Source: author.

parameters reflected the market's state in conditions of linear interactions between participants, with the human factor dominating decision-making. Digitalization has introduced new factors and mechanisms for ensuring stock market liquidity (Table 3).

Among the positive aspects of digitalization, there are increased market accessibility for private investors without geographical constraints and accelerated transaction processing. Negative aspects include higher liquidity concentration on specific platforms, increased systemic risks due to automated algorithmic behavior, and more complex regulatory oversight for new market participants.

Reducing information asymmetry, a fundamental function of the stock market, ensures equal access to information about financial instruments, issuers, and trading conditions. Traditional mechanisms such as regulated reporting, analysts' work, and exchange standards provided a certain level of equality but remained subject to human factors and delays.

With digital technologies, new tools have emerged to address information asymmetry:

– digital platforms offer access to vast datasets, including historical and forecast data;
– artificial intelligence (AI) processes data, enabling rapid trend detection;

Table 3. Transformation of mechanisms for ensuring stock market liquidity in the context of digitalization.

Aspect	Classical Model	Digital Model	Classical Tools	Digital Tools
Trading hours	Liquidity limited to trading sessions	24/7 trading of digital assets without time constraints	Trading platforms, exchanges	Digital exchanges, decentralized platforms
Pricing and spreads	Narrow spreads signified high liquidity; pricing depended on classical trading factors	Automated trading strategies influence spreads; pricing shows nonlinear fluctuations	Market makers, limit orders	Automated market-making algorithms
Transparency	Dependent on exchange regulations and trade registries	Blockchain technology ensures complete transparency and access to transaction data	Centralized trade registries	Blockchain, smart contracts
Liquidity concentration	Concentrated among major stock exchanges	Dominated by large digital platforms, increasing dependence on their policies and technical systems	National stock exchanges (e.g., NYSE)	Major digital asset platforms (e.g., Binance)
Liquidity risks	Linked to economic crises, regulatory restrictions, or issuer distrust	Added risks of asset volatility, algorithmic errors, and cybersecurity threats	Reserves, central controls	Hedging through derivatives, risk management algorithms

Source: author.

– distributed ledger technologies (DLTs) provide transparent access to transaction data, minimizing manipulation risks;
– social networks facilitate information exchange but risk misinformation and «herd effects».

Positive changes include instant access to data, enhanced transaction transparency, and automation of analytics (Table 4). However, challenges such as increased time asymmetry (advantage for high-tech users), misinformation risks, and manipulation through social media are evident.

Table 4. Transformation of mechanisms for reducing information asymmetry in the context of digitalization.

Aspect	Classical Model	Digital Model	Classical Tools	Digital Tools
Information disclosure	Periodic reports (quarterly, annual) verified by regulators	Continuous data flow via APIs and real-time updates	Financial reports	API platforms, blockchain registries
Data analysis	Analysts manually processed data and made forecasts	AI and machine learning algorithms analyze large datasets	Financial analysts	AI, machine learning algorithms
Data access	Provided through reports and specialized platforms	Instant access to historical and aggregated data on platforms	Exchange systems	Digital platforms, blockchain integration
Transparency	Aggregated trade data was published for transparency	Full transparency through blockchain and decentralized ledgers	Centralized registries	Blockchain, smart contracts

Source: author.

4 Discussion

The analysis of the transformation of the core functions of the stock market due to digitalization has revealed the need to adapt institutional regulatory mechanisms.

A lot of researchers, including I.R. Topunova, I.M. Safarov, and V.V. Yenshov [12] concur on the necessity of developing and implementing additional mechanisms to limit the market impact of high-frequency trading, such as introducing speed bumps to slow down trades. Similarly, D.I. Uhryn, A.O. Karachevtsev, S.F. Shevchuk, and A.D. Uhryn [13] suggest the introduction of transaction frequency taxes. Automated market anomaly monitoring systems based on artificial intelligence algorithms have also been proposed to detect nonlinear price movements at an early stage [2]. The author argues that establishing transparency standards for trading algorithms could reduce systemic risks associated with their unpredictability.

In terms of liquidity control, the introduction of hybrid liquidity assessment models, encompassing not only trading volumes but also specific characteristics of digital platforms (e.g., transaction frequency), could be meaningful. Regulating the liquidity of decentralized trading systems could theoretically be achieved by creating transparent mechanisms for onboarding major market makers. To reduce the volatility of digital financial assets, mechanisms such as implementing stability requirements for digital assets through reserve obligations for token issuers can be considered.

New approaches to mitigating informational asymmetry may include procedures such as:

– regulatory oversight of algorithmic trading;
– establishing global decentralized digital platforms that consolidate exchange data, potentially improving equitable access to information;
– developing educational programs focused on utilizing digital tools.

Systemic risks associated with digitalization necessitate adjustments to the legal framework.

5 Conclusion

The price discovery function has become more sensitive to nonlinear processes caused by algorithmic strategies and asymmetric data access. Liquidity has extended beyond traditional trading sessions, requiring new approaches to its evaluation and regulation. Efforts to reduce informational asymmetry face contradictions, as digitalization simultaneously increases data concentration among major players and creates opportunities for broader dissemination. The recommendations outlined in this work aim to improve institutional regulatory mechanisms to minimize risks associated with digitalization while enhancing the efficiency and resilience of the stock market.

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Stock Market Development: Financial Capital in the Evolution of Economic Systems

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Abstract. The study aims to fill existing gaps in the theoretical understanding of the role of financial capital, to develop new analytical tools for studying its impact on the evolution of the stock market and structural changes in economic systems. Particular attention is paid to an interdisciplinary approach to stock market research, taking into account new forms of capital. The study is based on an integrated approach, including theoretical analysis, empirical research and an interdisciplinary approach. The main tool used was the taxonomy of financial capital forms, which allows structuring its capital forms based on liquidity, level of digitalization, risk type and other factors. As a result of the study, a review of the evolution of theoretical approaches to stock market research was conducted, key changes in categories and concepts related to financial capital were identified, its forms were classified, and their impact on structural changes in the economy was determined. A methodological approach to stock market analysis is proposed, taking into account interdisciplinary aspects and new forms of capital. It is shown that new forms of capital contribute to increasing the efficiency of resource redistribution.

Keywords: Digital Financial Assets · Economic Theory · Evolution of Economic Systems · Financial Capital · Interdisciplinary Approach · Stock Market · Structural Changes

1 Introduction

Earlier scientific studies of the stock market has primarily focused on its role in ensuring economic stability within a country, promoting growth, and allocating resources among various sectors of the economy [1]. These approaches laid the foundation for further exploration of the stock market's role in the economy. However, under modern conditions, the research focus is shifting towards analyzing new forms of financial capital and their impact on the development of economic systems [2]. Today, particular attention is given to studying globalization processes, the digitalization of the economy, stock market instruments, and their effects on its structure and functions [3]. Central to scientific discussions are questions of adapting theoretical models of stock market functioning to new realities, the proliferation of digital financial assets [4], and the growth of automated trading [5].

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Despite the broad scope of research, a lot of theoretical approaches struggle to keep pace with the rapid changes in the market. Existing models often assume the static nature of core categories of capital and fail to account for qualitative changes in its forms and functions [6, 7]. This creates a need to reconsider foundational concepts and adapt the categorical framework to the new economic reality, where financial capital serves not only as a means of accumulation but also, as the author argues, as a tool for fundamentally restructuring economic systems. Despite numerous studies, significant gaps remain in understanding the interaction of financial capital with the evolution of economic systems. Theoretical works still suffer from excessive fragmentation [8].

A major issue is the insufficient development of a categorical framework that would make possible the consideration of new forms of capital and their role in the evolution of economic systems. In most studies, digital assets are viewed merely as an addition to traditional instruments [9], whereas they are already exerting a transformative impact on the fundamental processes of the stock market [10].

The purpose of this study is to develop theoretical foundations for analyzing the stock market through the lens of the role of financial capital in the evolution of economic systems, taking into account modern technological capabilities and an interdisciplinary approach.

2 Methodology

The research is based on a comprehensive approach that includes theoretical analysis, empirical studies, and an interdisciplinary perspective. A review of the evolution of scientific approaches to the study of the stock market and financial capital has been conducted. Key concepts of classical and modern economists were analyzed. Based on the analysis of scientific publications and empirical data, a classification of forms of financial capital in the stock market was carried out. The main tool used was the author's taxonomy of forms of financial capital [11], which structures its forms according to liquidity, level of digitalization, risk type, and other factors.

3 Results

New forms of financial capital (including digital financial assets (DFA), tokenized securities, and decentralized financial instruments (DeFi)) significantly influence the evolution of economic systems, causing structural changes in various aspects of the economy (Table 1). Digital financial assets alter the mechanism of capital accumulation, accelerate its mobilization through blockchain technologies and smart contracts, reduce transaction costs by eliminating intermediaries, and create more accessible capital-raising tools for enterprises of various scales.

Financial innovations have already changed and continue to influence the structure of the labor market. The emergence and development of blockchain technologies, big data analytics, and artificial intelligence have necessitated the formation and development of specific competencies, often referred to in academic literature as «digital competencies». This has led to the creation of new professions and increased the number of high-tech jobs. Consequently, educational programs and professional development courses for

Table 1. The main aspects of the influence of new forms of financial capital on the evolution of economic systems and their structural changes.

Aspect	Impact of new forms of financial capital	Examples
Capital accumulation	Acceleration of capital mobilization, reduction of transaction costs, expanded access to financing	Tokenization of real estate (Waves platform projects), DeFi platforms
Labor market	Creation of new professions, increased demand for blockchain, data analytics, and cybersecurity specialists	Growth in IT and FinTech job opportunities, blockchain technology education programs
Institutional environment	Emergence of new institutions, changes in the role of traditional financial institutions, stricter regulatory requirements	Crypto exchanges (Binance, Bybit), tokenized platforms (SberFactoring, Alfa-Flow)
Risk management	Emergence of new risks, development of algorithmic methods for risk management	Use of AI in portfolio management, DeFi risk management

Sourse: author.

workers are expanding, while the share of employees with flexible schedules and/or remote work is growing. These changes lead to a restructuring of economic systems, reflected in the redistribution of labor resources and changes in the industry structure.

Furthermore, financial digitalization influences the institutional environment. The integration of digital assets into the economy contributes to the creation of new institutions (crypto exchanges, token issuance platforms, etc.), reshaping the traditional roles of financial institutions and leading to hybrid interaction models among market participants. The transformation of risk management systems is another crucial aspect influenced by new forms of financial capital. The emergence of DFAs and DeFi increases uncertainty levels and creates new types of financial, informational, and technological risks. However, it also fosters the development of new risk management methods based on algorithmic trading and artificial intelligence.

Traditional methods of stock market analysis no longer fully align with these changes, necessitating the development of a new interdisciplinary approach. This approach must consider not only economic and financial aspects but also technological, legal, sociological, and behavioral factors (Table 2).

Considering all these aspects allows us to do a comprehensive evaluation of the impact of digital and technological transformation on the stock market, forming a basis for developing strategies for institutional regulation to mitigate financial, informational, technological, and other risks for investors, intermediaries, and other stakeholders. The algorithm for stock market analysis, considering interdisciplinary aspects and new forms of capital, based on the presented methodological approach, is shown in Table 3.

Table 2. Interdisciplinary aspects and their role in stock market analysis.

Aspect	Description	Role in stock market analysis
Economic	Study of pricing, competition, market structure	Asset valuation, determination of long-term trends
Technological	Blockchain, artificial intelligence, algorithmic trading	Optimization of trading strategies, reduction of transaction costs
Legal	Regulation of digital assets, investor protection	Risk assessment in regulation, adaptation of company strategies
Sociological	Investor behavior, public perception of new assets	Analysis of mass sentiments, forecasting market reactions
Behavioral	Neuroeconomics, behavioral finance	Consideration of irrational decision-making factors, identification of market anomalies
Geopolitical	Impact of international conflicts and sanctions on the stock market	Forecasting changes in investment climate, analysis of foreign economic policies

Sourse: author.

Table 3. Algorithm for implementing a methodological approach to stock market analysis, taking into account interdisciplinary aspects and new forms of capital.

Analysis Stage	Key Elements	Tools and Methods	Application
Data collection and processing	Monitoring the dynamics of traditional and digital assets, transaction analysis using blockchain technologies, consideration of macroeconomic and political factors	Big Data, blockchain analytics, API integration with exchanges	Market liquidity assessment, detection of market anomalies, analysis of macroeconomic environment impacts on asset prices
Institutional environment analysis	Interaction of traditional financial institutions with new players (crypto exchanges, fintech companies), study of regulatory practices and legal framework	Institutional analysis, legal analysis, comparative studies	Determining the market's adaptability to new forms of capital, assessing regulatory risks, evaluating market participants' readiness for financial infrastructure transformation

(*continued*)

Table 3. (*continued*)

Analysis Stage	Key Elements	Tools and Methods	Application
Modeling and forecasting	Scenario modeling of market behavior, forecasting asset volatility based on macroeconomic indicators and regulatory changes	Machine learning, econometric models, scenario analysis	Market trend forecasting, portfolio management strategy development, assessment of the investment attractiveness of new forms of capital
Evaluation of impact on the economic system	Influence on structural changes in the economy, redistribution of capital across industries, transformation of business models	Industry data analysis, case studies, multidimensional analysis	Interpretation of the impact of digital assets on economic growth, changes in the labor market structure, financial flows between sectors
Interpretation and recommendations	Evaluation of results based on a comprehensive approach: impact of digital assets on economic stability, assessment of risks and opportunities for investors, adaptation of regulatory strategies to changing stock market conditions	Synthesis of previous stage results, risk and opportunity analysis, development of recommendations for regulators and investors	Formulation of recommendations to enhance the market's resilience and adaptability to new challenges

Sourse: author.

The methodological approach to stock market analysis involves a comprehensive evaluation of all elements, starting from primary data collection to result interpretation. This approach is necessary to form a holistic view of the current market state, its potential development scenarios, and the impact of new forms of capital on the economic system as a whole.

4 Discussion

Data collection enables the evaluation of current market dynamics, identification of anomalies in market participant behavior and transactions, and analysis of market liquidity indicators in real time. Technologies like big data and blockchain analytics provide more accurate and transparent results. For instance, monitoring tokenized assets on Russian exchanges allows real-time consideration of changes and the formation of flexible portfolio management strategies for investors and market makers.

Analyzing the institutional environment is crucial for determining the interaction degree between new forms of capital and the traditional financial system. For example, comparing Russian and international digital asset regulations reveals how various

approaches influence market participants' investment activities. Modeling and forecasting based on machine learning and econometric methods enable the creation of scenarios for future market behavior, taking into account both macroeconomic factors and financial policy changes. Assessing the impact on the economic system requires studying the influence of new forms of capital on the redistribution of financial resources across economic sectors. International experience shows that asset tokenization simplifies access to capital for small and medium-sized businesses, gradually changing market structures [12]. Based on the obtained data, measures can be proposed to enhance market stability, reduce financial, informational, and technological risks, and stimulate innovative activity.

5 Conclusion

Transformations of financial capital and the integration of digital financial assets into financial systems represent not merely an adaptation of traditional instruments but an evolutionary process reshaping the fundamental aspects of stock market functioning. The digitalization of the financial environment exerts a multi-layered impact on economic systems, accelerating capital accumulation processes, altering labor market structures, and more.

The use of an interdisciplinary approach in stock market research enables the consideration of economic, technological, legal, sociological, behavioral, and geopolitical aspects, significantly enhancing analytical capabilities and ensuring more accurate forecasting of market changes.

The interdisciplinary methodological approach presented in this study aims to account for the dynamics of digital asset development and application, institutional changes, and macroeconomic factors. Based on the analysis, recommendations are proposed to improve the resilience and adaptability of the stock market to new economic and geopolitical challenges.

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Conceptual Model of Sustainable Competitive Development for Enterprises in High-Tech Industries

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Abstract. The work explores theoretical and methodological foundations of sustainable competitive development for enterprises in high-tech industries, as well as mechanisms for its implementation. The relevance of the study stems from the insufficient research on integrating sustainable development and competitive strategies, taking into account external factors and modern business conditions. The aim of the study is to present a conceptual model of competitively sustainable development for enterprises in high-tech industries. The author applies methods of systemic and comparative analysis, conceptual modeling, and a structural-logical approach. The theoretical foundation is based on studies in strategic management, enterprise competitiveness, and sustainable development. The study systematizes factors influencing the sustainable development of high-tech enterprises. Key conditions necessary for ensuring sustainable competitive development are identified. The author provides an original interpretation of sustainable competitive development as a process of long-term enterprise growth based on technological leadership in the industry, innovative activity, and adaptation to external changes. A conceptual model is presented, integrating economic, technological, environmental, social, and institutional factors into the enterprise's strategic management system. The practical significance of the research lies in the fact that the proposed model can be used by high-tech enterprises to develop adaptive strategies, enhance innovation potential, and minimize risks in the face of external business uncertainties.

Keywords: Balanced Scorecard System · Enterprise Adaptability · Innovation · Sustainable Competitive Development

1 Introduction

The issue of sustainable development in enterprises has been extensively covered in both domestic and international scientific literature. The conceptual foundations of sustainable development were first introduced in the concept of the «Triple Bottom Line», which covers economic, environmental, and social dimensions of business [1]. This concept was later expanded within the frameworks of Corporate Social Responsibility (CSR)

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and sustainable management, emphasizing the creation of «Shared Value» as a basis for long-term competitiveness in the market [2]. Despite the growing body of research on sustainable development and competitive strategies, the integration of these concepts in the context of high-tech industries remains underexplored. In particular, there is no unified concept of sustainability in competitive strategies, no tools for assessing their long-term effectiveness, and insufficient consideration of industry-specific development features [3].

2 Methodology

The study employs methods of systemic and comparative analysis to identify the key factors and conditions for ensuring sustainable competitive development in high-tech industrial enterprises. Elements of conceptual modeling were used to develop a model of sustainable competitive development, while a structural-logical approach was applied to justify the mechanisms for its implementation. The theoretical foundation of the research is based on works in the fields of strategic management, competitiveness, and sustainable development.

3 Results

The factors that determine the sustainable development of enterprises in high-tech industries can be systematized into groups, highlighting economic, technological, environmental, social, institutional and geopolitical factors (Table 1).

To ensure the sustainable development of enterprises in high-tech industries, certain conditions must be met:

- consideration and maintenance of a balance between the interests of all participants and stakeholders regarding the achievement of the company's economic, environmental, and social goals (that is, the development of the enterprise should be aimed not only at increasing profits but also at improving employees' quality of life and minimizing the negative impact of production on the environment [5]);
- the development strategy should be designed for the long term, applying scenario-based planning approaches to enterprise performance indicators, considering external factors and market trends (within the framework of the strategy, tactical and operational planning, ongoing monitoring of indicators, and adjustments to business processes, individual operations, and parameters must be carried out [6]);
- government support to create favorable conditions for innovative development of the industry and individual enterprises through funding allocation and tax incentives;
- increasing the enterprise's level of digital maturity, digitization, and automation of business processes, which form the foundation for enhancing competitiveness both now and in the future [7];
- collaboration with universities and research centers to enhance the enterprise's innovative potential, facilitate knowledge and technology exchange, and train qualified personnel that meet the modern requirements of high-tech industries [8];
- a rational approach to resource utilization, optimization of business processes, and cost reduction within the enterprise [4].

Table 1. Factors determining sustainable development of high-tech enterprises.

Group of Factors	Factor	Description
Economic	Investment Activity	Sufficient investment in production and technological development
	Financial Stability	Optimal balance of equity and debt, high solvency
	Production Efficiency	High labor productivity, optimization of business processes
Technological	Innovation Activity	Adoption of new technologies, investment in R&D
	Digitalization	Use of advanced digital solutions, process automation
Environmental	ESG Principles	Environmentally safe technologies, energy efficiency
	Eco-Friendly Production	Emission reduction, waste recycling
Social	Human Capital	Highly qualified employees, staff development programs
	Corporate Social Responsibility	Social programs, sustainable engagement with local communities
Institutional	Government Support	Incentives, subsidies, tax benefits
	Regulatory Compliance	Adherence to industry standards and legislation
Geopolitical	Supply Chain Diversification	Flexible supply chains, reduced dependency on a single region
	Degree of integration into global value chains	Cooperation with foreign partners, integration into global value chains

Source: author.

These factors and conditions form the foundation for the long-term sustainable competitive development of enterprises in high-tech industries, ensuring their competitiveness in the modern economy. The author defines sustainable competitive development as the process of enterprise growth over the long term, ensuring not only a balance of economic, social, and environmental factors but also establishing a sustainable competitive position through continuous technological renewal, high innovation activity, digitalization, and adaptation to external changes. This concept differs from sustainable development in two key aspects:

1. A focus on market competitiveness, active management, and the development of competitive advantages.
2. An innovation-driven approach: while sustainable development considers innovations as one of many factors, sustainable competitive development places innovations at the core of the enterprise's strategy.

In our opinion, the model of sustainable competitive development is a management concept for enterprises based on the integration of economic, technological, institutional, environmental, and social factors that ensure their long-term sustainability and market competitiveness (Fig. 1).

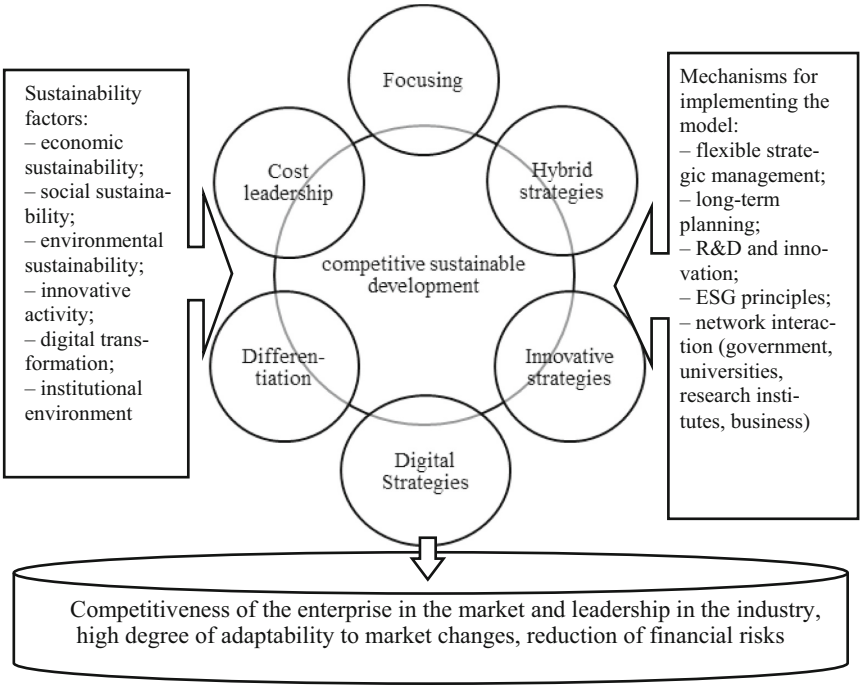


Fig. 1. Conceptual model of competitive sustainable development of an enterprise in high-tech industries (Source: author).

It involves the formation of adaptive development strategies aimed at proactively responding to changes in the external environment, driving technological transformation, enhancing the company's innovative potential, and ensuring efficient and rational use of available resources [9].

4 Discussion

The model of sustainable competitive development is not merely a conceptual approach but a strategic management tool that enables enterprises in high-tech industries not only to maintain stability but also to outperform competitors in the modern economy. In other words, competitive strategies play a decisive role in ensuring the sustainability of high-tech enterprises. The key mechanisms, based on sustainability factors, should include flexible strategic management, long-term enterprise planning, R&D and innovation, adherence to ESG principles, and network collaboration (government, universities, research institutes, and businesses).

5 Conclusion

The research has achieved its goal by developing the theoretical and methodological foundations for the sustainable competitive development of enterprises in high-tech industries and justifying the mechanisms for its implementation. Market competitiveness and industry leadership, a high degree of adaptability to market changes, and reduced financial risks are essential outcomes of this approach. The study has revealed the essence of sustainable development for enterprises in high-tech industries. It has been established that this process encompasses not only traditional economic, social, and environmental aspects but also innovative, institutional, and digital factors. Key conditions for ensuring sustainability have been identified, with particular emphasis on adaptability to external changes, the ability for technological renewal, effective collaboration with government and educational institutions, and the integration of ESG principles into strategic management. The definitions of «sustainable competitive development» and «model of sustainable competitive development» have been refined within the scientific discourse. It has been demonstrated that sustainable competitive development extends beyond the classical understanding of enterprise sustainability. The developed model of sustainable competitive development is based on the integration of various competitive strategies with mechanisms for ensuring enterprise sustainability.

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Digital State: Governance Principles, Realities and Opportunities

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Abstract. The contribution presents the implementation of the concept of transition to a digital state, defines and designates stages of improving the process of digital transformation of management processes. The transition to new, more modern forms is carried out on the basis of objectivity and data-centricity, processing speed, flexibility and adaptability. Complete digital transformation will lead to a decrease in general government expenditures. It will allow organizing control and monitoring in real time for the speed of all processes, for achieving the planned values of economic growth indicators based on the collection, processing, analysis of information from various sources. Organizational measures in the form of roadmaps, monitoring of implementation and the use of incentive methods can significantly facilitate this process. Classifying data by access levels and the required degree of protection remains a serious task. The depth of transformations and the complexity of processes are difficult to objectively assess.

Keywords: Cross-Functional Team · Data-Centricity · Digital State · Principles of Digital State · Risks of Digital Transformation · Stages of Digital Transformation

1 Introduction

Over the past decades, the issue of forming a digital state has been of primary importance. This topic has become relevant after the emergence of a wide range of new information technologies that can find active application in the sphere of building relations between the state, society as a whole and an individual, a citizen.

The implementation of the concept of transition to a digital state involves gradual improvement over a fairly long period of time. It is necessary to distinguish between the process of ordinary digitalization of processes and their digital transformation [1]. During the transformation process, the process undergoes qualitative improvement, optimization and rationalization. The costs of its implementation are reduced, the speed increases and it is changed based on constant feedback.

It is difficult to objectively assess the depth of transformations and the complexity of processes. The number of participants involved in the practical implementation of digital transformation is extremely large. Ensuring the stable functioning of the digital state will require serious financial and labor resources. At the initial stage, the necessary

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infrastructure, the foundation of the transition, is created, and later the traditional way of conducting processes is replaced by digital support [2].

The initial stage is traditional, assuming a gradual evolution of the processes being performed. In this way, the existing structure of government bodies is preserved, but qualitative improvement occurs due to the introduction of the latest technologies for collecting, processing, accumulating, storing, and utilizing information. Outdated equipment is removed, technology is replaced, etc. In fact, there is a fragmentary approach to improvement. New agencies are being organized that take on the role of digital leaders, as they are created to implement new digital approaches, systems and technologies [3].

However, this approach does not change the process itself. If the process was not built effectively enough, its shortcomings continue to have a negative impact on the efficiency of the system as a whole [4]. This path is labor-intensive and slow. At the same time, the main goal is not achieved, the ability to quickly adapt processes to a changing situation and environmental factors. As a result, the updated data management system is usually used only by the department itself and, therefore, the quality of data in the system is not high enough.

The final stage is digital transformation. In essence, this is a deep reorganization of government structures, high-quality reengineering of the processes being performed, based on new algorithms for processing information and managing data using modern technologies, tools and mechanisms. In fact, this is the path to a qualitative leap in the public administration system and the transition to a new formation. With this approach, the goal is not just to reduce time, increase speed, save on costs, but to obtain new characteristics, properties, qualities and capabilities. The transition to predictive management, including without the participation of a civil servant.

It cannot be said that the described paths along which the digital transformation of government structures is currently taking place on the way to the transition to a digital state are mutually exclusive. These paths are complementary. In fact, each department is implementing the path of traditional, evolutionary change. This allows employees to develop new digital competencies, instill digital immunity, ensure the availability of the necessary equipment, IT technologies, information systems, etc. However, the ecosystem formed as a result of digital transformation should gradually displace outdated existing approaches and technologies. All digital services must be integrated into a single digital system, a platform for interaction between all actors.

2 Methodology

A modern user already has the capabilities provided to him by a digital twin. When going through the identification procedure, within the framework of a developed and functioning digital ecosystem, a number of important functions and requests are processed by means of implemented algorithms for processing and obtaining ready information without the participation of authorities.

However, the achieved level of development of digital service solutions requires development. The transition to new, more modern forms is carried out on the basis of the following principles.

Objectivity and data-centricity. The principle is based on the process of constant accumulation of objective data. Control is carried out by using big data technologies,

the Internet of things, artificial intelligence, cloud technologies. The information system is given the right to make repetitive, routine decisions [5].

Process approach based on digital services. This approach is distinguished by considering the request not as a part, an action, but as a sequential chain of steps, actions, requests for solving situations with a comprehensive consideration, as a life situation.

Processing speed, flexibility and adaptability. Constant adjustment of the system to the changing environment and specific requests, taking into account the necessary forms of information provision.

State structures cease to perform supervisory and prohibitive functions, but become a source of realization of the possibilities of new technologies aimed at improving the life of citizens and the economic activities of various organizations [6]. On a single platform, which is a digital information platform, interaction of all participants is carried out. Under the auspices of the state, an ecosystem of the digital state is formed.

As in the basis of the activities of marketing commercial structures, the state monitors the satisfaction of the participants of this ecosystem, looks for problem areas that require a transition to digital with subsequent transformation and integration into the general system of functioning. In fact, the state becomes the center of digital transformation of society and the economy, as it is a single window, entry point, analytical center for improving almost all areas of activity.

3 Results

The principles on which the activities of the digital state will be based: ecosystem of digital services, reference data in a single metamodel, continuous process of monitoring data quality, unified architectural principles for the formation of information systems, complete digitalization of the entire range of services, maximum speed of adaptation of processes, continuous integration processes of improvement, widespread implementation of a digital twin of each citizen, creation of a digital profile, use of a digital signature, remote biometric unified identification system, proactive provision of integrated services, seamless digital interaction of all information resources on a national scale and beyond, automation of most decision-making by means of artificial intelligence. The implementation of these principles will require a significant change in the role of government structures. In essence, the foundations for the functioning of the largest IT companies are laid in the activities of the digital state. First of all, the form of state participation in the processes of interaction with citizens will change. The state becomes the center for satisfying the needs of citizens by providing various services.

At the moment, one can clearly imagine the strategic goals that the state will strive for in matters of digitalization of all processes with subsequent digital transformation to move to another qualitative level of its development. This is a state with an optimal amount of bureaucratic apparatus, which is sufficient for effective support of the services provided by the state. The management decisions taken are based on the principles of alternativeness, complexity, rationality, achievability and efficiency. The speed of decision-making and the quality of information for their adoption are constantly increasing.

For a citizen, the main effect of the state functioning in digital mode will be expressed in the ability to use convenient interactive services based on a digital platform, increasing the speed and quality of services provided remotely and, as a result, in increasing satisfaction in connection with the need to make a decision or provide information on emerging life situations. The consequence of these processes will be a high level of personalization of services for a specific request. For business, the digital state will allow achieving the following goals: reducing administrative costs and bureaucratic burden, increasing the speed of service provision and operation of government services, access to a colossal amount of necessary high-quality information and analytical data for carrying out production, business or trade activities.

It can be noted that for the state, a complete digital transformation will lead to a reduction in general government expenditure. It will allow organizing control and monitoring in real time for the speed of all processes, for achieving the planned values of economic growth indicators based on the collection, processing, and analysis of information from various sources. The most complete consideration of the requests and needs of citizens will be achieved, depending on its capabilities and ensuring the targeted provision of the necessary support or assistance from the relevant structures under the control of the state. Control and supervision can be carried out in the most effective and transparent form.

Government departments, bodies and structures already carry out their activities based on a single information array of data. Developed and implemented algorithms for working with an array of data have already been implemented for a number of services provided. The functioning of the digital state and digital services is based, among other things, on artificial intelligence. More attention is paid to issues of data storage and processing.

Algorithms for data processing and analysis, tools for obtaining predictive analytics are being actively introduced into the activities of government departments and agencies. The distribution center database is used to sort, store, accumulate, update, and reserve the necessary information and accumulated knowledge and data. Experience has been accumulated in solving the issue of exchanging data online, both directly and through indirect services. The solution to implementing access and data verification technologies is being implemented in conjunction with the solution to the issue of ensuring information protection and security.

Free access of actors allowed to use the unified information base of state information will lead to the absence of administrative resources, the possibility of monopolistic use and a reduction in the corruption component.

The bodies implementing the unified management of the digital transformation of the state pay special attention to:

- resolving issues of availability of necessary financial resources, attracting public-private partnerships to implementation;
- forming a unified methodological basis for digital transformations;
- developing the state personnel policy aimed at training the required number of employees with the necessary digital competencies, knowledge and skills capable of thinking within the framework of the modern technological paradigm;

– monitoring the progress of the transition, assessing the impact of information threats and risks, developing and implementing management actions to minimize the risk component;
– facilitating the transition from trial operation of services to their large-scale use by citizens and businesses, promoting services among the population.

Expanding functionality, increasing the volume of data, digitizing all processes and developing a wide range of services for any need will ensure interaction between all departments and transfer their work to uniform principles and approaches.

4 Discussion

A person, a user, as a key element of a digital state is considered not from the position of a specific request or process, but from the position of a comprehensive life situation with various scenarios for its development and the opportunities that open up to achieve the best result in each specific case, taking into account the interests of the subject himself and regardless of the area in which he encountered a specific situation [7]. This may be the most common everyday problem, or a more complex problem that requires a comprehensive solution. The result of working through each life situation should be an individual path to achieving the best result.

This approach will allow for the fullest realization of human potential, provide a comfortable living environment and a sense of safety and security, which will ultimately contribute to a more balanced development of the economy as a whole [8].

Modern states form the basis, the foundation necessary for the development of all socially significant sectors of the economy and areas of activity, from healthcare and education to industrial production based on the introduction of the latest technologies and innovations into their activities. It is the state that is the infrastructural factor that ensures the interconnection of citizens, commercial organizations and business structures, non-profit organizations and other participants in the ecosystem of interaction in everyday practical activities. Without such an ecosystem, digital transformation will not allow moving to a new qualitative evolutionary level. Of course, the availability of human resources for the implementation of digital transformation is important in this process. Digital skills and competencies of employees implementing the relevant functionality for working with new technologies and information systems are currently the main task [9].

Civil servants involved in the functioning of government agencies within the digital state are currently actively developing digital skills and competencies in using information systems, performing work operations in the conditions of digital reality and forming a digital way of thinking, a digital mentality. A fairly wide implementation of digital services and information processing technologies has already led to a reduction in the burden of routine operations on workers. The main labor function is becoming orientation not to the process, but to the result, to the quality of the output.

The speed of the changes that are taking place requires that all work be carried out using project teams, cross-functional teams [10]. The presence of representatives of various professional spheres and groups of interested users in a cross-functional team allows us to identify possible implementation risks, work out legislative support for

implementation, and ensure a comprehensive orientation of the service not so much to the consumer as to a specific individual life situation. In the process of developing services by cross-functional teams, duplication is eliminated, effective interaction between the participants responsible for the operation of the service and obtaining the result of solving the citizen's life situation is established, holders of functions and services responsible for their correct implementation and effective work are determined.

In the process of developing and implementing new services, there is a mandatory study of accumulated international experience, global trends in digital transformation, and directions for changing the digital social paradigm are analyzed. In fact, the cross-functional team is an expert-methodological and methodological basis for the development and implementation of new services.

5 Conclusions

There are several main risks that should be taken into account in the process of transition to a digital state. These are the slow adoption of the necessary regulatory and legal acts. Experts assess this risk as high, and the degree of its influence as maximum. This assessment is determined by the fact that regulatory and legal acts create a fundamental possibility of using certain technologies and are also directives for action for employees of the state administration apparatus. The next significant risk is the resistance of existing management structures. Its impact is also assessed as extremely high and negative. However, resistance to any changes is a frequent organizational process. Management practice has accumulated a lot of experience in implementing change management methods and overcoming resistance. Some of the most effective are motivation and incentive systems, as well as personnel training through advanced training, retraining, or participation in trainings [11].

The quality of data in existing storage facilities is a serious problem. Combining data from different storage facilities takes time and is accompanied by their verification, error correction, etc. Organizational measures in the form of roadmaps, monitoring of implementation and the use of incentive methods can significantly facilitate this process. Classifying data by access levels and the required degree of protection remains a serious task [12]. The risk of insufficient funding is taken into account in the implementation of any project. At the moment, there is an understanding of the importance of implementing the transition to a digital state for further development in the future and achieving national security of the country. In addition, it is possible to attract private investment.

There is no risk of lack of experience in creating such platforms. Russian specialists already have extensive experience in implementing federal-level information systems, while the development of new technologies and the introduction of modern tools and algorithms is already being carried out on par with leading foreign countries. The presence of a highly professional management team is of particular importance. It is possible to attract foreign specialists with the necessary unique experience.

The previously existing inertia of the population has now been virtually eliminated. Modern society and citizens who have mastered digital competencies at any level are actively involved in using the opportunities provided by the digital state. Qualitative growth in the sphere of public services, increased trust in the state and a high degree of

satisfaction from activities government agencies will allow new solutions and services to be implemented with even greater speed. Simplicity, convenience, speed, and quality of work are highly appreciated by the population.

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Analysis of the IPO Application by Russian Corporations in the Modern Russian Economy

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Abstract. The contribution considers problems and prospects of using initial public offering by Russian corporations to attract financial resources. In comparison with other sources of financial resources, the distinctive features of this instrument, prospects and limitations of its application were identified. The study also conducted a quantitative and qualitative analysis of the current financial results of companies that placed their shares in 2023. Conclusions were obtained that the initial public offering can become an effective source of financing only for those companies that operate in those industries that are significant for the Russian economy in the current geopolitical conditions, or for those companies that have an innovative product or technology. The current measures taken by the mega-regulator are analyzed, and the authors' recommendations for overcoming significant institutional constraints are presented. Research on this topic may be useful both for the management bodies of companies that are considering the possibility of using this instrument to attract financial resources, and for other researchers analyzing the Russian initial public offering market.

Keywords: Debt Instruments · Financing · Initial Public Offering · Stock Market

1 Introduction

The events of 2022 have had a significant impact on the Russian economy. More than 60 foreign countries have imposed sanctions that create significant restrictions on the implementation of economic activity [1]. This led to a global outflow of foreign capital from the Russian market, which made significant adjustments to the successful functioning of both small companies and corporations. Thus, businesses faced 2 interconnected problems: companies needed to restore the pace of their development to the pre-crisis level and at the same time find new ways to obtain sufficient funding. To support organizations during the difficult economic period, the state took a number of measures, the key one of which was the provision of preferential lending terms. However, these preferential terms were provided only to small and medium-sized businesses. There were other financial support measures available to both categories of businesses: reduced tariffs for merchant acquiring implemented through the fast payment system, loan restructuring, grants, subsidies, etc.

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The relevance of the research topic is determined by the fact that the economic situation is gradually stabilizing, so the above financial measures are becoming ineffective for both business and the state, and now it is necessary to take measures to adapt the Russian economy to new conditions. Some of these measures can be the development of the initial public offering market and stimulating organizations to use this tool to obtain the necessary amount of financial resources. Such measures can have a positive effect on the development of the Russian stock market.

2 Methodology

The purpose of the study was to assess problems and prospects of using IPO by Russian corporations to obtain financial resources in modern conditions. The following methods were used in the study: analysis of quantitative and qualitative data, synthesis, formation of expert assessments based on statistical data, systems approach, generalizations, induction and deduction, as well as methods of economic analysis.

In the existing scientific works [2–5], IPO is considered as a way to attract investment in conditions of macroeconomic instability, on the one hand; on the other hand, researchers write about the limited feasibility of using this instrument in the current conditions. The world experience of conducting IPO procedures, the distribution of IPO shares between functional and private investors are analyzed. Some scientists came to the conclusion that the price of the share already includes information about the future prospective results of the company. Anyway, in modern scientific literature there is no comprehensive study examining various aspects of the Russian IPO market, allowing to assess both the development prospects of individual companies and the national market of initial public offerings. This is a scientific gap in existing studies on this topic.

3 Results

Given the high interest rate which was adopted by the Bank of Russia in 2024, loans and credits, which were the most popular instruments of external business financing, are becoming less and less attractive for companies. This is what makes them pay attention to existing alternatives. One of which is the placement of debt and equity instruments on the securities market. Previously, this market was ignored by some companies, since the placement of securities is a complex procedure that requires a company to spend a lot of time and money, as well as to disclose certain financial and corporate information to attract investors. But in Russia, a trend of sustainable development is currently being formed. This is what affects the increase in demand for various securities on the market and, accordingly, allows companies to receive financing on favorable terms.

First of all, let's consider corporate bonds, which are a debt financial instrument. Bonds allow organizations to attract financial resources for a period of 3 to 5 years, and the amount of interest they pay may be much lower than that of a bank loan, especially in the context of the current interest rate. This advantage of this instrument partly led to the fact that in 2023, the corporate bond market amounted to 29.3 trillion rubles, with an increase of 5 trillion rubles in one year [6] (Fig. 1).

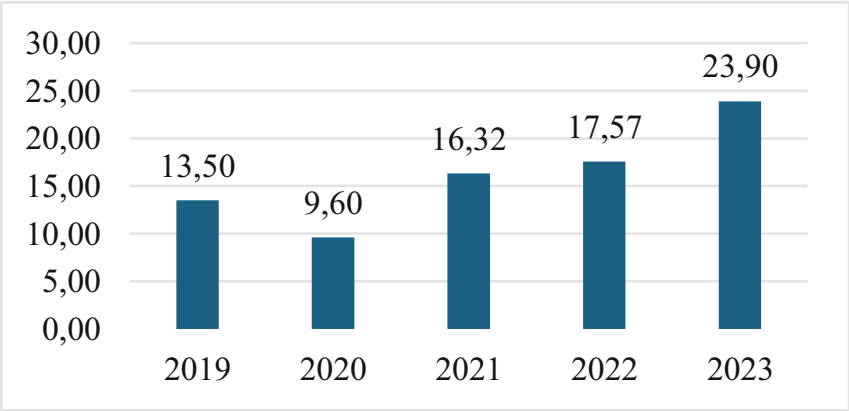


Fig. 1. Dynamics of the corporate bond market in Russia (Source: authors based on [7]).

However, not every company is ready to issue bonds, as this procedure has certain disadvantages. Even in 2023, when the Central Bank's key rate was significantly lower, the total number of corporate bond placements amounted to 1,372 issues [6]. Based on the results of 2024, we can say that the positive dynamics are maintained. But bonds are still a debt instrument that allows you to attract financial resources. They do not create additional value for the company, unlike shares. Shares are an equity instrument that does not involve directly raising funds. That is why the placement of shares is not a typical way of raising financing, which is available to companies of different sizes. Through the placement of shares, the company can receive significant amounts of financing not only for current tasks, but also for strategic development goals that can ensure subsequent growth of the company's capitalization.

In Russian practice, until recently, only the largest corporations resorted to the placement of shares: PJSC Lukoil, PJSC Sberbank, PJSC Gazprom, etc. But the effectiveness of share placements, which consists not only in raising funds, but also in creating a company's image, obtaining a mechanism of protection from external influence, maintaining financial stability, attracts more and more large companies and developing corporations. That is why in 2023 there was an IPO boom in Russia. Thus, 8 of the largest Russian companies have completed the IPO (initial public offering) procedure, which is a fairly high figure for the Russian market compared to 2022 [8] (Fig. 2).

However, to objectively assess the effectiveness of IPO as a source of financial resources for corporations, it is necessary to consider the state of the issued shares and, in general, characterize the IPO results. First of all, it is worth mentioning the Astra group of companies. It is the leader of the Russian information technology market in the field of software development. The group of companies held an IPO on the Moscow Exchange on October 12, 2023 [8]. Following the placement, the company's capitalization amounted to 69.9 billion rubles, and the demand for shares at the time exceeded the supply by 20 times. This is one of the most successful placements, which is considered as an example by companies that are currently undergoing the IPO procedure. Another large company that went through the IPO in 2023 is Henderson, the largest chain of men's

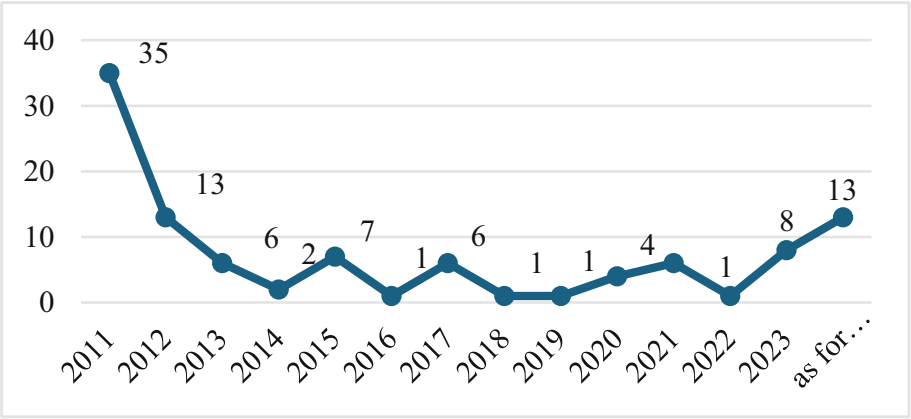


Fig. 2. Number of initial public offerings conducted per year in units (Source: authors based on [8]).

clothing stores in Russia. Following the IPO, the company's placement volume was approximately close to the placement volume of the Astra group, but the free-float level was higher The company was able to place its shares at the upper limit of the price range and received increased interest from investors.

4 Discussion

In general, all the companies that went public in 2023 were able to attract a sufficient amount of funds and a proper influx of investors [9]. The positive statistics are partly determined by the fact that the Russian stock market is quite narrow, with a very limited number of issuers represented on it, which makes new shares especially in demand among investors at the time of their placement and at the initial stage of their circulation on the secondary market. This is why the success of an initial public offering should be assessed based on the current state of the companies' shares (the state that was achieved after a certain period of time (about a year)) (Table 1).

Comparing the data with a time interval of about 1 year, it can be seen that the decision to conduct an IPO was not correct for all companies. The governing bodies of some companies that made the decision to place shares were unable to objectively assess the attractiveness of investments in the companies for investors, which was reflected in the systematic fall in the value of shares since their placement. Another fact confirming the impossibility of improving the situation with the value of shares of these companies on the secondary market is the crisis state of the stock market of the Russian Federation associated with new sanctions. Nevertheless, the results of the IPO of the second half of the company can be considered as positive.

The analysis shows that the IPO procedure does not always contribute to the development of financial stability of companies and is closely related to the state of the national stock market. However, it is important to remember that the decisive factor determining the possible increase in the value of both the shares of companies on the

Table 1. Performance of companies that had IPO in 2023.

Company	Date of IPO	Capitalization following placement, RUB billion	Cost of 1 share upon placement, RUB	Capitalization as of 4/10/2024, RUB billion	Price of 1 share as for 4/10/2024, RUB
GC Astra	12.10.2023	69,9	333	113,8	542
Henderson	02.11.2023	27,3	675	25,9	641
Eurotrans	21.11.2023	53	250	21,2	133,35
Yuzhuralzoloto	22.11.2023	117	0,55	148,96	0,70
Mosgorlombard	22.12.2023	3,17	2,5	3,13	2,47
Sovcombank	15.12.2023	230,5	11,5	283,3	13,69
Genetiko	25.04.2023	1,48	17,88	2,67	32,17
SmartTechGroup	3.05.2023	5,9	3,16	4,09	2,16

Source: authors.

secondary market and the company itself is the investment attractiveness of the issuer and its exceptional value for the national economy. The companies with successful IPOs operate in the industries that are currently the most relevant – IT, reproductive medicine and genetics, gold mining, banking (systemically important bank). Their products are in demand on the market, so investors are confident that the profit of these organizations will grow over time, which will directly affect the increase in dividend payments.

In addition, it should be noted that an IPO allows groups of companies not only to attract the necessary amount of financial resources, but also to think through a strategy for their sustainable development. This is due to the fact that when placing shares, they receive an objective assessment of their market value, acquire an additional tool for protection from external influences and become a real brand that receives great interest from investors. This feature of this source of financial resources influences the fact that the IPO market in Russia will significantly expand.

5 Conclusion

Based on the analysis of the results of IPO procedures carried out by Russian companies in 2023, the following conclusions were obtained:

At the current interest rate, servicing debt instruments for raising financial resources may be unprofitable for a number of large companies for which the state does not provide preferential lending terms or other support measures, which forces them to turn their attention to the equity capital market, including the IPO procedure.

The largest companies representing various sectors of the economy placed their shares in 2023, but not all of them turned out to be in demand among investors a year later, which suggests that the management bodies of organizations need to competently assess the prospects for the company's further activities before placing, as well as take into account the needs of the market.

Among the problems of IPO as a tool for raising financial resources, the following can be highlighted: in the current geopolitical situation, the Russian stock market remains unstable, which may negatively affect the price of shares regardless of the actions taken by the issuer itself. IPO does not guarantee the attraction of the required level of financial resources, unlike debt instruments. In some cases, IPO may be more expensive than servicing the debt under another instrument.

The prospects for the use of this instrument for attracting financial resources by corporations are promising, both in relation to the natural planned development of the stock market in our country, and in relation to the actions taken by government agencies. Thus, if companies issuing shares are really given the opportunity to compensate for IPO expenses, receive subsidies in the event of attracting equity financing, and also reduce the amount of taxes paid, it is likely that more and more organizations use this instrument, which will have a positive effect on the state of the stock market.

Thus, the use of IPO procedure is strategically important both for the country's economy and for the development of many corporations in modern conditions.

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Problems of Digitalization on the Example of Smart City Projects

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Abstract. In this work, the process of modernization of Russian cities according to the national project «Smart City» was considered and analyzed. The purpose of this study is to identify the level of development and implementation of the project to implement the smart city system in Russian cities. The methodological basis of the study is the analysis of data contained in reports, documents and scientific publications available in open sources, including foreign ones. Statistical methods are used, such as graphical and tabular presentation of research data, and a comparison of information related to the problem under study is carried out. During the analysis, difficulties faced by project implementers in the regions of Russia were identified, and risks that hinder the active creation of smart cities were identified. Conclusions were made that the concept of a «smart city» is aimed at introducing innovative technologies and activities that improve resource management and living conditions of the population, and for the successful implementation of smart city projects, it is necessary to increase public awareness, develop economically sustainable models and active international cooperation.

Keywords: Digitalization · Modernization · Projects · Prospects · Smart Cities

1 Introduction

Projects for the development of smart cities have become especially relevant in the global community over the past 10 years. Russia is no exception and keeps up with global trends. But since this direction has come to us relatively recently compared to other countries, there are a number of aspects that require active revision by the government in the legislative, economic and social spheres [1].In Russia, the national project «Smart City» is responsible for the modernization and creation of smart cities. Within the framework of this project, programs important for the economy are being implemented that are aimed at improving the lives of the population, such as «Digital Economy» and «Housing and Urban Environment». The main goal of this project is to form and organize an effective system of urban management, as well as to ensure the availability of safe and comfortable living conditions for the population and increase the competitiveness and attractiveness

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of Russian cities on the world stage [2].When implementing this national project, it is necessary to take into account various aspects, including the economic potential of each region, the availability of financial resources, the level of education and the age of the population, the scientific, technical and educational base, as well as the availability of appropriate business infrastructure. However, when implementing any project, risks arise, such as social, economic, political and technological, which must be taken into account when implementing the national «Smart City» project.

2 Methodology

The purpose of this study is to identify the level of development and implementation of the project to introduce the Smart City system in Russian cities. Based on the stated goal, the following tasks were formulated:

1. To identify the areas that are most often involved in organizing the Smart City ecosystem in Russia and compare them with international experience.
2. To determine the geography of cities where the implementation of Smart City systems begins and to find out the reasons for this choice.
3. To analyze the results of domestic and foreign authors on the topic of our study.

The scientific novelty of the study lies in the fact that we have collected and analyzed data on the process of implementing projects in Russia aimed at creating Smart Cities. Thanks to this data, you can get a clear picture of how the project is progressing and, based on this, take into account weaknesses and create the most effective projects.

The methodological basis of the study includes the study and analysis of data from reports, documents and scientific articles published in open sources, including foreign ones; a statistical method that includes graphical and tabular interpretations of research data; comparison of information on the research problem.

3 Results

The embodiment of the smart city concept is an innovative city, which involves the implementation of a set of innovative technical innovations and organizational measures aimed at effective and high-quality resource management and ensuring favorable conditions for life and business activity of the population. However, when implementing the national project, which is based on the development of Russian cities, certain problems arise. New cities are practically not formed in our country (less than 2%), and the development of existing ones depends on large cities (formerly industrial centers) and agglomerations. In addition, the speed of modernization and the standard of living of the population lag behind, and the concentration of the urban population in the country is not the same (21% lives in 14 cities with a population of over one million) [3].

In Russia, two approaches are being implemented for the emergence and subsequent improvement of smart cities:

– creation of smart cities (with this approach, requests come from the business community, and the principles of new urbanism lead to sustainable development of territories);

– smart transformation of cities. Requests for the creation of a smart city in this way are submitted by city communities and citizens, while a sustainable and unified system of city development is formed, while all groups interested in this process are involved in this process. In the process of introducing something new or improved into the life of the population, it is impossible not to encounter resistance in various spheres of society. Because of this, the process of introducing or developing the project in question is accompanied by risks reflected in Table 1.

Table 1. Risks of implementing the «Smart City» project.

Type	Risks
Social	- weak awareness of the population about what a «smart city» is, which leads to misunderstanding, mistrust and rejection of innovations; - low social level of the city population
Technological	- as the number of connected devices and sensors increases, the threat of cyber attacks and data leaks increases; - the complexity of integrating different smart city systems (e.g., transport management systems, energy management, security) can lead to conflicts and failures; - the collection and analysis of big data in smart cities may raise concerns about privacy and the ethical use of this data; - the need to ensure the continuous operation of smart city systems and their resilience to various unforeseen situations; - high costs of implementing new smart city technologies and systems, as well as potential financial risks if these investments are not used effectively
Economic	- low economic motivation of consumers to use technologies; - limited government budget; - insufficient number of business models; - high costs of maintenance and updating
Political	- the tense geopolitical situation does not allow for long-term planning; - tense relations with developed countries make it difficult to exchange experiences in creating smart cities, which deprives us of a model of successful modernization; - management plans are tied to political cycles; - disruption of supply chains due to sanctions restrictions; - lack of interaction in the development of new technologies and the use of best practices
Organizational	- shortage of managers with the necessary skills and qualifications; - lack of incentives for state-owned enterprises to implement and improve smart cities

Source: authors based on [2]

Having analyzed the risks, the following nuances were identified and conclusions were made based on them. All of the listed factors have a strong impact on the implementation of this project, but among them, several of the most significant can be identified.

One of them is the poor awareness of the population about the «Smart City» concept. In this regard, people, having received the opportunity to improve their lives in a comprehensive and qualitative way, ignore it. However, the most significant risk is the economic risk. If the state budget does not have enough money, then smart cities will not be created, all funds will go to more significant expense items. It should be noted that in recent years, the tense geopolitical situation in the world also affects the technological development of the country, which is one of the factors influencing the development of technologies. It disrupts the supply chain and blocks access to new foreign developments.

4 Discussion

The study examined the studies of domestic and foreign authors. Based on this data, information was obtained on smart city models that are very similar to the previously considered models of Russian cities. Having analyzed the results of these studies, it was concluded that Russia is moving in the same direction of technological development as the countries considered in foreign works [4]. There are examples of smart city projects that are significantly ahead of the Russian experience in terms of technicality and digitalization [5, 6]. At the same time, there are examples of those lagging behind in the development and use of high-tech mechanisms of the smart city concept [7]. There are also works that pay increased attention to the digital aspect of the development of the smart city system, as well as their individual components [8–10]. The authors examined the technological components of smart cities in more detail and thoroughly. Based on them, conclusions were made that the results of this work coincide with those analyzed [11]. Indeed, there is a tendency to increase the technological equipment of smart cities in a variety of areas.

The analysis of the research data led to the conclusion that the results obtained in the work do not contradict and coincide with the results of other authors. Indeed, most smart cities around the world implement the use of GPS, GLONASS and IRINS, artificial intelligence and machine learning to form and ensure the safety of the population, IoT, the popularity of which is rapidly expanding in the world market, as well as the desire to reduce the costs of using «Smart City» solutions.

5 Conclusion

The conducted analysis allows us to make a number of significant conclusions. The «Smart City» concept is aimed at introducing innovative technologies and measures that improve resource management and living conditions of the population. The implementation of the national project faces problems such as low modernization speed, low public awareness and economic constraints. One of the key problems is insufficient funding, which limits the possibility of creating new smart cities and modernizing existing ones. Geopolitical tensions complicate the development of technologies, disrupting supply chains and limiting access to foreign innovations. In Russia, two approaches are used to develop smart cities: creating new ones and smart transformation of existing ones, which allows taking into account the interests of all participants in the process. Technological risks, including threats of cyberattacks and complex systems integration, require special

attention and continuous improvement of security measures. For the successful implementation of smart city projects, it is necessary to increase public awareness, develop economically sustainable models and active international cooperation.

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Digital Transformation in Industry

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Abstract. Nowadays, digital transformation is becoming an integral part of industrial development, requiring relevant and comprehensive analysis. This article examines various aspects of the digital transformation of industry. The purpose of this study is to analyze the features of the digital transformation of industrial enterprises and identify the opportunities and challenges associated with the digitalization of the industrial sector. The main approaches to the study were collecting, studying and analyzing scientific papers of domestic and foreign researchers devoted to this topic, studying modern digital technologies used in industry, conducting a comparative analysis of methods for modeling complex production process control systems. The sources used in the work represent a variety of studies by Russian and foreign scientists providing a comprehensive overview of this topic. It can be concluded that the digital transformation of industry is a priority development area that can positively affect not only the manufacturing sector, but also the country's economy as a whole.

Keywords: Digitalization · Digital Transformation · Economy · Efficiency · Industry · Modernity

1 Introduction

Today, the topic of digital transformation of processes is of particular importance not only for banks and government agencies, but also for representatives of the industrial sector, so the consideration of possible ways of applying digital transformations in the industrial sector is a very relevant topic at the moment. Digital transformation, or digitalization, is a process associated with changes in socio-economic relations. These transformations affect all levels of management by transferring all the organization's resources to a digital format through the introduction of digital technologies [1]. The high popularity of digitalization among companies can be associated with new opportunities that arise when introducing innovations, for example, gaining a competitive advantage in the industry. The process of digital transformation of the industrial sector in Russia is still ongoing and is at the development stage, which, in fact, is reflected not only in the results of research and development work at the level of individual businesses, but also on a

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national scale [2]. Experts often note that the use of information and communication technologies is much lower than in other developed countries. It is worth noting that until 2019, there was some growth in this area, but due to the crisis caused by the COVID-19 pandemic, it stopped. However, the interest of industrial complex managers in introducing innovations gives hope for the resumption of a positive trend in this direction. Today, digital transformation is a priority area for the development of the Russian economy, since the introduction of innovations in production processes will not only increase the efficiency of the industry, but will also have a positive impact on other industries. The industrial sector needs to constantly improve its activities, since the development of production capacities, well-structured logistics and well-chosen sales points create excellent conditions for the operation of the industry.

2 Methodology

The purpose of this study is to analyze the features of the digital transformation of industrial enterprises and identify the opportunities and challenges associated with the digitalization of the industrial sector. The research objectives are:

- to study the current state of the issue of digital transformation of the industrial sector;
- to analyze various aspects of the digital transformation of industry, including automation of technological processes, development of methods for modeling complex control systems, IT projects, artificial intelligence, cybersecurity, digitalization and robotics of production, control technologies;
- to identify the main difficulties in the course of the digital transformation of industrial enterprises;
- to determine the opportunities and prospects for the implementation of modern digital technologies in the industrial sector.

The main research methods were the collection, study and analysis of studies by domestic and foreign authors on the topic under study; analysis of existing modern digital technologies used in the industrial sphere; comparative analysis of methods for modeling complex control systems for production processes.

3 Results

Considering digitalization from the point of view of manufacturing enterprises, we can assume the following goals pursued by organizations when trying to implement innovations: increasing the efficiency of the enterprise's production processes, reducing production costs, creating new competitive advantages. To achieve these goals, it is necessary to carry out a set of innovations related to production and resource management, the creation and implementation of the latest information and management standards and decision-making models in specialized areas. In the field of digitalization, there are quite a large number of areas that represent an opportunity for the industrial sector to meet needs. Thus, we can highlight:

- automation of technological processes and production;

– development of methods for modeling complex control systems;
– IT projects for the digital transformation of industry;
– artificial intelligence;
– management technologies in the context of digital transformation of the industry.

Let's consider each of them in more detail. The most promising and easy-to-implement direction for the industrial sector can definitely be considered the automation of technological processes and production. In essence, this direction can be described as the implementation of special technical solutions and systems for performing operations and monitoring production without direct human participation. This area plays a key role in modern industry precisely due to the opportunities it provides to the enterprise through the implementation of automated technologies. With the development of digital technologies and the introduction of the Industry 4.0 concept, automation has become even more important, allowing companies to effectively adapt to changing market conditions and meet the needs of modern consumers.

The most popular way to automate production processes in a company is to implement industrial robots, as they can perform a fairly wide range of tasks, from monotonous or cyclical operations to types of work that require a certain level of manipulation. They can be programmed for almost any task on the production line, which allows you to shorten the production cycle, thereby increasing productivity. In addition to increasing the speed of the product creation process, the implementation of such technologies reduces the risk of errors, which improves the quality of manufactured goods.

In addition to the implementation of industrial robots, an enterprise can use automated control systems that allow you to monitor and manage production processes, and completely different ones. For example, such systems can be assigned such tasks as equipment monitoring or planning production goals. In addition, automated control systems will help reduce equipment setup time, minimize downtime and improve overall productivity. Also, within the framework of the direction of automation of production processes, they use the Internet of Things, which allows you to collect data from various devices used at all stages of the production process, and transfer them to a central server for subsequent analysis.

In practice, these technologies are used in various industries. For example, if we talk about the automotive industry, automation can be used to help build vehicles. In factories, large robots can assemble cars and weld metal parts together. Some car manufacturers may also use robots that collaborate with each other or 3D printers that can create precise car parts.

Developing methods for modeling complex control systems using modern data analysis methods and modeling systems allows a company to conduct a detailed study of production processes in order to improve their efficiency and reliability through optimization. The control systems themselves include various elements that interact with each other in order to achieve the set goals.

There are approaches to the implementation of the process of modeling control systems, but the main ones include: Conflux, IDF0, ISO, NIIUK. We will consider their essence, advantages and disadvantages and identify the most suitable modeling method for performing tasks within the framework of digitalization in Table 1.

Table 1. Analysis of approaches to the implementation of modeling control systems.

Approach	Conflux	IDF0	ISO	NIIUK
Essence	This approach provides a general description and algorithm for the sequence of processes: production, management, etc	This approach describes the activities of the enterprise, including even those processes where it is necessary to show a logical sequence in time	When developing, implementing and improving the effectiveness of a quality management system, a process approach is used, which consists of organizing the work of an enterprise as a set of interrelated processes. The purpose of using this approach is to increase the satisfaction of the enterprise's needs	This approach is used for effective process management through resource allocation
Advantages	The model created using this approach reflects all enterprise processes in one diagram	The advantages of this approach include: - interconnection of all processes; - specification of inputs and outputs of processes; - maximumdetail; - widechoiceofsoftware	Requirements and satisfaction of needs are the main factor of the model A block related to improvement and perfection of the existing system has been implemented	Identification and interrelation of information flows and resources of the main processes in the company When dividing each of the processes into parts, the structure of the entire scheme is preserved. At the same time, the scheme does not become more complicated Inclusion in the general scheme of such processes as: transfer of the final result, information technology, security
Disadvantages	The model does not reflect or reveal the relationships and interactions between all processes, which makes detailing each process according to this scheme difficult. It is impossible to identify the direction of information flows in the model	Due to the high level of detail of the model, its size increases to enormous dimensions, which causes certain difficulties Complexity in development Complexity for perception due to the large number of elements and relations, the model becomes unreadable	The model will not allow for a detailed description of the process of creating and implementing products This approach creates the simplest and most abstracted models Due to abstraction, there is no description of interactions between departments	The need for specialized software

Source: authors.

Thus, having analyzed various approaches to the modeling process, we can say that NIIUK is the most suitable within the framework of the digitalization of the industrial

sector, as it helps to reveal the production potential of industrial enterprises. The only drawback is the need for specialized programs, which not every company can afford.

4 Discussion

The work by E.V. Kozlov and M.P. Sokolov [3] emphasizes the role of technologies such as artificial intelligence, the Internet of Things (IoT), big data and blockchain in transforming industrial processes. These technologies allow for automation of production, optimization of resource use and increased forecasting accuracy. According to the study by N.A. Ivanova and A.V. Stepanov [4] digital transformation helps reduce costs, increase productivity and create new business models. Particular attention is paid to studying the impact of digitalization on small and medium-sized enterprises. As P.D. Sidorov and S.V. Popov [5] noted, successful digital transformation requires revision of organizational structures, implementation of flexible management methodologies and active participation of management in the change process. The study by V.V. Gavrilov and E.S. Kuznetsova [6] shows that digitalization of production affects employment, requiring employees to have new skills and adapt to changing working conditions. At the same time, the need to develop training and retraining programs is emphasized. A.N. Petrovand K.M. Vasiliev [7] emphasize the role of technologies such as artificial intelligence, the Internet of Things (IoT), big data, and blockchain in transforming industrial processes. These technologies allow make possible the automation of production. According to V.P. Timofeev and D.G. Nikolaev [8], digital transformation helps reduce costs, increase productivity, and create new business models. Particular attention is paid to studying the impact of digitalization on small and medium-sized enterprises. As O.Yu. Sokolova and G.V. Morozov [9] note, successful digital transformation requires a revision of organizational structures, the introduction of flexible management methodologies, and the active participation of management in the change process. The study by D.A. Novikov and A.S. Kazakov [10] shows that digitalization of production affects employment, requiring employees to have new skills and adapt to changing working conditions. At the same time, the need to develop training and retraining programs is emphasized.

5 Conclusion

Digital transformation in the industrial sector is a hot topic related to the implementation of innovative technologies that can significantly improve the efficiency of production processes. This process affects all levels of management, transferring the resources of organizations into a digital format, which helps to improve manageability and optimize business processes. The popularity of digitalization is explained by its ability to create competitive advantages, reduce production costs and increase the overall productivity of enterprises. In Russia, the digitalization of industry is at the development stage, facing a number of difficulties, such as a lower level of use of information and communication technologies compared to developed countries. The introduction of technologies such as industrial automation, artificial intelligence, the Internet of Things and control systems provides enterprises with opportunities to optimize processes and increase productivity.

However, successful digitalization requires not only the introduction of new technologies, but also a revision of organizational structures, active participation of management and employee training programs to adapt to new conditions. Thus, the digital transformation of industry is a priority area of development that can positively affect not only the manufacturing sector, but also the country's economy as a whole.

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Problems of Applying Digital Solutions in Industry

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Abstract. The purpose of the work is to analyze the key problems associated with the implementation of digital solutions in the field of industrial production. This is especially important for many enterprises, as there are problems associated with outdated technologies. For the further development of digital technologies, financial support from the state is needed. Today, the percentage of investments in the development of digital economic activity is growing. Therefore, this proves that Russia is striving to keep up with global trends, which will increase the country's competitiveness. The authors consider a problem of using digital technologies in industrial enterprises of Russia. This topic is especially relevant in the context of the changing economic situation and some backwardness of Russia in terms of the development and practical application of digital technologies and developments. Since there is a huge number of industrial enterprises in Russia, they can cover the needs not only within the country, but also produce products for other countries, however, production technologies do not allow bringing production volumes to the required level, outdated developments and machines are often used, in addition to high energy costs, such outdated technologies require increased human resources, which is why the need to introduce digital technologies in the Russian industry is especially acute at the moment.

Keywords: Digital Technologies · Industry · Industrial Enterprises · Technical Progress

1 Introduction

The slow pace of industrial development in most countries is one of the main problems, domestic industry has been affected the most, among the main reasons, one can highlight the most prominent one – the lack or absence of information bases on technologies of previous breakthroughs or, in special cases, the first of their kind. The lack of information sources ultimately leads to the slowing down of digitalization, due to which even some leading industrial companies in their industries cannot afford to integrate it into direct production [1]. A decrease in the share of qualified employees – a lack of the necessary qualified personnel in the field of digital and IT technologies, their lack leads to the fact

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that some projects or systems are developed and remain «raw» even in the process of functioning, due to which it is extremely unprofitable to maintain such a system, which is why the problem arises in the professional development, integration and implementation of high-quality support for new projects.

2 Methodology

In the framework of this work, general scientific methods were used, including analysis, classification and typology method, generalization, system-functional method. The development of theoretical and practical aspects of the problem is the subject of the works of such foreign theoreticians-researchers and business practitioners. However, despite certain achievements in this area, there are still no generally accepted methodological approaches to the analysis of digital solutions. It is difficult to assess the feasibility of investment in these developments and their implementation. The impact of digitalization is the cause of various kinds of changes, even in established models. Artificial intelligence, the Internet of things, robotics have caused the largest transformation in various spheres of the economy and industry.

3 Results

Despite the sufficient breakthrough in the field of digital solutions, a lot of enterprises are adapting to these conditions slowly. Looking at the domestic industry in reality, the following problems can be identified:

- inadequate infrastructure: there are industries in which, due to legislative or technical restrictions in the infrastructure, it is impossible to fully apply new digital technologies, due to which, against the background of other industries, the industry constrained by restrictions looks slowing down or, in some cases, losing its relevance;
- high threshold of integration costs – the development of new digital systems or technologies represents a huge amount of investment funds with a high risk: whether the system or technology will actually take root; in addition to the risk and high cost of the development itself, sometimes the integration of the system will require high costs; despite all the advantages that it will give to the production of the enterprise, especially the high threshold of implementation costs will limit small and medium businesses that are not in the financial position to afford such costs;
- conflicts during integration with existing technologies: when improving existing systems and technologies, the basic version will use previous models, which will have a positive effect on integration, since this is an updated and improved version of the old one, however, when developing new digital systems and technologies, everything is created «from scratch» and the problem of integration with the «old» systems that were at the enterprise arises, which leads to disruption and the creation of obstacles when establishing business processes;
- violation of data security – in modern reality, all data is stored on digital databases, however, when an enterprise implements new systems, there are risks that data security and their leakage will become a difficult-to-solve problem for the enterprise both in terms of the company's reputation and in terms of competitiveness;

- short-sightedness of plans when implementing digital systems: before implementation, the enterprise must clearly understand what benefit this introduction will bring both from the side of business processes and their improvement, and on the other hand – to the needs of its current and potential customers;
- lack of digital culture at the enterprise: typical for the domestic industry, the lack of opportunity for the enterprise's employees to offer new ideas that would help improve both individual business processes and increase the efficiency of production as a whole;
- lack of interest from senior management in supporting digital innovations: without proper support from senior management, it is impossible to finance and implement digital systems and technologies at the enterprise, since management does not always understand their importance and potential;
- difficulties in optimizing business processes for digital systems: after the implementation of new digital solutions, the problem of adapting business processes to them is emphasized, in special cases, the organizational structure of the enterprise may change or the changes will affect various habits and norms for employees;
- lack of modernization of existing digital technologies: in order to maintain production efficiency, meet the ever-growing needs of customers and market conditions, it is necessary to update digital systems and technologies at the enterprise;
- violations of legal requirements and in the area of regulatory standards: for the operation of the enterprise without administrative fines and problems related to the legal sphere, it is necessary to comply with all requirements of the current legislation and regulations for the implementation and use of new digital systems and technologies.

The situation on the Russian market fully characterizes the above-described problems, in particular regarding the slow pace of development in the field of digital solutions. The lack of the necessary qualified personnel for the following areas: database analysis, study and use of artificial intelligence, programming, etc. This problem sharply emphasizes the difficulties in integrating digital technologies at all industrial enterprises, due to the lack of specialists who could work with digital systems and technologies. The problem associated with a vague strategy, when an enterprise without a clear understanding of the benefits of implementing digital technologies, mistakenly believes that this implementation will meet both their business goals and the needs of their current customers, is reflected in an acute discrepancy between expectations, and the benefits of implementing digital solutions will bring a negative result. One of the equally important aspects in implementing technologies at an enterprise will be the digital culture of innovations. If it is poorly developed or completely absent at the enterprise, then this is reflected in the inability of employees and their unwillingness to offer any solutions when implementing digital technologies to improve the efficiency of business operations, and on the contrary, a well-developed digital culture helps a business to improve its efficiency and implement what, in the opinion of the internal team, is more necessary than, in the opinion of management [2].

The problem of low or completely absent support from senior management is reflected in the fact that the same management assigns low priority to digital technologies, they do not understand the full potential and opportunities that these technologies and systems can give to their business. The need for management to understand all the benefits of using digital technologies can be achieved through digital transformation,

financial support and the share of funds allocated for investment in digital technologies will directly depend on this. After the introduction of new digital systems, the enterprise often needs to rework business processes to fit the implemented system. This process is accompanied by significant costs in monetary and time terms. However, this is justified by compliance with the new established requirements and opportunities opened up by the new system and technology. Changes can also affect the organizational structure, retraining of personnel and the development of new procedures and elements. One of the characteristic features of the Russian industry is the use of outdated processes and systems, however, this is due to the fact that enterprises do not want to face difficulties in the transition to new digital technologies and adapt to them, so they prefer to leave everything without any changes. Such decisions contribute to the loss of competitive advantages in the market and, as a result, the rapid closure of the enterprise [3]. When using digital technologies, one of their advantages is the ability to integrate with other systems, which can ultimately lead to complete protection of the enterprise's databases and increased efficiency, but the Russian market is faced with poorly developed standards for digital technologies, which has led to difficulties or a complete lack of integration of many systems and technologies with each other. One of the controversial aspects of digital systems is security, this is determined by possible hacking attempts or cyber incidents. In Russian practice, such problems arise often, so the domestic market is characterized by increased risks in the field of data security, which leads to a deterioration in reputation or fines from the legislature [4].

4 Discussion

There are prospects for solving problems related to the digitalization of industrial production in Russia. To increase the level of industrial digitalization, it is necessary, first of all, to integrate digital technologies into existing equipment and production processes of the enterprise. To implement this task, it is necessary to attract funding from the state, train personnel in accordance with the digital environment of the enterprise, and optimize the infrastructure. In general, the globalization of the economy has contributed to the development of technological solutions, the spread and introduction of innovations in various sectors of Russian production.

At present, the Russian Federation is under sanctions pressure from other countries, therefore, work on the joint creation of new digital technologies has been interrupted and does not give positive results, in this regard, Russia is determined to locally improve digital developments in the industrial sphere and use them in a closed format within the country. Russia currently has partner countries with which it is still possible to conduct parallel imports on mutually beneficial terms, while developing its own industry to meet the needs within the country. Such partners currently include Belarus, Kazakhstan, India, China.

The introduction of digital technologies into the Russian industry at the federal level will help accelerate the development of this industry as a whole, and in particular increase the competitiveness of manufactured goods and reduce their cost and price, thereby achieving a worthy replacement for foreign-made products. However, everything is not so simple: the main problem with the introduction of digitalization is the

difficulty of monitoring the implementation of the relevant state policy at all levels of its implementation. At the same time, it can be noted that Russia has all the resources, personnel and territories that are necessary for the creation and functioning of a digitalization structure, accordingly, the implementation of this policy at the domestic level is feasible and quite real. In addition, it is important to note that there are already successful examples of the implementation of projects related to digitalization (electronic government services, digitalization in the transport sector, digitalization in the field of medicine, digitalization in commerce, digitalization in the field of education) [5]. The successful experience can be used to develop digital technologies in the areas of industrial production. In addition, it is necessary to create a specialized research center that will develop new digital solutions that will subsequently be introduced into industrial production. The main objectives of this center are:

– training of qualified personnel for the modernization of industry and the economy, the introduction of digital technologies in these industries;
– development and application of software, taking into account the legal policy of the state in this industry, the application of scientific developments regarding the digital sphere as a whole;
– creation of a favorable environment for industrial digitalization, primarily in strategically important industrial sectors, and then in all other industrial sectors [6].

However, it is important to note that digitalization has both positive and negative aspects, which are listed in Table 1.

Table 1. Positive and negative aspects of digitalization.

Positive aspects	Negative aspects
Automation of production processes	Labor intensity associated with retraining personnel
Simplification of accounting and control of information	Possibility of loss or leakage of information
Increased productivity	Increased unemployment with a decrease in the number of jobs
Possibility of continuous operation (continuity)	Danger of information attacks and hacks

Source: authors.

When planning the introduction of digitalization in the industrial sector, it is important to take into account both its positive and negative aspects, while weighing the impact of both aspects on the activities of the entire sector as a whole and its individual parts.

5 Conclusion

Thus, we can conclude that digital technologies in the Russian Federation are at the initial stage of their development. For further progress in this area, financial support from the state is needed, the resource base must be directed to the creation of a specialized

technology center that will develop new information solutions, in addition, it is necessary to train qualified personnel who can ensure the operability of the center and will further provide assistance and support in training personnel for the functioning of technologies within enterprises.

The basis for the development of information innovations can include successful experience in the implementation of information technologies in the field of education and healthcare. The experience of implementing information innovations in these areas will significantly help in the development of digital solutions in the field of industry, since the already introduced digital solutions were developed on the territory of our country, and the development features and general specifics of the Russian economy, public policy, and society were taken into account.

This study as a whole can be useful for the top management of industrial enterprises, the working personnel of these enterprises. Among other things, the study may be of interest for developments in the field of digitalization and for further more detailed study of this issue.

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Economic Uncertainty: Conceptual Provisions

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Abstract. The category of economic uncertainty is the subject of research by a number of economic schools, the subject of long-term discussions, the need for which has not lost its importance in the context of modern geopolitical upheavals and digital transformations of modern economic systems. We consider it possible to include ideas that uncertainty is an immanent property of the functioning of complex self-developing systems among the provisions that are a consensus. The contribution investigates conceptual foundations of the uncertainty theory. The genesis of uncertainty is interpreted as an essential property of complex self-developing systems, which at points of high critical instability acquire the possibility of a variety of alternative development depending on a number of random non-deterministic phenomena and processes. The systemic and informational nature of uncertainty is analyzed. The issues of morphology of uncertainty are considered: its forms, types, levels, patterns of dynamics, interaction with related phenomena and processes such as risk, stability, safety, etc. It is concluded that technology is needed to transform uncertainty into a manageable and measurable risk.

Keywords: Crises · Economic Uncertainty · Epistemological Interpretation of Uncertainty · Essential Interpretation of Uncertainty · Recessions · Typologization of Uncertainty

1 Introduction

Being in a state of disequilibrium, the system acquires the property of randomness, increasing uncertainty in its behavior, and the latter begins to play a positive role in the self-organization of the system at a new level, contributing to its nonlinear development, characterized by high sensitivity to random, non-deterministic events. The maximum uncertainty occurs at the points of bifurcation, when there are certain «forks» in further development. In this state, the opportunity opens up for many further alternatives to movement as a mechanism for launching one of the many possible development options [1]. Uncertainty can be considered as an essential property of the world taken as a whole. Therefore, it can be argued that uncertainty acts as a mandatory attribute of the functioning and development of complex systems of any nature [2]. As applied to economics, uncertainty is a systemic, essential, and multidimensional characteristic of capital flows, market relations in general, and the financial market in particular. Therefore, it is natural that in the existing economic literature a number of aspects of economic uncertainty remain controversial, which allows the authors to express their position on this issue.

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2 Methodology

Further development of research on uncertainty issues requires a more precise methodological approach to analysis. We believe that the fundamental basis of the methodology for the study of economic uncertainty is the system-synergetic approach, justified by I. Prigozhin [1]. Uncertainty is an internal essential characteristic of any complex self-developing system, which in the course of its functioning periodically enters an unstable state as it moves towards the bifurcation point, which opens up the possibility of a multivariate further development. The development of such systems is nonlinear, allowing for reciprocating motion, accelerated forward running and deceleration. As such systems become more complex, a variety of development trends increases, as a result of the interaction of an increasing number of internal elements and constant changes in both internal and external processes. Thus, uncertainty has a systemic nature, becoming an adequate state of any complex self-developing system. Therefore, the category of uncertainty should not be analyzed by itself as such, in isolation from the system processes that determine it, but only in a system of relations that form the emergent properties of the system. Consequently, uncertainty is an immanent intrinsically inherent property of complex self-developing systems in the process of their development from entropy to synergy [3], since any evolutionary movement can be considered as its development, gradually overcoming uncertainty [4].

The second significant point of uncertainty analysis is its informational nature. Its qualitative and quantitative certainty as a phenomenon is formed by information processes that determine its existence, morphology, specific functions, the most important factors of its dynamics, and dialectical processes of further development. To a large extent, economic uncertainty is caused by the information asymmetry prevailing in the market.

The third component of the author's methodology in the study of the subject area of uncertainty is a new quality of modern dialectical probabilistic determinism, which is fundamentally different from the classical mechanistic Laplace variety. The modern understanding of determinism proceeds from the fact that the dynamics of any process is determined by a combination of a large number of fundamental and random factors, various correlations that are not strictly unambiguous, but probabilistic in nature, without a clear causal character. That is, dialectical determinism occurs with a certain degree of probability.

The fourth essential point of uncertainty analysis is the relationship and interaction with such phenomena as risk, instability, turbulence and economic security. The above-mentioned postulates serve as the foundation of the authors' methodological approach to the study of uncertainty.

3 Literature Review

Due to the versatility and multidimensional nature of uncertainty, there is an ambiguous interpretation of its essence as an economic category. Therefore, the general philosophical interpretation of this concept is very important. Uncertainty is a largely vague concept that reflects doubts in the minds of consumers, managers, and those who pursue economic policy. In addition, uncertainty is a broad, largely interdisciplinary concept: it can

refer to an uncertain trajectory of macroeconomic processes, such as GDP growth, or microeconomic processes, such as the growth of individual companies, or non-economic processes at all, such as wars or climate change. As a result, a lot of attention is paid in the economic literature to its general philosophical categorization, the study of the universal relationship between the categories «uncertainty» and «certainty». Researchers try to identify the essential features of «uncertainty» by contrasting it with «certainty» [5–7]. They named stability and autonomy from the environment as attributive properties of certainty, respectively, uncertainty is characterized by ambiguity, inaccuracy, uncertainty, unpredictability, erroneous and contradictory ideas, lack of stability, variability, and the constant formation of new relationships with elements of the external environment. Uncertainty has a certain ambiguity.

It is caused both by the complexity and probabilistic nature of the development of the market itself, and by an unreliable knowledge of the patterns of its development [8]. F.H. Knight [9] deduced uncertainty primarily from the unpredictability of the market and its complexity, but a number of scientists believe that the lack of reliable knowledge among decision-makers about the state and prospects of economic processes plays an equally significant role in the phenomenon of uncertainty. J.M. Keynes [10] understood uncertainty as the fundamental impossibility of determining the degree of probability of occurrence (or non-occurrence) of a certain event, due to the lack of a scientific basis for calculating «any probability» of a given event. This uncertainty of knowledge also determines the uncertainty of economic decisions and serves as one of the most important sources of uncertainty taken as a whole. The uncertainty of knowledge is largely determined by the inability to predict future development because of the lack of reliable information [11], and the final uncertainty depends on the structural concentration of reliable information (frequency of occurrence) [12]. Thus, due to the quality, structure, absence of distortion of information, its correct interpretation, its subjective and objective value, it can be argued that uncertainty has an informational nature, like other economic categories [13].

Due to the dependence of uncertainty on the quality of information, V.V. Mshvenieradze's view on the relationship between the categories uncertainty and blurriness is interesting, according to which «uncertainty is the lowest stage of our knowledge, and blurriness is some additional knowledge within uncertainty» [14]. In this regard, it is very fruitful to study the relationship of uncertainty with related categories. At the very beginning, we wrote about the relationship of uncertainty with the category of certainty, in addition, a number of researchers consider it important to study its relationship with the categories of risk, sustainability and economic security [4]. Regarding the relationship between the categories of uncertainty and risk, without joining the discussion, we adhere to the position of the need to transform uncertainty into a measurable and manageable risk, allowing us to take into account the full set of risks, classify them according to the probability of occurrence and the criterion of acceptability, and effectively diversify risks.

It is extremely important to analyze the determinants of uncertainty, the study of which should be based on the position that uncertainty is multifaceted both in its manifestations and in its origin. According to E.A. Kuzmin [4], due to the heterogeneity of uncertainty, its determinants are largely determined by whether it is fundamental

(systemic) or private (local). In general, it is necessary to clarify that there is a large morphological diversity of uncertainty in forms, types, and levels. Along with the fundamental [8], reflecting the macroeconomic (synergetic trend) uncertainty of the national economy as a whole (aggregating all systemic and private endogenous factors), there is private uncertainty related to individual areas, individual markets, industries, links and levels and other aspects of the economy. We can also talk about long-term, medium-term and short-term uncertainty.

Therefore, the determinants of uncertainty are determined in different ways. For example, R.M. Kachalov [15] identifies such factors as the interconnectedness and dynamism of quantitatively and qualitatively changing processes, the irrationality and subjectivity of the behavior of the main market actors, and qualitative changes in many areas of economic and social life provoked by scientific and technological innovations. In turn, H. Choi and H. Varian [16] points to the complexity of calculations, the unpredictability of the future, shadow and hidden processes (black holes of the economy) that cannot be studied and evaluated, which are natural limitations of knowledge, a kind of «clouds of ignorance». Finally, E.A. Kuzmin [4] writes about the impact on the uncertainty of the scale and density of system elements, the complexity of the system in all its manifestations. Very important are the possibilities and errors in calculating the level of uncertainty and its dynamics, forecasting errors, the list of available alternatives, the frequency and probability of individual alternatives, random subjective causes, and the well-known indicative nature of processes.

A. Greenspan [17] draws attention to the dependence of the level of uncertainty on the duration of financial investments. Investments in long-term assets are much more sensitive to uncertainty than investments in short-lived assets (hardware or software). Thus, the higher the expected life of an investment, the higher the yield needed to justify it, that is why he argues that the yield spread of a 4%-year treasury note and a 30-year treasury bond is the most useful tool for measuring uncertainty over a five-year horizon. It reflects the level of uncertainty associated with expectations regarding inflation, taxation, and many other factors.

4 Results

To reveal the essence of uncertainty, it is necessary to identify its deep properties and characteristics, relationships with related categories, and study its morphological characteristics (types, determinants, levels, sectors, dynamics, and factors). In this regard, the importance of analyzing factors determining the dynamics of the uncertainty level increases. V.D. Milovidov [18] identifies the following factors: the level of information asymmetry in the financial market, the level of irrational behavior of market participants, the degree of falsity of information, the inefficiency of ways to increase the predictability of results.

Another essential aspect of uncertainty theory is the concept of preadaptation or the phenomenon of «anticipating unpredictable changes», a kind of strategy for navigating the ocean of uncertainty, exploring the mysteries of mutual transitions between order and chaos, stability and instability [19]. Such preadaptation to uncertainty is carried out from the standpoint of a historical and evolutionary approach to analyzing the behavior

of purposeful developing systems. The phenomena associated with unpredictability, randomness, redundancy, and complexity as creative «engines» of evolution are discussed in the most detail in E. Kunin's polemical study [20], published in the USA in 2012.

The phenomenon of preadaptation in modern conditions is studied in detail in relation to the subject areas of biology and psychology, where it manifests itself as clearly, prominently and visibly as possible. All the arguments of the researchers, which are fully applicable to this field, despite the interdisciplinarity of the problem of uncertainty as a universal property of open complex self-developing systems, are probably relevant for economics as well. But the direct transfer of patterns from one subject area to another should be used very carefully and carefully. The approach itself can be considered very fruitful in the context of the digitalization of the economy. It seems that contemporary trends in digital transformation and the use of digital financial technologies, primarily Dig Data, AI and quantum computing, open up a qualitatively new opportunity to apply the concept of preadaptation to minimize uncertainty and translate it into manageable economic risk with subsequent diversification.

5 Conclusion

The development of methodological and theoretical aspects of the uncertainty category is significant not only scientifically, but also in practical terms. Despite the impossibility of completely overcoming uncertainty, reducing its level is the most important moment in predicting investment results in the financial market. Clarifying and specifying theoretical concepts about the essence of uncertainty is a necessary prerequisite for solving a fundamental practical problem – the transformation of uncertainty into a measurable and manageable risk. Moreover, modern digital technologies of Big Data, the use of the analytical potential of AI, and the modern level of risk management development make it possible to solve purely technical routine applied issues of transforming uncertainty into manageable risk and institutionalize them.

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Economic Security of Grocery Retailers

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Abstract. Currently, grocery retail is one of the protective mechanisms of food security in the Russian Federation. This is a key sector that creates jobs in all regions of the country, meets the needs of the population in a wide range of goods, and makes a significant contribution to the structure of the gross domestic product. Each major retail grocery chain has formed and is developing its own brand and distinctive business concept. Retailers such as X5 Group, Magnit, Mercury Retail Group, Lenta and others operate effectively and for a long time in Russia. Stores of such chains are created in locations with developed infrastructure, maximum passability of end consumers and a high level of competitive activity. To ensure economic security, retailers use automation, digitalization of processes, assortment analysis, merchandising, loyalty programs and self-service systems, and omnichannel. Force majeure circumstances force retailers to look for promising areas of format development. Large retail companies are striving to increase the range of products in the process of intense competition. Digital tools are being integrated into the trading space, new zones and services are being created, and a favorable atmosphere is being formed. Retailers optimize customer routes through pass-through systems to offer additional services. Because people make more purchases in one place if they find everything they need for their current needs.

Keywords: Economic Security · Digital Solutions · Food Retail · Food Security · Risks

1 Introduction

Retail of various formats works for the end user, combining the interests of buyers, sellers, suppliers and other participants in the process. Russians spend a lot on food, and the close presence of retail stores is important to them. In this industry, large retail grocery chains (LRGCs) carry out socially beneficial operations for society:

- providing the end user with freedom of choice and fast, convenient purchase of consumer goods – Fast-Moving Consumer Goods (FMCG) in the required quantity;
- providing manufacturers and distributors with organized channels for the sale of agreed volumes of products, guaranteed payment and long-term interaction;
- stimulating the processes of quality, competition, and sales for manufacturers through a system of selecting suppliers of goods and market surveys;

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– forming economic, functional and psychological value of interrelated processes of sale and purchase of goods;
– developing and landscaping the territories adjacent to the shops and others.

The sale of food and consumer goods in Russia is carried out in hypermarkets, supermarkets, minimarkets and retail outlets that are part of the LRGC structure or are independent economic entities. Store formats are characterized by the breadth and depth of the assortment, the size of the area, location and form of service, and various combinations of modern technologies. LRGCs such as X5 Group, Magnit, Mercury Retail Group, and Lenta include different types of stores in their structure (Table 1).

Table 1. The structure and key indicators of major food retailers in Russia.

Large grocery retailer/formats	Number of stores in 2023 /Retail chains	Revenue of a large grocery retailer by the end of 2023, billion rubles
X5 Group/convenience store, supermarket, hard discounter	24 472 store/Pyaterochka, Perekrestok, Chizhik	3138,50
Magnit/convenience store, superstore, cosmetics stores, pharmacies	29 165 store/Magnit, B1, Dixie, Magnit Pharmacy, Magnit Cosmetics	2500,0
Mercury Retail Group/alcohol market	25 000 store/Krasnoye&Beloye, Bristole	1150,0
Lenta/convenience store supermarket, hypermarket	2 800 store/Lenta, Monetka	615,80

Source: authors based on [1].

In conditions of ongoing uncertainty, FMCG retail shows not only stability of activity, but also growth in quantitative and financial indicators. The fact is that in crisis situations end customers (the population) cannot abandon everyday, seasonal goods, long-term storage products, and even goods related to holidays.

2 Methodology

The basis of economic research is the methods of analysis, synthesis, observation, abstraction and generalization, logical approach and formalization. To ensure the reliability of the information, reviews and reports from analytical agencies, materials from retail chains, works by Russian and foreign authors on the development of food retail and ensuring economic security, and open data from the financial statements of retail organizations were used.

3 Results

In the long term, the Russian food market will develop in accordance with new industry trends. Over the past decade, the leaders of the retail industry have been operating in a common trading space, increasing retail space, and creating a powerful production and logistics infrastructure in the contour of the country. The internal structure of each LRGCs depends on the strategic and current development plan of the company. The opening of each store of any format is associated with a study of the location according to key parameters: the number of residential buildings around the point, the number of people, car traffic, the proximity of competing stores, the number of customers (the level of attendance at the point on different days of the week), the average purchase receipt, the required range of products and consumer goods, working hours (13 h, 15 h, 24-h). The location of a retail business in a physical space correlates with its visibility and accessibility to consumers and competitors [2]. Food retailers are building a system of economic security based on the principles of inclusiveness, timeliness, efficiency, legality, and optimality. The system's functionality consists in diagnosing, stimulating, and communicating business processes, focusing on positive results, and correcting negative indicators of individual business lines.

Outlets operating under the same brand are legal entities, but they are included in the trading corporation as subsidiaries in accordance with the statutory documents, their activities are regulated and coordinated from a single management center. They are subject to corporate principles and requirements. For example, in the multiformat corporation PJSC Magnit, the following corporate documents have been created and approved, common to all divisions, regardless of the type of activity, and adopted in order to ensure economic security: the regulation on internal audit, the regulations on the corporate governance department, the list of insider information, the code of business ethics, the policy in the field of ensuring a responsible supply chain, the industrial safety policy, the packaging waste management policy, the policy on the quality and safety of food and non-food products, the policy in the field of internal control and risk management [3] and others.

Russian grocery retailers are overcoming a lot of challenges. Various external and internal risks, challenges, and threats significantly affect the level of economic security of large grocery retailers. Therefore, they must be identified, leveled, and even eliminated in time. It is worth highlighting some macroeconomic risks: interaction with government agencies, lack of growth in effective consumer demand, saturation of the market with grocery stores of various forms, reduced demand for high-margin products, increased tax burden for manufacturers of goods and sellers, staff shortages and rising labor costs, high refinancing rate and lower sales margins, the flow of some consumers to digital platforms (marketplaces), lack of government support. Challenges in food security in the value chain relate to five areas: input and production, infrastructure, public institutional support and policy, finance, and food market [4].

The Russian organizations that control various aspects of FMCG retail activities include the Rospotrebnadzor, the Ministry of Industry and Trade, the Rosstandart, the Federal Tax Service, the Rosalkogolregulirovanie, the Federal Assembly, the Chamber of Commerce and Industry, the Ministry of Agriculture, the Association of Retail Companies, the Association of Online Commerce Companies and others. And the network

should interact with all these entities in a positive way, as well as take into account the requirements of regional and local authorities to mitigate regulatory risks.

The most important market risk for LRGCs in the near future is the growth of online purchases, the cost of which is estimated at trillions of rubles. Large retail chains are closely monitoring the long- and short-term risks associated with the development of online commerce, as they make it difficult to physically increase the number of outlets. They study the main reasons for the transition of end consumers to online stores: lower prices for identical goods, the opportunity to obtain detailed information about the product, convenience of ordering, quick receipt of goods, identification of the supplier through the Honest Mark system, security guarantee and other advantages. For example, the price spread is significantly higher among online retailers than among offline retailers. Online grocery stores exacerbate price dispersion by using algorithmic pricing, defined as the practice of automating price setting using a computer [5]. Because of the declining standard of living, end customers are looking for products at promotions and discounts, trying to keep their grocery basket set at rising prices. Therefore, in order to maintain and increase sales, retailers make practical decisions by analyzing the experience of competitors:

– to fulfill the increasing demand for online grocery shopping, traditional bricks-and-mortar retailers use existing store networks to offer customers click-and-collect services [6];
– store-level sales for neighboring incumbent retailers rise upon entry of a hard-discounter, hard-discounters carry limited assortments of grocery products, most of which are private labels [7];
– trough omni-channel retailing, the transition to Retail 4.0 revolutionizes the traditional retailing workplace and promotes a twin skills transformation of the retailing workforce [8];
– with the help of modern digital channels, companies can reach a hyper-local audience, which until recently could not be done by physical stores in a fixed location [2].

The modern direction that ensures the economic security of retail is the digitalization of business processes in order to optimize, save, transparency and control. Retail and e-commerce in networks work simultaneously, forming a hybrid format for the end customer. At the same time, the customer's attachment to a particular retail network is only enhanced by loyalty programs and the necessary set and quality of products. Those who buy or order products at Perekrestok practically do not purchase goods at Magnit and vice versa. As the loyalty card provides the customer with the convenience of using offline and online modes, accumulation of points, versatility of application in any region of the country and other advantages. By digitizing processes, retailers must ensure the cyber security of individual customer data, information about which is collected through surveillance cameras, sensors, digital tags on products, loyalty cards, and personal accounts because this information is very personal and its dissemination is dangerous on the part of digital fraudsters. Therefore, additional resources (protection programs, reliable servers, and IT specialists) are required to minimize this risk. Within the framework of the retailers' economic security system, existing and potential competitors, end consumers, suppliers, new trends and tendencies, changes in legislation,

issues of import substitution of goods and related elements (for example, problems with packaging materials) and others are studied using open data and digital technologies.

4 Discussion

The general approach to the range of stores is to ensure that they are equipped with the types of goods that customers may need at any time. This position leads to excessive stocks and the appearance of unsuitable products for consumption. That inappropriate buying/delivery is the most significant cause of waste for fruit and vegetables, dairy products, fresh meat, fish and seafood, and baked products, whereas improper storage is the most critical cause of waste for frozen food [9]. At the same time, large food retailers take into account the request for environmental friendliness from counterparties and end customers. And in order to ensure economic safety, they are looking for solutions for greening the assortment, external and internal logistics processes, storage, and waste management because quantitative and qualitative commodity losses cause material damage to stores. For example, X5 Group noted in its sustainability strategy report for 2023: a 25% increase in the transfer of recyclable food products that lost their marketability before the expiration date.; up to 95% of the recycled resources generated in the own operations of retail chains are recycled; up to 100% of the packaging of ready-made food from our own production will be sustainable [10].

One of the ways to reduce food waste in stores is to use digital labels, which allow you to reduce prices in a timely manner and move stocks with expired shelf life to special shelves. Barcodes make possible the high-quality presentation of goods on the sales floor and timely reduction of the number of expired products, as well as reduce the cost of returnable flows of goods. The following solutions also exist: indicators (sensors) on the packaging (they change color as the statute of limitations expires), smart labels that change the surface according to the statute of limitations, QR code stickers for second-rate products and others. Using the example of working with food waste, we conclude that a large grocery retailer must develop a comprehensive monitoring system for all processes in order to achieve a high level of digital maturity. For this purpose, innovative digital tools are used to identify known and unknown material losses, event control and constant video surveillance of retail, warehouse and related premises of retail outlets.

5 Conclusion

Significant changes in the retail sector are inevitable. The industry is affected by sanctions, import substitution processes, uncontrolled consumer behavior, digitalization, staff shortages, and other factors. The modern buyer requires online delivery, loyalty cards, a convenient website, open information about the assortment, regular discounts and other convenient features from grocery retailers. The retailer must take into account the main requirement of the buyer – the minimum waste of time for the purchase of FMCG. Since the end customer is the main source of income for LRGCs and other participants in the product value chain, the companies carry out the following measures to ensure a sufficient level of economic security:

– provide regular customers with the opportunity to create personal accounts through loyalty programs for timely tracking of the assortment, price level, discounts, new products, suppliers;
– collect detailed information to create a portrait of the target audience and sales dynamics for each outlet to optimize costs;
– carry out digitalization and automation of internal processes (electronic price tags and receipts, self-service cash registers, the use of robot vacuum cleaners, smart store tools for monitoring and controlling the territory);
– expand the forms of payment for buyers (cash, card, smile, digital ruble, cryptocurrency).

LRGCs prefer to work with low-risk digital solutions, as they cannot afford disruptions in the operation of stores due to questionable digital tools, which, as we noted, operate according to the same principles and standards within the corporation. The harmonious development of food retailers will ensure the growth of agriculture and food security in Russia.

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Digital Innovations for Sustainable Use of Natural Resources and Energy Saving

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Abstract. Digital transformation of the economy and society and high potential of digital innovations for solving sustainable development problems is of high priority. The research aim is to analyze digital innovations in the context of sustainable use of natural resources and energy saving. The main methods include content analysis of literary sources, analytical; statistical, comparative analysis and data grouping method. The authors clarified the concept of sustainable use of natural resources and supplemented the economic criterion of sustainable use of natural resources by environmental and social ones. The most promising digital innovations are the following ones: artificial intelligence, big data processing technologies, the Internet of Things, computer modeling and machine learning, blockchain technologies. The authors specified opportunities in the field of sustainable use of natural resources and energy saving. The analysis of statistical information made it possible to identify a trend of increasing costs for digital technologies and determine sectors and types of activity in the Russian economy that are the main beneficiaries. Digital innovations gave the greatest effect for Russian enterprises in solving the problem of waste disposal and increasing energy efficiency. The work summarized the main risks of implementing digital innovations: employees, social and economic risks. It is concluded that the marginal revenue from digital innovations exceeds the marginal costs.

Keywords: Digital Innovation · Digital Technologies · Energy Saving · Sustainable Development · Sustainable Use of Natural Resources

1 Introduction

The problem of sustainability is very relevant for many developed countries. It prioritizes issues of preserving the environment for people living now, and for future generations. Sustainable use of natural resources is considered in the context of sustainable development, representing one of the priority areas. At the same time, existing practice shows difficulties in its implementation outside the economic and social context. Sustainable use of natural resources should contribute to solving urgent socio-economic problems, which include climate change, growing shortage of fresh water, reduction of biodiversity and forests, desertification, increased frequency of natural disasters, growth of poverty and inequality, degradation of some components of human capital, as well as the human habitat in many parts of the world.

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The integral element of sustainable use of natural resources is resource and energy conservation, with an emphasis on renewable energy sources (RES). The means and conditions for transferring the exploitation of natural resources to a system of reproduction of natural goods – the so-called «green» transition – are becoming relevant, and digital innovations are becoming tools for solving these problems.

The problem of sustainable use of natural resources is studied in the context of achieving the sustainable development goals formulated by the United Nations (UN) [1, 2], macroeconomic regulation [3, 4], development of national projects and programs, solving specific issues of enterprise functioning under external constraints (for example, the transition to renewable energy sources or resource conservation [5, 6]), territorial and ecosystems development [7, 8]. This issue is a separate subject of study for some scientific disciplines, such as, environmental economics or environmental management. The problem of energy saving is related to sustainable development principles, «green» energy transition. It is a main factor in achieving environmental sustainability. The integration of digital tools and green technologies provides unprecedented opportunities for improving monitoring, forecasting and managing environmental impacts, which is also studied in contemporary literature [7, 8]. Digital technologies provide innovative approaches to optimize resource use, increase the transparency of supply chains, and enable real-time monitoring of the environment [9–11]. Digital solutions open broad opportunities for automating production processes, facilitating of physical (manual) labor, and saving money for both businesses and consumers.

Digital technologies are truly revolutionizing approaches to energy efficiency policy in all sectors of the economy and in most countries in the world. Artificial intelligence [9] and digital platforms [11] are proposed for digital energy management. The Internet of Things has made autonomous vehicles a reality. Research results confirm that digital technologies in logistics and supply chain management have a moderate positive impact on environmental and social sustainability [10]. At the same time, their significant transformative potential is accompanied by new risks and threats, including the digital divide and digital inequality, high initial costs, data privacy issues and the paradox of increasing energy consumption [12]. Researchers study both the positive and negative impact of digital technologies on business practices, including environmental pollution parameters or individual aspects of the nation's biophysical capital. Digitalization prospects for solving problems of energy and resource conservation and sustainable use of natural resources require clarification and specification.

2 Methodology

The authors used materials from scientific research on issues of digitalization presented in periodicals, the use of digital technologies, and sustainable development. The following main research methods were implemented: content analysis of literary sources, analytical, statistical, comparative analysis and grouping method. The used source of statistical information is results of the study conducted by the National Research University of Higher School of Economics [13].

3 Results

The authors studied and clarified the concept of sustainable use of natural resources. It is a balanced use of natural resources, water, air, and geophysical shells of the earth. Sustainable use of natural resources satisfies interests of the present and future generations and it is based on the environmental imperative of human society: increasing economic efficiency and the level of satisfaction of human needs should not be accompanied by environmental degradation and uncontrolled growth of environmental risks. The ecological criterion of sustainability is complemented by economic and social ones: reducing the extraction of non-renewable natural resources requires mandatory compensation through the growth of other types of capital, both physical and human. This implies rational management of the environment and active sustainable consumption of renewable resources. Such a comprehensive approach makes possible a balance between ecological, economic and social interests, ensuring a more harmonious interaction between man and nature. New opportunities in the field of sustainable use of natural resources and energy conservation were substantiated (Table 1).

Table 1. The most popular digital innovations and possibilities of their use.

Digital technologies	Opportunities for ensuring sustainable use of natural resources	Opportunities for energy efficiency
Artificial intelligence	Improved monitoring, which speeds up the response to risks and threats, such as forest fires Optimization of resource consumption, business processes, minimizing pollution	Rationalized use of flexible and renewable energy sources Distributed generation
Big Data Processing Technologies	Data analysis helps identify trends and predict future changes. Modeling future changes in ecosystems. Developing strategies to minimize environmental impacts	Advanced energy analytics, demand forecasting, energy optimization
Internet of Things	Air, water, agricultural and forestry quality sensors [10]. Monitoring the state of water resources, air environment, forests to prevent pollution, fires, illegal logging and timely adoption of measures to protect ecosystems. Creation of a more comfortable and environmentally friendly urban and rural environment. «Smart factory», «Smart field», rational resource consumption and waste reduction	Energy consumption sensors. Optimized energy infrastructure. Rationalized use of flexible and renewable energy sources. «Smart home», «smart city», energy saving, improving the quality of life

(*continued*)

Table 1. (*continued*)

Digital technologies	Opportunities for ensuring sustainable use of natural resources	Opportunities for energy efficiency
Computer modeling and machine learning	Climate modeling. Anticipating changes and developing adaptation measures. Biodiversity modeling. Developing strategies for biodiversity conservation. Resource flow modeling Efficient management of natural resources	Modeling of energy flows, optimized energy consumption management, increasing the efficiency of energy resource use
Blockchain technology	Increased transparency of transactions. Carbon footprint management. Emissions control. Simplifying regulatory compliance, optimized emissions trading schemes	Energy monitoring. Transaction transparency and distributed generation maintenance

Source: authors.

A trend of increasing costs for digital technologies in the Russian economy has been identified. It may indicate that marginal revenue exceeds marginal costs, and that economic entities are extracting additional income as a result of digitalization. The share of digitalization expenditures carried out by the 2,500 largest global companies in the total volume of research and development expenditures already exceeded 30% in 2020 and continues to grow at present. In 2023, there was an increase in the volume of capital investment in digital technologies, in goods and services related to them, such as transportation and storage (+56.1% in current prices), public administration (+36.8%), information and communication technologies (+27.7%), and the financial sector (+25.1%) [14]. In 2023, the expenses of enterprises and organizations on software increased by 6.5%, which, in the context of limited access to foreign digital products, indicates that domestic demand is being met through domestic solutions.

More than 36% of all internal expenses of organizations on the development, distribution, application of digital technologies, as well as related products and services, are provided by the so-called «digital» industries: telecommunications (the share of expenses on digital technologies is 25.7% of the gross added value), the information technology sector (23.3%). Digital innovations are in demand, especially, big data processing technologies and artificial intelligence in the financial sector (7.7%) [14].

The importance of digital technologies in achieving environmental sustainability criteria by Russian enterprises has been determined. It has been established that their most significant positive impact is in solving the following issues: reducing energy intensity of production (36% of surveyed business executives), resource conservation (35%) [13]. The share of industrial enterprises in our country that have benefited from investing or using digital tools to solve environmental problems has increased from 47% to 70% (almost 1.5 times) from 2021 to 2023. The greatest positive effect was achieved in reducing the impact on the environment (from 49% in 2021 to 73% in 2023), in

environmental, health and safety standards (from 51% in 2021 to 73% in 2023), in reducing the energy intensity of products (from 54% in 2021 to 70% in 2023).

The statistics of companies implementing digital innovations in 2023 compared to 2019 revealed the increase in their share in solving problems related to waste disposal (from 12% to 27%), expansion of the number of electric vehicles (from 2% to 6%), reduction in the material intensity of products (from 5% to 9%), increased energy efficiency (from 17% to 24%), as well as more efficient use of water resources and other materials (from 13% to 18%). At the same time, digitalization in other areas was less active during this period: enterprises in Russia used digital technologies in green energy much less often, the number of leaders in this matter is stable (2%). The share of companies that reduced greenhouse gas emissions and pollutants using digital technologies remained at 6%, and a negative change was recorded in the production of clean and safe energy from 7% to 3% over the period 2020–2023 [13].

Risks arising from the use of digital innovations are summarized and systematized. Risks for the employee are information overload, increased load on some organs and systems of the body (vision, spine), monotony, decreased concentration and distraction of attention, release and replacement by automated labor, intensification of intellectual labor and growth of hidden exploitation, leakage of personal data and violation of personal boundaries during control. Social risks include alienation and autonomy of consumers, risks of mental health, fatigue and overwork of users, deficit of digital skills. Economic risks are growth in energy consumption (due to video content, growth in the number of devices used) and greenhouse gas emissions into the atmosphere, volatility of energy and raw materials markets (spikes in prices for fuel and energy resources), instable labor market in the digital sector (shortage of specific human capital and growth in unemployment in the non-specific human capital sector), cyber security, data leaks and growth in opportunity costs to minimize them, unfair competition and rapid market takeover by companies with comparative advantages in the use of digital tools, dependence on Western digital technologies and external management of the global economy. As a result, threats to energy, environmental and social security arise, which are to varying degrees relevant for specific countries and territories.

4 Discussion

Continuous improvement of digital tools for solving environmental problems, providing open access to environmental data for making rational decisions, environmental education, development of skills in the field of resource and energy conservation increase the sustainability and energy efficiency of economic growth. Digital innovations for enterprises, digital technologies, digital tools (devices, applications, software for working with data) and new business models (online interaction, training, online banking, trade, etc.) can solve the problem of sustainable use of natural resources and energy saving. At the same time, some traditional risks are weakened (for example, safety risks during production, physical fatigue with a high share of manual or manual-mechanized labor, the risk of leakage of waste harmful to humans, etc.). But other risks appear (for example, reduction in natural biodiversity or new types of environmental pollution). There is an opinion that if we keep the current rate of energy consumption by the information

sphere, its share in global energy will reach 20% in the very near future. Taking this into account, digital technologies can become one of the main sources of greenhouse gases by 2040. Researchers emphasize that imperfect digital technologies can increase processing errors, ineffective supervision procedures will lead to operational failures [15]. The spread of digital innovations and online services will create risks in obtaining high-quality financial services and will complicate the management and control.

5 Conclusion

Sustainable use of natural resources is a complex ecological and economic system aimed at the conservation and «smart» management of natural resources, reduction of environmental risks, energy conservation, prevention of biodiversity degradation and deterioration of the quality of ecosystem services. And it derives a positive effect from digitalization. The use of digital innovations is associated with an increase in factor productivity, an increase in the comfort of life, simplification of communications, strengthening of well-being on the way to achieving sustainable development goals, and with risks. However, the marginal income exceeds the marginal costs, which creates incentives for intensifying efforts to create and improve digital solutions.

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Transition to the Fourth Industrial Revolution, Russia's Potential from Manual to Digital

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Abstract. The work investigates the attitude of countries to innovations using the marketing approach to analyzing consumers' attitudes to new products. It identifies reasons that motivate countries to create innovations that contribute to the emergence of technological revolutions and paradigms, determined by the level of the country's scientific potential and financial well-being, which is facilitated by the modern migration policy of developed countries. The position of Russia and its capabilities in forming innovative development prospects in accordance with modern realities are studied. The Russian Government has identified priority areas of development, expressed in a combination of current goals outlined by national projects and strategic ones formed by the national technology initiative project, based on the end-to-end development of the direction of digitalization of processes. The authors studied changes in the number of enterprises using software for 2022–2023, analyzed types of software products, revealed a significant increase in Russian software. The need to create factories of the future based on industrial software and process management capabilities is identified. At the same time, problems related to low labor productivity, irrational activity of most large enterprises, expressed in high wear and tear of equipment, as well as inefficiency of technological processes associated with losses, high production costs and high cost of manufactured products, were determined, which led to the emergence of a national project combining the concept of frugality with the digitalization of processes.

Keywords: Factories of the Future · Innovativeness of States · Labor Productivity · Lean Manufacturing · Modern Migration Policy · National Project · National Technological Initiative · Scientific and Technological Progress

1 Introduction

Progress caused by rational human activity, scientific discoveries, innovations, reflected in industrial revolutions and changes in technological structures, inevitably pushes society to perceive and adapt the next innovative shocks, thereby continuing its development

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[1]. The marketing approach implies a conditional division of all consumers into five groups: innovators, early followers, early and late majority, and a small group of laggards or conservatives. This attitude to innovations can be compared with the attitude of countries to progress in general: in the world there will always be innovators striving to invent something, early followers who easily but with conscious caution perceive the new, early and late majority who are initially skeptical, but positively perceive the novelty and accept the new after confidently recognizing the benefits of those who have tried it before, as well as conservatives – clearly lagging behind in the perception of the need for application, the possibility of use and understanding the advantages of a given invention. Such differences in both advancement and lag are determined by different levels of socio-economic and technological development of countries.

2 Methodology

The authors studied reasons, the development of which influences the creation of an innovative climate in the country, which subsequently contributes to technological leadership among other states. The decisions of the Russian Government on the development of the National Technological Initiative as a measure to prevent the country from lagging behind developed countries, as well as National Projects based on the elimination of current problems and further development to ensure long-term goals, were analyzed. The positive dynamics of software types, including industrial software, process management tools used today by Russian enterprises and requiring further active implementation to create factories of the future were identified and assessed.

3 Results

The motivating factors that contribute to the development of innovative behavior of countries are determined by two main criteria: the level of scientific potential and the degree of financial well-being, while the latter acts both as an investment and as a solvent demand of the population, initiating further development of the potential of innovative companies. In this regard, a vicious circle arises: scientific knowledge launches innovations, supported by the solvent demand of the population, ensuring the leadership of leading innovative countries, but passing the diffusion stage, the in-demand innovation launches a similar process in other countries, similar to the marketing approach, starting from early followers to laggards, but the beneficiaries are certainly the leading countries in developments [2].

It should be noted that this process of creating innovation at the country level is the most important factor in the formation of its own scientific base and an incentive for further development of the state. At the same time, due to the openness of the economies of the whole world, the modern migration policy of developed countries implies the formation of their own scientific potential, including at the expense of other countries, while accumulation occurs not only in the field of knowledge, but also in finance, thereby providing an advantage in the scientific sphere, supported by the investment basis of their own country for the creation and provision of further well-being of citizens. The increased standard of living of developed countries, as a rule, provokes an outflow from

donor countries of people with intellectual abilities and financial opportunities. Such changes determine the governments and leaders of countries to create conditions for the development of individual capabilities of citizens in their country, forming and building strategic prospects for the development of their own country. Analyzing the richest countries in the world, it was revealed that in terms of the AI return indicator, the USA, China, Japan are confidently leading [3–5].

The situation of the Russian Federation today is characterized by a number of features, both economic and political factors of external influence, and socio-economic influences of the internal environment. In addition, at the moment Russia does not have the level of wealth of the USA, China, Japan and other European countries, providing investment activity, the country's population is also in dire need of population reproduction. However, Russia has certain technological developments in the field of production technologies, capable of competing in the international innovation market. The current situation forces the Russian government to take active macroeconomic policy measures to prevent the country from lagging behind the set pace of global scientific and technological progress and the standard of living of the population of advanced countries that are leaders in developments, contributing to the development of similar indicators in their own country.

A number of experts agree that a slight lag today, with a passive state policy, in the future may provoke a lag with a cumulative effect and the unattainability of leadership in scientific and technological progress. Along with the current short-term goals, the country's leadership in 2014 also outlined strategic goals for a long-term planning horizon of 10–15 years in the framework of the National Technology Initiative program. While national projects developed in the country are supervised by the state, the National Technology Initiative implies interaction not only of government bodies, but also of entrepreneurs, universities, and professional experts, whose interaction is aimed at creating an innovative basis for the future development of the country [6, 7].

Initially, the National Technology Initiative was presented as a matrix containing key technologies and support measures in training personnel for the development of promising areas represented by ten markets of the future, based on advanced production technologies. Today, this matrix has been significantly supplemented and specified: while the semantic structure has not changed, the markets of the future have been supplemented to 15 areas, which are combined into groups according to the degree of high cost of the infrastructure being created, the degree of business participation and the response to decision-making on emerging challenges, the structures (organizations) that form the training of personnel and the principles of talent formation have been specified, auxiliary communities have been designated and previously defined relevant areas have been significantly expanded, today consisting of 25 «explosive» technologies. An integral accompaniment to such areas is the «Digital Economy» program, which ensures the creation of an end-to-end infrastructure, legal regulation of processes, the personnel component, security, improvement of public administration, but most importantly – the implementation of support for IT startups in various sectors of the economy, the development of the use of AI, as well as the promotion of new technologies not only in Russia but also abroad [8, 9].

A clear example of the increased impact of digitalization is the increase in software used by enterprises. Thus, according to Rosstat [10], the number of organizations using various software in 2023 has increased significantly compared to 2022. In areas related to information security and application software, the growth was more than 3 times, software for industry and tools for managing processes in the organization show an increase of more than 2.5 times, and systems for collecting, storing, processing, analyzing, modeling and visualizing data and data analysis tools also show a more than two-fold increase, in addition, industry software appeared in 2023. In addition, in 2023, Rosstat data highlights information on domestic software, which occupies a significant share (about half or more) in the total indicator for 2023, practically in the same areas in which significant growth is noted.

Today, the economy resolves the contradiction expressed in limited resources and unlimited human needs in a new way, proposed by the next level of scientific and technological progress. Strategic goals in Russia regarding the factories of the future are gradually being developed, pilot enterprises have been selected, where programs are being created and applied that allow building modern robotic production based on digital models, artificial intelligence, characterizing industry 4.0. However, today, most industrial enterprises note a significant lag in the equipment and technology used, where there is almost complete physical wear and tear of 3/4 of the equipment, characterized by insignificant use of equipment with numerical control, downtime, a high level of defects and rework, underutilization of labor resources, a lag in labor productivity, etc., and, as a result, low efficiency of the entire enterprise.

4 Discussion

In order to improve the efficiency of domestic enterprises without using significant investments, the national project «Labor Productivity» was launched with the supervising organization Federal Competence Center (FCC), which trains company employees in lean manufacturing methods, which at the beginning of the last century already allowed the country to move to a new level of efficiency of enterprises and the country as a whole. The national project is aimed at solving the current urgent problem – eliminating the more than twofold lag of the Russian Federation in labor productivity, applying the lean manufacturing concept and increasing labor efficiency through the introduction of appropriate software and digital solutions in business. The project is designed to ensure an annual increase in labor productivity by 5%, providing companies with comprehensive support and consultations, demonstrating, on the one hand, the advantages of a conscious approach to the problem of careful treatment of enterprise resources, reducing various types of losses in production, systematically building a map of value streams for the consumer, on the other hand, the need and justification for using the appropriate software, which together leads to a decrease in the cost of production [11, 12]. As a result, by 2023, 85 constituent entities of the Russian Federation were covered, support was provided to more than 5,000 enterprises, of which 60% were able to show an annual 10% increase in labor productivity, allowing a total increase in profits by more than 300 billion rubles, which is almost 10 times more than the funds spent on the implementation of the national project, however, this work on reconfiguring enterprises in manual mode

continues, since it develops the ability of workers to identify and eliminate losses, to some extent allows the workers themselves to develop, «pumping up» their own skills and competencies, which ensures an increase in the efficiency of the enterprise and a decrease in the need for personnel [13]. The gradual change of enterprises in various types of economic activity, based on the support of the national project «Labor Productivity» prepares companies for more advanced and large-scale changes in the future, based on modern digital approaches, in accordance with the strategic directions of the national technological initiative, requiring more significant financial investments associated with the creation of factories of the future, the basis of which is the almost complete digitalization of production processes (about 95%), the unmanned nature of technological operations (from 50% or more) based on robotics, virtual management of a software complex (Big Data), etc. [14].

5 Conclusion

It's worth noting the competitive nature of the interaction between countries, conditioned by state policy aimed at developing innovative processes that contribute to the primacy of countries in a particular area, as well as the obviousness and timeliness of the measures taken today by the Russian Government to prevent the country from lagging behind in the transition to the next stage of technological development, allowing us to build a well-thought-out policy of gradually increasing potential in promising areas, as well as consistently changing the current situation in lagging areas.

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Transport and Logistics Sector in the Context of Digital Business Transformation

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Abstract. The contribution is devoted to the study of issues related to the processes of innovative development of the transport logistics sector through the use of tools and technologies for digital transformation of modern business. The current state and general prospects for the development of the transport and logistics sector are considered, and the relevance and significance of innovative development of this sector of the economic system are emphasized. The advantages of innovative and digital transformation of the transport and logistics sector are identified. The goal of further development of modern transport logistics is defined and the features of this process, closely interconnected with the course of digitalization processes and the use of its tools in various sectors of the economy, are noted. General trends in the development of the transport logistics sector are identified, a list of the most promising areas of innovative development of the transport and logistics sector in the context of digital transformation is formed, and characteristics of the identified areas are given. Such modern trends in the development of the logistics sector as seamless and flexible logistics are mentioned. Conclusions are made on the state and further prospects for optimizing processes in the transport and logistics sector.

Keywords: Digital Technologies in Logistics. Digital Transformation · Directions of Development of the Transport and Logistics Sector · Innovative Development · Transport Logistics

1 Introduction

In the modern conditions of the development of globalization processes and cooperation of strategic partnerships between various countries, often significantly distant from each other, the sphere of transport logistics is becoming increasingly important, acting as a link necessary for building connections and routes. The implementation of digital transformation processes, covering all spheres of the economic life of society, has an impact, among other things, on the transport and logistics sector, within which significant transformations are being carried out caused by changes in the structure of doing business. Today, the effective functioning of the transport logistics sector is impossible without the innovative development based on the implementation and use of digitalization technologies [1].

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Traditional methods of organizing logistics activities that have been actively used for a long period no longer bring the expected efficiency, which, in turn, requires business owners to revise their approaches to the transport and logistics sector. Achievements of scientific and technological progress and digital reorientation of socio-economic systems allow modernizing business processes and operations in the field of transport logistics, ensuring more transparent cooperation between partners, clear and convenient document flow, high quality of delivery, as well as a number of other various advantages. The relevance of the study is determined by the importance of optimization and innovative digital transformation of operations and processes in the field of transport logistics. The research purpose is to study a theoretical basis devoted to the selected topic, as well as further formation of conclusions on the state of the problem and identification of the most promising areas of innovative development of the transport logistics sector.

2 Methodology

The information and theoretical basis of the study is a combination of various sources, including regulatory legal acts of various levels, scientific materials and research articles, periodicals, studies of independent agencies and business associations, as well as official statistics. In the framework of this study, it is worth highlighting the application of several generally accepted methods of economic research in science, namely, the study of theoretical foundations and generalization of the information obtained, the method of analysis and synthesis, the method of statistical analysis and the formation of conclusions and proposals based on the studied material.

3 Results

The transport and logistics sector faces a variety of challenges from the external environment and changes in the way various economic entities conduct their activities, associated with transformations in consumer behavior, increased competition, as well as complications in technological, information and digital systems that form a basis of modern business and society as a whole. t the same time, the transport logistics sector has extensive prospects for further development associated with the introduction and use of innovative digital technologies.

In recent years, transport logistics has become an increasingly important area both within specific business units and in relation to the economic system as a whole. This situation is largely determined by the growth of consumption and, accordingly, production in the modern world, and also by significant transformations in international relations, requiring a revision of logistics routes and the transport component of the delivery of various types of cargo. Thus, according to statistics, by the end of 2023, about 6.3% of the domestic GDP was created in the transport and logistics sector, provided that more than 200 thousand organizations are registered in this industry, providing jobs for 6 million residents of the country [2]. The annual growth of indicators characterizing the state of the transport logistics sector determines the need to develop measures and implement activities aimed at implementing innovative development of this area, consisting in the use of new technologies, tools and strategies to optimize transport and

logistics activities and reduce costs. The development of the transport logistics sector in the current socio-economic conditions is based on the application of innovative digital technologies, the implementation of which has a number of significant advantages for this area of economic activity (Fig. 1).

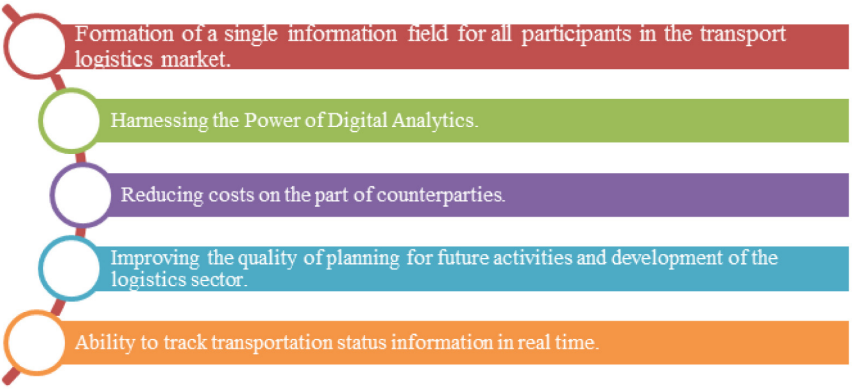


Fig. 1. Advantages of innovative development of the transport and logistics sector (Source: authors based on [3]).

The process of innovative development of the transport logistics sector is closely interconnected with the implementation of digital transformation of the industries in this sector and involves the development, implementation and active use of new technologies, including digital ones, strategies and approaches to organizing activities in the field of transport and logistics. The purpose of implementing measures for the innovative development of the transport and logistics sector is to optimize a wide variety of logistics operations, improve the quality of service in the transport logistics industries, and reduce business costs associated with the organization of transport and the logistics system as a whole [4]. It should be noted that the introduction of innovations in the transport logistics industry is a determining factor in efficiency in modern conditions, which is associated with the complex structural transformation of socio-economic systems caused by the widespread digitalization of various social and business processes. Innovations in the field of transport logistics, among other things, also have a positive impact on the speed of business processes in the industries of this sphere, which is associated with an increase in the level of automation of the sector and a reduction in the duration of logistics operations. In this regard, specialists working in this area are given the opportunity to free up some of their working time by automating routine operations, which allows them to concentrate on more important functions related to analytics, making management decisions and business development decisions, as well as developing an innovative strategy for further improving the functioning of the sector.

Digital and innovative technologies influence the implementation of deep transformations in the transport and logistics sector, uniting the entire sector with a variety of its modes of transport and features into a common network. The technologies and modes of transport used in logistics are becoming increasingly environmentally friendly and

autonomous, ensuring a high level of efficiency in the sector [5]. In the field of transport logistics, under the influence of transformative processes of digitalization and innovative development, entire ecosystems are being formed, ensuring the full implementation of a full cycle of logistics and transport services based on digital tools, platforms and solutions. Every year, the introduction of digital technologies and innovative products in the transport and logistics sector increases, which is confirmed by statistical research data. Thus, by 2030, the demand for digital and innovative technologies in this area will demonstrate an average growth of 21% annually, and the volume of investments in the innovative development of transport logistics will amount to more than 600 billion rubles annually [6]. This situation is associated with the high relevance and effectiveness of the introduction of digital technologies into the functioning of the transport logistics sector, as well as a wide variety of digital and innovative tools that can be used to optimize business processes in the industries of this sector of the economy.

Speaking about the general trends in the innovative development of the modern transport logistics sector, it should be noted that, in addition to focusing on the digital transformation of socio-economic systems, the basis for the process of innovative transformation of the sphere is formed by the trends of globalization and international integration with friendly countries. As for more specific tools and technologies for innovative and digital development of the transport logistics sector, the authors analyzed and identified the most promising and effective areas that can significantly improve the quality of transport and logistics operations and optimize the main business processes in the field of transportation and other various logistics operations. The formed directions of innovative development of the transport logistics sector and their brief characteristics are presented in Table 1.

In addition to the above-mentioned current areas of innovative development of transport logistics in the context of digitalization, it is also necessary to note the popularity and effectiveness of such innovative technologies in the functioning of the transport and logistics sector as biometrics, cloud technologies, connectivity technologies and machine learning, as well as the use of the principles of seamless logistics, which is the implementation of logistics operations in the conditions of unimpeded movement of various vehicles along the entire supply chain [8]. The set of areas of innovative development of industries in this sector represents in modern conditions a trend towards flexible logistics aimed at the digital transformation of the sector and the active use of digital tools and technologies.

4 Discussion

The issues of innovative development of the transport and logistics sector are becoming increasingly relevant every year, which is associated with both the implementation of digital transformation of business processes and the development of trade and transport relations with friendly countries. The study of the processes of innovative development of the transport logistics sector, especially in recent years, is reflected in many different studies by domestic and foreign authors, as well as in reports and documents of independent sources and business representatives [9, 10]. In addition, the development of transport logistics through the introduction and use of innovative and digital technologies is one of the priorities of national development in the field of optimization of

Table 1. Current directions of innovative development of the transport and logistics sector in the context of digital business transformation.

Innovative development direction	Brief description
Artificial intelligence	AI in the field of transport logistics allows solving a lot of problems and optimizing various processes, from supply chain management to scaling up business in this field. AI is one of the most promising areas of innovative development in the logistics sector and has excellent prospects for practical application
Robotization	Robotics makes it possible to significantly reduce costs by optimizing warehouse logistics, as well as improve the quality of service in the field of transportation. Robots in logistics work quickly and are easy to learn, which allows you to quickly adapt to market changes and external conditions
Clean technologies	Transport logistics is one of the leaders in the amount of emissions into the environment, which in modern conditions makes the use of clean technologies a relevant direction for development. The use of clean technologies in logistics not only makes the sector more environmentally friendly, but also increases the attractiveness of transport and logistics companies in the market
Blockchain	Blockchain technologies in logistics allow you to increase the level of traceability of goods and transactions, which reduces the number of errors and makes it possible to implement better control
Big data analytics	This area of innovative development in the field of transport logistics makes it possible to conduct a thorough analysis of large amounts of information from various sources, thanks to which business entities can more accurately predict the demand for their services and manage stocks
Virtual reality technologies	Virtual reality allows you to predict various situations by comparing digital data with the real market situation, which makes it possible to make informed management decisions in real time

Source: authors.

business processes, which is confirmed by the approval and active implementation of state programs in the logistics sector. For example, it is especially necessary to highlight the state program «Development of the transport system» [11].

5 Conclusion

Based on the results obtained, several key conclusions can be made. Firstly, the transport logistics sector is becoming increasingly important for the country's economic and social system, which is associated with both the processes of globalization and the development of international cooperation, and is determined by the development of trade and the growing need for timely and safe activities in the field of logistics and transport. In this regard, the relevance of transforming the transport and logistics sector is increasing, which in modern conditions is most effective through the use of innovative and digital technologies. Secondly, the implementation of innovative development of the transport logistics sector has a number of significant advantages both for business representatives in this area and for the economic system as a whole. Improvement of transport logistics industries and processes aimed at optimizing basic logistics operations and transport functioning is a comprehensive process of development, implementation and application of innovative and digital technologies. Finally, today the variety of digital technologies and tools that ensure the process of innovative development of the transport logistics sector is so extensive that it allows each specific business entity to select individual, most optimal and effective directions for further development in each specific case, taking into account the implementation of innovative and digital processes.

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Integrated Approach to Assessing the Greening of Innovative Activities of Enterprises (Regional Aspect)

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Abstract. The Russia's transition to innovation-oriented economic growth and the strengthening of the role of technology as a factor in the development of the economy and social sphere may lead to a decrease in environmental safety. In this regard, the study of regional aspects of the greening of innovation processes is relevant, since the adversely affecting social and environmental trends of recent decades are expressed in risk factors in the regions of the country and a decrease in the negative effect of their interaction, which is a basis for environmental policy and stable economic and environmental development of the federal subjects. Innovative solutions aimed at achieving the ultimate goal are called environmental innovations, and the existing trends to increase their quantity and quality are interpreted as a manifestation of a single process of greening innovative activities. The purpose of the study is to develop a methodology for an integrated approach to assessing the environmental aspect of enterprise innovations using the example of the regions of the Volga Federal District (VFD). Based on the integral indicator and its components, the ratings of subjects are determined and the types of regions are identified by the level of greening of innovative activities of enterprises. Typological grouping according to the integral indicator of greening of innovations revealed regions in which it is necessary to increase the share of enterprises using innovations in their activities aimed at solving environmental problems and which need support from regional government and administrative bodies.

Keywords: Ecology · Enterprises · Innovations · Integral indicator · Regions

1 Introduction

In accordance with the national development goals of the Russian Federation until 2030, an important task for creating technological conditions for socio-economic development is the transition to innovation-oriented economic growth and strengthening the role of technology as a factor in the development of the economy and social sphere [1]. Intensification of innovative activities that contribute to economic growth may lead to a

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decrease in the environmental safety of production complexes and their products, which will lead to irreparable consequences. An increase in the number of man-made disasters, pollution of water, air, soil and food will directly affect the health of the population. One of the components of the state policy is to ensure environmental safety, in connection with which the study of regional aspects of the greening of innovation processes is relevant. Environmental innovations are new or significantly improved goods, works, services, production processes, organizational or marketing methods that contribute to increased environmental safety, improvement or prevention of negative impact on the environment [2, 3]. The absence of a single methodology for quantitative assessment of greening innovations at enterprises using the appropriate statistical tools also determines the relevance of this work.

2 Methodology

The study was conducted based on official statistical data from Rosstat for the subjects of the Volga Federal District (VFD) for 2023. The following methodology for constructing an integrated indicator of innovative activities of enterprises aimed at greening or an integrated indicator of greening of innovations (IIGI) is proposed:

- for each particular indicator of greening of innovations, standardized or normalized values are calculated by comparing the values of each indicator for each federal subject with the average value for the population;
- from the normalized values of particular indicators for each block, a generalized assessment is calculated using the geometric mean formula;
- from the generalized assessments, by weighting them by the number of indicators included in each block, an integral indicator is calculated using Eq. (1):

$$\text{IIGI} = \text{GALIO} *6/10 + \text{GALIU}*4/10 \tag{1}$$

where GALIO is a general assessment of the level of innovations that provide environmental benefits received by organizations; GALIU is a general assessment of the level of innovations that provide environmental benefits received in the process of consumption or use of goods/services by end users. Based on the integral indicator and its components, ratings of subjects are determined and types of regions are identified according to the level of greening of innovative activities of enterprises.

3 Results

Innovations to improve the environmental component of the production process are not used by all enterprises in the regions. The official website of Rosstat provides information on the share of enterprises implementing innovations aimed at improving the environment, as a percent of the total number of surveyed organizations (Fig. 1). In the Russian Federation, the value of this indicator in 2023 was 1.1%, in the Volga Federal District – 1.4%, in the subjects of the Volga Federal District there is a variation in values from 0.7% in the Ulyanovsk Region to 2.2% in the Republic of Tatarstan. It should be noted that, compared to 2010, there was a significant reduction in enterprises using innovations to green their activities in almost all regions of the VFD, with the exception of the Republic of Mari El, where the share of such enterprises did not change.

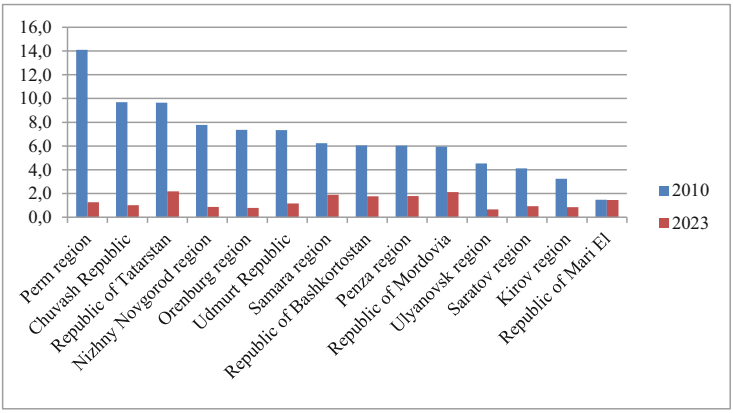


Fig. 1. The share of enterprises implementing innovations aimed at improving the environment (in % of the total number of surveyed organizations) in the regions of the Volga Federal District for 2010 and 2023 (Source: authors based on [4]).

The share of enterprises decreased to a greater extent during the analyzed period in the Perm Krai (from 14.1% to 1.3%), in the Republic of Tatarstan (from 9.3% to 2.2%), in the Chuvash Republic (from 9.7% to 1.0%). To improve the environment, enterprises use various types of innovations in their activities, which can be divided into two groups: those obtained for the organization and those obtained in the process of consumption or use of goods and services by end users (Table 1).

Table 1. Types of innovations carried out by organizations to improve the environment.

Indicators	Conventional designation
1. Innovations that provide environmental benefits to the organization:	GALIO
Reduction of material costs for the production of a unit of goods, works, services	$X_{1.1}$
Reduction of energy consumption or carbon footprint (CO2 emissions)	$X_{1.2}$
Reduction of noise, soil, water or air pollution	$X_{1.3}$
Replacement of raw materials and materials with safe or less hazardous ones	$X_{1.4}$
Replacement of part of fossil energy sources (fuels) with renewable energy sources	X1.5
Recycling of production waste, water or materials for own use or sale	$X_{1.6}$
2. Innovations that provide environmental benefits obtained during the consumption or use of the product/service by end users:	GALIU

(*continued*)

Table 1. (*continued*)

Indicators	Conventional designation
Reduction of energy consumption or carbon footprint (CO2 emissions)	$X_{2.1}$
Reduction of noise, soil, water or air pollution	$X_{2.2}$
Easier recycling of the product after use	$X_{2.3}$
Increased product lifespan due to greater strength and durability	$X_{2.4}$

Source: authors based on [3, 4].

For the integrated assessment of innovation greening (IIGI) using a nonparametric assessment method – the multivariate average method, general assessments were calculated for each block of indicators: GALIO and GALIU, and the ranks of regions were determined based on these assessments (Table 2). The leaders in innovation greening obtained for organizations are the Mari El Republic, Saratov and Samara regions, in which the values of private indicators are on average higher than the average regional values by 24.9%, 10.2% and 9.6%, respectively. The indicators in the Republic of Tatarstan and the Penza region are also higher than the average values. In Mari El, 100% of enterprises with innovative activities use a reduction in noise levels, soil, water or air pollution, 80% reduce energy consumption or CO2 emissions, 60% replace raw materials and materials with safe or less hazardous ones. In the Ulyanovsk region, all types of innovations related to ecology are applied only by 20–30% of enterprises using innovations, which explains the lowest value of the general assessment (0.610).

The analysis of the summary assessment of the level of innovations providing environmental benefits obtained in the process of consumption or use of goods and services by end users showed that the values of private indicators of innovation greening are above the average in the Republic of Tatarstan, Penza, Samara, Saratov regions and some other regions. All types of innovations are least used in the process of consumption by users at enterprises of the Udmurt Republic, in the Kirov and Orenburg regions.

The integrated indicator of greening of innovations (IIGI) calculated according to Eq. (1) made it possible to identify the types of regions of the Volga Federal District by the level of greening of innovative activities of enterprises (Fig. 2.). The group with a high level of innovation greening included five regions with values exceeding the average levels in the VFD by 1.13–1.22 times. The Republic of Tatarstan is a leader in this group, the Samara Region is in second place. The group with average values of the integrated indicator from 0.780 to 0.988 included 5 regions. The lowest level of greening of innovations is observed in 4 regions, the worst value is in the Udmurt Republic (55.1% of the average indicator values).

The obtained results made it possible to identify regions of the Volga Federal District in which it is necessary to increase the share of enterprises using innovations in their activities aimed at solving environmental problems.

Table 2. Ranking of regions of the Volga Federal District by the integrated indicator of greening of innovations and its components for 2023.

Regions of the VFD	GALIO	Ranks by GALIO	GALIU	Ranks by GALIU	IIGI	Ranks by IIGI
Republic of Bashkortostan	0.769	11	0.746	11	0.760	11
Republic of Mari El	**1.249**	1	**1.045**	7	**1.168**	3
Republic of Mordovia	0.770	10	0.964	9	0.848	8
Republic of Tatarstan	**1.027**	4	**1.513**	1	**1.222**	1
Udmurt Republic	0.624	13	0.442	14	0.551	14
Chuvash Republic	0.944	6	**1.055**	6	0.988	6
Perm region	0.829	8	0.779	10	0.809	9
Kirov region	0.688	12	0.584	12	0.646	13
Nizhny Novgorod region	0.841	7	**1.082**	5	0.937	7
Orenburg region	0.822	9	0.538	13	0.709	12
Penza region	**1.014**	5	**1.375**	2	**1.159**	4
Samara region	**1.096**	3	**1.280**	3	**1.170**	2
Saratov region	**1.102**	2	**1.171**	4	**1.130**	5
Ulyanovsk region	0.610	14	**1.034**	8	0.780	10

Source: authors.

4 Discussion

Scientific works analyze various aspects of innovations in the territorial aspect: innovative activity as a component of the socio-economic development of a region [5], innovative activity of enterprises [6], features of the introduction of environmental innovations in industrial production in the regions [7, 8], the importance of innovations for the competitiveness of enterprises [7]. A statistical assessment of trends in innovative activity and factors influencing territorial differences in innovations is presented in the work [9]. At present, in our opinion, there are not enough relevant works devoted to the greening of innovations, in particular, methods of their quantitative assessment. For cross-country comparisons of innovations, since 2007, the Global Innovation Index (GII) has been used, which is calculated based on indicators and is a source of information for improving innovation policy in states. It evaluates the effectiveness of the innovation ecosystem of the economies of 133 countries and tracks the latest global trends in the

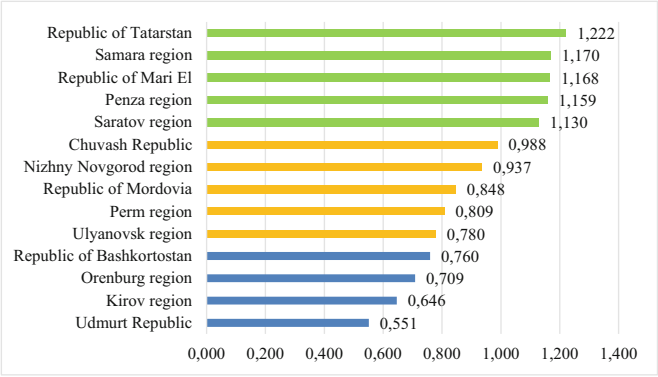


Fig. 2. Distribution of regions of the Volga Federal District by the integrated indicator of greening of innovations in 2023 (Source: authors).

field of innovations [10]. The rating of innovative development of the constituent entities of the Russian Federation has been calculated by the Institute for Statistical Research and Economics of Knowledge by Higher School of Economics since 2012 according to the Russian regional innovation index and 15 sub-indices by indicators grouped into five thematic blocks [11]. The scientific literature presents a lot of approaches to constructing an integral indicator that includes various innovation indicators, but the environmental aspect of innovative activity, in particular its analysis using an integral approach, is insufficiently covered in existing works.

5 Conclusion

The obtained results of the study allow us to conclude that in the regions of the VFD, the share of enterprises using innovations in their activities to improve the environment has decreased over more than 10 years. In the regions of the VFD, there is a significant differentiation in the use of various types of innovations: those obtained for the organization and those obtained in the process of consumption or use of goods and services by end users. Based on the calculated integral indicator, the types of regions are identified by the level of greening of innovative activities of enterprises in the VFD: high, medium and low. Developing a methodology for assessing the innovative activities of enterprises aimed at improving the environment in the regions will contribute to improving the quality of information and analytical support and the validity of management decisions aimed at forming a single information space.

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BIM Technologies in the Construction Industry as a Key Factor in Increasing Efficiency

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Abstract. The construction industry is a low-innovation sector. Advanced technologies can have a positive impact on the quality of work. Leading companies in the industry are struggling with low profitability by investing heavily in new technologies, data analysis methods, robotics and artificial intelligence. If construction companies want to achieve higher profits, they need to be proactive in project management, improve supply chain management, simplify and modernize construction and support processes. For these reasons, this work is devoted to the relevance of implementing building information modeling (BIM) technologies. In practice, BIM methods are now mainly used in the planning and preparation of construction projects. In addition to technical and IT subject areas, the potential of BIM as a methodology for integrated planning and collaboration is demonstrated. Therefore, in the context of working with BIM technology, there is an addendum that includes general questions about the methodology of work, entrepreneurial thinking and understanding of roles. Thus, the purpose of this contribution is to theoretically substantiate the importance of BIM technology as a factor in increasing the efficiency of construction projects, as well as to develop practical recommendations for its application. This is not about formulating fixed operational recommendations for action, but about certain standards that can be easily transferred to a specific construction project.

Keywords: Artificial Intelligence (AI) · BIM Technologies · Cooperation Strategy · Construction Industry · Construction Technologies · Efficiency

1 Introduction

The construction sector is very sensitive to any fluctuations in the economy. Currently, many national projects are being implemented in Russia, which contributes to the development of the construction industry. But meanwhile, the construction industry remains very vulnerable due to the great influence of the state. GDP growth, inflation rates, balance of payments, national currency exchange rate – all these factors affect the construction industry. It is necessary to consider the possibility and necessity of modernization in the construction industry. The use of environmentally friendly materials, improvement

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of all processes at various stages of construction, including the introduction of the latest technologies in design, the use of new machines and mechanisms, new equipment. Ensuring the quality of work performed in construction is of the highest priority. Defining quality standards is extremely labor-intensive in terms of technical, organizational, economic and legal criteria, as well as the individual nature of each construction project [1, 2]. Certain professional areas in the construction industry demonstrate qualified work. But there is still no sufficient level of inter-company and inter-process interaction of competencies. For this reason, the construction industry has shortcomings in planning, work organization, and ensuring the release of quality products. Completing construction projects on schedule and to the agreed quality level in the contract remains a serious problem. This problem can be minimized by using building information modeling (BIM) technologies [3, 4].

BIM is the continuous use of digital building models as an information and operational basis throughout the entire life cycle of a facility. Its goal is a comprehensive digital recording of all properties of a building object, taking into account geometry, networks and other parameters, which form a basis for optimized process design in the construction industry. Three-dimensional information models provide the central basis for this. Over the past decade, BIM has been increasingly introduced into the Russian construction industry and has had a significant impact on working methods [5]. BIM offers potential for improvements for all those involved in the planning, implementation and operation of a project. The implementation and operation of this technology is still lagging behind. However, some innovative companies are already using BIM, for example in calculations and work preparation, these applications are mainly carried out within the company without the involvement of other participants. In construction, BIM is only applied locally and in detail. This means that a large part of the potential for increasing the efficiency of this activity is lost. Taking this fact into account, this work presents a systematic approach to the methodology of BIM technologies and its importance for improving the efficiency of construction projects.

2 Methodology

The BIM performance methodology describes conceptual conditions for BIM-based collaboration in the relevant project. In addition to the project goals, organizational units, and respective roles, it defines the BIM processes and requirements for individual participants. The client provides information requirements as the basis for the project implementation plan, which include the project goals, technical implementation, and requirements for the potential contractor. A detailed BIM project implementation plan is ultimately compiled based on these requirements and then usually becomes part of the contract between the client and the project participants. The BIM performance methodology is presented in Table 1. The BIM methodology for improving efficiency describes the procedure, responsibilities and processes for implementing the defined requirements and services depending on the respective project.

These organizational rules facilitate collaboration between project participants and create a common understanding of the services to be provided. The bidder can make potential additions and adjustments to the project implementation plan during contract

Table 1. Methodology of using BIM technologies to improve efficiency.

BIM Project Implementation Plan	
General project information BIM objectives and added value in the project BIM applications in the project BIM responsibilities and contacts BIM collaboration strategy BIM quality management Technical agreements (software, formats) References to exchange and process agreements BIM service definition	
BIM data exchange	**BIM Exchange Process**
BIM model application area BIM elements Exchange formats	Technological sequence Responsibility BIM transfer
Project Services	
BIM model handover Definition of BIM handover for each stage in the agreed degree of readiness in the agreed format	

Source: authors.

negotiations so that a common basis is created for implementing the planned BIM use cases.

3 Results

In addition to the necessary processes and agreements that must be concluded at the beginning of the project, the BIM methodology is presented as an overall process. Information management regulates the preparation, planning and execution of BIM-based processes in the project and thus plays a decisive role in achieving the agreed project objectives. During the project implementation phase, BIM information management ensures that defined exchange scenarios between the contractual partners are implemented and achieved. In addition, it defines the requirements for the BIM models, such as their structure, content and quality of the associated information, as well as the specifications of the BIM technologies and technical parameters, such as the approved software, data formats, exchange formats and the project platform used [6]. When defining these specifications, it is always important to consider whether an open or closed BIM approach is used. With regard to the building object models that serve as the information basis in the work process, the following aspects must be defined [2, 7–9]: responsibility for the creation of specific building object models, an agreed standard with which the specific models must comply, the deadline for developing the building object model, the purpose of developing the corresponding building object models, rules for exchanging

information about the building object model between project participants, subsequent processes that can be optimized using building object models.

It can be concluded that for intercompany cooperation, open standards and guidelines are crucial in order to link the different information systems of those involved in the project as quickly and closely as possible. Further examples of documents that should be defined in a BIM project before the project starts are summarized in Table 2.

Table 2. Examples of documents when implementing a BIM project before the project starts.

Document	Description
Modeling Standard	BIM data requirements and definition of general BIM guidelines are services provided by a client with BIM support: advice and provision serve to ensure that contractual BIM services are met at the relevant planning and implementation stages
BIM Use Cases	Defined data exchange scenarios are described in BIM use cases. It is important to define how this should be implemented and which services should be provided within the relevant use case
Data Management	The BIM project implementation plan should describe technical requirements for the collaborative work environment and processes for creating, processing and using data. It also includes the definition of relevant roles and responsibilities

Source: authors based on [4, 5, 10].

To better understand building information modeling, we consider the collaboration approaches. The basis for collaboration are digital models of building objects from different project participants, which are created within the framework of an open BIM approach using a variety of different modeling tools. Since these models reflect the subject characteristics of the respective domain, they are also called subject models. In addition to the geometric representation of the building object models, the technical content also plays a decisive role.

Specialized models are created by the responsible object and the planning specialists of the various professions at the appropriate stages of the planning process. Ideally, companies implement their execution models on this basis. At the end, a so-called as-built model is created, which reflects the actual construction and represents the starting point for the use phase. At the present stage, not all design specialists will work with special models. In the future, the commitment and willingness of design specialists to implement their services using the BIM methodology will depend on the client's specifications. Below is a list of some important specialized models [11]: architect's models (structure model, architectural model, room model, envelope model, extension model, facade model), structural designer's models (structural model, calculation model, reinforcement model), civil engineer's models (HVAC (Heating, Ventilation, & Air Conditioning) model, plumbing model, electrical model), builder's models (bid preparation model, construction and installation model, construction site equipment model, construction process model (4D model), calculation model (5D model)), construction product

manufacturer's models (individual BIM objects of a product or parameterized for a series of products, such as windows, doors, sanitary facilities), city or neighborhood models (urban environment model, property model, terrain model), infrastructure models (route, earthworks, road, bridge, tunnel, railway construction model).

An interesting factor in the application of the BIM work methodology for increasing efficiency is the new design of collaborative work processes based on construction object models. The goal of BIM technologies is to enable all construction participants to work together with different construction object models. Only then can the full potential be represented within the model-based work order.

A BIM workflow is a system-supported (partially) automated workflow that is carried out according to a predefined pattern. Exact knowledge of these work steps is especially necessary when several participants are involved in a project and the methods have to be coordinated across company boundaries. However, compared to other industries, the formal representation of standardized work processes in construction is extremely difficult. However, for complex construction tasks, it is also possible to identify recurring sub-processes that can be clearly represented and described using selected notations. Both at the general level of the execution stages and at the detailed level of the individual process steps of a specific task, these processes can be analyzed, documented and then processed according to the sequence.

4 Discussion

The created specialist models are combined for coordination purposes at specific planning stages. This can be done, for example, using suitable BIM management software or as a separate coordination model in an integrated BIM viewer on a common collaboration platform [12]. The coordination model thus represents the integration of several sub-models and is the central information resource in the BIM methodology. The main purpose of the coordination model is usually to check whether the separately created technical models agree with each other and whether they have any technical conflicts. In addition, coordination models are used to compare models with each other, to discuss options or to carry out target/actual comparisons. The designated BIM manager is responsible for coordinating the individual trades when combining the individual specialist models, a task often taken over by the relevant project management team. Any conflicts and ambiguities that arise can be noted manually or (partially) automatically using 3D markers and comments. The open data standard BIM Collaboration Format (BCF) provides a suitable tool for efficient conflict management and resolution. The main difference from previous workflows is the ability to detect specific issues and process them on partial or coordination models. In addition, various documents can be included in the workflow via a document link. This creates a kind of information container that fully describes the available facts and provides a better understanding for all parties involved. The extent to which individual processes can be implemented depends on the customization options of the various software providers. Thus, the digitalization of workflows leads to significantly more structured and transparent project management and thus increased efficiency.

5 Conclusion

The requirements for cooperation and coordination via BIM and the data exchange processes must be precisely defined and coordinated. In order to be able to combine various special models that are created in practice with different software systems into a coordination model, the manufacturer-independent data format Industry Foundation Classes (IFC) is used. In order to ensure a consistent transfer of data between the parties involved, it often makes sense not to exchange the entire IFC data model, but only a certain part of it that is necessary for the specific task. Unnecessary information, such as floor covering information contained in the structural model, can lead to problems with data consistency. In addition, subsequent applications are usually unable to read or evaluate information that is not relevant for them. Therefore, it often makes sense to specialize the building aspects depicted in the model for certain purposes, process steps and users.

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Competitiveness of Organization in the Contemporary Russian Market Conditions

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Abstract. The research topic is relevant, since there is a need to study the process of forming a competitive position of a company in modern conditions of the Russian market within the framework of digitalization of business, which leaves an imprint on the development of society as a whole. The authors studied and analyzed the competitiveness of a trading enterprise in a digital market, the legislation on which has no clear framework and boundaries and is in constant dynamic development, which requires special care on the part of companies, a high level of adaptability and flexibility, and great efforts to combat monopolies, since «gray» uncontrolled ones are increasingly appearing zones that can provide loopholes for establishing the power of one of the players due to digital technologies (in particular, standardization and automation processes). To do this, first of all, it is necessary to disclose the term «competitiveness», its essence, concept, characteristics, structure, information base, consider methods for determining the attractiveness of a company with the introduction of digitalization elements into daily activities, give an organizational and economic characteristic of a retail company, evaluate the competitiveness of Metro Cash & Carry LLC as an example, analyze financial stability and give recommendations on management of competitive advantages.

Keywords: Competitive Advantages · Competitiveness · Digitalization · Indicators of Financial and Economic Activity · Market Economy · Pricing Policy

1 Introduction

The events that are taking place in Russia and abroad require a new look at the enterprise management process to maintain its competitive position, whereas the old methods cease to give the desired results and they must be abandoned. Practice calls for new breakthrough actions aimed at the formation of sustainable methods of creating a competitive enterprise, which also need to be justified theoretically. Cardinal shifts in the Russian economy have led to the transformation of the activity of retail companies. Trade has undergone the most positive changes, which require prompt responses to the challenges of the internal and external environment.

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2 Methodology

The purpose of the work is to develop theoretical and scientific and methodological foundations, as well as practical recommendations on the formation of a mechanism for increasing competitiveness and its implementation at wholesale enterprises. The objectives are to consider existing tools for improving the competitiveness of trade enterprises, as well as methods for assessing the competitiveness of enterprises to determine the level of the enterprise in a competitive environment. The contribution reveals the modern aspect of understanding the competitiveness of an enterprise, examines various ways to diagnose competitiveness using the example of Metro Cash and Carry LLC. The main research methods include dialectical method of cognition, methods of system-functional, comparative analysis, scientific abstraction, and economic-statistical method.

3 Results

The issue of competition, perhaps not in a direct form, has always been a root of economic science and practice, even at a time when science as such did not yet exist, and all requests were formed only at the household level. For many centuries, economic theory has looked at competition quite narrowly, only in terms of price and quality of goods and services provided, without considering other factors affecting it in real life. One of the most productive ideas is the value chain at all stages of the production process and its subsequent consumption. This concept applies not only to goods, but also to services to which a similar logical spiral can be applied. This idea allows us to perceive each subsequent stage of production as an element of the puzzle of the overall picture of the formation of the final price of the product.

The value chain concept considers human resources, information systems, and business infrastructure services as part of a common production process along with technological modifications. It also helps in the development of the company's strategy, allowing you to separate the most effective ways and stages of generating added value of the product and reduce the least useful ones. Enterprises, having such information, use various tricks to occupy the most advantageous position in the market for them, striving for monopoly dominance in a particular area.

The main characteristic features of a leading company are quick reactions to any changes, flexibility, rapid restructuring of internal processes in accordance with market demands, rapid implementation of innovations, and finding the company simultaneously in a state of daily restructuring and stability. In such companies, there is an atmosphere of welcoming changes and therefore employees do not resist them but perceive them positively and themselves are their generators. Thanks to constant innovations, it is possible to ensure maximum adaptability to any internal and external challenges. Firms regularly learn new methods and practices. Leaders are the very first to do everything: they introduce new product lines, reconstruct their processes, introduce and master new technological processes, answer questions and consider customer comments [1].

To assess how effectively a company carries out its activities and takes a position in relation to other companies, various methods can be used, some of them are presented in Table 1.

Table 1. Ways to diagnose a company's competitiveness.

Way	The essence of the method	Algorithm
Calculation of the desirability function	The essence of the method is to determine the value within the desirability function, located in the range from 0 to 1. It is used as a scale for comparing various elements and parameters of the observed products	The desirability function helps to determine whether certain parameters and characteristics of products are suitable or not in real practical life or should be removed. There is an economic explanation for all the values of the desirability function, which ultimately determines how much a particular product will be in demand or competitive in the market of goods or services
Rating assessment	These characteristics include the quality of management, the cost of goods/services, compliance with the terms of the contract and payment terms for them, and the quality of the goods/services provided	The company is assigned a final rating value after calculating all indicators. First, the very indicators are selected that will determine the success of the company and will be included in the model, then they are all assigned a certain weight value, depending on the degree of its influence on the final value and competitiveness

Source: authors.

The most important characteristics of organizations that allow them to maintain and multiply their competitive advantage are search and consolidation in their niche in the market, regular monitoring of product quality, introduction of innovations, prompt response to existing changes in the external environment, maintaining partnerships with contractors, the company's activities on the international in the arena, maintaining highly qualified personnel at all grades [2].

Metro Cash & Carry LLC is one of the largest international wholesale companies with a huge sales network. The financial analysis of an enterprise is determined by each specific analyst in different ways, since each of them considers various factors that affect the results. Analyzed the Metro Cash & Carry LLC (Table 2) a high degree of competitiveness the potential for its development.

Summing up, we can conclude that Metro Cash & Carry LLC is competitive in the market and has practically no direct competitors in the wholesale trade. Customized internal processes, well-established and cohesive teamwork, competent and impartial management allow the company to remain leaders in its industry for many years [5, 6].

Table 2. The matrix for determining the competitiveness of Metro Cash & Carry LLC.

Evaluation Indicator	Unsatisfactory (0)	Satisfactory (1)	Good (2)	Excellent (3)
1. Geolocation	Out of town and lack of parking spaces	In the city, but there is little room for cars	Inconvenient location of parking spaces	Excellent location, comfortable parking
2. The quality of treatment on the territory of the trading floor	Lack of department staff, few goods	There is a shortage of employees, the goods are laid out randomly	Employees in each department, the product is systematized	Competent staff and comfortable location of goods
3. Quality of service at the checkout	A long queue, many strollers near the ticket office, rough service	The cash register is slow, the trolleys are not always removed from the cash register area	The cashier works in standard mode, there are no trolleys and queues	Friendly, fast cashier, no trolleys, and answers to all questions
4. Other services provided	Are not provided	A chaotic performance	Few, high-quality services	A wide selection with excellent service
5. Quality and breadth of product selection	Lack of assortment, a lot of unloaded goods	There are no products on some shelves, there is little choice	The average breadth of the assortment for the average user	A wide range of products, including narrow product lines
6. The quality of staff in all areas of the shopping center	There are few staff, and their qualifications are low	Low qualification of staff, high degree of turnover	Enough staff, average qualifications	The optimal number of employees, high qualifications of each
7. Price Policy	Inflated prices for low-quality goods	Average market prices, sometimes higher than necessary	Prices are average in the market, in some places lower	Optimal pricing policy
8. Share Policy	Not provided	Rare holding of shares	Promotions happen regularly	Daily promotions
9. After-purchase service	Missing at all	Unsystematic service	Mailing list only	A wide range of services

(*continued*)

Table 2. (*continued*)

Evaluation Indicator	Unsatisfactory (0)	Satisfactory (1)	Good (2)	Excellent (3)
10. Feedback from the manager of the shopping center	Incompetent management that does not respond to customers	Good staff with low results	Qualified management, customer support	Highly qualified staff, regular feedback

Source: authors.

4 Discussion

Competition, especially perfect competition, is an unattainable ideal in the modern world rather than a real practice, however, as a reference value it exists, and it must be sought in an ever-changing external environment. Some companies deliberately do not comply with the principles of healthy competition and try to achieve monopoly power in the market. One of the reasons for this phenomenon in the 21st century is the emergence of digital technologies and their active infusion into the production and sales process. The state, which controls the competition process, is currently facing problems in this aspect, since the existing antimonopoly legislation has become irrelevant. A solution suggests itself, which consists in the formation of new principles and control over the monopoly, considering the use of the latest technologies. The work is needed in the following aspects:

- updating and revision of existing legislation;
- description of all the points and subtleties of using software, various information systems, equipment, virtual spaces;
- implementation of tools for monitoring bank payments, online commerce, and advertising;
- collective ownership and division of responsibility in accordance with it.

All these measures will create global changes in the country's economic relations through the use of IT technologies, which will improve the environment and products within the framework of perfect competition and give a new round to the development of digital technologies.

5 Conclusion

Metro Cash & Carry LLC occupies a stable, leading position in the segment and has all the prerequisites for large-scale development in the next five to ten years according to its SCORE strategy. Metro Cash & Carry LLC's updated business strategy consists of three main elements: a focus on wholesale trade for professional clients and individuals, a significant expansion of the business model, and the development of a new business. This means constantly improving the product range to meet all the needs of professional

customers. The development of the new business involves expanding the franchise concept for trader clients and further developing the business with HoReCa's key clients. As a result, the business model of a retail and wholesale company will focus even more on professional customers, who account for more than 80% of sales. To do this, they need to be flexible in pricing, show loyalty to customers, continue to cooperate with government agencies and maintain quality at all stages of the sale.

The most important advantage and distinctive feature of Metro Cash & Carry LLC is its long (more than twenty years) stay in the Russian market, mutually beneficial relationships with suppliers and other contractors, loyal attitude from government agencies, a huge list of articles and services provided. Metro Cash & Carry LLC is a huge range of exclusive imported goods from different parts of the world with high quality, exclusive prices under one roof. The offered range of products is optimized both for the professional needs of customers – shops at home, restaurants, cafes and canteens, offices, and for their personal needs. In conclusion, we can say that the choice of Metro Cash & Carry LLC is the choice of European service and optimal prices for all the variety of goods [9].

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Assessment of Prospects for Increasing Labor Productivity in a Transportation Company

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Abstract. Socio-economic analysis in the system of integrated economic focuses on the study of the relationships between a company's economic activities and its social role. It helps to assess how business processes affect employees, the local community and other stakeholders, and how social factors influence the efficiency and sustainability of the enterprise. Labor productivity analysis is one of the significant factors that contribute to the stability of the production process and the achievement of the objectives set by the leadership of the country. The work identifies the main stages of labor productivity analysis on the example of a transport organization. The methods used in the work were observation, description, statistical analysis, comparison, deduction, visualization of statistical data, synthesis. The research materials were used as the indicators of Russian transportation companies for 2022–2023. The peculiarity of the industry under study is the high share of automation and capitalization of personnel. On the basis of estimation of productivity level the proposals on elimination of revealed negative tendencies are formulated.

Keywords: Labor Productivity · Labor Resources · Productivity Growth · Socio-Economic Analysis

1 Introduction

Analysis of labor productivity and its remuneration represent an important area of research in today's economically unstable and competitive environment. In the context of rapid changes in technology and growing demands for quality services, employee performance becomes one of the determinants of organizational success. When considering the activities of a company, the method of socio-economic analysis aims to study the relationship between the economic performance of the company and its social role [1–3]. It helps to assess how business processes affect employees, the local community and other stakeholders, as well as how social factors influence the efficiency and sustainability of the enterprise.

The main aspects of socio-economic analysis at the enterprise level are:

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1. Economic indicators (revenue, profitability, margins, profit, productivity, investment, etc.).
2. Social indicators (wages, safety, security, comfort, employee satisfaction, etc.).
3. The interrelationship of economic and social indicators. How improvement of working conditions and social programs affects productivity and loyalty of employees.

Main objectives of socio-economic analysis at the enterprise level include:

– increasing business efficiency through improving working conditions and employee motivation;
– strengthening the company's reputation through socially responsible activities;
– ensuring sustainable development of the enterprise in the long term;
– minimizing risks associated with social and environmental problems.

Socio-economic analysis at the enterprise level helps not only to improve financial results, but also to create a sustainable business model that takes into account the interests of all stakeholders [4, 5].

2 Methodology

The authors used methods of observation, description, statistical analysis, comparison, deduction, visualization of statistical data, synthesis. To assess the efficiency of labor resources use, a system of labor productivity evaluation indicators is applied, including: generalized indicators, frequent indicators and auxiliary indicators. The stochastic multifactor correlation model is used for factor analysis of average hourly output. However, the analysis of labor productivity in the company can also be carried out using other models, which is an additional opportunity for a deeper study of factors affecting labor efficiency [6, 7]. To carry out factor analysis of the absolute deviation of the wage fund, research models are selected. Equation (1) can be chosen as a model:

$$ZP = L * Z \tag{1}$$

where L is the average annual salary of one employee of the enterprise; Z – average annual salary of one employee of the enterprise.

$$ZP = L * D * Z_d \tag{2}$$

where D is the number of days worked by one employee in the period; Zd – average salary per day of one employee of the enterprise.

$$ZP = L * D * T * Z_h \tag{3}$$

where T – average duration of one working day; Zh – average hourly wage of one employee of the enterprise.

Further, the method of absolute differences is used to calculate the impact of factors on the payroll of employees. If a different factor model is used to analyze the wage fund of employees, the calculation is carried out and a conclusion is made on those factors that are specified in the factor model [8, 9]. The research is based on regulatory legal acts, theoretical and methodological provisions developed by domestic authors, revealing issues of the automotive industry, as well as innovative activity.

3 Results

Causes of changes in labor productivity and its place in the socio-economic situation of the firm was made on the basis of the data of the existing transport company. The main indicators of financial and economic activity of this organization, formed on the basis of accounting statements for 2023, are presented in Table 1.

Table 1. Main economic indicators of the transportation company's activity.

Indicator	Year		Variation, rub	growth rate, %
	2022	2023		
1. Revenue, thousand rubles	840094	915504	+75410	108,98
2. Cost of sales, thousand rubles	738432	719024	−19408	97,37
3. Profit from sales, thousand rubles	17353	103391	+86038	595,81
4. Net profit, thousand rubles	17267	91824	+74557	531,79
5. Average annual balances of current assets, thousand rubles	278474	309340	+30866	111,08
6. Average number of personnel, people,	286	271	−15	94,76
including workers	175	160	−15	91,43
7. Specific weight of workers in the number of personnel, %	61,19	59,04	+441	115,02
8. Average annual output of an employee, thousand rubles	2937	3378	+922	119,21
9. Average annual output of a worker, thousand rubles	4800	5722	+17724	118,44
10. Remuneration fund, thousand rubles	96096	113820	+9,2	538,10
11. Return on sales, %	2,10	11,30	+75410	108,98

Source: author.

Table 1 shows that in 2023 the revenue increased by 75410 thousand rubles or by 8.98% compared to 2022. And the cost of sales for the analyzed period decreased by 19408 thousand rubles or by 2.63%. The excess of revenue growth rate over the growth rate of cost of sales is a positive trend. Profit from sales increased in 2023 by 86038 thousand rubles or by 495,81% compared to 2022. Accordingly, the return on sales increased by 9.2 p.p. as compared to 2022. At the same time net profit increased by 74557 thousand rubles or by 431,79%. In 2023, there is an increase in labor productivity by 441 thousand rubles / person or by 15.02% compared to 2022, which is due to both an increase in revenue and a reduction in the average headcount by 15 people. The labor remuneration fund increased in the analyzed period by 17724 thousand rubles or by 18,44%, and the average annual salary of 1 employee increased by 84 thousand rubles or by 15,02%. Excess of growth rate of labor remuneration fund and average salary over

the growth rate of labor productivity is a negative factor and indicates a decrease in the efficiency of the use of labor resources and remuneration fund. In general, the efficiency of this transport company in the analyzed period is confirmed by the growth of return on assets, which increased by 19.5 pp. Table 2 presents the initial data for the factor analysis of the labor remuneration fund of the transport company.

Table 2. Data for factor analysis of labor remuneration fund.

Indicator	Year		Variation, rub	Dynamics index
	2022	2023		
1. Average annual output of one worker, thousand rubles/person	840094	915504	+75410	108,98
2. Average annual salary of an employee, thousand rubles / person	738432	719024	−19408	97,37
3. Coefficient of lag of labor productivity growth rate over the average wage growth rate	595,81			

Source: author.

The coefficient of lagging labor productivity growth rate over the growth rate of average salary was 0.92. The lag in the growth rate of average salaries causes unjustified overspending.

To determine the amount of overspending (+E) of the remuneration fund due to changes in the ratios between the growth rates of labor productivity and its payment, the following formula can be used:

$$+\mathrm{E} = 113820 * (1,18 - 1,15) = +3414,6 \text{ thousand rubles.}$$

Thus, higher growth rates of labor remuneration compared to the growth rate of labor productivity contributed to the overspending of the wage fund in the amount of 3414.6 thousand rubles.

Table 3 shows the calculation of the influence of factors on the change in the remuneration fund in the transport company.

The results of the analysis of labor force movement revealed that the number of total personnel decreased by 15 people due to the reduction in the number of workers. There was no movement in other categories of employees in the analyzed period. The majority of the company's personnel are workers – 59%. This structure corresponds to the activities engaged in by the organization. Thus, the analysis of the dynamics and structure of the number of employees of the transport company showed that there is a negative dynamics at the enterprise.

The analysis of labor force movement shows that the coefficient of total turnover of personnel in 2022 increased by 0.0658 compared to 2021. In 2022, the turnover ratio on the intake of personnel is lower than the turnover ratio on the departure of personnel. Initial data for factor analysis of labor productivity and its impact on revenue in the studied transport company is presented in Table 4.

Table 3. Factor analysis of labor remuneration fund.

Factor	Interacting factors		Strength of factor influence on the resultant indicator	Specific weight of the factor
	average number of employees (L)	average annual salary (Z)		
ZP(L)	−15	18,56	−278,4	−0,99
ZP(z)	336	84	28224	100,99
Cumulative effect of factors			27945,6	100,00

Source: author.

Table 4. Data for factor analysis of labor productivity and its impact on revenue.

Indicator	Year		Variation, rub	growth rate, %
	2022	2023		
1. Volume of output (V), thousand rubles	840094	915504	75410	108,98
2. Average number of employees (L), people	286	271	−15	94,75
2.1. Including workers (La), people	175	160	−15	91,43
3. The share of workers in the total number of employees (Pa), %	61,19	59,04	−2,15	96,49
4. Days worked by one worker per year (D), dn	226	250	24	110,62
5. Average duration of a working day (T), h/day	7,5	7,8	0,3	104
6.1. Average annual output of a employee, thousand rubles/person: (Vb)	2937,39	3378,24	440,85	115,01
6.2. Average annual output of a worker, thousand rubles/person (Va)	4800,54	5721,9	921,36	119,19
7. Average daily output of a worker (Vbd), RUR thousand / person (Va)	21,24	22,89	1,65	107,75
8. Average hourly output of a worker (Vba), rubles/person	2,83	2,93	0,10	103,61

Source: author.

The results of calculations show that the average annual output per 1 worker increased by 440.85 thousand rubles, which is caused by the growth of output in 2023. We see the growth of the average annual output of a worker by 921.36 thousand rubles, the average daily output of a worker by 1.65 thousand rubles and the average hourly output of a worker by 0.1 thousand rubles, which is also caused by the growth of output.

4 Discussion

To assess the validity of the obtained conclusions, a factor analysis of the impact of labor productivity of employees on the total output was carried out (Table 5).

Table 5. Factor analysis of the impact of labor productivity of employees on the output.

Factor	Interacting factors		Strength of factor influence on the resultant indicator (Q)	Specific weight of the factor
	average number of employees (L)	average annual output of a employee (V)		
ΔQL	−15	2937,39	−44060,87	−58,43
ΔQv	271	440,85	119470,87	158,43
Cumulative effect of factors			75410	100

Source: author.

The data in Table 5 shows that the output increased by 75410 thousand rubles, including due to the following changes:

– reduction in the number of employees by 15 people decreased output by 44060 thousand rubles;
– increase in the average annual output of 1 worker by 440 thousand rubles in 2022 led to an increase in output by 119470 thousand rubles.

Thus, the greatest impact on the growth of output was the growth of average annual output of 1 worker.

Indicator of labor productivity, and as a consequence of the volume of production, directly affects the economic performance of the enterprise as a whole. Therefore, it is necessary to identify the reserves of labor productivity growth in this organization, as well as to consider the main factors affecting them [10, 11].

In the organization, there is a problem of intra-shift losses of working time because of violations of labor discipline. According to the personnel department, which were obtained as a result of data from video surveillance cameras in the shop, there is a problem of labor discipline, because of the queue in the canteen. Employees leave about 60 min early to take the queue. Accordingly, the actual lunch time is not 60 min, but 120 min. This is certainly an unregulated waste of time that needs to be eliminated. Further it is necessary to analyze labor indicators and identify factors affecting output. The data are presented in the appendix.

Analyzing the obtained data for the period 2021–2023, we can draw the following conclusions. The number of production and industrial personnel for this period increased by 10.8%. Including the number of managers, specialists, clerks (MSC) increased by 27.6%, while the number of auxiliary workers increased by 9.1%, and the number of basic workers increased by only 4.2%. Therefore, the share of workers in the total number of personnel is decreasing. In the period from 2021 to 2023, this indicator decreased by

5.9%. This is a negative dynamics, as the MSC is the so-called «expenditure staff». And workers are «income personnel».

Over the period from 2021 to 2023, the number of days worked decreased by 6.8%. At the same time, the total amount of time actually worked by all employees increased by 3.9%. But the negative trend in the ratio per 1 employee is also subject to a downward trend and represents a decrease rate of 2.4%. The average duration of a working day for this period decreased by 2.3%.

This is primarily due to overtime work, directly with the consent of the employee. A tendency was revealed that employees intentionally want to work overtime, as in accordance with the Labor Code of the Russian Federation such work is paid at double the tariff rate [12]. Accordingly, this leads to fatigue and deterioration of the employee's health, which subsequently leads to an increase in the share of defects in production. In 2023, the level of scrap in the shop amounted to 24% of the output. However, the average annual output per employee decreased by 7% and the average annual output per worker by 1.2%. Despite this, the average daily output per worker increased by 3%. This is also due to overtime work. If a worker worked only in the main shift, there would be negative dynamics of the average daily output indicator.

5 Conclusion

According to the obtained data, when analyzing the main indicators in the shop it is necessary to carry out planning of labor productivity, that is, to find out what will be the savings in the number of employees when using the identified reserves. We can conclude that if there were no such negative factors as: marriage, shift losses of working time, absenteeism, lack of modernization of equipment shop could produce the same volume of products at a lower number. So, there are intra-production reserves, with the correct use of which can increase labor productivity in the shop, and as a consequence, and the volume of manufactured products.

On the basis of the analysis we will identify several key areas of optimization of work processes in this transport company:

1. Automation and digitalization of processes. This area includes several effective measures for labor optimization: ERP system implementation, automation of accounting, warehouse logistics, finance and other internal processes through ERP system will reduce the time for routine operations and minimize the human factor.
2. Optimization of logistics processes. The company's activity is closely connected with cargo movement and delivery organization, so the work of the logistics department is a priority area for improvement. In the system of these activities effective are:
   - routing and planning of deliveries (the use of software products to optimize delivery routes will help reduce fuel costs and delivery time);
   - inventory management (implementation of an inventory management system (e.g., JIT method) will minimize storage costs and reduce the risk of surplus or shortage of goods, which slows down the flow of profits to the organization).
3. Improving customer service. This area of production activity is also an area of competitiveness building, as it comes into contact with the final consumer of the company's

services and requires a powerful mechanism to prevent various kinds of conflicts. To improve this area effective suggestions are:

- implementation of CRM-system of customer relationship management (CRM) in the company's work, which will improve interaction with customers, allow to analyze their preferences and increase the level of loyalty;
- implementation of an instant feedback system (development of mechanisms for receiving and analyzing feedback from customers will help to promptly respond to problems and improve the quality of services).

4. Development of personnel and corporate culture. The system of this sphere of the company also includes psychological climate at workplaces, support of the level of actual competencies, etc. Effective measures in this case will be:

- employee training and development activities (courses, trainings), regular monitoring of competence level (testing, attestations);
- active propaganda of the company's mission, promotion of the company's values in the life of employees by various means of increasing motivation and loyalty of employees in the company.

Implementation of the above measures requires a comprehensive approach and investment of both time and financial resources. However, in the long term it will significantly improve the work of the transportation company, increase its competitiveness in the market and the level of customer satisfaction. Summing up, we can conclude that the organization has internal reserves of labor productivity growth, as a result of the use of which, it is planned to increase production volumes, and as a consequence, and profit due to savings on labor remuneration.

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Opportunities for Innovative Modernization of a New Type of Economy

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Abstract. Innovative modernization is a factor that ensures the dynamic development of a new type of economy in the Russian Federation. It takes place when understanding and actualization of a balanced system of relationships «science-production-society» depends on the level of development of this process. The authors consider problems that need to be solved through the infrastructure of innovative modernization, the theory of modernization and its main trends while studying a new type of economy. Innovative modernization is one of the prerequisites for achieving the sustainable development of a new type of economy. As a methodological basis, the authors used general scientific methods such as system analysis, synthesis, generalization and classification, abstraction and analogy. The analysis results show that it is necessary to transform and change approaches to innovative modernization of the Russian economy to ensure the sustainable socio-economic development of the Russian Federation. As a result, the key development areas for innovative modernization were highlighted: possibilities of innovative modernization within the development of elements of a new type of economy are determined, the mind map of innovative modernization is developed.

Keywords: Depreciation of Fixed Assets · Innovative Modernization · New Type of Economy · Priority Areas

1 Introduction

The problem of modernization has been and remains relevant for Russia for several decades. In the current conditions of sanctions pressure, the issue of modernization is discussed at all levels of economic management. Various approaches to solving this problem are proposed and launched. It includes the creation of a commission on economic modernization under the President of the Russian Federation (the «technocratic» path determines priorities of scientific and technological development of the Russian Federation and it supports the basic areas of industrial modernization), administrative influence is exerted on companies to introduce innovations (project solutions «Skolkovo», «Innopolis», Akadempark in Novosibirsk, etc.); a «personnel reform» is based on modernization of the higher education system, end-to-end practice-oriented training at all levels of education, and on increased investment in human capital).

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All listed mechanisms are practically feasible. But this is not enough to achieve a positive result, since modernization is a complex, systemic category and should be implemented on a full scale in the current technological structure of the Russian economy, and not in individual breakthrough technologies. Statistical data do not allow us to draw conclusions about the dynamic development of innovative modernization. Even though the share of industrial enterprises developing and implementing technological innovations increased from 7.3% in 2016 to 22.7% in 2023, the share of innovative products in the total volume of industrial production decreased to 6.2% in 2023 against 8.4% in 2016 [1]. It necessitates the study of issues related to practical tools aimed at developing innovative modernization of the Russian economy. Formation of a modernization strategy requires clear theoretical ideas about its essence, patterns and conditions for effective implementation. The research hypothesis is: innovative modernization significantly accelerates a new type of economy. The purpose of this work is to determine the relationship between innovative modernization and effective development of a new type of economy.

2 Methodology

The concept of modernization is controversial and ambiguous. In general, it is understood as the transition from the state of the system in which it is in the current period to what it should be for its successful development in the future. Modernization is usually understood as a process of transition from a traditional society (agrarian) to the industrial one based on large-scale machine production and rational management of social processes [2]. Modernization is a modern term used to characterize the process of social change through which less developed societies acquire the characteristics that distinguish most developed societies [3].

3 Literature Review

In theory, modernization is a set of processes of industrialization, secularization, urbanization, the formation of a system of universal education, representative political power, increased spatial and social mobility… Etc., leading to the formation of a «modern open society» as opposed to a «traditional closed society» [2]. Scientific studies and articles [4, 5] present a wide range of understandings of modernization. As a result, it made it possible to apply this category in two aspects:

- as a «process of comprehensive improvement of the social structure (systemic modernization)» [6], there is a transition to more modern forms and states based on achievements of scientific and technological progress, systemic changes affect productive forces, political, social and institutional structures;
- as a «process of improving one of the spheres of social life (industrial production, social security of citizens, public administration, army, political system, etc.)» [7].

Within the framework of the first direction, the paradigm of modernization as a national project is formed [8–12]. It implies the entry of countries into new technological structures while maintaining the basic socio-cultural and institutional features of

Table 1. Stages of evolution of modernization theory.

Stages	Term	Description
50s – early 80s of the 20th century	Classical theory (catch-up modernization)	There is a transition from the agrarian society to the industrial one, from the agricultural economy to the industrially oriented one. This period is characterized by industrialization, urbanization, marketization and democratization
middle 80s of the 20th century	Neomodernization theory	There is a transition from the industrial society to the information society, from the industrial economy to the knowledge economy. This period is characterized by intensified knowledge, informatization, globalization and greening
late 1980s – present	Postmodern (innovation) theory	There is an active use of innovations and possibilities of transnationalized production. Modernization processes affect the economic, political, social and cultural spheres

Source: authors.

their social structure. Evolutionarily, the theory of modernization has gone through the following stages (Table 1).

Regardless of the stage of development, modernization can be carried out in two ways – extensive and intensive. Intensive methods include changing the technological process and introducing technologies in innovative modernization. The analysis of existing approaches showed that the concept of innovative economy modernization is considered quite generally. The definition of «innovative modernization», used in modern scientific research, is presented in Table 2.

Innovative modernization is the intensified economic reproduction, which is achieved under labor differentiation, energy equipment, the transformation of science into a productive force and the development of rational production management. The following components of innovative modernization are distinguished: replacement of animated labor with inanimate energy sources, growth of the secondary (industry and trade) and tertiary (service) sectors of the economy, reduction of the primary (extraction) sector of the economy, expansion of production and consumption, clustering of production, consumption and distribution, replacement of existing tools with machines and complex technologies, industrialization [17]. When all components of innovative modernization

Table 2. Interpretation of the concept of «innovative modernization of the economy».

Author	Interpretation of the concept
O.Yu. Kerimov [13]	A comprehensive transformation that presupposes changes in all spheres of society's life, one that cannot be isolated from large-scale socio-cultural changes
L.M. Borsch [14]	It is not only the transfer of the economic system to a new level. It is the effective interaction of methods and tools in the management of innovative renewal
D.B. Eroshok [15]	A complex, targeted impact on the economic system, which involves a fundamental renewal of its elements through the generation or transfer of innovations
E.V. Dolzhenkova [16]	Intensified economic reproduction, which is achieved through the growth of differentiation of labor, energy equipment, production, the transformation of science into a production (economic) force and rational production management

Source: authors.

are developed, it becomes the practical basis for a new type of economy, which involves the integration of «science-education-production», complication of interactions in the scientific and production process, innovative focus of investments, etc.

4 Results

In 2023, the share of high-tech production and knowledge-intensive industries in GDP was 23.5% [1]. It is significantly lower in Russia than in the US, where the share of fifth-level production is 60%, fourth-20%, and sixth-level production accounts for 5% [18]. Significant technological backwardness and depreciation of the industrial production base create obstacles to the efficient use of available resources. Although it is estimated that Russia has the potential to move to the fifth technological order and consolidate some positions within the sixth. For example, there are opportunities to form the industry based on NBIC technologies. The state enterprise Rosnanotech has been created, and fundamental research is being conducted in the physics of nanostructures. There are five technology parks and more than 10 government business incubators in Russia, and the infrastructure of the national innovation system is being formed. But the high degree of depreciation of fixed assets is the main obstacle to innovative development. Investments in fixed assets are of great importance in modernization of production. Their dynamics shows that investments in fixed capital relative to GDP volumes are close to the accepted regulatory standards (20–25%). Their share of GDP in the Russian Federation averages 20–22% (Fig. 1).

According to Rosstat data [1], the share of fixed capital investments in GDP was 22% (2017 – 21.4%, 2018 – 20.0%, 2019 – 20.6%) in 2023. In 2023 fixed capital investments in Russia increased by 9.8% compared to the same period in 2022. Fixed capital investments in Russia increased by 8.6% to 13.75 trillion rubles at the end of

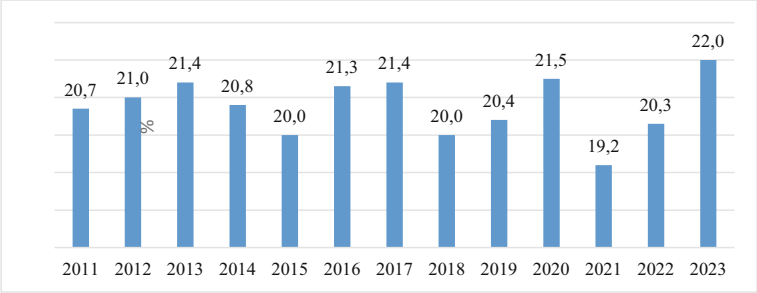


Fig. 1. Investment in fixed capital in GDP (%) (Source: authors).

2023 compared to the same period in 2022. About 70% of fixed capital investments were spent on developing eight types of economic activity in 2023 (Fig. 2).

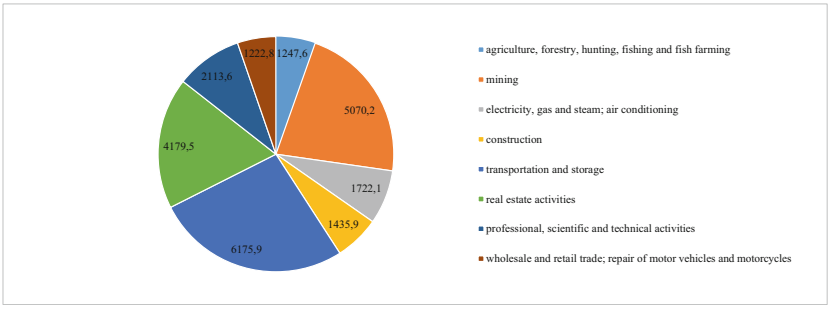


Fig. 2. Investment in fixed assets, trillion rubles (%) (Source: authors).

In 2024, the main source of financing investments in fixed assets were the companies' own funds (59.4%), while the share of attracted funds accounted for 40.6% of investments. Budgetary funds at all levels account for 13.9% of the total investment. The key factor that determines the need to renew fixed assets is depreciation. The dynamics of depreciation of fixed assets over the past few years is shown in Fig. 1. The highest degree of depreciation was noted in 2014 and amounted to 49.4% (Fig. 3). In 2023, depreciation of fixed assets amounted to 41.4%.

Reduced depreciation of fixed assets will allow developing the updated economic model that is focused on qualitative changes in all areas of society. Such an economic model is characterized by holism, differentiation, negative entropy, cyclicity of events, the ability to change the nature of the elements of the system in response to changes in any parameter. Let us determine the possibilities of innovative modernization within the framework of developing elements of a new type of economy (Table 3).

To develop a new type of economy and stimulate the formation of new markets, it is necessary to create a special infrastructure for innovative modernization (Fig. 4).

The main trends of innovative modernization are:

1. Industrial robotics (robotization of laying out goods, their packaging and palletizing).

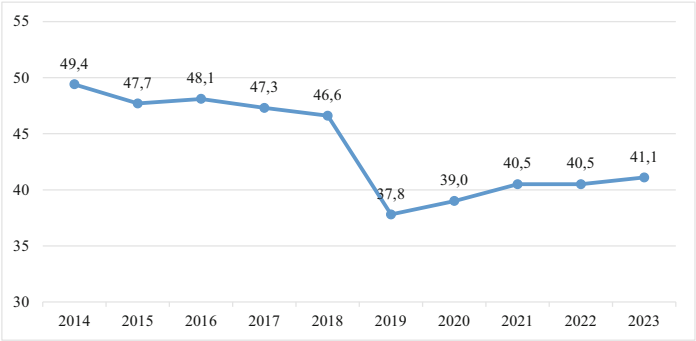


Fig. 3. The degree of depreciation of fixed assets in the Russian Federation at the end of the reporting year (%) (Source: authors).

Table 3. Elements of a new type of economy.

Element	Impact of innovative modernization
Knowledge Economy	It allows intellectual component of economic processes to dominate over the material ones
Information and communication	It increases production of computer and communications equipment, software, Internet systems for the formation, storage, management and receipt of information
Priority technologies	It accelerates the development of biotechnology, nanotechnology, resource-saving technologies, creation of new materials, eco-technologies, etc
Intangible assets	It increases the share of intellectual capital of specialists, the value of Russian brands, company images, and improves the business reputation of Russian companies
Management and Marketing Technologies	It develops new modern technologies for marketing and management

Source: authors.

2. Digitalization of production by introducing programs for automation of technical maintenance, business process management, production dispatching, which allows reducing the cost of paying labor costs for line specialists.
3. Reverse engineering – designing working 3D models of parts.
4. Computer vision. Provides control of production lines, tracks and records failures or defects in operation, classifies products. The advantages of machine vision include an increase in product quality, a reduction in the number of defective products, and monitoring of equipment operation.



Fig. 4. Mind map of innovative modernization (Source: authors).

5 Conclusion

Innovative modernization creates a system of relationships «science-production-society», in which innovations become the basis for the competitive development. To summarize, we should highlight the identified opportunities for innovative modernization:

- increase the competitiveness and sustainability of the economy: the transition to a higher technological level of production contributes to the growth of innovative activity, export orientation and environmental friendliness;
- form effective parameters and mechanisms of public-private partnership, this contributes to the change of technological structures, changes innovative associations of high-tech and knowledge-intensive industries;
- integrate use of scientific and technical achievements;
- develop a sustainable, balanced national industry independent of external influence, capable of generating innovations and transforming them into products;
- use energy-saving technologies;
- develop biotechnology, nanotechnology to create materials with new properties;
- increase labor productivity based on materialization of scientific potential and production of products in the context of modern needs;
- develop information technology and mass media.

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Methodology for Assessing the Level of Economic Independence of a Country

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Abstract. The contribution presents the essence of the concept of «economic freedom of the country from the government», the methodology for determining the level of economic freedom of the country from the government by the leading research institute of the Heritage Foundation of the USA. The assessment of the economic freedom of the country by the research institute of the Heritage Foundation of the USA is carried out in the interests of transnational corporations seeking to create a «global economy without borders», as well as in the interests of the US government. Based on the study of data published by the research institute of the Heritage Foundation of the USA, the author came to the conclusion that those countries that have significant debts to international financial organizations and transnational corporations are considered by the Heritage Foundation of the USA as economically free countries. As an alternative concept of economic freedom of the country» from the government, the author proposed the concept of «economic independence of the country».

Keywords: Country · Economic Freedom · Economic Independence · Financial Structures · National Economy · Transnational Corporations · World Economy

1 Introduction

In the encyclopedic literature, the world economy is considered as a system of international social division of labor and economic relations of individual national economies of countries. The global economy unites all aspects of national economies and international trade, economic, financial and scientific-technical relations between countries. International trade and management of financial flows are influenced by both the governments of each country and large transnational corporations and international financial institutions. Since the mid-20th century, the term «global world economy» has been used alongside the term «world economy», which on an international scale includes all economic activity carried out both within countries and between countries, including production, exchange, consumption of manufactured products, as well as savings and accumulation of income for investment to expand the scale of production. Transnational corporations play an active role in the formation of the «global world economy». At the beginning of the 21st century, transnational corporations on a global scale have become

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a «virtual country» with a population of 50.0 million people. In 2000, the financial assets of transnational corporations amounted to about $25.0 trillion. The volume of sales of goods, services, securities and currency by transnational corporations on a global scale amounted to about 16.0 trillion dollars. According to UNCTAD [1] estimates, in 2000 the income of transnational corporations in 2000 amounted to about 7 trillion 462.8 billion dollars, the capitalization of income of the 50 leading volume of income in the same year was 4 trillion 102 billion dollars [2]. Transnational corporations are mainly interested in directing investment funds into profitable sectors of the national economy of any country, especially into developing and poor countries of the world. At present, transnational corporations are investing funds into countries with high potential for mineral resources.

2 Methodology

The contribution presents the essence of an alternative concept – the concept of economic independence of the country in the interests of national security of the state. The author proposes a method for assessing the level of economic independence of the country from international financial structures, as well as transnational corporations. The research methodology consists of the basic principles of marginal utility, mathematical, statistical research methods and comparative analysis. An algorithm for assessing the level of economic independence of a country is proposed.

3 Economic Freedom of the Country from the State

Transnational corporations, in order to develop investment programs, study conditions of state influence: on the process of production of goods in the country, on taxes on the income received, on the customs policy of export of manufactured goods from the country, on the use of accumulated funds from income for reinvestment in the national economy of the country. Under the title «economic freedom of a country» from the state, a strategic research institute, the Heritage Foundation, operating in the United States, prepares data on a country's economic freedom from the state [2–4], intended for use by transnational corporations. The prepared data cover the following group indicators (indices):

1. Rule of law: 1) protection of property rights; 2) the effectiveness of the legal system; 3) indicators of the «cleanliness» (non-corruption) of state bodies.
2. Limitation of state power: 1) tax exemption (tax burden); 2) the amount of government spending (does not depend on the government); 3) use of financial resources (does not depend on the government).
3. Efficiency of state regulation of the economy: 1) freedom of entrepreneurial activity; 2) freedom of labor relations; 3) indicators of free ownership of money, freedom of purchase and sale.
4. Market openness: 1) freedom of trade; 2) freedom of investment; 3) indicators of financial freedom to withdraw funds from the country.

The above indicators are assessed by experts selected by the institute. This assessment is formed not by analytical calculations, but on the basis of subjective opinions of experts.

When investing in countries around the world, transnational corporations use the above-mentioned indicators prepared by the Heritage Foundation Institute for Strategic Studies to make decisions taking into account the existing legislative system in countries, the level of government intervention in business activities, the level of effectiveness of government regulation of investments, as well as the level of government intervention in doing business, making investments and managing financial resources. In addition to the above, a report prepared by the Heritage Foundation Institute for Strategic Studies is being submitted to the US government with the goal of pursuing policies to ensure the competitive advantage of US multinational corporations in the global marketplace. The results of this report form the basis for the formation of the US government's mechanism of influence on the global economy. Thus, we believe that the concept of «economic freedom of countries from government» serves the interests of large transnational corporations.

The Heritage Foundation, based on expert assessments as of the beginning of 2024, included Singapore, Switzerland, Ireland, New Zealand, Estonia, Luxembourg, the Netherlands, Denmark and Sweden among the most economically state-free countries [2–4]. However, our calculations showed that the debts of these countries to foreign countries are many times higher than the gross domestic product produced in the country, and the foreign debts per capita in the country are extremely high. So, by the beginning of 2024:

1) Singapore's external debt was USD 1,997.0 billion, the size of the external debt was 4.0 times the annual gross domestic product (GDP) produced in the country, and the size of the external debt per capita was USD 378.0 thousand;
2) Switzerland's external debt amounted to 2,277.6 billion USD, the size of the external debt was 2.6 times higher than the annual GDP produced in the country, and the size of the external debt per capita was 253.6 thousand USD;
3) Ireland's external debt amounted to 3,144.3 billion US dollars, the size of the external debt was 5.8 times higher than the annual volume of GDP produced in the country, and the size of the external debt per capita was at the level of 635.9 thousand USD;
4) New Zealand's external debt amounted to USD 224.3 billion, the size of the external debt amounted to 90.1% of the annual GDP produced in the country, and the size of the external debt per capita was USD 41.9 thousand;
5) Estonia's external debt amounted to 37.6 billion US dollars, the amount of debt to foreign countries amounted to 92.3% of the annual volume of GDP produced in the country, the amount of external debt per capita was at the level of 29.9 thousand USD;
6) Luxembourg's external debt amounted to USD 3,787.1 billion, the size of the external debt was 44.1 times higher than the annual GDP produced in the country, and the size of the external debt per capita was USD 5,823.1 thousand;
7) The external debt of the Netherlands amounted to 4270.8 billion USD, the amount of debt to foreign countries was 3.8 times higher than the annual volume of GDP produced in the country, and the amount of external debt per capita was at the level of 241.3 thousand USD;

8) Denmark's external debt amounted to 547.8 billion USD, the size of the external debt was 1.4 times higher than the annual volume of GDP produced in the country, and the size of the external debt per capita was at the level of 93.2 thousand USD;
9) Denmark's external debt amounted to 547.8 billion USD, the size of the external debt was 1.4 times higher than the annual volume of GDP produced in the country, and the size of the external debt per capita was at the level of 93.2 thousand USD;
10) Sweden's external debt amounted to 1,041.6 billion USD, the size of the external debt was 1.8 times higher than the annual GDP produced in the country, and the size of the external debt per capita was at the level of 99.1 thousand USD.

In this way, according to the rating compiled by the Heritage Foundation at the beginning of 2024, economically free countries include countries with an extremely high level of external debt per capita.

4 Economic Independence of the Country

We believe that the concept of «economic independence of the Country is an alternative to the concept of «economic freedom of the country», indicating the level of independence of the country's economy from transnational corporations and international financial structures. In our opinion, in general, the level of economic independence of a country can be assessed using the following indicators: 1) investment from domestic sources; 2) balance of exports and imports of goods and services; 3) the balance of income received into the country and income transferred from the country; 4) external public debt of the country; and 5) national income of the country.

Using the methodology we have developed, it is possible to determine the level of the index of general economic independence of the country χM, using the subindices listed below. The value of the subindices varies in the range $(0 \div 1)$.

1. Subindex χI – the specific weight of domestic investments *Id* in the total volume of investments *I* in the country's economy Eq. (1):

$$\chi \mathrm{I} = \mathrm{Id}/\mathrm{I}, \tag{1}$$

An increase in the value of the χI subindex, that is, the condition $\chi \mathrm{I1} > \chi \mathrm{I0}$, indicates an increase in the country's economic independence according to the χI subindex.

2. Subindex χNx – the specific weight of the balance of exports and imports of products and services (±NX) in the gross national income *Gm* of the country – Eq. (2):

$$\chi \mathrm{Nx} = (\pm \mathrm{Nx})/\mathrm{Gm}, \tag{2}$$

An increase in the value of the χNx subindex, that is, the condition $\chi \mathrm{Nx1} > \chi \mathrm{Nx0}$, indicates an increase in the country's economic independence according to the χNx subindex.

3. Subindex χGa – the specific weight of the balance of income received in the country and transferred from the country (±GA) in the gross national income *Gm* of the country – Eq. (3):

$$\chi \mathrm{Ga} = (\pm \mathrm{Ga})/\mathrm{Gm}, \tag{3}$$

An increase in the value of the χGa subindex, that is, the condition $\chi Ga1 > \chi GA0$, indicates an increase in the country's economic independence according to the χGa subindex.

4. Subindex χQ – the specific weight of the country's external public debt Dq in the country's gross national income Gm – Eq. (4):

$$\chi Q = Dq/Gm, \tag{4}$$

A decrease in the value of the χQ subindex, that is, the condition $\chi Q1 < \chi Qo$, indicates an increase in the country's economic independence according to the χQ subindex.

5. Average annual level χM of economic independence of the country for a certain period T – Eq. (5):

$$\chi M = \sum \chi M/N, \tag{5}$$

In the ratio (5), N shows the number of years T of the period under study. Thus, we believe that the change in the economic independence of the country χM, as a function, can be measured by changes in indices (χI, χNx, χGa, χQ, N), i.e. – Eq. (6):

$$\chi M = f(\chi I, \chi Nx, \chi Ga, \chi Q, N), \tag{6}$$

After assessing the subindices of the country's economic independence indicators, the algebraic sum of a number of subindices for T years is calculated according to Eq. (7):

$$\sum \chi M = [(\sum \chi I + \sum \chi Nx + \sum \chi GA + \sum \chi Q)/N], \tag{7}$$

Based on the ratio (7), conclusions can be drawn about the level of economic independence of the country.

5 Conclusion

Using the methodology we developed, we examined the state of economic independence of the Republic of Azerbaijan from the finances of transnational corporations and from international financial structures for the period 2016–2021. Research conducted on the basis of data from the State Statistical Committee of Azerbaijan showed that in 2016–2021, the country's economic independence index χM had an upward trend. Based on the data of the State Statistical Committee of Azerbaijan [5–7], it was found that in 2016, the level of the economic independence index of Azerbaijan was 0.557, in 2017 – 0.713, in 2018 – 0.902, in 2019 – 0.900, in 2020 – 0.865, and in 2021 – 0.884. The calculations showed that in 2016–2021, the χM index of economic independence of Azerbaijan, in accordance with the Eq. (8):

$$\chi M = (0.0597 \cdot t + 0.5944), \tag{8}$$

increased by an average of 0.060 units every year.

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Ethical Aspects of the Use of Artificial Intelligence in Modern Conditions

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Abstract. In the context of the development of a digital society, the issue of ethical and moral standards for the use of artificial intelligence is becoming more acute. Artificial intelligence has gained recognition in almost all areas of social and economic life. The speed of its distribution and implementation poses such problems as freedom and human rights, protection of privacy, responsibility for possible consequences, etc. The existing problems do not relate to the field of technical support, they relate to social, cultural, value, economic aspects of society. The contribution considers issues of ethical and moral standards for the use of artificial intelligence. The areas of application of artificial intelligence are analyzed, possible risks and threats are identified. The authors formulate proposals on issues of ensuring ethical approaches to the development of artificial intelligence. The basic provisions of the code of ethics of artificial intelligence are defined. In order to systematize the accumulated practical and theoretical experience of using artificial intelligence, an attempt is made to organize this area based on a general system approach. Recommendations are given to solve problems of using artificial intelligence in modern conditions.

Keywords: Artificial Intelligence · Code · Ethics · Information Risks · Society · Security · Technology · Threats

1 Introduction

The legality and feasibility of using artificial intelligence (AI) in solving a number of problems leads to the creation of unique ethical dilemmas that humanity has not encountered before [1, 2]. Interest to this problem leads to the need to organize a broad discussion in society [3]. Discussing the problem of the AI ethics is not a tribute to the fashion for a new phenomenon in society. This is a vital necessity that will allow us to define state and legal regulation of this issue, warn about the presence of risks and threats, formulate rules of conduct for users, define boundaries of what is permitted for developers, and form an attitude towards the moral and ethical foundations of society and its value model of existence. Attempts to organize this area by individual organizations that independently develop codes of digital conduct, prescribe regulations for compliance with ethical principles, and formulate digital policies and declarations do not contribute to a systemic solution to the problem. The growth in the number of publications allows us to determine directions for creating a unified approach.

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2 Methodology

Artificial intelligence is understood as algorithms that have the ability to self-learn in order to apply the acquired knowledge to achieve human goals [4]. According to another approach, AI is understood as a computer program that is capable of learning based on the analysis of a large amount of data in order to further obtain new analytical information for independent decision-making [5]. The term itself was first used in 1956, but the origin of the idea dates back to 1935, when it was proposed to consider intelligent systems as those systems that would not differ from humans in communication. A qualitative leap in the development of artificial intelligence occurred in the 80s of the 20th century. The AI field includes machine learning, deep learning, neural networks. Thus, machine learning is a way to obtain new knowledge and solve problems by generalizing many complex examples through appropriate algorithms and models, while deep learning is a part of machine learning, built on the use of neural networks capable of independently finding algorithms and solution methods. The neural network is built on the principles on which the human nervous system is built.

Artificial intelligence has become a tool for studying important and still unsolved scientific fundamental problems and applied problems. This includes the study of consciousness, thinking, decision-making, big data processing, etc. In the Russian Federation, special attention is paid to the development of artificial intelligence [6]. In the context of import substitution policy, it is very important to use the achievements of artificial intelligence in supporting scientific research and design development, the development of software based on primarily responsible technologies. AI is developing in all spheres of public life, but the greatest interest in its development is in business. This is determined by the fact that the achievements of AI make it possible to obtain analytical information and the corresponding informed decisions that can significantly increase the income of companies and strengthen their position in the market. In conducting the research, the authors used methods of system analysis, statistical methods, logical analysis, and general scientific methods of cognition.

3 Results

Artificial intelligence performs tasks in organizations that were performed by different structural divisions in a parallel-sequential manner. The time spent by specialists was measured in days and weeks, while AI solves these tasks as quickly as possible. In addition, the level of development of artificial intelligence allows it to generalize data, systematize and analyze them, draw conclusions, make plans, forecasts and management decisions. By freeing employees from routine, frequently repeated operations, AI helps to speed up virtually all organizational processes. The most widespread application is the introduction of electronic document management and automatic document processing. Specialists get the opportunity to implement their professional competencies, analytical skills and unique knowledge. The specifics of the modern business environment led to the development of a situational approach to decision-making by managers. Managers made decisions based on their experience, management skills, wisdom and intuition, which certainly did not always correspond to making the most rational or effective

management decision. The possibility of using artificial intelligence allows obtaining information to substantiate alternative options for management decisions, forecasting possible scenarios for the development of the situation taking into account the identified trends and dynamics. The quality of such management decisions will be significantly higher, they can be assessed from the standpoint of efficiency and implemented in practice in the shortest possible time.

The ability of AI to learn based on experience and identified errors leads to constant development [7]. It is already possible to recognize images, implement voice guidance, use different languages, analyze characteristics of users' tastes and habits. The possibilities of using AI in education and training are limitless. The ability to understand speech, analyze text, recognize images contributed to the widespread introduction of intelligent automation programs for consulting users on any issues of contact in automatic mode using chatbots and voice assistants. The development of trading platforms is based on the use of searching for the product needed by the buyer by the available image, detailed tracking of the order status during assembly in the warehouse and during its subsequent movement directly to the buyer. Manufacturers, trading platforms, and buyers can see in real time the remaining stock of products in warehouses, changing pricing policies, opportunities for obtaining benefits, and much more.

Calculations of the company's performance indicators in any areas, performance indicators, financial stability, performed in dynamics and the construction of trends, form a basis for obtaining predictive analytics and building dashboards that clearly display the state of processes in the organization [8]. Increasing the level of safety by recognizing road users, car numbers, faces of citizens on the streets, in the subway, transport has led to a significant reduction in forensic and disciplinary risks. In fact, society has opened up unlimited analytical possibilities that were previously limited by the capabilities of the human brain. However, along with achievements, artificial intelligence has brought a huge number of risks, problems and consequences of its use [9].

The problems of the AI ethics can be divided into scientific and empirical ones. Scientific problems include the solution of copyright issues, the legal personality of artificial intelligence, the compliance of AI algorithms with the human mind, the potential for creating mega-powerful AI. Empirical problems lie in the plane of practical application. The concept of personal life, personal space and personal information has become erased, the boundaries have become blurred. Each individual strives for the necessary level of privacy. However, in order to analyze and obtain new data, AI must have access to all information. The results of the work of artificial intelligence can become available to an unlimited number of people whose interests are not defined.

The issue of confidentiality and protection of information has become acute. In the process of training, artificial intelligence uses a large array of information and data, which is determined not by artificial intelligence, but by its developers. This array of data may not reflect the entire sample volume, training can occur on a separate, limited base with its own characteristics and features. AI trained on this array will receive the appropriate skills and assessments, which will be biased and distort the approaches generally accepted in society. Moreover, if the training doesn't take place on high-quality sources, then the training results will be appropriate. The question of trust in the results of the work of artificial intelligence and the decisions made on this basis arises [10].

The cause-and-effect relationships of the relevant decisions must be clear to the user, it is important to know for what reason it was taken, how justified it is. How the issue of achieving justice is ensured within the framework of the implementation of artificial intelligence in controversial situations and ethical or social dilemmas.

There is an acute issue of ensuring the confidentiality of the information received and processed, and the protection of personal data. Moreover, when AI is used in areas that process data on the state of critical areas and objects, human health, etc., not only data leakage, but also data manipulation in the event of information threats and possible attacks can have extremely negative consequences. The problem of protecting data from information threats and cyber attacks is present in many industries, such as the protection of critical infrastructure, energy, and the organization of road and air traffic. Just as a manager who is responsible for the results of the decision he makes, the issue of liability of artificial intelligence in the event of erroneous actions must be resolved. The solution to this issue requires serious legal development.

The large-scale introduction of AI will lead to structural changes in the labor market. Some professions will become obsolete and will no longer be in demand, new labor functions will appear. These processes will require changes in vocational and school training programs, and training in retraining programs. Problems of a technical nature, cybersecurity, information threats, in matters of artificial intelligence development have become the most complex. And if the above-mentioned problems are subject to analysis and elimination, then the questions in the plane of ethics and morality of AI development are only beginning to form. In accordance with the current algorithms, artificial intelligence, in the process of analyzing the data array and the identified patterns, offers the user to apply a predetermined action or solution in accordance with the identified preferences. However, strengthening the user's existing beliefs and offering only the algorithms that correspond to it does not contribute to the development of personality and alternative actions. A person, unlike artificial intelligence, is a social, emotional creature, has empathy. At the heart of its existence is critical thinking and the need to take into account the diversity of approaches, opinions, alternatives and their rethinking. Over the centuries of evolution, humanity has formed its own values, moral principles and much more that distinguishes humans from the animal world.

AI is capable of creating results of creativity and art that surpass existing achievements. They are more technically correct, competent, clear. However, often, an imperfect result of labor becomes a masterpiece, often having an error or a blot, which gives it exclusivity, uniqueness, originality. The ability to process an unlimited array of data will not replace the perception of the world around you. Moreover, AI is nevertheless a product created by man. The rules that are laid down in the AI development are determined by people, in this regard, the subjectivity of artificial intelligence and its limitations are the corresponding characteristic.

4 Discussion

In order to systematize the accumulated practical and theoretical experience of using artificial intelligence, the following directions can be proposed. Code of Ethics of Artificial Intelligence [11]:

- the main priority of development in protecting the interests of the individual, social group and society;
- the responsibility for the creation and use of artificial intelligence is proportional to the scale and significance of the use of technologies;
- responsibility always lies with the person;
- new technologies are important and should be implemented if they benefit the individual and society;
- the interests of the development of artificial intelligence are higher than the interests of competition;
- maximum awareness, transparency, truthfulness and impartiality are important;
- technologies and ethics of artificial intelligence are beyond boundaries;
- ethics evolves along with new challenges, threats, knowledge.

To solve problems, including ethical ones, developers should be able to exchange experiences and work out possible scenarios of use. This approach will minimize the main fears of using artificial intelligence, including excessive uncertainty, high risks that cannot be assessed and analyzed, and the lack of regulation in this area. Even under normal conditions, the norms of ethics and morality were not subject to strict systematization and regulatory influence. The norms and rules of public life, values, and beliefs were passed down in the family from generation to generation, and were adjusted by the influence of society. In the context of artificial intelligence, ethical norms should be the basis of the source of law. Specialized legal norms, laws, regulatory impacts, possible consequences, and punishment will be able to determine the legal field for the development of artificial intelligence. Public opinion should become the source of the legal basis for ethical standards. Ethical standards will not be implemented if they do not correspond to the worldview of society and are not accepted by the majority. The purpose of such standards is mostly not to develop punishment or regulate control, but to determine the consequences and dangers of using artificial intelligence, to form a public consensus.

The problem under discussion is not unique. There is a wide variety of regulatory legal standards in related areas that can be successfully adapted to artificial intelligence. Threats and risks may be new, and approaches to solutions already exist in the legal environment. Existing standards should not be replicated, it is possible to expand the scope of their application. Developers in the process of creating and developing AI models and at all stages of its implementation must take into account potential threats of using the technology for other purposes and take the necessary measures to minimize and prevent them. The consequences of the risks in the context of the AI application are serious reputational losses, direct losses and business destruction for the organization and companies [12]. When making a decision to use new technologies, it should be approached as carefully as possible.

The possibility of widely using new developments, open solutions in the process of their free distribution, on the one hand, will significantly increase the capabilities of small and medium businesses, improve business processes and increase the efficiency of activities, on the other hand, it will complicate the solution of liability issues. The use of ready-made models for their further development also contributes to the complexity of determining the levels of responsibility. Side effects identified in the process of use

cannot be eliminated, since subsequent users and developers may not be familiar with the initial structure of the model and its vulnerabilities. The consequence is a decrease in the safety of using artificial intelligence, the accumulation and replication of risks and vulnerabilities [13]. Perhaps it is necessary to consider the introduction of a stage of assessing all ideas and models for compliance with ethical principles. It is important to understand that the ethics of artificial intelligence as a scientific field is at the initial stage of formation. There is no complete and systematic picture of all possible risks, methodologies for their assessment and modeling. Therefore, the negative consequences of the use of artificial intelligence systems can be difficult to predict and unexpected, even if after the fact they seem obvious.

5 Conclusion

Artificial intelligence is certainly developing in all spheres of public life [14]. Gaining experience and the consequences of digitalization requires addressing the issues of morality, responsibility for actions taken by both the developer and the artificial intelligence, and global responsibility for the future of humanity in the new digital reality.

The algorithms for the AI functioning must be understandable to the user, transparent, logical and accountable. This will help identify and solve potential problems. The introduction of standards, regulations and protocols for monitoring AI algorithms for compliance with ethical standards will ensure its accountability. In the event of disputes, commissions and bodies can be created to consider them. Users must be trained in the basics of working with artificial intelligence. For developers of artificial intelligence, the priority task should be to ensure the security of both the data itself and the processing algorithms. The mechanism for identifying and tracking the actions of artificial intelligence, testing possible behavior scenarios in real conditions will allow identifying potential problems at early stages.

Negative consequences of AI actions should be regulated in the legal field of the state. Sources of additional income and benefits resulting from the introduction of AI should be distributed at the state level according to the principles of justice. The algorithm for the AI development must take into account various approaches, the presence of alternative options, and a variety of opinions. Control over the bias of artificial intelligence can be carried out through monitoring and auditing with the involvement of independent experts. The developed code of ethics for artificial intelligence, based on the principles of fairness, security, transparency, and responsibility, should be systematically reviewed taking into account new threats and technologies.

Developers and users should be aware of possible risks and current threats. Actions of users and developers, as well as artificial intelligence, should be based on ethical and moral standards. The identified problems should be widely assessed by professional communities and ordinary users. Discussions around various kinds of AI dilemmas will help create a responsible approach to its application. Probably, in the near future, the question of developing a common international approach to resolving issues of AI ethics will arise. A wide range of actors, such as business, representatives of the scientific community, governments, and public organizations, should be involved in the

formation of an international approach and standards. The solutions developed should meet the criteria of fairness, safety, and balance. Such a new phenomenon as artificial intelligence is a dynamically developing field of knowledge. It is constantly adapting to new challenges and requires increased attention. The introduction and development of new mechanisms and technologies cannot be stopped, however, regulation and control should be introduced, training should be provided, and awareness of all stakeholders should be raised. With this approach, artificial intelligence can become an ethical tool that contributes to the development of our society.

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Digital Transformation of Economic Activity: Managing the Innovative Development of Territories

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Abstract. This work considers key trends in territorial development (the presence of a synergetic relationship between 'man and machine', the fight against a new generation of risks and threats, the presence of a new round of computing development), which leads to improved customer experience in general, growth and transformation of business in the regions, increased operational efficiency, risk management, and talent development among the segment's business and state apparatus. Based on the analysis, a prioritization matrix of technology trends was formed to identify growth areas in the area of territory development management. It was revealed that the format of high-speed introduction of innovations in the state apparatus, the format of initiating technological transition, the strategy of express evaluation of other regions' experience to introduce the possibility of cost reduction, as well as the strategy of adapting the trend to the region's tasks are distinguished. Prospective directions and tools of territorial development management are investigated on the basis of the problems of regional development. It was shown that the introduction of the method of determining the region's cooperation potential as a tool for managing the innovative development of territories makes possible to assess the level of education, human resources, technology, practical experience of a region-supplier to make a profile of a region-consumer, on which it is necessary to identify a list of potential demand, resources and conditions for further development through SWOT-analysis of the region to form a pool of opportunities for interregional partnership.

Keywords: Digital Transformation · Ecosystem · Governance · Innovation · Region-Consumer · Region-Supplier

1 Introduction

The need for continuous monitoring of innovative development of Russian regions is determined by the active implementation of domestic IT solutions, the development of quantum technologies, artificial intelligence, digital platforms that form a digital infrastructure with efficient data transmission channels, create a basis for public services with standard cloud solutions, basic services and data factories [1]. Ensuring technological leadership is expressed in the synergetic combination of critical technology components, instrumentation base and achievement of technological sovereignty to ensure the

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well-being, and competitiveness of regions, which creates an effective environment for knowledge-intensive business with high involvement of authorities (regional programs and preferential development subsidies) and an environment for researchers with techno-weapons, publication and patent activity, social support [2]. Thus, Russia has formed principles of management of innovative development of territories taking into account digital transformation, which include:

- improvement (of the research management system),
- increase (growth of investment attractiveness of business),
- identification (search for best practices of regional and federal authorities to achieve results in S&T development),
- independent evaluation (analysis of the results of the efforts of regional and federal authorities aimed at S&T development of the subjects),
- motivation (additional incentives for authorities of all levels in the regions to take effective measures to improve S&T development),
- incentivisation (additional incentives for authorities of all levels in the regions to take effective measures to improve S&T development),
- independent evaluation (analysis of the results of the efforts of regional and federal authorities aimed at S&T development of the subjects),
- motivation (additional incentives for authorities of all levels in the regions to take effective measures to improve S&T development of the subjects) [3, 4].

National technology leadership projects focus on industrialization of transport mobility, growth in space development, expansion of the field of unmanned aircraft systems, new health saving technologies, bioeconomy, manufacturing and automation tools [5]. The main directions of development today touch upon three aspects: technological trends, fintech trends and business trends, which combine the field of innovative application of digital and information technologies with the synergy of man and machine, innovative cross-industrial approaches to increase efficiency, development and transformation of business with new customer experience, process optimization, transformation of business models, directions of application of digital technologies for the development and transformation of the financial market with digital assets [6].

Among the solutions offered in the market, there are generative artificial intelligence technologies, agent AI, AI management platforms, quantum-stable cryptography, misinformation protection systems, hybrid computing, smart customer experience solutions, interactive sales, emotional AI, platform economics, friendly localization, digital care strategy, BigTechs, multi-segment banking, multimodal bio-acquiring, digital infrastructure and many more. For this purpose, the following tasks were carried out:

- key trends in the field of innovative development of territories were considered;
- the peculiarities of digital transformation of economic activity were identified to find promising tools for managing innovative development of territories;
- innovative management solutions were analyzed.

2 Methodology

The author conducted a review analysis of relevant sources to select and structure the key features of digital transformation. Thus, domestic and foreign materials were used, three areas were selected for consolidated and cross-cutting analysis (fintech, business trends,

technological trends), which allowed to prioritize development areas, rank trends based on surveys of Russian business and entrepreneurship, and conduct a detailed description of the drivers of territorial development. The study involved experimental-theoretical methods of deduction in the form of high-coverage analysis of general tendencies to reduce to a private conclusion, comparison, methods of theoretical level in the form of analysis and synthesis.

3 Results

The economic activity of the Russian regions showed the following results in December 2024 – January 2025: GDP grew by 1%, the main contribution was made by construction, manufacturing, mining and freight turnover. By the end of 2024, economic activity is expected to grow by 4.1%, which is higher than the forecasted 3.8%. The main drivers of growth include higher demand in the domestic market, and an increase in the volume of new orders [7]. In December 2024, industrial production showed strong growth due to mining and processing industries (+4.6%), oil refining, metallurgy, food processing, chemistry and machine building showed positive dynamics, cargo turnover grew for the second month in a row, railway, road, sea and water modes of transport had a positive impact. Passenger turnover showed zero growth, the positive dynamics of railway and road transport was offset by the negative contribution of air transport. Agriculture showed a slight growth, but did not compensate for the decline in October-November. The construction sector showed unexpectedly high growth in December, despite the decline in housing construction and production of construction materials [8]. Retail turnover in December decreased by 0.9%, growth for 2024 was 7.2%. Paid services in December increased by 0.2%, growth for 2024 was 3.3%. Budget revenues grew by 11% in January 2025, while expenditures reached a record level. The volume of public procurement increased by 3.4 times due to the prompt conclusion of contracts [7].

Analyzing the key trends in territorial development, we should highlight the presence of a synergistic relationship between ‘man and machine’, the fight against a new generation of risks and threats, the presence of a new round of computing development, which leads to an improved customer experience in general, growth and transformation of business in the regions, increased operational efficiency, risk management, and talent development among the segment’s business and state apparatus. Thus, a matrix of prioritization of technological trends was formed to identify growth zones in the area of territorial development management (Fig. 1) [6]. Figure 1 shows the readiness of regions to adapt innovation processes, as well as the impact of trends on key areas of activity. The matrix is of a general nature and is suitable for a personalized study of each participating region.

According to the matrix, it is necessary to assess the degree of trend impact on the region of presence based on the parameters of trend impact on activity (low – high), readiness for adaptation (low – high) in order to form development strategies. Thus, the format of high-speed introduction of innovations in the state apparatus, the format of initiation of technological transition, the strategy of express evaluation of the experience of other regions to implement the possibility of cost reduction, as well as the strategy of adaptation of the trend to the objectives of the region are distinguished.

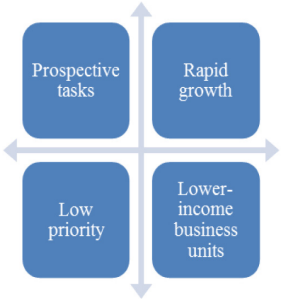


Fig. 1. Matrix of prioritization of key technology trends in the regions of operation (Source: author).

Digital transformation today leads to the disconnection of economic, scientific and technical components of spatial development of territories, which affects the formation of interregional technological partnerships, adjusts management tools, changes the model of the 'open information system', formed in the course of high differentiation and unevenness of the Russian regions. Thus, the mismatch between the economic and technological map of the country's regions was formed, which affected the logarithms of the average value of GRP, the Russian Regional Innovation Index, where the leading regions with a highly developed scientific and technological sphere, developed innovation infrastructure and ecosystem and weak lagging regions with the possibility of project introduction of technologies for the development of technological foresights, the formation of partnerships that will strengthen the potential and allow to reach a new level of economic development were formed [9].

The problem of regional development lies in the blurring of motives for the development of interregional cooperation, thanks to which it is possible to increase the pace of socio-economic development (development of strengths and compensation of weaknesses), to significantly strengthen the diversification and efficiency of the economy, which will lead to increased connectivity of individual regions, accelerate the pace of economic growth, technological development, expand the possibilities of spatial development, strengthen the experience of horizontal partnerships. For this purpose, it is necessary to consider the implementation of the method of determining the potential of cooperation of the region as a tool for managing the innovative development of territories [10]. This method implies SWOT-analysis of a region to form a pool of opportunities for interregional partnership [11]. Thus, it is necessary to assess the level of education, personnel, technology, practical experience of a region-supplier to make a profile of a region-consumer, on which it is necessary to identify a list of potential demand, resources and conditions for further development. For example, let's make a SWOT-analysis table of the supplier region in terms of technology (the Samara region) (Table 1) [12].

By the example of the Samara region it was revealed that there is a high growth potential in the ICT sector, which will allow to form an effective ecosystem of innovative interaction with the region-consumer, which needs to meet the need for the formation of a digital field (ecosystem), to conduct scientific and technological cooperation, to implement the profile of IT competencies, to carry out digital modernization to strengthen

Table 1. SWOT-analysis of the supplier region (the Samara region).

Strengths	Weaknesses
- technology and innovativeness for sector development; - the availability of industrial facilities and high-tech equipment; - professional profile of human resources; - prioritization of the region towards innovation policy (IT sector focus)	- limitation of the public sector in the field of innovative technologies and low demand potential for IT solutions; - weakening of IT sector diversification
Opportunities	Threats
- digital transformation and innovative development of regional companies; - technology export; - development of the innovation ecosystem	- risks of administrative regulation (change of prioritization at the state level); - effect of excessive concentration of risks

Source: authors based [12].

regional institutions. The Saratov Region can be an example of a consumer region. In this aspect, a 'win-win' strategy is implemented, when each participant in the transaction acquires a pool of opportunities, minimizes weaknesses and strengthens strengths [13].

4 Discussion

At the same time, the formats of interaction include interregional cooperation between the region and business through financial and non-financial systems, including interregional agreements and associations, representative offices, acceleration programs, budget transfers and loans, public procurement, budget investments, which leads to the establishment of joint companies and non-profit organizations for the subsequent identification of promising teams and the creation of advanced products within the region [14]. For example, the digital transformation of the oil and gas industry and the development of digital solutions for carbon balance control are becoming a relevant area for the Samara Region, while the Saratov Region is focusing on human, plant and animal biosafety and the digitalization of the agricultural sector.

Promising management tools in this context are reduced to the development of partnership systems, cluster solutions and effective ecosystems, which will unite public authorities, regional development institutions, business representatives, scientific, educational and research organizations in a single field, with a high level of key competencies in the main areas of support, stimulating demand for innovative products by creating a system of fiscal incentives, subsidies and preferential lending, stimulating the demand for innovative products by creating a system of fiscal incentives, subsidies and preferential lending, stimulating the demand for innovative products by creating a system of fiscal incentives, subsidies and preferential lending [15].

5 Conclusion

The digital transformation of economic activity makes it possible to adjust the tools for managing the innovative development of territories. Thus, it is necessary to highlight the matrix of prioritization of key technological trends in the regions of presence, thanks to which it is possible to assess the degree of influence of the trend on the region of presence based on the parameters of the impact of the trend on the activity (low –high), readiness for adaptation (low – high) in order to form development strategies. Practical experience allows us to distinguish the format of high-speed introduction of innovations in the state apparatus, the format of initiating technological transition, the strategy of express evaluation of the experience of other regions to introduce the possibility of reducing costs, as well as the strategy of adapting the trend to the objectives of the region. The qualitative distribution of regions-suppliers of resources and regions-consumers for the implementation of the 'win-win' strategy, when each participant of the transaction acquires a pool of opportunities, also minimizes weaknesses and strengthens strengths, becomes a tool.

The example of the Samara and Saratov regions shows co-operation of efforts. In the Samara region it was revealed that there is a high growth potential in the ICT sector, which will allow the formation of an effective ecosystem of innovative interaction with the region-consumer, which needs to meet the need for the formation of a digital field (ecosystem), to conduct scientific and technological cooperation, to implement the profile of IT competencies, to carry out digital modernization to strengthen regional institutions. For example, for the Samara region, the digital transformation of the oil and gas industry and the development of digital solutions for carbon balance control are becoming a relevant area of focus, while for the Saratov region it is human, plant and animal biosafety and the digitalization of the agricultural sector.

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Innovations and Digital Transformation of Socio-Economic Systems of Russian Regions

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Abstract. The work investigates the main indicators of innovative development and digital transformation of the Russian Federation, which are implemented within the framework of national projects. Summing up the implementation of the first project «Digital Economy», it can be noted that the level of achievement of target indicators and results of the national project was 99.34%. In most areas, the planned indicators were achieved. In five areas (training of IT personnel, Internet accessibility, online public services, electronic document management), the planned indicators were achieved by 100%. In one area (digital profile of a citizen), the level of achievement of indicators was 97.5%. The work analyzes the ratings of digital maturity and innovative development in the context of individual regions. It is noted that there is a regional imbalance in innovative development and digital transformation. The work notes that for successful innovative activity and ensuring the digital maturity, it is necessary to systematically and widely create innovative and digital infrastructure facilities, coordinated work at the regional and federal levels. This will avoid lagging behind individual regions. For sustainable development, it is necessary to provide support for regional initiatives and disseminate the most successful practices for the development of innovations and digitalization in other regions.

Keywords: Development Targets · Digital Transformation · Innovative Development of Regions · National Project

1 Introduction

Digitalization of processes and innovative development have become global development trends in recent decades. Digitalization involves the transition of work processes to a digital format, digitalization of analog data, and the active use of IT technologies. This accelerates and improves the accuracy of data processing and the quality of decisions made. The most significant indicators of innovative development and digital maturity include digital education and the development of skills in the IT sphere (this means both an increase in the number and quality of knowledge of IT specialists and the level of awareness and consciousness of citizens in the field of digitalization), the development of business in the field of digital technologies, and the digitalization of public services.

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According to the research conducted, the factors influencing the development of regions and reflecting digital transformation include:

– public administration and the level of its digitalization [1];
– social factors and digitalization of industrial enterprises [2];
– digitalization of small and medium businesses [3]. Digitalization of the economy and digital transformation in Russia are carried out within the framework of the implementation of national projects. Let's look at them. From 2019 to 2024, the national project «Digital Economy» was in effect. Its main goals were: increasing the share of domestic spending on the digital economy in GDP, creating a sustainable and secure information and telecommunications infrastructure, using predominantly domestic software by government agencies and organizations.

2 Methodology

The purpose of the study is to identify target indicators and trends in innovative development and digital transformation of socio-economic systems of Russian regions. Based on the goal, the following research objectives can be formulated:

– to determine the key factors of innovative development and digital tyranny formation;
– to analyze target indicators and development directions in accordance with national projects in the field of digital transformation;
– to identify patterns of regional development in the field of innovation and digital transformation.

The study is based on the application of scientific, systemic and conceptual approaches using quantitative and qualitative methods of analysis.

3 Results

Summing up the results of the implementation of the Digital Economy project, it can be noted that 90% of citizens (about 130 million) use the Internet, the share of mass socially significant services was 100%. As of December 15, 2024, the number of users of the State Services portal was about 112 million people. Since 2018, about 3,500 IT companies have received grant support within the framework of the national project, 28 particularly significant projects were supported. In 2023, more than 250 thousand students of Russian universities were enrolled in «digital specialties», over 70 thousand completed training under the «Digital Professions» project [4].

At the end of 2024, the national project «Digital Economy» completed its action, currently the main results of its implementation are being summed up. According to preliminary data from the Ministry of Digital Development (Min-Digital), the level of achievement of target indicators and results of the national project was 99.34%. In most areas, planned indicators were achieved. According to Fig. 1, in five areas (IT personnel training, Internet accessibility, State Services online, electronic document management), planned indicators were achieved by 100%. In one area (digital profile of a citizen), the level of achievement of indicators was 97.5%.

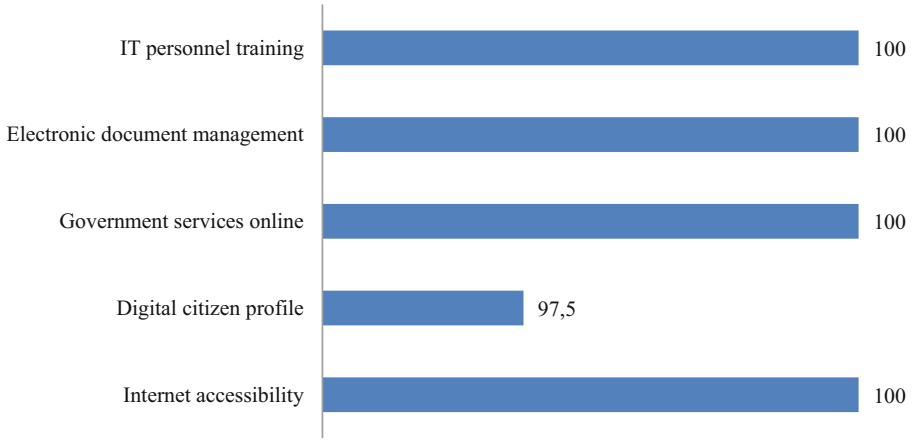


Fig. 1. The level of achievement of development targets in individual areas of the national project «Digital Economy» (Source: author based on [5]).

On January 1, 2025, the national project «Data Economy and Digital Transformation of the State» was launched in the field of digitalization. It is aimed at ensuring the technological independence of Russia, digitalization of various sectors of the economy and social sphere, and increasing the efficiency of public administration. Individual areas of the project include:

- «Internet access infrastructure», which involves the creation of a low-orbit satellite constellation with 100% Internet coverage of the entire territory of the Russian Federation;
- «digital platforms» such as «Science», «Smart City», «My School», «Universities», «Safe Environment»;
- «digital governance», which provides for the transition to paperless document management, 100% digitalization of public administration;
- «artificial intelligence» is based on the active implementation of AI in the economy, social sphere and public administration;
- «domestic solutions and information security»;
- «personnel for digital transformation».

One of the objectives of the national project «Digital Economy» was to eliminate regional inequality in the field of digital development. To achieve this, regional development programs were developed, various projects for the digitalization of various spheres were implemented depending on regional priorities. Among them, we can highlight projects in the field of artificial intelligence, digital twins, robotics, big data, cloud services and platforms. In the starting project «Data Economy and Digital Transformation of the State», one of the key tasks is also the elimination of regional inequality in the field of digitalization. To monitor the level of regional development, the Ministry of Digital Development has developed a level of digital maturity of regions. This indicator is calculated by industry: healthcare (11 indicators), public administration (11 indicators), urban economy and housing and communal services (8 indicators), education (5

indicators), public transport (3 indicators) [6]. Among the key factors influencing the digitalization of individual regions, the following can be highlighted:

– development of IT infrastructure (availability of high-speed Internet, development of communication networks, cloud services and platforms),
– level of economic development of the region (GRP, investment opportunities),
– level of education and IT literacy of the population,
– regional policy in the field of digitalization.

4 Discussion

In 2024, the work of 88 regions (except Moscow) was analyzed according to the digital maturity rating; the leading regions in digital development and transformation were the Yamalo-Nenets and Khanty-Mansi Autonomous Okrugs, Tatarstan, Bashkortostan, Belogorodsk, Rostov, Chelyabinsk, Lipetsk, Kaluga, Sakhalin, Moscow, Tula regions and Yakutia. The level of digital in Russia has grown to 75% [7]. In February 2025, there was some redistribution of the subjects of the Russian Federation in this rating. Thus, the Belogorodsk Region took the leading position. The top 10 included Sverdlovsk (+12 positions), Novosibirsk, Orenburg Region, Sakhalin Region, displacing Tula, Kaluga, Lipetsk Regions, the Republic of Sakha (Yakutia) [8].

Let's analyze the rating of innovative development of the subjects of the Russian Federation. The first group by the value of the Russian regional innovation index included Moscow, St. Petersburg, the Republic of Tatarstan, Nizhny Novgorod, Novosibirsk regions. Moscow and St. Petersburg took first place in the rating for favorable socio-economic conditions for innovation activity. Among the subjects occupying leading positions in scientific and technical potential, the Tomsk Ulyanovsk Region, Moscow, Novosibirsk, Belogorodsk, Nizhny Novgorod regions, St. Petersburg, the Republic of Mari El, Moscow region stand out. According to the value of the «Innovation Activity» index, the leaders are the Republic of Tatarstan and Moscow.

The first group in the «quality of innovation policy» rating was occupied by the Republic of Tatarstan, Novosibirsk Oblast, Moscow, the Republic of Bashkortostan, Nizhny Novgorod and Novgorod Oblasts, the Chuvash Republic, the Republic of Karelia, Kaliningrad Oblast, Krasnoyarsk Krai, St. Petersburg, Tula Oblast, Khanty-Mansi Autonomous Okrug, Kaluga Oblast, Sakha Republic, Stavropol Krai, the Republic of Mordovia, Saratov and Moscow Oblasts [9, 10].

5 Conclusion

The analysis conducted in the work shows that innovative development and digitalization are proceeding at a rapid pace in Russia, however, there is differentiation of these processes by regions. This is determined by the peculiarities of regional development, the nature and directions of state support. For successful innovative activity and ensuring the digital maturity of the Russian economy, it is necessary to systematically and widely create innovative and digital infrastructure facilities, coordinated work at the regional and federal levels. This will avoid lagging behind individual regions. For sustainable development, it is necessary to provide support for regional initiatives, disseminate the most successful practices of innovation and digitalization development in other regions.

The state must create conditions for successful development: develop relevant legislation, encourage entrepreneurial initiative in the field of investment and innovation, promote security, including cybersecurity.

These activities require the implementation of a systemic and dynamic approach. The systemic approach is based on the development of progressive, constructive solutions for the successful development of subsystems and elements of individual regions, helping to prevent a regional gap in innovative development and digital maturity. The dynamic approach is based on tracking the dynamics of development of individual regions and making appropriate adjustments to the scale and specific mechanisms of state influence on digital development processes.

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New Vectors of Russian Entrepreneurship Development Within the Framework of Technological Sovereignty

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Abstract. This work investigates trends and results of development of small and medium-sized businesses (SMEs) in the Russian Federation using the example of the Republic of Tatarstan for 2024. The main stages of the historical development of entrepreneurship in Russia are considered, and the key factors influencing the success of SMEs in modern conditions are identified. Particular attention is paid to technological entrepreneurship, which is a key element of the innovative economy. In 2024, about 100 new technology companies were registered in the Republic of Tatarstan, which allowed the region to enter the top 3 in terms of the number of such enterprises. State support for SMEs remains an important development factor, including preferential lending programs, infrastructure development and stimulation of innovations. However, the sector faces challenges: a high key rate, lack of production space and a decrease in consumer activity. Despite this, SMEs continue to play a key role in import substitution and the creation of new jobs. The results of the study can be used to analyze the activities and development of SMEs in other regions of Russia.

Keywords: Challenges and Tasks of SME Development · Small and Medium Entrepreneurship · Technological Entrepreneurship · Quantitative and Qualitative Indicators

1 Introduction

Small and medium-sized businesses (SMEs) in Russia play a key role in the socio-economic development of the country, providing a significant share of turnover and employment. As of the beginning of 2025, the number of SMEs exceeded 6.59 million, which is a record figure since the start of the unified register of SMEs in 2016.

The Republic of Tatarstan plays a key role in increasing the share of SMEs in the Russian Federation. Thus, according to 2024 data, there are 178 thousand small and medium-sized enterprises in the Republic of Tatarstan, which demonstrates a stable growth in entrepreneurial activity [1]. In 2024, the implementation of the national project [2] aimed

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at expanding access to financial resources, improving the digitalization of support measures and developing industrial parks. These measures contributed to the qualitative growth of business and the transition from micro to small and medium-sized companies. Today, small and medium-sized businesses provide a significant share of turnover and employment. In order to improve the quality and quantity of SMEs, the state continues to support their development at the federal and regional levels through various programs and legislative acts aimed at creating favorable conditions for entrepreneurial activity. It is worth noting that during the pandemic, direct financial support for small and medium-sized businesses in Russia increased significantly [3]. Within the framework of the development of small and medium-sized businesses, a separate category of technological entrepreneurship is now distinguished. According to the Concept of Technological Development for the Period up to 2030 [4], our country faces the task of achieving accelerated growth of technologies for the construction of an innovative economy. And the shortest and surest way to solve this problem is the creation and development of technological startups – the most dynamic element of the new economy [5–9]. It is worth noting here that technological entrepreneurship includes both large companies, but also small companies up to startups. The development of technological entrepreneurship cannot do without the support of the state and enterprises engaged in the production of import-substituting products and the production of innovative products. This is determined by the fact that technological entrepreneurship contributes to the occupation of niches vacated after the departure of Western companies and innovative development.

2 Methodology

The research object is small and medium entrepreneurship in Russia and the Republic of Tatarstan, including its historical development, current status, main development trends, role in the country's economy and key factors influencing its efficiency and sustainability. The methodological basis includes an integrated approach that combines various methods of comprehensive analysis of SME development in Russia. A comparison of the current state of SMEs in Russia with its state in previous periods was conducted. As part of the study of regional experience, the Republic of Tatarstan was chosen, which is one of the leaders in the support and development of small and medium entrepreneurship. The study analyzed data from regional reports on entrepreneurial activity and business conditions in the Republic of Tatarstan. The sources of information are data from analytical centers, national reports, legislative acts and regulations governing the development of small and medium entrepreneurship in Russia. In addition, publications of leading economic journals and reports of international organizations were used to ensure the comprehensiveness and relevance of the analysis.

3 Literature Review

The history of small and medium-sized businesses in Russia goes back to ancient times, when professional merchants and trade and industrial centers appeared in Rus' [10]. However, if we consider the contemporary understanding of SMEs, its development

can be associated with several key stages [11]: the pre-revolutionary period, the new economic policy (NEP), and the modern period.

During the first period, entrepreneurship in Russia developed in the commercial and industrial forms. The first entrepreneurs were small traders and merchants. The development of industry and entrepreneurship accelerated during the reign of Peter I and after the reform of 1861. At the beginning of the 20th century, entrepreneurship became a mass phenomenon, but the revolution of 1917 led to the elimination of market relations and the nationalization of large enterprises [12].

In 1921, the NEP began, which made possible some revival of entrepreneurial activity. However, this was temporary, and by the end of the 1920s, the country moved to a command-administrative economy. Modern small and medium-sized businesses in Russia began to develop in the late 1980s, when laws were adopted permitting individual labor activity and cooperative ownership [13]. In the early 1990s, the number of small entrepreneurs increased significantly, and the privatization of state enterprises began, which strengthened the position of entrepreneurship in the country. In 1995, the Federal Law «On State Support for Small Entrepreneurship in the Russian Federation» [14] was adopted, which became a basis for the development of small business in Russia. Since 2007, the main regulatory legal act governing state support for SMEs in Russia has been Federal Law «On the Development of Small and Medium-Sized Entrepreneurship in the Russian Federation» [15], which regulates relations arising between legal entities, individuals, government bodies of the country and constituent entities of the Russian Federation, and local governments in the field of SME development.

4 Results

During the period of an unstable external environment in the Russian economy, the development of small and medium-sized businesses, which respond more flexibly and adapt to modern conditions, actively developing the sphere of import substitution, is of particular importance. Small enterprises perform significant socio-economic functions, being a creator of new jobs and innovations in the economy, an important taxpayer creating a wide range of goods and services, an agent of market relations, smoothing out fluctuations in the economic situation. Among the regions, the highest volume of purchases from SMEs was noted in Moscow (3.1 trillion rubles), St. Petersburg (801.4 billion rubles) and the Republic of Tatarstan (552.6 billion rubles) [16]. Table 1 presents the qualitative indicators of SME activity in the Republic of Tatarstan for 2024.

The average age of SMEs in Tatarstan in 2024 was 6.8 years. If we consider this in the structure of SMEs, micro-companies exist for 6.6 years, small ones – 7.7 years, medium ones – 7.6 years. In 2024, this indicator is 2.5% lower than the previous year, which indicates barriers to business creation, such as a complex regulatory environment, lack of financing and the difficulty of obtaining it because of insufficient awareness and fragmentation of data on current programs. A decrease in the share of newly created SMEs may be a signal of possible stagnation or insufficient activity in creating new businesses. In addition, the development of SMEs not only in the Republic of Tatarstan, but also in the Russian Federation, is affected by challenges associated with a lack of production space, land and the necessary engineering and road infrastructure; the need to

Table 1. Key quality indicators for assessing SMEs in the region.

No	Indicator	Units of measurement	Description	Last year
1	Average age of SMEs	years	6,8	
2	Number of companies that have become SMEs +	units	167	
3	Number of newly created SMEs	thousand units	31,7	– 2,5%
4	Share of newly created SMEs	%	18,1	– 1,1 p.p

Source: authors based on [17]

ensure productivity growth due to a shortage of labor resources and obsolete equipment; high bank rate for legal entities; the difficulty of finding sales markets and building cooperation with large businesses. In 2023–2024, the small and medium-sized business sector in Russia demonstrated significant achievements and faced some difficulties. Let's consider some quantitative indicators.

The share of SMEs in Russia's GDP remains stable, exceeding 20%. Some forecasts expect an increase to 23.5% by the end of 2025. This value is inferior to global indicators, both in developed countries (USA, EU) and some developing countries (for example, China). The number of SMEs created in 2024 exceeded 1 million, of which 814 thousand were registered as individual entrepreneurs (IE). The total number of SMEs, including the self-employed and IE, exceeded 6.5 million [18]. The number of people employed in the SME sector amounted to 29.2 million people, which is 40% of the total number of people employed in the country. However, the number of SME employees decreased slightly by 0.1% – from 15.13 million to 15.11 million people [19]. The change in SME employment can be divided into several main stages: growth from 2010 to 2019, a decline during the pandemic, and a recovery in growth in the last three years.

Despite initial expectations of expansion, by mid-2024 there was a decline in SME business activity due to an increase in the Central Bank's key rate and a decrease in consumer activity. The share of unprofitable companies increased to 8%, while the share of companies with significant profits remained at 10%. One of the new areas of business development is also the creation and development of small technology companies, which in turn are aimed at achieving the goal set by the President of the Russian Federation for technological leadership and independence. As of January 1, 2025, about 170 small technology companies (STCs) were registered in the Republic of Tatarstan, in 2024, about 100 new companies were registered, which allowed them to gain a foothold in the top 3 regions in the STC register. In general, there are already more than 4.5 thousand STCs in the register in the Russian Federation, by 2030 their number should increase to 7 thousand companies.

5 Conclusion

In conclusion, we note that in 2025, the development of small and medium-sized businesses in Russia will be determined by several key trends:

Government support: within the framework of the national project «Efficient and Competitive Economy» [20], the state plans to allocate 308.8 billion rubles to support SMEs until 2030. The main areas of support include the development of priority industries, such as manufacturing, IT and tourism. It is expected that these measures will increase the share of SMEs in GDP to 25%.

Introduction of the SME + category: it is planned to introduce an intermediate SME + category for companies that have outgrown the SME criteria, but have not yet reached the status of large enterprises. This should help businesses that have already left the SME support system to continue to develop and grow. It is expected that about 10% of companies previously classified as SMEs will move into the SME + category.

Innovation and technology: the introduction of artificial intelligence and process automation will become key trends for SMEs in 2025. Companies that are already implementing AI and analytics systems will be the most competitive in the market. More than 50% of SMEs plan to implement AI in their business processes in the next two years.

Financial support: preferential lending programs will continue, including the credit stimulation program and lending to high-tech companies. Over 100 billion rubles will be allocated for these purposes in 2025.

Regional and industry programs: regional support programs will continue to play an important role in the development of SMEs, especially in regions with a pronounced territorial aspect. More than 70% of regions plan to increase funding for their SME support programs.

Expanding SME participation in technological sovereignty: increasing purchases from small technology companies to 1.2 trillion rubles by 2030. This area is aimed at ensuring technological independence and the development of innovative industries.

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Digital Sukuk: Innovative Tools for Transforming Socio-Economic Systems

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Abstract. The object of the study is digital sukuk. The research purpose is to assess the potential of digital sukuk as a tool for digitalization of socio-economic systems for their integration into the global financial architecture, taking into account the requirements of Sharia and modern technological trends. Using such general economic methods as analysis and synthesis, comparison and contrast, logical and systemic approaches, the work investigates three projects for issuing digital sukuk: Marhaba, Sukuk-Token from Indonesia (Project Tokenization) and SukukChain from Malaysia (digital sukuk market). Based on the results of the study, key aspects of the potential of digital sukuk as a tool for digitalization of socio-economic systems for their integration into the global financial architecture, taking into account the requirements of Sharia and modern technological trends are identified. Among them, the most important are: compliance with Sharia requirements, digitalization and integration into global markets, modern technological trends and socio-economic impact. Complying with Shariah requirements and using advanced technologies such as blockchain, smart contracts and artificial intelligence, they have the potential to change the traditional approach to financing and investing, opening up new horizons for Islamic and conventional financial institutions. Unlike previous studies, the focus on the environmental aspects of digital sukuk allows us to go beyond the traditional approach and offer a new perspective on the role of digital sukuk in the context of the modern global agenda.

Keywords: Blockchain · Digitalization · Digital Sukuk · Islamic Banking · Sharia · Sukuk

1 Introduction

Digital sukuk are Islamic securities issued using digital technologies (such as blockchain), making them easier to issue, trade, and manage. They retain the core principles of sukuk, such as asset backing, no interest payments (riba) replaced by profit shares or rental payments, and Shariah compliance certified by Islamic experts. While digital issuances are still rare, traditional sukuk have been widely used by major corporations, with General Electric and Goldman Sachs issuing sukuk to raise capital from Islamic investors. The World Bank has also issued sukuk to finance infrastructure projects in developing countries, and Saudi Aramco placed $6 billion in sukuk in 2021, becoming

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one of the largest corporate issuers. These examples demonstrate the growing demand for sukuk as an alternative to traditional bonds, particularly in the Middle East and Southeast Asia.

Like any modern financial market, the sukuk market is actively integrating digital solutions, such as asset tokenization, i.e. the use of blockchain to issue sukuk in the form of digital tokens. For example, in 2022, the UAE launched a pilot project to tokenize sukuk through the Dubai Blockchain Center platform. Platforms such as Liquidity Network and Fasset, which offer digital sukuk to institutional investors, can also be used to digitalize the issuance of sukuk.

Another area of digitalization of sukuk is the use of «smart contracts», i.e. the automation of payments to investors and asset management, which reduces operational risks. Compared to conventional sukuk, digital sukuk have a number of advantages and disadvantages: global availability (digital platforms allow you to attract investors from different countries), transparency (blockchain provides real-time tracking of transactions and assets), cost reduction (the elimination of intermediaries (for example, SPV) due to the automation of processes). However, like any digital instrument, the introduction of digital sukuk is associated with a number of challenges. First of all, these are: regulatory barriers (not all countries have clear rules for digital sukuk), Sharia compliance (the need to adapt technologies to Islamic financial standards), cybersecurity (risks of hacking and fraud in the digital environment). Thus, digital sukuk are currently at an early stage of development, but their potential is enormous. Pioneers can be companies from the UAE, Malaysia and Saudi Arabia, where Islamic finance is combined with active digital transformation.

2 Methodology

The purpose of this study is to assess the potential of digital sukuk as a tool for digitalization of socio-economic systems for their integration into the global financial architecture, taking into account the requirements of Sharia and modern technological trends. To achieve this goal, we will set and solve the following tasks: 1) to study three projects for issuing digital sukuk; 2) to highlight the potential of digital sukuk as a tool for digitalization of socio-economic systems for their integration into the global financial architecture, taking into account the requirements of Sharia and modern technological trends; 3) to identify aspects of digital sukuk that will allow us to go beyond the traditional approach and offer a new look at the role of digital sukuk in the context of the modern global agenda.

To solve the above tasks, the author used the following methods: a method of analyzing scientific literature to study the current state of the scientific research problem, methods of analysis according to the checklist for the study of three digital sukuk issuance projects: Marhaba, Sukuk Token from Indonesia (Project Tokenization) and SukukChain from Malaysia (digital sukuk market) on the following issues: type of sukuk, purpose of the issue, technologies used, advantages. Methods of comparative analysis were used to study the potential of digital sukuk as a tool for the digitalization of socio-economic systems for their integration into the global financial architecture in accordance with the following modern trends: compliance with Shariah requirements, digitalization and

integration into global markets, modern technological trends, socio-economic impact. Methods of comparison and analogy were applied to identify aspects of digital sukuk that will allow going beyond the traditional approach and offering a new perspective on the role of digital sukuk in the context of the modern global agenda.

3 Literature Review

Digital sukuk have been the subject of research by some foreign scholars both in the East and in the West, quite recently. The first publications in the field of sukuk digitalization date back to the 2020s [1–3]. Further, several areas of digital sukuk research can be identified. First of all, this is the forecasting of further innovations in the field of digital sukuk and related technologies, as well as the identification of new areas of application of digital sukuk, such as startup financing, venture capital and crowdfunding [4–9]. Scientists conduct research on the development and implementation of blockchain technologies for the issuance and circulation of digital sukuk, the analysis of existing technical solutions and platforms for the placement and trading of digital sukuk, and also consider issues of cybersecurity and data protection within the framework of digital sukuk platforms.

We should also note such areas of research in the field of digital sukuk as modeling the profitability and risks of digital sukuk in comparison with traditional financial instruments, analyzing the behavior of investors and factors determining the choice of digital sukuk as an investment instrument, developing methods for assessing the cost and effectiveness of investments in digital sukuk [10–12]. Each of these areas has its own significance and unique research challenges. The choice of a specific area depends on your research interests, current trends in the economy and financial markets, as well as the current needs of the industry. In Russia, sukuk is also the subject of special research [13–17]. Thus, based on the results of the analysis of the literature devoted to the topic of sukuk digitalization, we can conclude that this topic is relevant abroad, and there is almost no similar research in Russia.

4 Results

The results of the checklist analysis of three digital sukuk issuance projects: Marhaba, Sukuk-Token from Indonesia (Project Tokenization) and SukukChain from Malaysia (digital sukuk market), are presented in Table 1.

The examples presented in Table 1 demonstrate various approaches to the application of blockchain technology in the Islamic financial sector. From national initiatives to international platforms, digital sukuk are becoming an important part of the global financial ecosystem. The DIFC digital sukuk has become an important example of the introduction of modern technologies into the traditional Islamic financial system. The innovativeness of the Indonesian project was that Indonesia became one of the first countries in Southeast Asia to implement blockchain technology for the issuance of government bonds that comply with the principles of Sharia. This allowed the country to attract investments not only from within the country, but also from abroad, in particular, from the Persian Gulf countries. The results of the study of the potential of digital

Table 1. Comparison parameters of three digital sukuk projects.

Sukuk	Description	Type	Goal	Technology	Advantages
Marhaba	In 2018, the Dubai International Financial Centre (DIFC), together with a major technology firm, announced the launch of the MARHABA project, the world's first digital sukuk issuance via a blockchain platform	Tokenized Sukuk Al-Ijara (leasing sukuk)	Attracting investments to finance the construction of commercial real estate in Dubai	A blockchain platform that ensures transparency and security of transactions	Transparency Accessibility Sharia legitimacy
Sukuk-Token from Indonesia (Project Tokenization)	In 2020, the Indonesian Government announced plans to create the first national platform for issuing digital sukuk, as part of an initiative to digitalize the country's economy and expand opportunities for attracting investment in infrastructure projects	Tokenized Sukuk Mudharabah (profit sharing)	Financing of state projects, including development of transport infrastructure and improvement of housing and communal services	The blockchain platform developed by local IT companies provided a high level of security and reliability	Scalability Efficiency International Interest
SukukChain from Malaysia (digital sukuk market)	In 2019, Fintech Consortium Malaysia announced the creation of SukukChain, a platform designed to trade digital sukuk. The aim was to create a global marketplace for Islamic financial products where investors could easily buy and sell these instruments	Various types of sukuk including Ijara, Mudaraba и Musharaka	Establishing an international trading platform for digital sukuk	Blockchain Hyperledger Fabric for Data Privacy and Security	Decentralization Global availability Acceleration of processes

Source: author

sukuk as a tool for the digitalization of socio-economic systems for their integration into the global financial architecture, taking into account the requirements of Sharia and modern technological trends are presented in Table 2.

Table 2. Research into the potential of digital sukuk as a tool for digitalization of socio-economic systems.

Trend	Direction	Description
Shariah Compliance	Transparency and fairness	Sharia principles and rules require full transparency of all transactions and fair distribution of income between the parties to the transaction. Digital sukuk provide openness and access to data thanks to blockchain technologies, which allows participants to monitor all transactions in real time
	No usury (riba)	Traditional financial instruments often include interest, which is contrary to Sharia principles. Digital sukuk allow creating profit- and loss-sharing structures, making them acceptable to Muslim investors
	Ethics and social responsibility	Sharia principles and rules also require an emphasis on business ethics and social responsibility. Digital sukuk can be used to finance environmentally friendly projects, social initiatives and other activities aimed at the benefit of society
Digitalization and integration into global markets	Reducing barriers to entry	The technological basis of digital sukuk reduces the costs of issuing and managing these instruments, making them accessible to a larger number of financial market participants. This opens up opportunities for small and medium-sized businesses, start-ups and individual investors

(*continued*)

Table 2. (*continued*)

Trend	Direction	Description
	Increased liquidity	Thanks to blockchain and smart contracts, digital sukuk can be transferred quickly and efficiently from one owner to another, making them attractive to institutional investors looking to diversify their portfolios
	International standardization	Standardization of the issuance and circulation of digital sukuk facilitates their integration into the international financial architecture. This will allow Islamic financial institutions to interact with global capital markets on equal terms
Modern technological trends	Blockchain	Blockchain technology ensures the reliability, security, and immutability of records, which is critical for financial transactions. The blockchain structure eliminates the need for intermediaries, reducing transaction costs and increasing trust among participants
	Smart contracts	Automated contracts make it easier to execute transactions, minimizing human error and the risk of errors. This is especially true for complex structured products such as sukuk
	Artificial Intelligence and Machine Learning	These technologies can be used to analyse large volumes of data, predict market trends and optimise risk management strategies, thereby increasing the efficiency of digital sukuk operations

(*continued*)

Table 2. (*continued*)

Trend	Direction	Description
Socio-economic impact	Supporting sustainable development	Digital sukuk can finance projects that address environmental issues, improve living standards and ensure social justice. This is consistent with sustainable development goals and Shariah requirements
	Financial inclusion	Making digital sukuk more widely available helps to increase financial literacy and involve more people in the investment process. This can help reduce inequality and improve the economic situation in developing countries
	Infrastructure development	Using digital sukuk to finance major infrastructure projects such as roads, bridges, airports and energy facilities will stimulate economic growth and improve the quality of life of the population

Source: author

Traditional studies of digital (and not only) sukuk focus on financial aspects, legal basis and economic benefits. The issue of the impact of these instruments on the environment remains less studied. Therefore, we propose an environmental focus when studying the potential of digital sukuk as a tool for the digitalization of socio-economic systems for their integration into the global financial architecture, taking into account the requirements of Sharia and modern technological trends, which will help go beyond the traditional approach and offer a new look at the role of digital sukuk in the context of the modern global agenda. Thus, we propose to define the potential of issuing digital sukuk to finance environmental projects as follows:

1. Environmental sustainability. Digital sukuk can support projects aimed at reducing the carbon footprint, using renewable energy sources and sustainable agriculture (for example, financing solar power plants or wind farms through digital sukuk).
2. Waste management. Digital sukuk can support projects for waste recycling, recycling of electronic devices and developing innovative solutions to reduce plastic waste.
3. Green finance. Digital sukuk are part of the green finance system aimed at supporting environmentally responsible projects and companies.

4. Social responsibility. Social and environmental projects financed through digital sukuk can contribute to the development of local communities, the preservation of biodiversity and the maintenance of cultural heritage.
5. Energy transition. Digital sukuk can finance projects to transition from fossil fuels to renewable energy sources.
6. International cooperation. Digital sukuk can become a tool for international cooperation in the field of ecology and sustainable development.
7. Innovative regulation. By regulating the environmental aspects of digital sukuk, national governments and international organizations can create conditions for the growth of this sector while protecting the environment and public interest.

5 Conclusion

Based on the results of the study, it can be concluded that digital sukuk have great potential as a tool for the digitalization of socio-economic systems, facilitating their integration into the global financial architecture, especially taking into account the requirements of Sharia and modern technological trends. The key aspects of this potential are as follows: 1) compliance with Sharia requirements: transparency and fairness, no usury (riba), ethics and social responsibility; 2) digitalization and integration into global markets: reducing barriers to entry, increased liquidity, international standardization; 3) modern technological trends: blockchain, smart contracts, artificial intelligence and machine learning; 4) socio-economic impact: support for sustainable development, financial inclusion, infrastructure development. Thus, digital sukuk have enormous potential to digitalize socio-economic systems and integrate them into the global financial architecture. Complying with Sharia requirements and using advanced technologies such as blockchain, smart contracts and artificial intelligence, they are capable of changing the traditional approach to financing and investing, opening up new horizons for Islamic and conventional financial institutions.

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Single Digital Portal of Rare Earth Resources for Effective Management

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Abstract. International cooperation is important in global issues that require solutions through the unification of efforts of various countries, in terms of technology exchange, convergence of interests, assessment and minimization of risks of interaction of each of the parties. Rare earth reserves are vital in various fields – petrochemistry, energy, medicine, in the defense industry and, of course, are a reason for increasing interaction between countries. Irreplaceable resources can also become a regulatory economic lever for some codependent states. In order to ensure innovative growth of both an individual country and international technological development, the exchange of knowledge and experience in the extraction and processing of rare earth minerals is undoubtedly necessary. The solution of such global issues requires the development of a unified regulatory framework for all parties, where the availability of technology, practical experience plays a key role in the creation of new advanced developments. The implementation of these tasks can be implemented through the creation of a digital portal of rare earth resources at the level of government agencies of all world and regional powers. In addition, this aspect requires mutual responsibility for the implementation of agreements, which also requires careful and comprehensive development. A well-established system of internal control over operations for the extraction and processing of rare earth reserves can become an effective tool for compliance with all necessary requirements both on the part of the state and within the management system of each mining company.

Keywords: Digitalization · Digital Portal · International Cooperation · Internal Control System · Rare Earth Reserves · Resource Development · Technological Entrepreneurship · Technology Exchange

1 Introduction

It is safe to say that there are practically no areas of life that have not been penetrated by digitalization. It has become so well-known that everyone, young and old, is aware of it and actively uses it. Its distribution and role are growing exponentially. From year to year, there is a task of modernizing what, at first glance, has already reached its peak.

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Without the use of this approach, innovative development of the country is impossible. Technologies both optimize routine work and participate in the creation of something completely new and unknown.

Having heard about the penetration of technologies into the sphere of extraction and processing of minerals, namely the development of rare earth world resources (REM, rare earths), it is difficult to quickly navigate how exactly technologies are related to them. A lot of questions arise. What are rare earth metals in general? Why are they so valuable both for the technological development of one country and the world as a whole? Why does the presence of rare earths raise an incredible noise among advanced countries? What are the features of rare earths and rare metals? All this needs to be sorted out by defining goals and objectives.

The fundamental goal of the study is a detailed examination of the distinctive characteristics of rare earth metals, their types, methods of accounting and internal control. To achieve this goal, the following tasks have been set: 1) defining the trend in digitalization, 2) considering the concepts: rare earth metals and rare metals, 3) classifying rare earths (dividing them into types and providing characteristics), 4) defining the areas of application of rare earth metals, 5) identifying countries with the highest concentration of metals (accounting and internal control of rare earth metal mining and processing), 6) proposing a solution for tracking and forecasting potential and developed reserves (creating a single database, the main object of which is rare earth reserves), 7) identifying the most significant information characterizing rare earth metals (defining the types of data necessary to understand deposits, the amount of reserves).

The struggle of world powers for leading positions makes the availability of rare earth reserves and the determination of methods for their extraction and processing an increasingly relevant and decisive topic. Rare earths are becoming an object of influence on international economic cooperation. Their presence allows reducing dependence on other countries. Rare earths can even act as a regulator of imposed or predicted sanctions.

2 Methodology

To achieve the research tasks, the following methods were used:

1. Literature review. An analysis of current literature was conducted. It touches upon such aspects as rare earth deposit locations and areas of their application. Some of the 17 rare earth elements and their properties are indicated. Scientific articles were studied. Their publication is located in international sources (indexed in Scopus and Web of Science), as well as Internet resources.
2. Analytical comparison. Based on the identified characteristics, the concepts of rare earth reserves and rare minerals were compared. Each concept has its own characteristics. For a better understanding of the difference, examples of each type of metal are given. The difference between a portal and a website is indicated.
3. Classification. Depending on the purpose of creation, portals were divided into types and characterized. In addition, after determining the type of portal, the types of information on which the digital portal is based were identified and classified.

4. Case analysis. For a deeper understanding of the cooperation of countries in the development and extraction of rare earth metals, a specific example is given. The forum with the participation of Russia and India is an important event for both countries. It discussed issues related to the development of the Arctic and the exchange of knowledge and experience in the study of deposits. The idea of involving students in research was also put forward.

These methods made it possible to provide a multifaceted consideration of rare earth reserves, to identify the necessary information on their identification. The need to track and record them is a multifaceted and complex task. Its solution requires compliance with legislative aspects, the desire to provide information of most countries.

3 Results

Digital technologies are confidently penetrating not only everyday life, but are also being introduced into knowledge-intensive areas. Among the international digitalization trends, the following ones can be highlighted:

1. Improvement of artificial intelligence (AI). It is predicted that in the near future, digital assistants with AI will perform a huge range of complex tasks: conduct scientific research, create entertainment content, etc.
2. Creation and regular updating of digital portals that allow for the prompt exchange of information and replenishment of the database in the field of international relations between countries on the extraction and processing of rare earth reserves.
3. Development of specialized programs that allow for the optimization of not only the process of rare earth metal extraction, but also the process of stock management in order to achieve higher economic and financial performance of companies in the mining industry.

Minerals, called rare earth resources, are characterized not only by the rarity of their existence, but also by unique properties. Some have strong magnetic properties, others are known as excellent conductors of various elements, and others give some materials bright colors. But one should not confuse two similar concepts at first glance – «rare earth metals» and «rare metals». Rare metals are characterized by the fact that they are really rare in nature, not included in a group of similar elements (for example, lithium, rhenium, germanium, etc.). In turn, rare earths are distinguished not so much by the rarity of their existence, but by the complexity of extraction and processing, since they are most often not found in pure form and are scattered in various minerals, making up a single group of 17 elements – thulium, samarium, erbium and others [1]. One of the classifications of such important natural resources is their division into light (promethium, cerium, neodymium) and heavy (terbium, holmium, scandium). Light metals are more often used in manufacturing, petrochemistry, mechanical engineering, glass industry, while the latter are used more in narrower areas, for example, in devices that allow measurements to be taken with the least error: laser and optical devices, microscopes, etc. Heavy metals are more important and rarer and make up only 20% of the total amount of rare earths [2]. Such metals are concentrated mainly in the south of China in tropical and subtropical regions with hilly terrain. Due to the high use of REM

in various fields, their presence is a strategically important aspect for the development of the country (Fig. 1) [3].

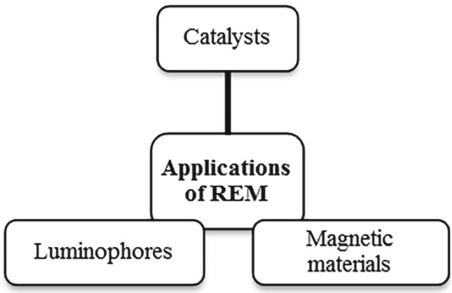


Fig. 1. Applications of rare earth metals (Source: authors).

The usefulness of rare earth metals is difficult to dispute. Their extraction, use – creation of advanced products allows the country to build up technological potential, increase the level of international cooperation. Extraction of rare earth minerals is an important way of international technological cooperation, requiring communication in terms of technology, finance and international interaction, where experience and available rare earth reserves are of enormous importance (Table 1).

Each country is rich in rare earth metals (REM) to some extent, but faces certain difficulties in mining or processing such necessary wealth, which slows down the technological and innovative development of the country. To solve this problem, it is necessary to combine knowledge, technologies, and practices of different countries. A practical example is the «Northern Forum – India: Uniting North and South for Sustainable Development», held on March 20, 2025 in New Delhi, the purpose of which was to discuss issues related to the development of Arctic zones, finding common ground between the two countries. It is planned to conduct joint research, young scientists and students will be involved to gain a practical vision and understanding of the importance of the work being carried out.

Rare earth metals are vital for the technological development of the country. But it is important not only to understand the importance of the presence of rare earths, but also the need to record both the size of existing reserves and their development potential in various regions of the globe, as the demand for them increases every year. One of the ways to track REM could be the international «Digital Portal of Rare Earth Metals». A digital portal in the general sense is an Internet resource that combines various information about a separate group of similar objects, includes various databases that are updated automatically, and is divided into several types depending on the purpose of creation:

1. Commercial (B2B, B2C) portals are portals of partners and clients where goods/services are bought and sold (for example, Lamoda).
2. Portals for employees are necessary for quick and clear access to information at work – trainings, client analysis, electronic document management and other information about work processes in the company.

Table 1. Countries possessing REM.

Country	Note	REM production volume in 2022	REM production volume in 2023
China	It is a leader in available reserves of rare earth minerals and is engaged in their purification and separation	210,000 tons (70% of world REM production)	240,000 tons
USA	The USA has about 15% of REM and is making every effort to develop their processing in order to reduce the influence of China	43,000 tons	43,000 tons
Australia	Australia is known for Lynas, a huge producer of rare earth metals that is involved in the full cycle of metal processing and mining	18,000 tons	18,000 tons
Myanmar	The country is famous as an important source of heavy REMs, not engaged in recycling	12,000 tons	38,000 tons
Russia	Russia has reserves of approximately 12%, while production is quite low and amounts to 2%	2,600 tons	2,600 tons

Source: authors based on [4]

3. Vertical and horizontal portals. The first one is focused on a specific topic – international sports, finance, art, it is designed for a certain circle of users, it is more narrowly focused, while the horizontal one collects various content without concentrating on one thing. The user can find information about the current weather, news and even chat with friends and colleagues (for example, Google).
4. International portsls contain extensive statistics, publications from magazines on a variety of topics, from health to politics (for example, Dimensions).
5. Educational portals provide the opportunity to receive distance education in various fields: economics, psychology, IT, etc. Companies post educational content that users consume for a fee (for example, Netology).
6. State portals provide the opportunity for interaction between the state and society through an Internet resource (for example, the State Services portal).

In our opinion, it would be interesting and useful for interested parties to receive updated information on possible methods for creating a universal system for accounting

for rare earth metals and internal control of technological processes for the extraction and processing of rare earth metals. Thus, in the structure of each of the specified types of digital portals, it is proposed to create a database that discloses information based on the experience of existing mining and processing companies in terms of introducing internal control tools into the activity management system. For many years, one of the acute problems of increasing the volumes of rare earth metals has been the fact that the process of their extraction and processing is quite labor-intensive and expensive. This is a very capital-intensive production that requires the use of high-tech equipment, additional resources in the form of special catalysts, chemicals and energy, highly qualified personnel [5], and mechanisms for the disposal of waste containing harmful substances. In addition, the extraction of rare earth metals is a staged production and the capacities of several plants located in different regions of the country are operated at once, which entails additional costs for the transportation of the extracted raw materials. It should also be noted that chemicals and various hazardous substances are used in the processing of minerals during the extraction of rare earth metals, which has an adverse effect on the environment. Consequently, additional costs arise for the creation of treatment facilities and the creation of an environmentally friendly system to protect the health of the country's citizens [6].

A lot of manufacturers are interested in a reasonable reduction of all costs, the elimination of unjustified losses in the extraction of REM. The actual production cost of REM directly affects the marginal income and the final financial result, which entails the payment of taxes and replenishment of the country's budget. That is why an optimal accounting and internal control system can become an effective tool in the process of managing activities in any company [7]. For a more effective cost management system and obtaining the most up-to-date information for analysis and making management decisions in the process of accounting for REM, it is necessary to use modern information technologies to create reliable accounting information [8, 9]. Moreover, the interdependence of REM and AI is of interest: REM are needed to create AI in the same way as AI is needed to mine REM. On the one hand, the development of AI increases the demand for REM (as a necessary element), as well as for electricity (to power AI and database processing centers). On the other hand, for sustainable energy production, some types of REM are simply necessary, which prevent electricity leakage from the network, increase its throughput and reduce the heating of devices. Everything is interconnected in this world.

Thus, it is possible to create another digital portal with the provisional name «Controlling and management of REM», which will provide access to interested users of different levels and statuses. For example, for external users – providing information on possible methods of calculating the cost price and accounting for REM costs, as well as on the methods and tools of internal control of the process of REM mining and processing. For internal users – providing employees of a specific company with access to the database of the accounting and management accounting system of the process of REM mining and processing for the purpose of conducting an economic analysis of the main financial and non-financial indicators, implementing internal control at various stages of REM production, internal audit of the reliability of financial statements and taxation of the results of activities [10].

Digital portals contain a wide range of possibilities and make possible a comprehensive solution of problems, providing relevant information in various fields of knowledge, classifying it into certain categories. Having understood the types of digital portals and projected them onto the topic of «Rare earth metals», it is necessary to propose the creation of a vertical international portal. After determining the appropriate type of digital resource, it is necessary to highlight the main parameters of the information that the portal will include (Table 2).

Table 2. Main parameters of information of the vertical international portal.

Data type	Essence
Geological information	Reports and information on the subsoil of the earth and the presence of rare earth materials in it, results of work carried out in these places, information on methods of resource development
Rare Earth Resources Data	Volume of extracted materials, distinctive properties of REM: physical – manifestations when affecting rare earths without changing their composition (color, density, elasticity), chemical – indicators that determine the behavior of resources in chemical reactions, their ability to interact with other materials, oxidation level
Maps	1. Maps of actual deposits provide information on deposits of rare earth minerals, highlighting places with the highest density of their location by country depending on the types of rare earths 2. Maps of patterns provide information on the identified patterns of extracted minerals, analyzing the climate, type of terrain (hilly, flat), the presence of other elements in the composition 3. Forecast maps show promising locations of rare earth resource deposits, their possible volumes, and serve as a proposal for conducting research work
Remote sensing of the earth	Reports on the conduct of research on the earth's surface using specialized flying instruments, thanks to which information on electromagnetic radiation is received
Additional information	1. Dating of both developed rare earth reserves and forecast studies 2. Indication of methods of extraction and processing of materials 3. Statistics of REM extraction by countries by year 4. Methodology for calculating the cost price and accounting of REM expenses 5. Methods and tools for internal control of the process of extraction and processing of REM

Source: authors

Availability of accessible, complete and reliable information on rare earths will simplify their extraction and processing, reduce the time of resource search, and accelerate international industrial renewal.

4 Discussion

The results obtained during the study were compared with significant Russian and foreign studies published over the past 5 years. The comparison was based on key aspects of the classification of rare earth metals and digital portals and their areas of application. Thus, S. Gholami, M. Pérez-Page, C. D'Agostino and J. Esteban [1] indicate 17 types of rare earth metals. The researchers focus on their importance for the country's technological breakthrough and are convinced that the growing demand for energy raises serious concerns about the shortage of these resources. They mention the complexity of processing REM and the detrimental impact on the environment during their extraction.

Researchers [2] divide rare earths into light and heavy ones. In addition, they indicate the areas of application of each type. Other scientists confirm the indicated areas of application of REM. In addition, they indicate the principles and mechanisms of their modification [3]. Digiteum Team [11] discusses the topic of web portals, highlighting 8 main types. For a more accurate understanding of the essence of each type, they give specific examples highlighting advantages of using a particular type of resource. Scientists describe in detail functions for various types of digital portals. A. Voroshilova [12] confirms the distinctive features of a digital portal, comparing it with a website. She also indicates the main tasks that a digital resource solves. The researcher highlights different types of portals, pointing out corporate, educational and others.

Having analyzed additional sources and taking into account the above-mentioned opinions, the value of REM is confirmed. The need for their calculation and recording is proven. This is required for the purpose of exchanging knowledge in the field of metal mining and processing. There is an importance of identifying key information about metals and their deposits to understand how they can be mined.

5 Conclusion

The need for an international digital portal of rare earth reserves is easy to trace. The exchange of knowledge and experience in the extraction and processing of rare earth elements will contribute to the technological progress of countries, creating completely new devices or optimizing existing ones. The fields of medicine, defense, and energy will acquire new forms. Another advantage of having a portal is the strengthening of international cooperation through economically advantageous transactions. The following key points were identified among the results:

1. Understanding rare earth metals and rare metals. The study provides a detailed examination of these concepts, highlighting some of the types. This contributes to a deeper understanding of their characteristics and areas of application.
2. Classification of rare earth metals. The study offers a classification of REMs and specific examples of them. Their division will help to more accurately determine the areas of application of reserves.

3. Key countries that own much-needed wealth. A group of key countries that have rare earth metals on their territory is identified. But not only availability is important. Another determining factor is the ability to extract and process the mentioned resources, which is also indicated in the study.
4. The need to create an international digital portal for rare earth reserves. The complexity of metal extraction and processing requires the exchange of knowledge and technology between countries in order to ensure technological growth.
5. Creation of a management digital portal for internal control of the process of REE mining and processing with the provision of access rights to its data at different levels – access to external interested users (open access to all global mining companies) or access only to internal users (within the framework of the activities of one economic entity).
6. Allocation of parameters/data that will define rare earth metals. Information describing the methods of REM mining and processing, the location of deposits is of great importance for the exchange of technologies at the international level. In addition, it is necessary not only to record the locations of developed resources, but also to predict their possible deposits for the purpose of subsequent study and extraction of metals.

The study emphasizes that the need for rare earth metals is growing, which requires special attention to their accounting and control.

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Features of Industrial Development in the Conditions of Digitalization of Modern Economy

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Abstract. Transformation of current processes of globalization and regionalization in the modern world economy requires the analysis and consideration of new factors of industrial development, as well as the emerging opportunities and existing limitations of industrial development in the national and regional economy. The research purpose is to identify opportunities and limitations of industrial development determined by the globalization, as well as features of industrial development in the modern economy in this context. The theories of industrial and sustainable development of the national economy, process and resource approach to industrial development in the national economy served as a methodological basis of the study. The authors applied methods of generalization and comparison, evolutionary analysis of the main elements of industrial development in the conditions of the formed limitations and opportunities of the globalization process. In the framework of this study, features of the processes of industrial policy implementation (within the framework of its innovation and investment components) in the context of globalization have been determined, features of the ongoing processes of regionalization of the world economy within the framework of strengthening the influence of the state on economic systems (in the context of counteraction to the general existing trends of globalization) in the modern economy have been revealed, the interrelation between the processes of import substitution development and regionalization in the world economy has been determined.

Keywords: Efficiency · Globalization · Industrial Development · Industrial Policy · Industry · Import Substitution · Innovations · Regional Economy · Regionalization

1 Introduction

Globalization processes are currently the main factor affecting the features of transformation and development of industrial sectors of the economy. The processes of growth in the efficiency of industrial enterprises and the processes of allocation of material, financial and labor resources are interconnected with the process of globalization and

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possible regionalization of the economy. It is globalization that at present can be perceived as the main driving mechanism for the development of industrial sectors of the territorial economy. The use of evolutionary analysis methods makes it possible to identify the most important features of the impact of globalization processes on the national economy in the sphere of analysis of industrial development transformation. Methods of system analysis and comparison allow us to determine possibilities of potential industrial development in the context of identifying the key features and emerging constraints and opportunities of industrial development in the modern economy.

Current globalization processes and their transformation in the modern world economy have a direct impact on the features of industrial development in the national economy. The analysis of the impact and significance of globalization processes in a particular national economic system requires, in turn, a direct consideration of the existing approaches to assessing the role of globalization in general in the impact on the national economy, and in the context of the impact on individual sectors or industries.

When analyzing peculiarities of industrial development in the national economy and social development in general in the conditions of globalization and regionalization of the world economy, it is necessary to pay attention to the resource approach to the analysis of industrial development processes. The founders of this approach in the world economic science should be considered such economists as E. Penrose [1], B. Wernerfelt [2, 3], J.B. Barney [4], C.K. Prahalad and R. Bettis [5], C.K. Prahalad and G. Hamel [6, 7]. In turn, in the Russian economic thought in the direction of the development of this scientific approach it is necessary to note the works by V.S. Katkalo [8], M.R. Safiullin, G.M. Galeeva and R.I. Zinurova [9], M.R. Safiullin, A.R. Kadyrov and G.M. Galeeva [10] and others. The focus of the industrial policy toolkit on the relevant elements (resources and infrastructure) allows us to ensure the effectiveness of this toolkit while accepting the fact that the basis of industrial development should be considered as a resource base for the functioning of society. Under this assumption, industrial development is a common element of sustainable economic development as a whole.

When analyzing industrial policy within the framework of an individual industrial enterprise, it is necessary to note the process approach. In this case, when using the process approach, the existing indicators of the planned development of the enterprise can be considered as a factor in the formation of the features of the development of the industrial enterprise. At the same time, the very order and peculiarities of actions taken in management and in the use of tools and methods of effective management are supported by a significant methodological basis. For example, when considering the development of industrial enterprises, researchers define a methodological approach to directly identify the necessary conditions for achieving the goals of sustainable development [11]. The importance of assessing the role of improving the control of management and production processes in ensuring the necessary sustainable development has led to the need to conduct a preliminary analysis of the software products used when planning the development and programming the development of industrial enterprises [12]. A.I. Shinkevich, A.R. Akhmetshina and R.R. Khalilov [13] considered the issues of sustainable development in the framework of analyzing its peculiarities. In their analysis they paid attention to the basic elements of sustainable development, to which they attributed the processes of development and formation of innovations. Subsequently, J.L. Chen,

Y.C. Xiao and J.L. Zhou [14] formed a forecasting model within the framework of research work on the definition of sustainable development.

T.A. Selischev [15] drew attention to the toolkit for achieving sustainable development. The conducted studies have connected and substantiated the growth of efficiency in the management of industrial enterprises with the solution of common adaptation tasks. Consideration of possible deviations in the achievement of sustainable development in this case was associated with the prevention of the emergence of negative scenarios of deviation from the goal. Within the framework of the current situation analysis, the formation of an effective management system was thus associated with the forecasting of possible changes in the conditions of adaptation of management actions. The issues of achieving sustainable development in the modern digital economy were also analyzed in detail by M.M. Imamov [16] who considers aspects of the implementation of the innovation process and innovation development in general.

2 Methodology

Analyzing the industrial development and its peculiarities, as well as the peculiarities of the application of investment and innovation tools of industrial policy during its implementation, it should be taken into account that the processes of industrial development and their transformation are interrelated with the general processes of economic development in the world economy at present. The processes of transformation of industrial development and the world economic system as a whole can be based on the general theoretical concepts reflected in the studies of I.Wallerstein [17] and S. Huntington [18]. Considering capitalism, I. Wallerstein [17] linked the possible effectiveness of the toolkit of industrial policy implementation with the existing peculiarities of resource distribution (including labor force) within the regions of the world economy, as well as the possibilities of extracting revenues from the implementation of the innovation process in the countries of the capitalist core with the global processes of formation and resolution of contradictions in the world economic system. When analyzing the current development processes, S. Huntington [18] drew attention to the fact that the existence of traditional and constant formation and strengthening of the importance and role of new centers of industrial development allow minimizing current costs (in the development of industry), as well as determining the effectiveness of the directions of implementation of industrial development tools and industrial policy. In fact, all this allows us to say that the prospects for the overall development of the world economy at present determine both opportunities and limitations for industrial development and the effectiveness of industrial policy in national economies. At present, it is assumed that there are three basic scenarios of industrial development in the world economy.

Scenario 1. Development is determined on the basis of existing conditions. There is no desire or possibility to change anything in the future. Under such development of the situation, the world economic community will not be able to promptly and effectively solve such problems as the depletion of natural resources and their shortage for industrial development on the necessary scale. In this scenario, it is possible that the economic development rates of developed countries will decrease. Developing countries (including the Russian economy) will continue to grow.

Scenario 2 assumes the strengthening of regionalization of the world economy, gradual reduction of the positive role of globalization in world economic development. Strengthening of the role of state power in developing economies, redistribution of investment flows towards new economic leaders will lead to a sharp decline in the world economy. Inter-country conflicts will intensify against the background of a deficit of natural resources.

Scenario 3 characterizes a more optimistic situation for the developed Western economies. In this scenario, positive trends from globalization processes are preserved and Western economic systems are consolidated as leaders of the innovation process with the possibility of Western economies to continue to redistribute financial flows in their favor with their subsequent investment use. International cooperation in this case continues to develop according to the established scheme, and with the help of production and financial shocks in the development (including environmental consequences), there will be consolidation of the chosen stereotypes of economic behavior in the industrial development of traditional and new production world centers. At the same time, this scenario can no longer be realized in the planned scale and variant at present. Initially, this option assumed the strengthening of cooperation between Russia and Western countries, which was supposed to increase competition between Russian (domestic) and foreign companies in the domestic Russian market, which, in essence, in the conditions of the dominance of foreign companies in the innovation and investment process, was supposed to consolidate the raw materials focus of Russia's economic development.

When considering the set problems taking into account the analysis of theoretical approaches to determining factors of industrial development in the national economic system in the conditions of globalization, as well as theoretical approaches to the applied toolkit of industrial policy in achieving the set goal and objectives, the study applied methods of comparison and generalization, evolutionary and scientific analysis and synthesis of the main elements of development and transformation of industry in the conditions of globalization and regionalization of the economy.

3 Results

When considering existing options for industrial development in the global economic system and at the level of individual regional economic systems, it can be noted that it was precisely in countries successfully undergoing integration processes with the global market that there were initially significant potential opportunities for development (due to the presence of established conditions for access of products to external markets), which should have stimulated the industrial development of these economies. In relation to Russia, a similar process has not been implemented, and at present we are witnessing a consolidation of trends that stimulate the necessary and objective development of import substitution processes. At the same time, there is still no possibility of fair competition with foreign (Western) producers, which is determined by the presence and strengthening of sanctions pressure on the Russian economic system. Currently there is a whole group of additional limitations in the development of industry in the national economy. These limitations are also formed by the current processes of globalization and they include:

1. The existing and increasing violation of the rules of fair distribution of the effects of globalization, when the uneven distribution of positive effects negatively affects both a number of national economic systems as a whole, and individual enterprises and sectors of the economy.
2. Possibility of deindustrialization of the national economy with suppression of national industry development as a result of competition with innovative and investment-backed international corporations.
3. Possibility of transfer of control over the national industry and its development to more developed economies, international organizations or transnational corporations.
4. The possibility of destabilization of the national financial and monetary system due to the interpenetration and interconnectedness of individual national economic systems. This instability reduces the ability of the national financial system to influence industrial development and increases the influence of various supranational financial structures on industrial development.

Taking into account the above (within the framework of the structure of constraints and potential opportunities for industrial development), it is necessary to identify the most important indicators to assess the effectiveness of industrial policy implementation. In fact, the matrix for assessing the features of industrial policy implementation in the context of globalization at the macro, meso and micro levels is presented in Table 1.

Table 1. Assessing industrial policy in the context of globalization.

	Innovations	Investments	Infrastructure
Micro level	Degree of use of innovative technologies in the work of industrial enterprises	Regulation of investment flows within transnational companies (TNCs)	Improvement of production, information and transportation infrastructure within the framework of an international corporation
Meso level	Extent to which innovative technologies are applied in the interaction of industries and industry sectors	Integration of investment processes within economic sectors between countries and groups of countries	Implementation of infrastructure projects within industries and industry sectors
Macro level	Extent to which innovative technologies are used in the interaction of national economies	Regulation of the process of accumulation and distribution of investment resources within the global economy	Formation of new elements of transportation and information infrastructure in the global economy

Source: authors

In general, summing up the above-mentioned, it can be argued that it is the export-oriented industries that benefit from the development and functioning in the conditions of

globalization, while those industries that are not related to foreign economic activity and are oriented to the domestic market face increased competition from foreign companies.

4 Discussion

In general, in the conditions of the activities of TNCs and the applicability of the corresponding instruments, the following factors of the modern economy become the reasons for the strengthening of the processes of regionalization of industrial development:

1. Closeness of positions of local authorities and regional TNCs in counteracting the activities of global (world) TNCs in the local markets of individual countries or groups of countries (including in the framework of counteracting the export of profits and capital from the region by global TNCs).
2. Possibilities of effective work of local regional TNCs in ensuring industrial development (of the main industries and related industries involved in technological chains) in the countries of the region of origin of local TNCs.
3. Proximity of mentality, business traditions and values of the population of neighboring countries, which increases the possibility of penetration and effective work of regional TNCs in neighboring countries within the region.

Summing up, we can assert that these above-mentioned bases for the effective development of regional markets (including the development of import substitution, support for the activities of own TNCs and improvement of the innovation process within the national economy) become the economic basis of regionalization in the modern world.

5 Conclusion

Turning to the issue of industrial development in Russia at present, it should be noted that three basic scenarios of industrial development have been considered in the Russian economy recently. The first way of development actually predetermines the consolidation of existing trends. As a result of refusal to participate in globalization processes, the Russian economy will miss the opportunities for activation of the innovation process, without support and purposeful development of new technologies the process of exchange of raw material resources of Russia for high-tech equipment, new technological and innovative solutions will be realized. At the same time, it can be noted that this scenario could indeed be realized earlier, but the intensification of sanctions pressure on the Russian economy in recent years has made this scenario unrealistic. Russia is forced to develop the processes of innovation and investment transformation of industry in the face of the threat of a catastrophic slowdown of its economic and social development. The next way of development of the Russian economy assumed initially full acceptance of globalization processes and active participation in it, sharing the values and economic methods of globalization. This scenario was possible in the recent past, but at present it is also impossible to realize. The third possible development path was taken as a basis for industrial and social development of the Russian economy. Within its framework, the Russian economy can preserve its cultural and value specifics while transforming in such directions of industrial development that allow to use the internal competitive

advantages of the industry in the world market. At the same time, the Russian economy is almost fully included in the globalization processes.

When considering three basic scenarios for the implementation of industrial policy in the Russian economy in the context of globalization, it should be noted that none of the selected scenarios has been implemented. Changing the rules of the economic game, increasing sanctions pressure on the national economic system, the need to develop import substitution and solve the issues of innovation and investment renewal of the economy and industry requires the formation of a special way of development of the Russian industry based on the preservation of cultural values and traditions.

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The Impact of Information and Communication Technologies on Regional Development Indicators

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Abstract. The development of the state economy is determined by a number of external and internal factors. Undoubtedly, one of the main factors is households. They are an active consumer of public services, form demand and supply in the market of various types, acting as an active sustainable driver of economic growth of the country. Currently, households are actively using information and communication technologies which is a new trend in economic development, including providing opportunities for digitalization of industries and spheres of production. The use of modern information and communication technologies makes possible to ensure high competitiveness of households, quality of goods, also guarantee a stable position in the market economy, acts as a catalyst and guarantor of sustainable development of the region. This work puts forward a hypothesis about the relationship and correlation of such an element as information and communication technologies in households on the domestic regional product, shows the dynamics, defines indicators and presents a logarithmic model.

Keywords: Artificial Intelligence · Foreign Experience · Household Economy · Households · Information and Communication Technologies · Investments in Internet Resources · Machine Learning · Gross Regional Product (GRP) · Trends in the Use of Automated Technologies

1 Introduction

As it is known, for the modern era, such trends are objective, based on the analysis of indicators of regional economic development, as forced dynamic processes of increasing the practice of application of a large array of information resources of various kinds and content in the social and economic activities of households. Undoubtedly, the determining vector contributing to the intensive growth of the economy is the structural components of the factors of production. The factors of production, digitized and classified according to new criteria, are a new component and point of growth of the regional economy [1]. It should be noted that in the classical structure of factors of production fixed assets of production in tax accounting are assets worth more than 100 thousand rubles. Generalization and analysis of macroeconomic indicators of regional development shows that

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the development of information and communication technologies (hereinafter ICT) acts as a driver of effective growth and contributes to positive socio-economic effects at the macro- and micro-levels.

2 Methodology

Let us consider the methodological aspects that determine the indicators of development of the economic complex of the region. Figure 1 identifies possible components that determine the impact of ICT development pathways on gross regional product (hereafter GRP) growth. The efficiency of ICT application lies in the possibilities of rapid and manoeuvrable application of significant amounts of data [2].

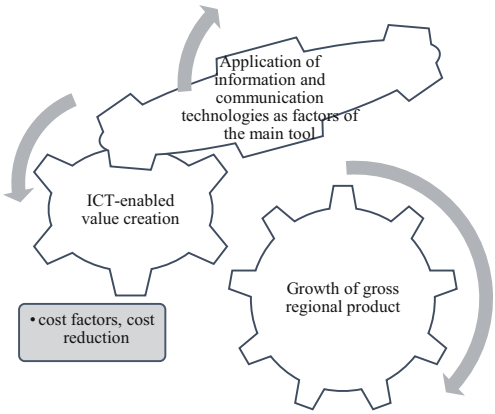


Fig. 1. Elements of the impact of ICT development on GRP growth (Source: authors).

It is the presence of such properties of ICT that allow using them to ensure the fulfillment of the state task, including the transition and coverage of the population with public services in digital format [3]. Figure 2 defines the importance and role of information technologies as factors of production. The state is interested in ICT development, as these resources act as a driver of economic development and contribute to the formation of economic sustainability of the region [4]. Due to the development of ICT in the regions, the process of communication with potential and existing investors is accelerated, new business models such as financial technologies and e-commerce are created, new forms of employment and business development are created. The development of ICT technologies leads to modernization of production and upgrading of equipment. As mentioned above, ICTs today aim to reduce the costs associated with communication and monetary transfers. Examples are automation of accounting, document flow, emergence of electronic marketplaces for supplier search, etc.

Developed ICT makes the region attractive for the development of IT organizations, start-ups and innovative companies. In addition, developed ICT attracts qualified personnel to the region, as a rule, highly qualified personnel attract migration of personnel with similar qualifications [5].

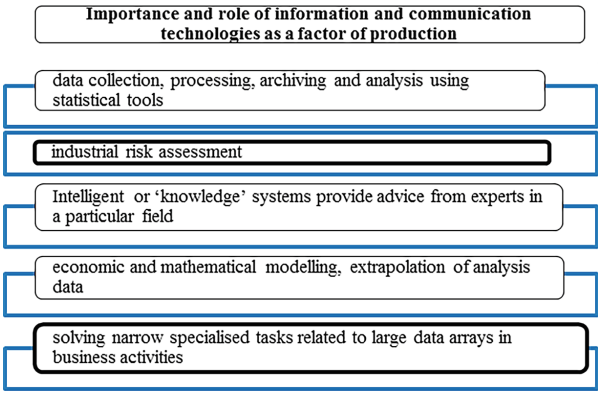


Fig. 2. The role and importance of ICT as a factor of production of the regional economy (Source: authors).

3 Results

Let us consider the indicators of the use of Internet resources in households as a factor of influence on GRP in dynamics for 2016–2022, which is presented in Fig. 3. The data are provided by state statistics bodies [6].

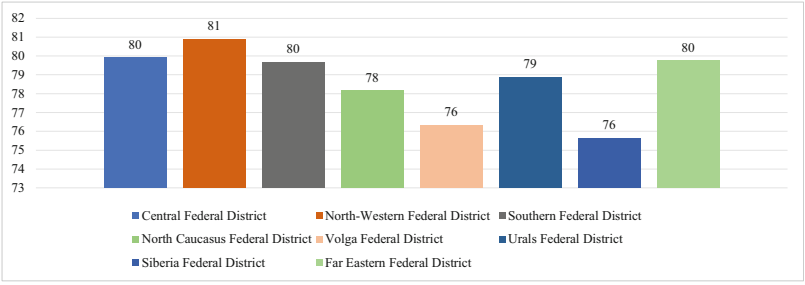


Fig. 3. Dynamics of data on the use of Internet resources in households from 2014 to 2023 in the federal districts of the Russian Federation (average value for the period from 2014 to 2023, in per cent) (Source: authors).

GRP estimates for 2016–2022 are based on statistical data and are presented in Fig. 4 [6]. The GRP dynamics is positive and shows a steady growth in the federal districts for the period from 2016 to 2022. We will also give a number of specific examples of the impact of ICT as an external factor and the positive impact on the social and economic development of the region. In Moscow and Moscow region transport, the Smart City project has attracted investments in road construction and modernization of the housing stock. In Estonia, the 'Digital Government' program stimulated the inflow of investments in the construction of office spaces.

Testing of the hypothesis of the impact of information and communication technologies on the GRP indicator is given below. We formed a sample of indicators shown in

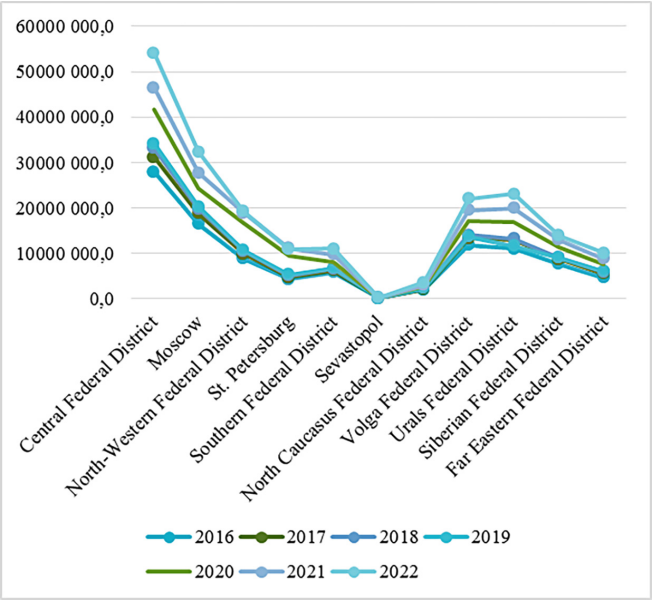


Fig. 4. GRP dynamics by sources of income by constituent entities of the Russian Federation in 2016–2022, in million rubles (Source: authors).

Table 1 for the period 2015–2022 in the context of the subjects of the Russian Federation. Then, we used the Gretl and Stata8 packages to build models. The analyzed sample area did not include such regions as the Nenets District, the Arkhangelsk Oblast without an autonomous district, and the Tyumen Oblast due to objective criterion reasons. To check the autocorrelations, a correlation matrix was made to exclude multicollinearity of the model, which is presented in Table 1.

Table 1. Correlation matrix of indicators.

	int	EP	GO	inf	inv	org	pk	tov	VRP
int	1	0,37	0,47	–0,33	0,55	–0,32	–0,37	0,54	0,45
EP		1	0,16	–0,23	0,18	–0,04	–0,06	0,22	0,35
GO			1	–0,31	0,76	–0,28	–0,38	0,56	0,20
inf				1	–0,50	–0,39	0,41	–0,11	–0,03
inv					1	–0,51	–0,59	0,61	0,22
Org						1	0,91	–0,22	–0,04
Pk							1	–0,31	–0,07
Tov								1	0,44
VRP									1

Source: authors

To test the hypothesis about the impact of ICT on socio-economic development of regions, the dependent variable (y) is GRP, while the explanatory variables are int, org, inf, go, tov, ep. The GRP indicator was prologarithmized. The symbols indicated in the correlation matrix of indicators are presented in Table 2.

Table 2. Indicators of the correlation matrix.

GRP	VRP
Use of information technologies and telecommunication networks in households, by constituent entities of the Russian Federation (Internet access)	int
Proportion of organizations that used the Internet by entity	int_org
Percentage of organizations that used personal computers by region	pk_org
Share of persons under 15 years of age and older who have used information security measures by region	inf_zach
Indicator of the share of persons who interacted with state and local self-government bodies via the Internet	go
Weight of the population aged 15–74 who used the Internet to order goods (services), by type of settlement and gender, by constituent entities of the Russian Federation (as a percentage of the total population aged 15–74 who used the Internet in the last 12 months)	tov_int
Share of persons aged 15 to 72 years who have an electronic signature registered on the unified and/or regional portal of public services, by region	ep

Source: authors

The model includes indicators from each of the three groups, and there is no autocorrelation between the variables. The model is tested for multicollinearity. Next, regression models of panel data with fixed effects and with random effects were constructed. The random effects model was taken for analysis as it showed better quality. The random effects model assumes that differences between regions are random over time and are not described by any fixed variables. It assumes that the differences between regions in terms of ICT development are not fixed over time but are variable. The model showed significance at 1% confidence interval for all selected explanatory variables. The coefficient of determination is equal to 0.75. LnVRP = 12,54 + 0,0086int + 0,0053ep + 0,0038go + 0,0059tov-0,0052inf-0,003org.

The analysis of the model presented in Table 1 allows us to summarize that all the selected ICT development indicators have an impact on the socio-economic development of the regions, namely on GRP. The study of the model coefficients allows us to conclude that the most significant impact is made by the breadth of households' Internet coverage, with a 1% increase in the breadth of households' Internet coverage, GRP increases by 0.86%. At the same time, an increase in the share of organizations using the Internet leads to a slight decrease in GRP. Indicators related to the growth of ICT competences: having an electronic signature and ordering goods online lead to an increase in GRP by 0.53 per cent and 0.59 per cent, respectively. However, the use of information security tools leads to a decrease in GRP, which is probably due to the additional costs that

information security requires. Thus, the hypothesis was confirmed. The conclusion was made about the impact on GRP of such indicators as the width of population coverage by the Internet, the share of the population using electronic signature, receiving public services via the Internet, ordering goods via the Internet, using information security tools, the share of organizations using the Internet.

4 Discussion

The practice of application of 'knowledge' (intelligent) systems in foreign countries shows their active use in economic activity [7]. At present, a large number of ICTs are used as means of production to ensure the process of economic activity. Based on the above, this factor of production acts as an integral driver of transformation of regional economy, a decisive factor in the implementation of tasks at the macro- and micro-levels. A great breakthrough in the formation of the significance of artificial intelligence and information technology was made by Polish scientists R. Tadeusiewicz and M. Szaleniec [8], who in their research provide recommendations for the implementation of solutions for the management of economic and technical fundamental systems. Information and communication systems as factors of production are characterized by the following properties:

- intangible form;
- absence of a tangible concrete form, due to which the possibility of assessing the value of this factor of production is quite specific and requires the application of all forms and types of assessment;
- act as the only means of production in such types of activities as creative entrepreneurship, industry of games and innovative technologies and others;
- have a multiplicative effect;
- specifics of risk management process.

5 Conclusion

The most ICT-differentiating factors related to the development of digital competences – the use of electronic signatures, information protection means, ordering goods via the Internet, receiving public services via Internet resources – influence the provision of socio-economic development of the region (Fig. 5).

When testing the hypothesis by economic and statistical methods, panel data models were built for the regions of the Russian Federation for the period 2015–2022, models with fixed and random effects were built, in all cases models with random effects were chosen. The coefficient of determination is greater than 50%, the p-value of the model was checked. The model was tested for the Durbin-Watson statistic, the Hannan-Quinn test, and the Schwartz test. The model was tested for Hausman and Breusch-Pagan test. Thus, we have proved the impact of ICT on socio-economic development of regions. A significant impact on the GRP of the region is the coverage of households by the Internet, with a 1% increase in the breadth of coverage of households by the Internet, the GRP of the region increases by 0.86%. At the same time, an increase in the share of organizations using the Internet leads to a slight decrease in GRP.

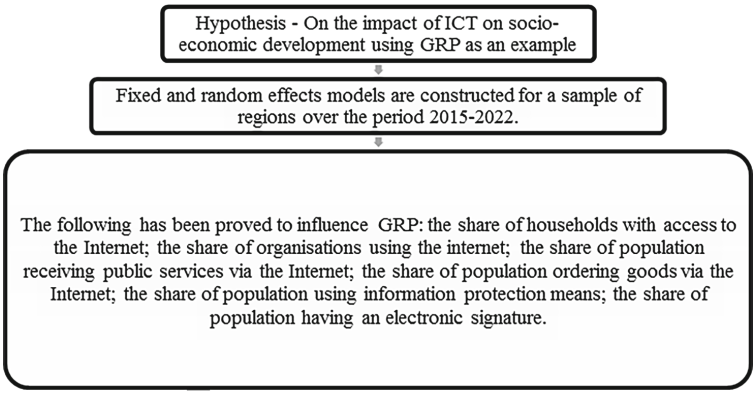


Fig. 5. Structure of the model of economic and statistical research on the impact of ICT on the socio-economic development of regions (Source: authors).

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Problems of Applying Digital Technologies in Configuring MSME Business Management Systems

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Abstract. This work highlights problems of using digital technologies to manage small and medium businesses. The purpose of this study is to identify problems and difficulties, as well as approaches to solving these difficulties for real businesses when solving the problem of configuring a company management system. The authors conducted a comparative analysis of popular business management systems, which allows us to verify the existing complexities of configuring and designing the management environment. The results of the review of international articles on business management, the analysis of modern business management information systems allow us to see the presence of problems of automation and implementation of information systems in small and medium businesses despite the rapid growth of technologies. The authors draw attention to difficulties in implementing digital technologies in the management of small and medium businesses and offer a number of solutions that will allow owners of micro, small and medium-sized businesses to mitigate the difficulties and use the potential of digital technologies to configure the management system of their company.

Keywords: Business Management · Configuration Management · CRM-System · ERP-System · Information Technology Management · Small and Medium Business Management

1 Introduction

Digitalization is a key factor that has a significant impact on all areas of the economy, micro, small and medium enterprises (MSMEs) are not left out of this process [1]. Today, digital technologies are becoming an integral part of business, opening up new opportunities to optimize processes, increase efficiency, and improve interactions with customers and employees.

However, at the same time, the implementation of digital solutions in MSMEs raises a number of specific problems and barriers that require in-depth analysis and development [2]. A lot of small and medium-sized enterprises do not always realize how digitalization can help them increase competitiveness and improve financial performance. In a highly competitive environment, the importance of intelligent automation, data analytics and cloud solutions is becoming increasingly obvious, but insufficient information among

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entrepreneurs and a lack of resources often jeopardize the ability of companies to realize these opportunities.

In addition, the high speed of technological development and the constant emergence of new tools create a difficult situation for MSMEs, requiring rapid adaptation and acquisition of new skills. In this regard, an important aspect is the need for continuous training and upgrading of employees so that they can effectively work with modern digital systems. Also, as practice shows, a lot of enterprises face a shortage of qualified personnel [3], which prevents the full implementation of innovations. It is worth noting that small and medium-sized enterprises start their activities with limited resources and, as a rule, may not be ready for large investments in digitalization. This leads to an uneven level of technology implementation: while large companies have the opportunity to allocate significant funds for digitalization projects, for MSMEs, each investment often becomes strategically important [4].

Thus, the implementation of digital technologies in MSMEs is a complex, multi-level process that requires taking into account the factors: from understanding the relevance of technologies to assessing risks and management decisions. It is important to approach this task systematically, using both domestic and international experience in order to avoid obstacles and maximize the potential of digitalization for business development [5–7].

2 Methodology

In recent years, the MSME management sector has seen a significant change in approaches to configuring management systems in the context of the active implementation of digital technologies [8]. These changes are determined by a number of trends that are shaping new realities for business practice.

The first trend is the desire to automate processes [9]. MSMEs are beginning to realize that the use of automated management systems allows them to reduce the time spent on routine tasks and reduce the likelihood of errors. Software for integrating various business processes, such as ERP systems, is becoming increasingly accessible even to small companies. This allows them to more effectively manage resources and optimize work processes. It is important to note that within the frame-work of this trend, the use of AI technologies, the use of artificial intelligence to automate routine tasks, is actively developing [10].

The second important trend is the transition to cloud technologies. Cloud solutions provide flexibility and scalability, allowing MSMEs to adapt to changing market conditions without the need for significant capital investments in IT infrastructure. In addition, cloud technologies provide access to data and systems from anywhere, which is very important in the context of remote work.

The third trend is the increasing importance of data analytics. Modern management systems are increasingly focused on using big data to make informed business decisions. With the help of analytical tools, MSMEs can extract useful insights from their data, predict customer behavior, and optimize offerings. It is also important to note the growing interest in systems based on artificial intelligence and machine learning. These

technologies help in predicting market trends, automating customer service, and improving service personalization. MSMEs that begin to implement these technologies gain a competitive advantage and can offer a higher level of service.

Last but not least, the focus on sustainability and social responsibility is a trend that MSMEs are increasingly taking steps to integrate environmental and social aspects into their business activities. Digitalization of management processes makes possible better consideration of these aspects and increases business transparency. Thus, the analysis of current trends in the configuration of management systems in MSMEs confirms that digitalization opens up new horizons for improving productivity and competitiveness. It is important that enterprises are aware of these trends and actively use them for their development.

3 Results

3.1 Analysis of Modern Business Management Systems

The authors conducted a review and comparative analysis of 7 popular business management software systems on the market. Table 1 presents the main characteristics of the programs and their purpose.

Table 1. Review of 7 popular business management programs.

Name	Purpose	Format	Main functions
Bitrix24	CRM and business management	Cloud / On-premise	CRM, tasks, projects, telephony, HR
1C: Enterprise Management	ERP and accounting	On-premise / Cloud	Finance, warehouse, sales, salary
Zoho One	Complete business package	Cloud	CRM, accounting, marketing, projects
Odoo	ERP and CRM	Cloud / On-premise	Modules: sales, HR, finance, website
Monday.com	Project and team management	Cloud	Planning, automation, reports
Trello + Power-Ups	Simple visual task management system	Cloud	Kanban, checklists, integrations
AmoCRM	Highly specialized CRM	Cloud	Leads, deals, sales funnel, telephony

Source: authors

The comparative analysis of software functions and qualities presented in Table 2 reflects the presence of shortcomings in each information system due to the focus on other functions that are significant for this system. This causes difficulties in configuring a suitable environment for information management of MSME businesses. Entrepreneurs

Table 2. Comparative analysis of 7 popular business management programs.

Criterion	Bitrix24	1C	Zoho One	Odoo	Monday.com	Trello	AmoCRM
CRM	✓✓	⚠ (basic)	✓✓	✓✓	⚠ (through integrations)	✕	✓✓
Task and project management	✓✓	⚠ (uncomfortable)	✓✓	✓✓	✓✓	✓✓	⚠
Financial accounting/Accounting	⚠ (limited)	✓✓	✓✓	✓✓	✕	✕	✕
Process automation	✓✓	✓✓	✓✓	✓✓	✓✓	⚠ (limited)	✓✓
Integrations with other services	✓✓	⚠ (via third-party modules)	✓✓	✓✓	✓✓	✓✓	✓✓
Price	There is a free tariff	Paid (modules)	Relatively accessible	Relatively accessible	Paid	For free	Paid
Flexibility/Customization	Average	High	Average	Very high	Average	Low	Average
Ease of learning	Average	Complex	Average	Complex	Simple	Very simple	Simple

Source: authors.

Symbols:

✓✓ – the function is presented in full

⚠ – the function is presented with restrictions

✕ – the function is missing

are forced to combine several software systems, engage in system integration, and train employees to work in diverse environments.

Based on the data from the analysis of 7 information systems for business management, the authors identified several types of solutions for configuring IT systems for business management at different stages of development:

- small business / startup: Trello + Zoho One / AmoCRM – easy entry, fast implementation [11];
- medium business: Bitrix24 or Odoo – balance between capabilities and cost;
- large business/holding: 1C + Odoo – full automation, financial control;
- IT teams / project work: Monday.com or Odoo (if flexibility is needed).

It is obvious that the choice of software for systematization and business management is now huge and entrepreneurs face a serious task of choosing from this multitude of solutions the best option for their business.

3.2 Problems and Barriers to the Use of Digital Technologies in Business Management Practice

The main problems in configuring a current digital management system for small and medium businesses are:

- lack of a clear understanding of the technologies themselves and their capabilities;
- low awareness of how digital solutions can improve the efficiency of their business;
- high cost of implementation and maintenance of digital technologies;
- limited financial resources of MSME businesses for implementation and adaptation of professional software;
- need to invest in new equipment, software and training of employees;
- lack of qualified specialists capable of correctly setting up and integrating digital tools into business processes;
- the problem of incompatibility of new digital solutions with existing systems, which complicates the integration of new solutions and increases the costs of modernization;
- the issue of cultural barriers: employees, especially in traditional industries, may not perceive innovations as useful and may resist change;
- the need to change the usual way of working causes stress and negative perceptions among employees.

Thus, all the listed problems and barriers require a comprehensive approach to their solution. For the successful implementation of digital technologies in MSMEs, both efforts from entrepreneurs and support from the state and educational institutions are necessary.

4 Discussion

Recommendations for optimizing the configuration of MSME management systems should take into account both technological and organizational aspects aimed at increasing the efficiency and adaptability of the business. One of the first recommendations

is to conduct a comprehensive analysis of current business processes. Understanding bottlenecks and inefficient processes allows developing a strategy for their optimization and subsequent automation [12]. The next important step is to choose a suitable platform for the management sys-tem. We need to pay attention to systems that offer integration capabilities with existing solutions and flexibility in scaling. This will avoid excessive costs for replacing the entire infrastructure.

Personnel training is becoming the cornerstone of success in the implementation of new technologies. It is necessary to develop training programs for employees that will help them master new tools and approaches to work. It is important that training is continuous, allowing employees to adapt to changing conditions and technologies. Automation of routine tasks can significantly increase productivity. It is recommended to implement systems that allow robotization of processes, such as inventory management, accounting or CRM, which will free up employees' time for more strategic tasks.

The importance of ensuring cybersecurity should also be taken into account. As digitalization increases, so does the risk of cyberattacks, so it is necessary to implement modern data protection systems and train employees in basic security principles. We must not forget that feedback from employees using the system in practice can provide valuable ideas for improving the configuration. Regular surveys and collecting opinions will help make adjustments and improvements to the system in real time.

Finally, it is important to have a vision for future development. Optimization of management systems should not be viewed as a one-time event, but as an ongoing process that will require regular revision and investment in new technologies and trends.

5 Conclusion

Digitalization of small and medium-sized enterprises is a key factor in promoting their competitiveness and sustainability in a dynamic market. It should be emphasized that although there are significant barriers and challenges on the path to full digitalization, such as insufficient staff qualifications, difficulties in integrating with existing systems and high initial investments, the prospects for development remain encouraging. Firstly, the growing number of government support programs and subsidies for digital initiatives creates additional opportunities for small and medium-sized companies. This, in turn, contributes to improving the quality of services and products, allowing MSMEs to enter new markets and attract more customers. Secondly, MSMEs adapt to rapidly changing market conditions and consumer preferences faster than large businesses through the use of data analytics and process automation. It is also worth noting that with the development of technologies such as artificial intelligence and machine learning, new horizons are opening up for the creation of unique business models, allowing MSMEs to move towards more proactive approaches to management. In conclusion, it can be argued that despite the existing problems, the future of digital technologies in MSMEs looks promising. Optimization of business processes based on modern information solutions will be the key to the survival and prosperity of small and medium enterprises in the global economy.

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The Impact of Digitalization on the Effectiveness of University Human Capital Development

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Abstract. The digital transformation of higher education increases the flexibility and accessibility of educational programs, expands the possibilities of individual learning. This study highlights potential risks of distance education and the need to combine face-to-face and online learning formats in order to provide students with fundamental knowledge. Attention is focused on the digital maturity of the university and the importance of digital competencies for research and teaching staff. The digital environment contributes not only to the progress of the university's human capital, but also opens up opportunities for its application and integration into international academic research and projects. This work highlights the key areas of digitalization of higher education, and outlines the advantages of digital academic and business cooperation for the development of human capital. The characteristic features of the human capital of scientific and pedagogical staff of universities are highlighted. Conditions for the development of a favorable digital environment in the Russian higher education system are considered. It was emphasized that the university's well-developed digital infrastructure helps attract talent and retain key research and teaching staff.

Keywords: Digitalization · Higher education · Human capital · Information technology · University

1 Introduction

In modern society, digital technologies have been integrated into key areas of economic development, the national economy, and the higher education system. The digital environment promotes greater flexibility and accessibility of higher education, as well as the formation and development of a global educational space. The emergence of digital universities focused on individual educational trajectories increases possibilities of training students, taking into account their personal characteristics, needs and opportunities. However, when implementing distance learning, there is a potential risk of reducing the fundamentals of education and the fragmentation of knowledge [1]. In this regard, the task of developing a balanced «hybrid» educational model based on a substantial fundamental block with the inclusion of separate educational modules and specialized courses in accordance with current market demands is being actualized.

The current process of digitalization of higher education takes place in three basic directions:

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1. Development of the digital educational space and digital infrastructure.
2. Development of digital technologies, including the development of electronic learning materials, services, tools for the ongoing monitoring and final assessment of students' knowledge.
3. Formation and promotion of new educational models focused on the holistic process of knowledge acquisition, combining face-to-face and online learning using digital technologies and platforms.

The digital transformation of education and the transition to infocommunications require the development of digital competencies, digital pedagogy and online communication skills among research and teaching staff. It is not only about the interaction of teachers with students, but also about professional collaborations with the external environment. Conducting joint scientific research and participating in developments is an integral component of the development strategy of modern universities. Digital technologies simplify communication within the framework of joint research, allow working with large amounts of data, diagnose and demonstrate research results, attract interested scientists regardless of their geography, and much more.

Let us highlight the key advantages of the formation and development of the human capital of scientific and pedagogical workers in the context of digitalization of higher education.

1. Digital technologies contribute to the accessibility and speed of obtaining up-to-date data, open up expanded opportunities for online collaboration for the progressive development of human capital of research and teaching staff.
2. The development of academic and scientific cooperation beyond geographical boundaries improves the quality of the human capital of scientific and pedagogical staff. The accumulated knowledge and experience through participation in scientific research and development improves the quality of educational activities, contributes to the progress of the human capital of scientific and pedagogical workers.
3. Online collaboration promotes the involvement of research and teaching staff in research projects and practices, the development of creative, innovative and scientific potential, develops teamwork skills, expands networking, opens up opportunities for discussion, exchange of ideas and points of view.

From the perspective of the formation and development of the personnel potential of scientific and pedagogical staff, we note the diversity and accessibility of remote and online programs for additional professional education. Digital interaction helps to attract and involve young scientists and teachers in educational, scientific and pedagogical activities.

2 Methodology

Human capital becomes a dominant instrument of the digital economy when intellectual labor is the dominant driver of its development [2]. The economic development of the state is based on the quality of the formed national human capital. The development and accumulation of intellectual abilities, professional knowledge and skills is directly

related to the quality of higher education. Consequently, the professional level of scientific and pedagogical staff of higher education institutions determines the level of development of graduates' human capital.

The subject of this research is a scientific approach to determining the importance and role of digitalization in the concept of human capital development of higher education institutions. The goal includes solving such tasks as: research of theoretical and methodological concepts on the research topic, definition of the role of digitalization in the higher education system, identification of positive and negative factors of the influence of digitalization on the development of human capital of scientific and pedagogical workers.

The main hypothesis of the conducted research is the scientific assumption that the effectiveness of the manifestation of their human capital depends on the level and quality of the integration of digitalization into the research activities of higher school teachers, and, consequently, the formation of positive human capital of graduates, the speed of their employment, their demand in the labor market.

The process of studying the impact of digitalization on the human capital of research and teaching staff is based on reviews of scientific literature on the subject, on the study of advanced domestic and international practices, on methods of logical, analytical, and statistical analysis. The methodological framework is represented by a set of scientific, comparative, and empirical methods.

3 Literature Review

The opinion that digitalization will replace low-skilled labor with high-performance labor in the near future, which will lead to an increase in the importance of digital competencies, has been put forward by a number of scientists who note the risks of dehumanization of personnel management as a result of the introduction of technology [3]. Researchers emphasize that digital transformation can to become a threat of the disappearance of a number of professions and the reduction of jobs as a result of the automation of labor functions. The probability of computerization of most professional tasks can lead to a decrease in workers' salaries. Thus, in the next 10–15 years, it is possible to increase social tensions due to the transformation of labor market needs. It should be noted that the scale of automation of the functionality directly depends on the size of the company and its industry orientation. The larger the company is, the more complete the automation cycle of all processes is. In large companies, standardization of work processes and a single database for analytics and controlling are practiced, which contributes to the introduction of digital technologies.

The research of Russian scientists highlights advantages and disadvantages of digital communications and social connections, and highlights the advantages of digital adaptation technologies [4]. The authors' position on accelerating the development of digital education is of interest. The lack of digital literacy, digital infrastructure and related technical problems hinder the development of the distance learning format. Distance learning will determine the forced transition to self-study (self-study) of many topics and issues, which reduces the quality of higher education and the level of development of national human capital.

In the research of Russian scientists, human capital is considered primarily as a return on investment in educational practices. The changing requirements for the components of the human capital in the context of digitalization of higher education were noted by V.M. Volodin, I.A. Pitaikina and S.A. Vlazneva [5]. The researchers highlight the importance of digital competencies, and also note the need for the activity of the scientific and pedagogical worker himself in the transition to advanced training and the restructuring of educational processes. This position deserves attention, the scientists emphasize that continuous learning contributes to improving the quality of human capital at both individual, micro and macro levels. And it is in the higher education system that the quality of human capital is formed, which subsequently ensures rapid or slow economic progress.

The study by N.A. Litvinova [6] confirms the conclusions about the development of human capital in higher education ecosystems (science-business-government), which increases the competitiveness of the digital economy and the effectiveness of higher education. The digital modernization of higher education enables the expansion of university interaction with external representatives through the implementation of joint research and projects, the expansion of technology parks and infrastructure, automation of processes, and the creation of high-tech conditions for networking. The scientist emphasizes the importance of the digital environment for the development of the human capital of educational institutions of higher education.

A number of researchers suggest that the large-scale introduction of digital technologies into everyday life dictates a new format of competencies, knowledge and skills, which changes the content of human capital, especially for education. The actualization of human capital development in academic communities is emphasized [7].

4 Results

4.1 Characteristics of the Human Capital Elements of Higher Education Institutions

A characteristic feature of the human capital of scientific and pedagogical staff of educational institutions of higher education is the continuity of investments (temporary, financial, health) in their own development through training programs, research, grants, internships and other practices. Consumers of educational services are both students and highly qualified specialists who receive additional professional education at the university, the cost of which is quite high. Accordingly, higher school teachers are required to meet strict requirements for the quality and volume of courses and disciplines taught.

Intellectual, educational, scientific and talent capital are becoming important components of the human capital of educational institutions of higher education. The degree of manifestation of human capital is largely influenced by the motivation of a teacher. Strong internal motivation helps to increase energy. As a result of achieving the set goals, the emotional background improves, contributing to the physical and psychophysiological health of a person. Motivation also contributes to increased engagement.

An important role in the professional activity of scientific and pedagogical workers is played by the culture, morality, values, spirituality, traditions that dominate in the organization, in a particular department. The academic environment has traditionally

been denied by a special highly moral culture, which is reflected in the corresponding elements of human capital.

A special feature of the formation of human capital is the accumulation of knowledge, skills and abilities throughout a person's life, which he applies in various fields of activity. At the same time, it is important to take into account the factor of obsolescence of these components of accumulated human capital. This aspect plays a special role for higher school teachers, especially in conditions of rapid changes, in an environment of accelerated information exchange.

It should be noted that the higher the quality of human capital is, the greater the contribution the teacher makes to educational and scientific activities. Consequently, promising scientific research is reflected in the educational activities of teachers. The higher the employees' contribution to research and development is, the more they claim to be paid. High material well-being opens up opportunities for further progressive development of human capital.

4.2 Characteristics of the Conditions for the Formation and Development of Human Capital of Educational Institutions of Higher Education in the Context of Digitalization

Next, we focus on the conditions for the development of digitalization of the Russian higher education system. Let's identify three key indexes: firstly, readiness for a networked society (the level of dissemination and application of information technologies, flexibility and scale of network resource management, the degree of impact of digitalization on the financial and economic development of the organization are considered). Secondly, we will highlight the inclusivity of the Internet, namely its accessibility for teachers and students, technological parameters and capabilities, as well as the willingness to use the Internet. The third index is the mobility of interaction, namely the level of implementation and the extent of the spread of the mobile Internet.

According to the statistical data [8] (Table 1), indicators of Russia's digital development in the field of inclusive Internet and mobile interaction are steadily growing [8]. However, there has been a decline of 8 positions in the Russian readiness index for a networked society.

Table 1. Russia's position in global digital development rankings.

Indicators of digital development	2019	2020	2021	2022	Total countries
The Online Society Readiness Index	48	48	43	40	131
The Inclusive Internet Index	21	27	25	30	100
Mobile Interaction Index	41	42	38	42	170

Source: authors

The creation of a favorable digital environment, as well as increased interest in information and communication technologies, contributed to the growth of publication

activity of Russian scientific and pedagogical workers in this field. The dynamics of the number of publications by Russian scientists on the issues of information and communication technologies indexed in Scopus is presented in Fig. 1. Note that the peak of publication activity occurred in 2020 and amounted to 18,695 publications.

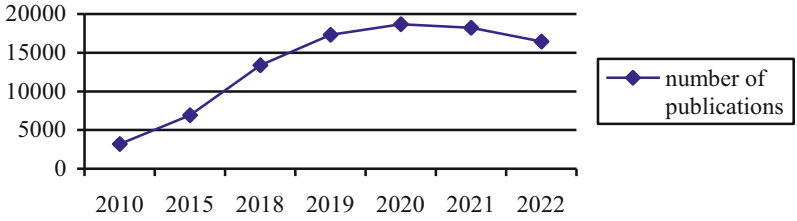


Fig. 1. Dynamics of the number of works by Russian scientists on the problems of information and communication technologies in publications indexed in Scopus (Source: authors).

The digital transformation of the higher education system provides for the following areas:

1. Development of the digital space and digital infrastructure of higher education.
2. The use of digital technologies in the educational process, digital assessment of students' academic performance.
3. Development and dissemination of digital teaching materials, platforms, and tools.
4. Development and development of digital models of educational process organization (online format, hybrid format).

Digitalization of education requires the development of digital competencies and technical skills among research and teaching staff. Modern technologies, programs, systems, and tools are used not only in the educational process, but also in scientific research to conduct experiments, collect and analyze big data (surveys, focus groups, and observations). In order to develop and increase the competitiveness of their human capital, teachers can regularly undergo additional digital training, expand their knowledge and skills in the professional and related fields. Neural networks, artificial intelligence, simulation and immersive technologies are actively used in educational activities today. Therefore, a modern teacher should be able to use combinations of text, visual, and audio materials to involve students in the learning process.

5 Conclusion

The introduction of digital technologies contributes to the formation and development of a progressive innovative educational environment of the university. The human capital represented by the scientific and pedagogical collection is progressing in a favorable digital environment: digitalization promotes the expansion of communications, accessibility to the scientific base and research results, the implementation of joint projects and developments, the development of digital academic communities, and scientific leadership. As a result of digital research collaboration, the quality of research and development is improving and, consequently, the university's revenues are increasing.

The activity of the university's human capital in the digital academic environment promotes the university's brand as a scientific leader, which increases the status of the educational organization and attracts additional investments from both the government and business representatives. The university's well-developed digital infrastructure attracts talented young scientists, helps retain key research and teaching staff, and ensures high research results.

Digital maturity and the developed digital competencies of scientific and pedagogical staff increase the possibilities of using their human capital, including regardless of their geography. Digitalization opens up opportunities for participation in mobile academic project groups, virtual practices and consulting.

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External Audit Risks in Digital Transformation of Integrated Business Processes

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Abstract. Changes in the end-to-end business processes of enterprises resulting from digital transformation are also significantly altering the environment in which external audits are conducted. For instance, there is widespread adoption of electronic accounting systems, big data processing technologies, and artificial intelligence (AI) systems. Substantial changes are taking place particularly in areas such as revenue recognition, fixed asset management, and taxation. These changes are often financed through external funding, which places greater emphasis on operational efficiency and ensuring the transparency of financial reporting. An assessment of the significance of short-term debt burden (STD), long-term debt burden (LTD), profitability, size, tangibility, tax, business risk parameters of the 43 market companies for the period 2015–2023 was conducted. In the context of growing economic uncertainty and market volatility, the role of effective control procedures in supporting accounting functions, internal audit departments, and external auditors in managing and mitigating financial risks is becoming increasingly important for market-oriented companies. The digital environment, supported by advanced digital tools, enhances these functions by enabling real-time monitoring and automation of control and audit processes. Accordingly, study aims to provide empirical evidence, based on panel data models of commercial organizations, to evaluate the significance of key determinants influencing financial risk levels. It further aims to develop recommendations for strengthening internal control systems with a view to enhancing the effectiveness of external audits within the framework of the digital transformation of business processes.

Keywords: Control Procedures · Debt · External Audit · Financial Risks · Market-to-book · Panel Data · PPE · Revenue · Tax

1 Introduction

Digital transformation is reshaping accounting and auditing through technologies such as AI, automation, and blockchain. These tools enhance the accuracy of figures reported in companies' financial statements and support the performance of real-time analytical procedures during audits. The value of these technological tools is particularly high for companies with significant debt levels, as there is a need to ensure transparency and build trust among external stakeholders. Therefore, in order to deliver high-quality services, auditors must also acquire additional digital competencies to effectively work

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with digital data. High levels of corporate debt are associated, among other factors, with an increased audit risk due to the rise in both inherent and control risks. Companies may be inclined to manipulate financial reporting indicators in order to meet debt covenant requirements, that is particularly evident in areas such as revenue recognition, asset valuation, and disclosures related to going concern. Consequently, the presence of financial constraints combined with deficiencies in the control environment requires auditors to exercise heightened professional skepticism when analyzing company performance indicators. This includes expanding the scope of testing and adjusting the audit strategy in accordance with the identified risks. Digital integration is also associated with increased efficiency of end-to-end business processes. At the same time, the vulnerability of these processes leads to potential errors and fraud increases. The automation of control procedures is linked to higher risks due to system complexity and limited traceability of information from input to output data. Therefore, it is advisable to implement adaptive structures to maintain the integrity of business processes in a digital enterprise environment.

The aim of this study is to assess the interrelation of factors such as short-term and long-term debt burden, profitability indicators, firm size, asset structure, tax burden, and risks in external auditing within the context of business process transformation. The study aims to determine the degree of influence of each factor on risk exposure. The development of practically and theoretically grounded recommendations is intended to improve control procedures within digital business processes. Consequently, this also enhances the efficiency, accuracy, and reliability of external audits by relying on a more robust internal control system within organizations.

A panel dataset of 43 commercial organizations covering the period from 2015 to 2023 was used. Relevant econometric models were employed to ensure robust empirical analysis. Specifically, the study examined the interaction between the determinants of short-term and long-term debt levels, a value creation metric within the context of digital transformation of business processes, internal control systems, and external audit mechanisms. The research proposed insights into how these factors collectively influence the external audit process. Based on the findings, recommendations were developed to help companies enhance the effectiveness of control procedures, thereby reducing the likelihood of risks or mitigating potential adverse consequences.

2 Methodology

The digitalization of business processes necessitates both the enhancement of auditors' competencies and a reassessment of the interaction models between external and internal auditors. P. Nkansa [1] provides evidence that high levels of coordination between external and internal auditors increase internal auditors' sensitivity to fraud risk. Such coordination is essential for identifying complex threats, such as cybersecurity vulnerabilities and errors in automated reporting processes. It contributes to a more accurate assessment of audit risk, thereby enhancing the effectiveness of audit planning procedures. In contrast, insufficient coordination may result in the oversight of potentially significant risks within the digital business environment. Furthermore, collaboration between external and internal auditors is particularly effective in high-risk areas. This,

in turn, enhances the credibility of the internal control system as perceived by external stakeholders who are not directly involved in financial reporting. As a result, agency costs and the degree of information asymmetry are reduced, thereby lowering perceived risk for external users. Consequently, companies are better positioned to attract external financing.

The effectiveness of traditional audit methods has been found to decline in the context of business process digitalization, due to increasing process complexity and a growing number of potential risk areas. These challenges could be addressed through the integration of Process Mining Techniques with the International Standards on Auditing (ISA) to enhance risk identification. Auditors may direct their audit procedures towards the identification of internal control weaknesses, potential regulatory non-compliance, and instances of fraud. The use of digital event logs and process models is of particular relevance in high-risk areas, such as the «Order-to-Cash» and «Purchase-to-Pay» processes. When inefficiencies or deviations in control operations are identified within these processes, Process Mining technologies can assist in mitigating operational risks and enhancing the accuracy of data utilized for financial reporting. Such transparency also reinforces external stakeholders' trust in the reliability of financial information. As a result, Process Mining may serve as an effective tool for improving audit efficiency and reducing the integrated risk levels within enterprises.

The study by [2] highlights how digital transformation contributes to economic uncertainty (EU), which in turn raises the cost of debt (COD), thereby influencing how external auditors perceive and assess corporate risk. Traditional mechanisms for ensuring the proper preparation of companies' financial statements, such as external audits, have shown signs of declining effectiveness in digital environments. To uphold the quality of audit services amid ongoing transformation, it is imperative that auditors place greater emphasis on the effectiveness of corporate governance structures. The presence of significant economic uncertainty increases the cost of debt capital, thereby heightening financial risks. Under such conditions, robust corporate governance serves to mitigate the negative effects of rising debt burdens. The relationship between corporate governance and the cost of debt capital is realized through its influence on the risk perceived by investors. Based on this information on potential risks in the business processes «taxation», «from potential to payment», «fixed asset management», hypotheses of determinants of the integrated risk management system of commercial organizations were compiled (Table 1).

In contemporary econometric literature, the determinants of integrated risk management systems are typically analyzed using variables such as company size (Size), asset structure (Tangibility), return on capital (Profitability), and revenue volatility (Business risk).

Table 1. Hypotheses of the determinants of the integrated business processes in the context of digital transformation.

No	The content of a hypothesis
H1	Risk factors (LTD, STD) are positively related to the EVA-Book value creation indicator
H2	Higher profitability of business (Profitability) contributes to greater operational efficiency in listed companies
H3	Organizational scale (Size) is positively associated with business performance
H4	Accepted business risk (Business risk) is positively correlated with the Market-to-Book ratio over a three-year horizon
H5	A positive correlation exists between the size (Size) of market companies and their exposure to long-term and short-term risks
H6	Business profitability (Profitability) has a negative influence with the level of long-term and short-term debt
H7	Inherent business risk (Business risk) is negatively correlated with indicators of short-term and long-term leverage
H8	The tax burden (Tax) has a negative influence on the risk appetite of market-oriented companies
H9	The proportion of non-current assets (Tangibility) has a positive relationship with the extent of debt financing

Source: authors.

3 Literature Review

G. Baader and H. Krcmar [3] propose combining red flags with process mining to overcome limitations of traditional fraud detection methods, including high false positive rates and insufficient process context. The use of ERP system event logs and their linkage to indicators of potential fraudulent activities can help auditors effectively identify weaknesses in internal controls within organizations. The integration of red flag analysis with process mining reduces the scope of potentially suspicious transactions by lowering the number of false positives, thereby decreasing the volume and cost of audits. At the same time, the functioning of such a system results in a lower risk of asset misappropriation and enhances the reliability of financial reporting figures. Consequently, increased transparency in the purchase-to-pay process helps reduce monitoring costs and supports more informed financial decision-making.

S. Thiery, S. Lhuillery and M. Tellechea [4] propose an analytical model that is valuable for the assessment of external audit risks in the digital age, although the primary focus of the study is on enhancing the quality of internal auditing. The researchers identify corporate governance, communication, and human capital as key factors in ensuring high audit quality. Weak oversight of audit execution, limited auditor competence in data analytics and information systems, as well as communication inefficiencies and barriers, can significantly undermine audit effectiveness. The index-based approach suggested by the scientists in relation to these factors provides a foundation for identifying complex

digital risks and adapting audit strategies to sophisticated, automated end-to-end business processes. Consequently, high-quality internal auditing enhances the transparency of financial reporting, reduces agency conflicts, and mitigates information asymmetry between financial statement preparers and external users.

Y. Peng and H. Jin [5] suggest that the digitalization of auditing enhances auditors' responsiveness to emerging risks by leveraging advanced technologies, including artificial intelligence and big data analytics. At the same time, technological innovations introduce greater complexity into the risk landscape, necessitating more adaptive auditing approaches. The study indicates that non-state-owned companies tend to exhibit greater flexibility in adopting digital tools, whereas state-owned enterprises are more reactive to changes in institutional conditions. Accordingly, the researchers emphasize the need to tailor risk identification strategies by taking into account the organizational context and the level of digital maturity. Enhancing transparency and the quality of risk assessment improves firms' access to capital markets, thereby enabling more effective debt management and the adoption of flexible strategic responses in competitive market environments.

The literature review highlights the critical need for research with the objective of identifying key determinants of risks associated with external audit within the context of corporate digital transformation. Understanding these factors enables the development of informed managerial decisions aimed at improving control procedures integrated into both risk management and internal control systems, thereby enhancing the reliability and adaptability of external audit practices in a rapidly evolving digital environment.

The high dependence of external auditors on the functions of internal audit heightens the risks associated with audit procedures in the context of digital transformation of end-to-end business processes. In addition, the growing automation and remote nature of interactions increase the importance of auditors' professional judgment and perceived barriers to communication [6]. Inaccuracies in assessing the competence of the internal audit function, particularly under budget-constrained audit engagements, can lead to reduced audit effectiveness and reliability of audit opinions. Consequently, reducing communication barriers can lower the perceived level of risk from the perspective of stakeholders who are not directly involved in the preparation of accounting (financial) statements. This, in turn, reduces the required rate of return and improves access to debt financing, thereby enhancing firm value.

4 Results

The results of the study of the determinants of the Market-to-Book indicator are presented in Table 2.

H1. Risk factors (LTD, STD) are positively related to the EVA-Book value creation indicator. The hypothesis is partially confirmed in terms of the LTD component. Investments in new technologies and digital infrastructure require substantial capital, which is often supported by access to debt financing. Since the majority of such investments are long-term in nature, external auditors should pay increased attention to whether the capitalization of expenses complies with the requirements of key accounting standards, and assess the validity of management's estimates and assumptions. Errors in asset

Table 2. Results of the study of the determinants of the Market-to-Book indicator.

Factor	Coefficient	P-value	Standard error
STD	2,065	0,278	1,879
LTD	5,431	0,021**	2,264
Profitability	1,827	0,243	1,541
Business risk	3,865	0,003***	1,244
Size	–0,846	0,023**	0,359
const	15,691	0,039**	7,366
R-squared = 0,643			
Standard error of the model = 1,431			
F-statistic = 0,000			
Number of observations = 387			
Note: *** – significance at the 1% level, ** – significance at the 5% level			

Source: authors.

recognition and the application of standards can distort financial ratios that investors rely on for decision-making. Therefore, when an organization has capital investment programs, including those related to digital infrastructure, auditors should evaluate the reliability of procurement information, the consistency of procurement approval procedures, and the risks of misclassification of expenditures. It is also important to assess the accuracy of how potential tax consequences are reflected, especially regarding risks of non-compliance with regulatory requirements or possible future obligations.

H3. Organizational scale (Size) is positively associated with business performance. As organizations grow and business processes become more complex, system fragmentation often occurs. The generation of data across multiple systems increases the risk of distortions or incomplete information disclosure. The proliferation of systems and digital solutions – such as ERP systems, AI algorithms, and blockchain – may complicate the assessment of the reliability and completeness of financial reporting indicators.

At the same time, audits of large companies are conducted according to more rigorous standardized procedures, which may result in insufficient consideration of specific technological risks arising from digital transformation. Although digital systems are intended to enhance transparency for users of financial information, they may also give rise to more sophisticated forms of financial data manipulation. In the complex IT infrastructure of large enterprises, the risks of falsifying digital records, concealing transactions, and compromising data integrity are increasing. This complicates risk identification tasks and necessitates the use of advanced audit methods.

H4. Accepted business risk (Business risk) is positively correlated with the Market-to-Book ratio over a three-year horizon. Higher revenue variability is associated with the expectation of increased returns for external investors. At the same time, rapidly growing companies must place greater emphasis on strengthening their internal control systems. From the perspective of external auditors, rapid organizational growth and

increasingly complex business processes expand both the volume and complexity of information, increasing the likelihood of unintentional errors and fraudulent activities. Also, the greatest risks are associated with automated sales systems, digital distribution channels, and real-time data processing. Therefore, high volatility should be considered when assessing inherent risk, to more effectively identify areas prone to material misstatements.

The establishment of effective internal control procedures, designed to minimize the occurrence and impact of risks, plays an increasingly important role in managing both long-term and short-term debt burden indicators. In the context of digital transformation of companies' business processes, this role becomes even more critical. New technological environments introduce previously unrecognized or rapidly evolving threats, which require external auditors to have a deep understanding of internal control systems and their ability to adapt to digital change. Consequently, robust and transparent internal controls not only support financial stability through efficient debt management but also form a basis for identifying audit-relevant risks during external audit procedures [7]. This dynamic underscore the need for integrated approaches to risk identification, especially as companies move toward automated and data-driven operations. The results of the study of determinants for the LTD indicator are presented in Table 3.

Table 3. Results of the study of the determinants of the LTD indicator.

Factor	Coefficient	P-value	Standard error
Profitability	–0,207	0,229	0,169
Business risk	–0,051	0,317	0.050
Size	0,007	0,692	0,019
Tax	–0,077	0,018**	0,031
Tangibility	0,249	0,092*	0,249
const	0,000	0,999	0,417
R-squared = 0,689			
Standard error of the model = 0,109			
F-statistic = 6,102e-05			
Number of observations = 387			
Note: ** – significance at the 5% level, * – significance at the 10% level			

Source: authors.

The results of the study of determinants for the STD indicator are presented in Table 4.

H7. Inherent business risk (Business risk) is negatively associated with indicators of short-term and long-term leverage. The hypothesis was partially confirmed for the STD factor. The digital transformation of end-to-end business processes also changes the nature of risks that may be identified during an external audit. A key aspect of external

Table 4. Results of the study of the determinants of the STD indicator.

Factor	Coefficient	P-value	Standard error
Profitability	–0,001	0,992	0,087
Business risk	–0,158	0,005***	0,053
Size	0,031	0,051	0,031
Tax	–0,073	0,259	–0,073
Tangibility	–0,017	0,751	–0,017
const	–0,432	0,145	–0,432
R-squared = 0,585			
Standard error of the model = 0.084			
F-statistic = 0,020			
Number of observations = 387			
Note: *** – significance at the 1% level, * – significance at the 10% level			

Source: authors.

auditing is the assessment of inherent risk, particularly the risk of material misstatement, while the second component involves evaluating control risk.

The negative correlation between short-term debt burden and revenue volatility may be linked to companies' tendency to rely more heavily on equity capital under conditions of external uncertainty. Consequently, external auditors may consider this relationship as a relevant signal during the risk assessment phase of audit planning.

However, the widespread use of algorithmic models, automated tools, and big data analysis necessitates a reassessment of the adequacy and focus of audit procedures and an adjustment of traditional approaches. For auditors, a critical factor in improving efficiency will be not only an understanding of the client's digital transformation characteristics but also the adaptation of methodologies, including the incorporation of revenue volatility analysis as a proxy indicator of elevated inherent risk.

Moreover, the growing emphasis on ESG adds another layer of complexity to risk assessment [8]. Companies proactively managing ESG-related risks may also exhibit more conservative financial strategies, including lower leverage, to signal long-term sustainability and risk awareness [9]. Accordingly, a comprehensive understanding of the relationship between inherent business risk, leverage, and ESG priorities constitutes an essential element in re-thinking risk identification and assessment approaches within the digital transformation context.

H8. The tax burden (Tax) has a negative influence on the risk appetite of market-oriented companies. One of the significant factors contributing to increased risk is the tax burden on enterprises. Generally, the willingness of companies to take risks decreases, as they seek to minimize uncertainty due to expected increases in future tax liabilities. As a result, the digital transformation of business processes may be more restrained under high tax rates. However, for external auditors, this requires consideration of the company's strategic objectives in response to increasing fiscal pressure. As companies strive to

automate tax reporting and implement tax monitoring tools, auditors must reconsider their approaches to collecting and evaluating audit evidence. To reduce their tax burden, companies may employ digital tools to facilitate aggressive tax planning strategies.

H9. The proportion of non-current assets (Tangibility) has a positive relationship with the extent of debt financing. The hypothesis was partially confirmed for the LTD factor. A positive correlation between the share of non-current assets in the overall asset composition and the pattern of debt financing is partly due to the use of physical assets as collateral, which reduces risks for creditors and facilitates greater access to debt financing. At the same time, the transition to digital platforms complicates audit procedures due to the growing reliance on software.

5 Conclusion

As a result of the conducted empirical research, the understanding of the development of risk identification processes in external audit within the context of the digital transformation of business processes in commercial firms has been expanded. The complex interaction of key indicators – such as the level of debt burden, profitability, company size, revenue volatility, tax burden, and the proportion of non-current assets – necessitates increased attention to these areas during external audits. This need arises due to the intensive digitalization of end-to-end business processes. The statistical significance of indicators such as long-term debt burden, revenue volatility, and organizational growth in relation to the value creation metric (Market-to-Book ratio) underscores their importance for further in-depth investigation.

Identifying specific areas of a company's operations where potential adverse risk outcomes may significantly affect the company's value presents a considerable challenge. At the same time, a key objective of the risk management system is to identify areas where taking an acceptable level of risk provides the greatest advantages – for example, using borrowed financing to accelerate the expansion of production capacity in a growing market. Information gathered through the integrated risk management system enables management to make informed decisions by effectively balancing opportunities and potential threats to the enterprise. This, in turn, supports both the operational and financial stability of the organization. A comprehensive approach to risk management ensures a holistic understanding of risks not only within individual departments (such as procurement, production, and sales), but also facilitates the analysis of interrelated risks. For instance, disruptions in the supply chains of raw materials and components may lead to bottlenecks in production capacity. Consequently, even a minor shortage of critical components can result in a complete production halt and substantial financial losses, thereby adversely affecting financial reporting.

Various integrated risk management approaches have been effectively implemented within commercial organizations. These frameworks were developed by leading associations in the field of risk management and outline stages and procedures for managing different types of risks. The application of these guidelines contributes to enhancing the effectiveness of risk management and internal control systems. Digitalization is transforming not only the business processes of enterprises but also their associated inherent and control risks, thereby necessitating a reassessment of traditional audit approaches.

The integration of advanced technologies gives rise to new risks in areas such as data traceability, system reliability, and algorithmic transparency. Consequently, there is a need for adaptive audit models that employ modern digital tools, including process mining and real-time analytics. These models are aimed at effectively identifying and addressing risks through substantive testing procedures.

Risk mitigation, including the mitigation of risks associated with high debt levels, can be achieved through the implementation of effective control procedures designed to reduce the likelihood or adverse consequences of risk events. Moreover, the complex control environment of enterprises, within which these controls operate, poses an additional challenge for external auditors, as it requires a high level of expertise and digital competencies among audit team members.

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Tax Control Risk Management in the Context of Digitalization

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Abstract. Tax risk is a possibility of an adverse event, as a result of which a company that has made a particular decision in the field of taxation may lose or not receive resources, lose its intended benefit or incur additional financial or image losses. Currently, the conduct of financial and economic activities with high tax risk is one of the most common elements when a taxpayer is included in the plan of field tax audits. Compliance of an organization with only one tax risk criterion is not a reason for its automatic inclusion in the audit plan. The organization's activities are considered comprehensively. However, if there are risk criteria and the taxpayer refuses to independently revise tax obligations, it is highly likely that the organization will be included in the on-site audit plan.. Tax control risk management is a condition for the well-being and sustainable growth of the company. Digital transformation is the transition of socio-economic systems of various levels to a qualitatively new level of use of digital technologies, the rejection of outdated technologies contributes to improving the efficiency of tax control risk management. Recommendations of tax control risk management in the context of digitalization were developed and proposed based on the analysis of the activities of a particular company, the assessment of existing risks and the tax control risk management measures.

Keywords: Digitalization · Risk · Tax Control · Tax Risk

1 Introduction

Digitalization is a process of introducing digital technologies for the generation, processing, transmission, storage and visualization of data into various spheres of human activity. Today, digitalization makes it possible for the Federal Tax Service of the Russian Federation to freely analyze information about taxpayers because of the creation of digital platforms, which are a software and hardware complex of organizational and technological solutions. Under the conditions of modern developing economic relations,

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such a phenomenon as «tax risks» is acquiring universal significance in the field of taxation. This phenomenon is influenced by many processes and factors that occur all over the world [1]. The tax control risk of companies is a specific subcategory of tax risk and focuses on the interaction of companies with tax authorities. Tax authorities are trying to adapt to the ongoing processes, creating various electronic services for the convenience of interacting with taxpayers and using automated systems that improve the quality of tax control, but taxpayers are also looking for new ways to optimize their tax burden [2].

2 Methodology

To comprehensively study the problem and achieve the set goals, the following scientific research methods are used: theoretical, empirical methods, modeling and forecasting methods, as well as practice-oriented methods. Theoretical methods provide a scientific basis for the study. Empirical methods allow analyzing real problems of a company. Modeling helps predict risks and propose solutions. Theoretical methods include: analysis (study of scientific literature, regulations), synthesis (generalization of theoretical approaches to tax risk management in the digital environment), comparative legal method (comparison of Russian and international experience of tax control in the context of digitalization), system approach (consideration of tax risks as part of a general risk management system of a company). Empirical methods include case-study, assessment of the applied digital tools (CRM, ERP, tax monitoring systems) and observation (study of processes of interaction of the company with tax authorities in digital format: electronic document management, online cash registers, automated information system «Tax-3»). The following modeling and forecasting methods were also used during the study: SWOT analysis (identifying the strengths and weaknesses of the tax risk management system in the considered company), economic and mathematical methods (calculating the probability of risks and their financial consequences). The framework of the investigation is formed by the Tax Code and other legislation of the Russian Federation. Thus, the comprehensive application of these methods allowed developing recommendations for optimizing tax risk management taking into account digital technologies.

3 Results

The phenomenon of tax risks in practical activities should be assessed as negative provided that their negative effect has specific forms of manifestation. Each payer of taxes and fees uses various schemes of minimizing the tax payments to save on taxes [3]. The Federal Tax Service establishes criteria for the selection of taxpayers for pre-audit analysis and the appointment of on-site inspections directly. The availability of publicly available criteria and the ability to independently apply and evaluate them enable taxpayers to reduce the likelihood of an on-site tax audit and thereby minimize their tax risks, providing a favorable environment for doing business [4]. For this reason, at present, when managing projects, the project manager must use risk management methodology, forecast the probability of risk events in the field of taxation, assess possible losses or the amount of additional profit [5]. Each company can independently assess these risks. As part of this study, the tax control risks are assessed for ALFA + LLC (hereinafter referred to as the company) for the period 2021–2023.

The first criterion is the size of the company's tax burden. Tax risk is a risk that companies may pay or account for an incorrect amount of tax (including both income tax and indirect tax), or that the tax positions taken by the company are not consistent with the tax risk appetite that the directors have approved or consider reasonable [6]. According to [7], the total tax burden is the ratio of the amount of taxes paid according to tax authority reporting data to the amount of revenue determined according to the State Statistics Committee data (i.e. according to the income statement, excluding VAT) [7]. Taxes paid by the company in the analyzed period are given in Table 1.

Table 1. Taxes paid by the company for the period 2021–2023 (in thousand rubles).

Name	2021	2022	2023
Taxes paid, including:	6612	6142	7699
Insurance contributions for compulsory social insurance in case of temporary disability and in connection with maternity	256	256	31
Single imputed income tax for certain activities	347	0	0
Transport tax	147	16	92
Insurance and other contributions to compulsory pension insurance credited to the Pension Fund of the Russian Federation	2141	2245	3254
Insurance premiums for compulsory health insurance of the working population credited to the budget of the Federal Compulsory Health Insurance Fund	550	583	46
Personal income tax	1178	1242	1307
Tax imposed due to application of simplified taxation system	1993	1800	2969
Taxes taken into account for the total tax burden	3665	3058	4368

Source: authors

The second criterion is the reflection in the accounting or tax statements of losses over several tax periods. The company worked profitably throughout the analyzed period, so there is no risk of verification by the tax authorities according to this criterion. Risk is always associated with uncertainty. This uncertainty occurs because of the lack or unavailability of information regarding what will happen [8].

The next, third criterion is the reflection in the tax reporting of the company of large amounts of tax deductions for a certain period. The company applies a simplified taxation system, therefore, tax reports do not reflect tax deductions, and, therefore, there is no risk of the company being checked by tax authorities according to this criterion. Dynamics of indicators of the total tax burden of the company in 2021–2023 are presented in Fig. 1.

The fourth criterion is that the growth rate of expenses outstrips the growth rate of income from the sale of goods (works, services). A comparative analysis of the above indicators is performed to assess the risk for this criterion (Table 2). As calculation shows, only in 2022 the growth rate of expenses exceeded the growth rate of income: expenses increased by 9.5%, and income decreased by 17.8%. In 2023, expenses decreased in comparison with their value in 2022 at a higher rate than the rate of decline in income,

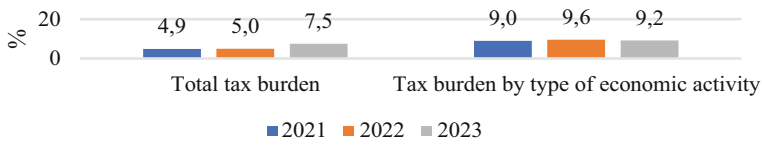


Fig. 1. Dynamics of indicators of the total tax burden in 2021–2023 (Source: authors).

there was no growth. The risk of inspection by the tax authorities on this criterion is present in 2022, since they may suggest that the company wrongfully overestimates expenses or underestimates income for tax evasion. This requires special attention to documentation and the validity of expenses in order to minimize claims from the tax authorities.

Table 2. Comparative analysis of the dynamics of expenses and income of the compnay.

Name	2021	2022	2023	Growth rate 2022–2021	Growth rate 2023–2022
Sales revenue, RUB thousand	74647	61339	58277	-17,8	- 5,0
Ordinary expenses, RUB thousand	53409	58480	25874	9,5	-55,9

Source: authors

The fifth criterion is the value of the average monthly salary of one employee, compared with the value of the average monthly salary by the type of Russian Classification of Economic Activities (RCEA) in the region. A comparative analysis is performed to assess the risk for this criterion (Table 3). The analysis shows that the salary paid to the company's employees in the analyzed period is significantly lower than the industry average level in the Republic of Tatarstan, which increases the risks of the company's tax audit according to this criterion.

Table 3. Comparative analysis of the average monthly salary of one employee of the company.

Name	2021	2022	2023
Average monthly salary of one employee of the company, RUB	13515,0	14922,0	24170,0
Average monthly salary by RCEA type in the Republic of Tatarstan, RUB [7]	28026,9	30308,4	36505,5
Deviation, RUB	14511,9	15386,4	12335,5

Source: authors

In the period from 2021 to 2023, the average monthly salary of one employee of the company increased significantly, from 13,515 rubles in 2021 to 24,170 rubles in 2023,

which indicates a positive trend. However, it remains significantly lower than the average level of wages for RCEA in the Republic of Tatarstan: in 2023, the gap was 12,335,5 rubles. Despite the gap narrowing in 2023 compared to previous years, the salaries of the workers still lag well behind regional figures. The results of the analysis are presented graphically in Fig. 2. There are no requirements to maintain the average industry level of salaries in the region in the Russian legislation. Nevertheless, a deviation from this indicator may cause the tax authorities to suspect that the company has underestimated the tax base for personal income tax, as well as the company's underpayment of insurance premiums.

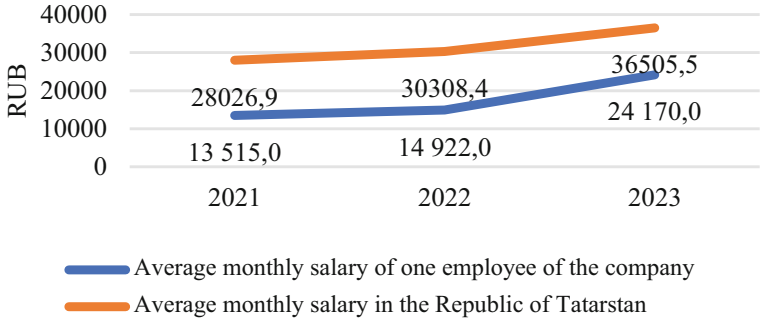


Fig. 2. Dynamics of the average monthly salary of one employee of ALFA + LLC and the average monthly salary by type of Russian RCEA in the region in 2021–2023 (Source: authors).

The sixth criterion: limits of indicators that give the right to apply special tax regimes are established by law. If the company repeatedly approaches these limits, then this may be a reason for verification, ALFA + LLC applies a simplified taxation system, which requires compliance with such conditions as the amount of income, the average number of employees, etc. Let's analyze the company's compliance with these criteria (Table 4).

As the comparative analysis showed, the limit values have not been exceeded for any of the indicators established by law. There is no risk of inspection by the tax authorities on this criterion. The seventh criterion is established in relation to individual entrepreneurs, that's why it is not analyzed.

The eighth criterion that can increase the likelihood of an on-site inspection is the formation of an unreasonably long chain of counterparties (intermediaries and resellers) without the presence of a so-called business goal. In the company's activities, there are no such facts as the development of commercial transactions, the affiliation of their participants, the use of inappropriate forms of settlements, etc. The documentation available in the company confirms each stage of commercial transactions and the validity of costs. There is also no risk of inspection by the tax authorities on this criterion.

The ninth criterion affects the absence of explanations of the company on notifications of tax authorities about the identification of discrepancies in its indicators to the established criteria. Failure to provide explanations, refusal to transfer the requested documents, ignoring the requests of the tax authorities – there are no such facts in the company's activities, as well as the risk of becoming the object of verification by the

Table 4. Analysis of the approximation of ALFA + LLC to the limit value of indicators established by the Tax Code of the Russian Federation in the period 2021–2023.

Name	2021	2022	2023
Annual income (standard and increased rates), RUB million	154,8 – 200,0	164,4 – 219,2	188,55 – 251,4
Actual income, RUB million	74,647	61,339	58,277
Number of employees (standard and increased rates), people	100 – 130	100 – 130	100 – 130
Actual headcount, people	60	57	51
Net book value of property, plant and equipment, RUB million	150	150	150
Actual residual value of property, plant and equipment, RUB million	0	0	0
Share of participation of other legal entities in the company's management,%	25	25	25
Actual share of other legal entities in company management,%	0	0	0

Source: authors

tax authorities for the reasons listed above. This demonstrates the transparency and integrity of the company in relations with tax authorities. The company demonstrates a high degree of tax discipline.

The tenth criterion concerns the frequent re-registration of business with the tax authorities for manipulating tax deductions or for reducing the tax burden. ALFA + LLC has been registered with the Interdistrict Inspectorate of the Federal Tax Service No. 6 in the Republic of Tatarstan since 13.01.2014, i.e. since the beginning of its activities, therefore there is no risk of the company being checked by the tax authorities according to this criterion. The tax authorities have no reason to doubt the company's activities, since it did not make frequent changes in registration data. Also, the lack of re-registration indicates the stability of the business and its compliance with tax legislation, which reduces the likelihood of possible tax violations.

The eleventh criterion is deviations in profitability from the industry average according to Rosstat [9]. We will analyze compliance with this criterion (Table 5).

A graphical comparison of profitability measures is presented in Fig. 3.

According to the results of the analysis, we can say that the criterion under consideration was not met only in 2022. Thus, the return on sales of the company amounted to 1.5% against 5.9% of the industry average, and the return on assets amounted to 0.2% against the required 2.4%. The risk of verification by the tax authorities for this criterion is present. Low profitability, according to tax authorities, may indicate possible tax evasion schemes. However, for companies on the simplified taxation system, this criterion is practically not evaluated by the tax authorities, it is relevant for companies on the general taxation system.

Table 5. Analysis of the deviation of the profitability of ALFA + LLC from the industry average according to RCEA 56 in the period 2021–2023.

Name	2021	2022	2023
Industry average return on sales,% [9]	5,1	5,9	10,7
Actual return on sales,%	24,5	1,5	46,8
Industry average return on assets,% [9]	1,9	2,4	4,6
Actual return on assets,%	4,8	0,2	5,9

Source: authors

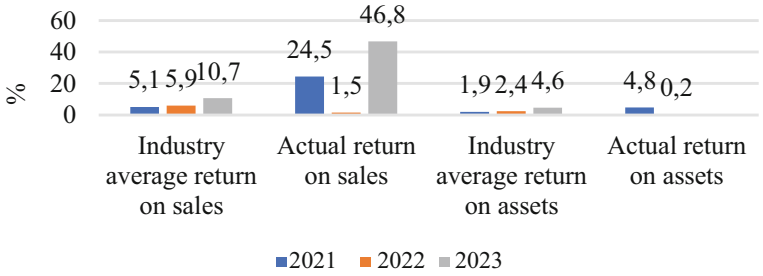


Fig. 3. Dynamics of the deviation of the profitability of ALFA + LLC from the industry average profitability in 2021–2023 (Source: authors).

The twelfth criterion is high tax risk when carrying out activities. The Federal Tax Service uses various methods to assess the tax risk of companies. If the organization falls into a group with high tax risk, this can lead to an on-site audit. A high tax risk arises when using the services of one-day firms, fictitious intermediaries, obtaining tax benefits for the fraudulent use of the labor of disabled people, obtaining unjustified benefits in transactions with real estate or securities or precious metals, alcohol production, etc. There are no similar facts in the company's activities, therefore, there is no risk of becoming the object of verification by the tax authorities on these grounds.

The analysis showed that according to four criteria out of twelve, there is a tax audits risk:

– deviation of the total tax burden of the company from the tax burden by type of economic activity (in 2021 – by 45.6%, in 2022 – by 47.9%, in 2023 – by 18.5%); according to the established practice, the tax authorities may allow such deviations, since companies have at least half the load on the simplified tax system than on the general taxation system;
– excess of the growth rate of expenses over the growth rate of income (in 2022, the company's expenses increased by 9.5%, and revenues decreased by 17.8%);
– the value of the average monthly salary of one employee of the company, compared with the value of the average monthly salary by type of RCEA in the region, is significantly lower than the industry average level in the Republic of Tatarstan;

– return on sales of the company is below the industry average (1.5% versus 5.9%), as well as return on assets (0.2% versus 2.4%); however, as practice shows, for companies on a simplified taxation system, this criterion is practically not evaluated by the tax authorities, it is relevant for companies on a common taxation system.

Thus, only two criteria can become a real threat to the company's on-site tax audit. The company regularly takes measures to manage the tax control risk. Firstly, it conducts full analysis of counterparties. Counterparties with whom contracts are concluded for an amount exceeding 100 thousand rubles are selected. Then, according to data from open sources, information about them is studied. For example, through the service «Transparent Business» of the website of the Federal Tax Service, the details of counterparties, data on the main type of their activities, etc. are checked; on the website of the Federal Antimonopoly Service to study business reputation, the absence of counterparties in the register of unscrupulous payers is checked, and on the platform «Know your counterparty» of the Central Bank of the Russian Federation, the level of risk assigned by the platform is checked. To assess solvency, the Enforcement Proceedings Data Bank checks the availability of enforcement proceedings against counterparties. In order to verify the experience of performing similar work or providing similar services, all cases involving these counterparties are analyzed in the Arbitration Case Map. On the website of the Federal Notary Chamber, the relevance of the notarial power of attorney is checked, on the basis of which the representative of the counterparty will sign the contract, etc. Secondly, if a counterparty with a high level of risk is identified, a package of documents is collected before concluding an agreement with it (a request to the counterparty about the availability of sufficient resources, both material and labor, for the execution of the agreement; certificate of reconciliation of payment of funds under previously completed or existing contracts; correspondence with the counterparty by mail (including electronic), notarized, postal receipts and checks; claims and responses to them; minutes of meetings of the parties, etc.). This package will be claimed in the event of various proceedings. Thirdly, since the company cooperates with individual entrepreneurs and self-employed persons, facts are excluded, the presence of which may become a reason for retraining this cooperation in labor relations, namely: attraction of such persons is carried out by the company only through online services, and not by announcement; documenting the fact that they (individual entrepreneurs and self-employed) have other clients; work in the company earlier under an employment contract and more. When concluding contracts with them, such issues as requirements for subordination to labor discipline and the company's regulations, the duration of the relationship; the availability of a workplace on the company's territory; payment not for the labor process, but only for the final result, etc. are avoided. Besides, the company checks the purity of transactions with affiliated entrepreneurs, carries out regular analysis of prices of transactions performed for the absence of price deviations in these transactions from contracts with non-affiliated counterparties. It analyzes cost growth trends and income growth trends.

4 Discussion

As our world becomes more complex, governments and tax authorities seek greater self-accountability and self-regulation, both internal and external stakeholders expect strong governance, tax controls and tax reporting frameworks to ensure transparency and a culture of no surprises when managing tax risk [10]. As part of the study, measures were developed and proposed to improve tax risk management and the efficiency of activities for ALFA + LLC:

1. Implementation of a systematic approach to tax planning. It is proposed to adapt tax planning to changes in the tax legislation that come into force from 2025. In particular, it is recommended to use the standard VAT rate of 20% and establish partnerships with counterparties working at a similar rate. Such a measure will minimize tax costs. Given the high deviations of the company's tax burden from the industry average (45.6% in 2021, 47.9% in 2022 and 18.5% in 2023), this decision will increase the financial stability and efficiency of tax policy management.
2. Automation of VAT accounting through electronic document management. It is recommended to switch to electronic document management to automate VAT accounting, invoicing and maintaining tax accounting registers (books of purchases and sales). This measure minimizes labor costs, reduces the risk of errors and late paperwork, and ensures compliance with legal requirements. This enables to avoid penalties and increases the overall efficiency of tax accounting processes.
3. Optimization of expenses and assortment policy. It is proposed to revise the range of products with an emphasis on positions with high margins, as well as adjust the level of wages to bring it in line with industry averages. This is due to the growth of the company's expenses by 9.5% and a decrease in revenues by 17.8% in 2022, which indicates the need to strengthen control over costs. The implementation of these measures will strengthen the financial stability of the company, increase its competitiveness and reduce the likelihood of increased attention from the tax authorities.
4. The implementation of the risk map for ALFA + LLC using the proposed algorithm of analysis and assessment of risks associated with tax control in order to form the financial stability and improve the financial situation will make it possible to effectively identify and minimize potential threats, ensuring timely management decisions to strengthen the financial base of the company. It will also ensure transparency of processes, improve forecasting and increase confidence from investors and partners.

5 Conclusion

The implementation of the proposed measures will ensure ALFA + LLC adaptation to changes in tax legislation and strengthen the company's financial position. Optimization of tax policy, including the use of the standard VAT rate and document automation, will minimize the risks of tax audits, reduce the likelihood of penalties and increase the transparency of reporting. A set of measures aimed at increasing profitability, including a revision of the assortment, reducing costs and optimizing the level of wages, will strengthen the company's market position, increase counterparty confidence and retain key employees. The implementation of the proposed recommendations will help reduce

tax and financial risks, strengthen financial stability and ensure sustainable growth of ALFA + LLC in the long term.

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Marketing Tools of Customer Loyalty Management in Telecommunication Sector Organizations

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Abstract. Loyalty is considered in the marketing paradigm. It implies that attention is provided to customers by companies that provide services at different stages of the buying decision. In the B2B market, suppliers aim at customer cost efficiency. The loyalty is seen as an extended value in relation to the services provided by the company. The telecommunications market is characterized by a high level of competition. To strengthen customer relationships, comprehensive loyalty programs need to be applied. We have investigated the formation of loyalty of a telecommunication operator in the Republic of Tatarstan on the basis of a survey of 128 clients of the company. Digital asset management capabilities, the level of consulting support and the quality of digital support tools were considered as criteria. On the basis of satisfaction ratings and the importance of the parameters of communication services, it was revealed that in order to strengthen loyalty it is necessary to provide a high level of technical support, as well as to develop server solutions for certain groups of customers. Taking into account the segmentation of the audience by profit and profitability, it was proposed to divide loyalty management tools. At the advanced level, in addition to a permanent discount, tech support, videoconferencing and a personal manager, there is a constructible template for transcribing Internet sessions and webinars. This approach allows shaping incentives for specific customer groups when managing telecom loyalty.

Keywords: B2B · Corporate Sector · Customer Characteristics · Customer Loyalty · Customer Loyalty Management · Customer Satisfaction · Loyalty Assessment

1 Introduction

The term «loyalty» was introduced into scientific circles in 1923. Consumer loyalty was defined as purchasing a brand in 100% of cases [1]. In the late twentieth century, F.F. Reichheld [2] introduced the concept of «useful profit» which contributes to continuous and sustainable development. The key point is the manager's ability to correctly align the organization's goals over time. The researcher reveals fundamental principles of effective functioning of the company. These are an individual approach to the client, a constant advertising campaign and continuous improvement of the quality of products

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or services. R.L. Oliver [3] identifies five possible scenarios of relationships between loyalty and satisfaction. If in the first scenario the concepts of loyalty and satisfaction are considered identical and can be interpreted in the same way, the fifth scenario highlights common features that characterize satisfaction and loyalty, so certain characteristics of satisfaction are present in loyalty, but are not the main elements of the latter. The affective state of customer satisfaction in industrial relations emerges from the overall assessment of the working relationship between firms.

Customer loyalty must be considered within the framework of the relationship marketing concept, the goal of which is to form mutually beneficial long-term cooperation with the company's stakeholders, including consumers. Successful interaction in the B2B sector requires suppliers of goods and services to understand the peculiarities of customers. It is important to realize that customer attrition in the B2B market can have a significant impact on business success, while losing customers in the B2C market will not have a major impact on a company's financial health. However, many B2B managers believe that customers act rationally and make decisions mainly based on price, customer loyalty is not taken into account. We believe that the level of customer satisfaction plays an important role in building customer loyalty, especially in the B2B context. Each customer has its own unique characteristics that need to be taken into account when interacting with them. By increasing customer satisfaction, an organization creates a desire to interact with a supplier of goods or services on a long-term basis, eliminating all risks associated with changing counterparties.

Interaction with corporate customers in the B2B segment has much in common with loyalty management in the B2C segment. In a study by M. Strenitzerová and J. Gaňa [4], representatives of these segments have different perceptions of services and approaches to increase satisfaction and customer loyalty. In the B2B sector, suppliers need to understand the nature and circumstances of customers because of their unique characteristics. In industrial relations, satisfaction is an affective state resulting from a shared appreciation of all aspects of the working relationship between one firm and another.

Regarding the relationship between loyalty, perceived value and satisfaction, the literature suggests that satisfaction plays a predominant role in achieving customer loyalty, although the presence of satisfaction in the supplier-customer relationship does not necessarily mean the presence of loyalty. This requires the ability to establish a deep and ongoing relationship with customers, and therefore to know them better to be able to adapt quickly and effectively to their preferences and real values to create future commitments between the parties.

A. Eggert and W. Ulaga [5] analyzed the relationship between industrial suppliers and companies in a cross-sectional study in Germany and determined that the causal relationship starts with perceived value, goes through overall satisfaction, and ends with loyalty. However, their study only examined perceived value from a cognitive and economic perspective. In the study by [6], emotional and social factors were also added. M.H. Askariazad and N. Babakhani [7] studied the most important drivers of customer loyalty in the B2B sector using European Customer Satisfaction Index (ECSI).

2 Methodology

Loyalty programs in the B2B market form a joint value creation with customer-partners, based on the development of joint ideas, creation of new formats of communication on the basis of joint projects, collection of information within the framework of collaborations. Such platforms can be used to test product offerings and improve management of information flows, advertising, and marketing distribution efforts. Essentially, one company sells services to another. In doing so, the vendor creates a customer reward system that helps strengthen relationships in a competitive marketplace. Service selection criteria involve two levels. At the first level, service, price level and company location are emphasized, while at the second level – benefits at the level of emotions and a sense of belonging to the company. That is why so much attention in loyalty management is paid to the stages of relationships: from the first touches with the brand to the formation of commitment to it [8].

In terms of customer relationship management in the B2B market, traditional (face-to-face sales, phone calls), digital (email marketing, social media, CRM systems) and innovative (analytics, AI and Big Data platforms) tools are emphasized. For loyalty management at the customer-company level, it is recommended to integrate technologies into a single system, while failures in analytics are attributed to incomplete segmentation and personalization, as well as insufficient coordination between the vendor company's departments. Therefore, a number of authors point to the need for omnichannelization in the application of traditional and digital tools, and continuous training of the vendor's employees.

A survey was used as a method of collecting primary information. In the process of data analysis a variety of scientific tools were used: from analytical analysis to synthesis of the obtained facts, as well as methods of induction and deduction for logical justification of the results. Tables and figures were used to visualize the results of the study. Studies show that only 7% of companies in Russia create platforms for interaction in the B2B market [9]. At the same time, only 60% of companies measure loyalty program indicators. To track the dynamics, both data on customers and sales in the B2B market, as well as the sales volume of business partners and the level of their loyalty should be taken into account [9].

In the Republic of Tatarstan, operators' revenue from the provision of telecommunications services amounted to RUB 20.15 billion in the first six months of 2023. Most of this – RUB 8.8 billion – is attributable to wired Internet, RUB 5.14 billion to mobile communications, RUB 1.39 billion to postal communications, and RUB 4.82 billion to other communications services. There are several large cellular operators operating in the republic's market, providing communication services for the B2C and B2B segments [9]. A regional organization operating in the market of communication services was chosen as the research object. Corporate clients of the organization differ in their functional technical needs and volumes of consumed services. To develop measures to manage the customer loyalty, it is necessary to assess the level of customer satisfaction. The assessment was conducted in the form of a survey, as respondents were small and medium-sized companies with the number of employees from 15 to 200 people, the total number of respondents is 128 people. The respondents evaluated the level of satisfaction with the quality of services of the regional telecommunications market operator on

a ten-point scale. The evaluation criteria were: 1) quality of digital asset management tools, including detailed analysis of Internet sessions, cloud video surveillance, protection against viruses and DDoS attacks; 2) level of consulting services: technical support, domain name registration and maintenance, web hosting services; 3) quality of facilities for the development of digital assets: video calls, virtual servers, etc.

Loyalty in the communications sphere can be increased by creating a reliable community with clients and forming special offers for community members. At the level of potential clients, the primary selection factor is already achieved performance and customer feedback, and at the level of large businesses – reputational support, participation in associations, industry forums, and awards for achievements.

3 Literature Review

The studies emphasize that the level of awareness and commitment of companies influence the building of mutual relations with customers. This indirectly affects customer satisfaction and is more capable of increasing profitability and loyalty. With the competent use of CRM strategies, managers in telecommunication companies provide customers with a personalized experience and increase the likelihood of long-term relationships [10]. The telecommunications industry is exposed to high risk - a 30% customer outflow could spell the end of a company. In addition, there are obstacles related to the development of the technology itself, resulting in responsibility for the allocation of resources within the company and the economy. It is necessary to implement an integrated approach of interaction, knowledge and trust management in order to achieve a harmonious combination of profitability and loyalty, in addition to avoiding these risks of overcoming these obstacles [11]. Thus, on the basis of permanent ties, relationships with customers are maintained, which to a greater extent provide the company with profits and remain loyal to the product.

Another aspect that builds loyalty is brand attitude, that is, the perception of brand characteristics by consumers. In fact, this perception is determined by the level of brand memorability, which ultimately enhances the image and increases commitment, which generates higher levels of loyalty, satisfaction and profitability. The positive nature of interactions with customers leads to increased loyalty when there is a connection between the consumer and the brand. This can be influenced by the development of digital relationships across channels [12]. This provides brand visibility in industries where competitors have equal access to open and technological infrastructure [13].

An unquestionable factor that can be used to judge the formation of loyalty and satisfaction is the customer's perception of the price of the product. Together with the growth of customer efficiency, the company gets a potential source of competitive advantage. At the same time, the competent selection of marketing tools provides an increase in the level of trust and awareness in industry markets. Of course, this is facilitated not only by price conditions, but also by the quality of the product and service delivery, promotion channels and the place of sale. Within the four classic stages of loyalty development, it undergoes a transformation, moving from the desire to recommend to an increase in the share of the client's overall budget.

If we consider the market of industrial goods, consulting services help to identify not only explicit but also hidden needs of customers. And trust in the supplier forms

favorable attitude and loyalty. Provided that price does not always determine the choice, attention in relationship building is paid to the payment process, as well as to the analysis of data in CRM-systems in order to identify the most profitable segments and «weed out» groups that are known to be unable to bring profit [14]. Since B2B consumers seek to rationalize their choices in the decision-making process, two components of loyalty should be managed, optimizing the ratio of subjective measurements (attitude) to brand- and price-dependent characteristics (behavior). There are four levels of loyalty programs: from fixed discounts to personalized offers for specific groups of customers. In general, a loyalty program allows, in addition to saving company costs and reducing customer churn, to increase customer awareness and establish new contacts for relationships with them [15]. Customer loyalty has been studied to a high degree, but requires clarification in terms of the peculiarities of customer loyalty management in the B2B market, taking into account the industry specifics of companies.

4 Results

Consumers particularly appreciate the high speed of response and efficiency in resolving problematic issues in the helpdesk (Table 1).

Table 1. Satisfaction with the services of the regional telecommunications market operator.

Parameter	Satisfaction	Significance
Digital asset management tools		
Detailed analysis of internet sessions	8,25	6,89
Cloud video surveillance	7,13	6,24
Protection against viruses and DDoS attacks	8,14	7,74
Tools for the development of digital resources		
Virtual server solutions	9,14	7,84
Colocation	8,27	7,22
Videoconferencing	7,86	8,17
Consulting support		
Technical support	9,02	8,95
Domain registration and support	8,84	5,81
Web hosting	7,25	7,66

Source: authors

In order to increase the level of customer satisfaction it is necessary to improve the quality of work of the telecom operator's employees, for example, refinement and improvement of scripts, reduction of time for providing feedback, development of instructions for solving the most frequent problems and their placement in a special section on the organization's website.

Small businesses looking to avoid unnecessary costs appreciate web hosting services. It is important for them to be able to get hosting for their business card site, small online store or landing page. Business representatives and their marketers actively use specialized platforms where you can pick up a domain name, check its availability and purchase it for your company. The official site required for contextual advertising is successfully placed on the resources offered for corporate clients.

A lot of corporate clients rated virtual servers and colocation highly because of the difficulties they encounter in organizing server spaces and placing equipment. The problem of overheating of their own servers, causing them to stop working several times a month, was also noted by respondents. Among the positive aspects of using videoconferencing is the convenience of holding meetings with different departments in different locations. Quality communication without distortion is considered one of the advantages of implementing this technology. The limited number of users per session is a disadvantage when viewing video surveillance in the cloud, which is relevant for a small number of respondents when using different devices. Antivirus and DDoS protection tools that ensure the security of electronic resources are of high importance for consumers of telecom operator services. Satisfaction on this parameter does not reach high values because protection itself represents a quasi-permanent characteristic of the service and is not perceived as something unique.

To assess loyalty with the operator's services, we additionally determined the Net Promoter Score (NPS) indicator. Among the survey participants about every tenth turned out to be a critic, while more than a third showed themselves as promoters. The final NPS result turned out to be quite high – 28.1% (Fig. 1).

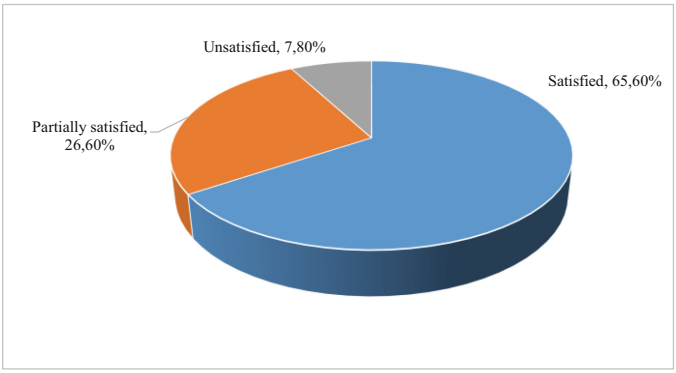


Fig. 1. Results of the assessment of customer satisfaction of the regional telecommunications market operator (Source: authors).

We evaluated the consumers of the organization under study for satisfaction with the pricing policy, based on the fact that some of the most important factors for the corporate sector are cost optimization and profit maximization. In the course of the analysis, the company's pricing strategy shortcomings were identified. The main problems include regular price increases and inconsistency of pricing solutions with the quality characteristics of goods and offers of competitors, including well-known federal telecom

operators. Special attention was paid to the poor quality of mobile communications and high-speed Internet.

In addition, respondents evaluated the work of personal managers according to the following criteria: speed of feedback, no delays in the preparation of accounting statements, empathy and attentiveness of managers, no intrusiveness in providing additional services. It turned out that according to these criteria 60% of respondents rated the level of personal service as «excellent» (8–10 points), and a large share of respondents gave a score of 7 (out of 10 points). It can be concluded that it is advisable for the enterprise to invest in human capital (staff development, training, updating sales scripts and adjusting existing instructions) and to eliminate problems existing in communication processes such as sending reports and correspondence.

According to the general results of assessment of corporate customers' satisfaction with the services of the analyzed company, we can speak about their high commitment. At the same time, certain services, such as domain support, are not demanded by users, and for others respondents noted the need to improve them to meet consumer requirements (cloud video surveillance). Based on the results of the analysis, we propose the following methodology for creating an updated corporate user loyalty management system in the company using modern marketing tools.

At the initial stage it is necessary to segment customers into three key groups by applying the appropriate tool (ABC-analysis). In our opinion, it is necessary to conduct segmentation according to the following indicators – profit and profitability, which will help to divide the organization's customers into mass segment, customers with potential and valuable customers. The next stage is the analytical work of budgeting decision management, the purpose of which is to determine the acceptable values of the amount of money that the company can allocate to customer loyalty management. It is then proposed to form service packages that contain a set of loyalty management tools, of general and individual nature. We offer an example of systematized loyalty management tools for corporate clients based on segmentation (Table 2).

Implementing a differentiated approach to customer loyalty management will allow an organization to pay special attention to the needs of each customer. In addition, we propose to create incentives for corporate clients to buy more of the company's services and gain access to privileged programs.

When considering the complex of loyalty management in telecommunications, it is impossible to level the peculiarities of the product and the capabilities of the operator. In the process of interaction with corporate clients, the quality of services provided is an important aspect. No matter what offers the operator's loyalty program is filled with, the primary criteria of communication quality and the possibility of uninterrupted operation in terms of solving business tasks still remain in the first place.

In addition to the existing content of software products, it is possible to add maintenance and support functions, special interaction formats, expansion of the educational telecom function. This will increase the attention to the product and allow working on retention of corporate clients in the long term.

Table 2. Loyalty management tools for corporate clients of a regional telecommunications market operator.

Basic level I	Medium level	Increased level
Virtual server – 30 days technical support 24/7 Personal manager e-mail distribution for holidays Web hosting services up to 500 Mb Videoconferencing (up to 5 people)	3% off Virtual server – 45 days Hosting of the client server – 30 days technical support 24/7 Personal manager Holiday Email Newsletter	5% off Virtual server – 60 days Hosting of the client server – 45 days technical support 24/7 Personal manager E-mail distribution for holidays Web hosting services up to 2 GB
Transcript of Internet sessions in a template	Web hosting services up to 1 GB Videoconferencing (up to 5 people) Transcript of Internet sessions template Participation in partnership programs	Videoconferencing (up to 8 people) Transcription of Internet sessions according to a constructible template Participation in partnership programs Webinars

Source: authors

5 Conclusion

To further develop approaches to loyalty management, it is advisable to monitor data on the economic efficiency of customers. The growth of their profitability and profit determines the need to use additional telecommunication tools. Segmentation and formation of a database on all corporate customers allows operators to control the processes of the outflow of premium clients who bring the highest profit. The strengthening of relationships and the growth of equipment quality contribute to the return of customers to the operator's services. Monitoring such data is critical for developing relationships and building loyalty in the B2B market. Managing customer loyalty is one of the most complex areas of business activity. And increasing repeat sales is the result of complex work on building relationships with customers. It requires regular and targeted actions from the organization that can change the behavior and attitude of customers in its favor. The cost of keeping in touch with corporate customers is on the rise. Leading companies operating in the B2B market are developing and applying new methods to the customer loyalty management process. Most B2B markets are at a mature stage and the potential for exponential growth through new customer acquisition has been exhausted. Building customer loyalty in the corporate sector presents significant challenges due to the dual nature of B2B customers and managers' lack of understanding of the nature of customer relationships. In oligopoly and monopoly markets, it is important to recognize that attracting new B2B customers is costly. At the same time the increase in profitability of existing clients can exceed 30–40%. It is necessary to take these factors into account to increase

business efficiency and successful interaction with organizations in the corporate sector. It is important to take into account that interaction with specific employees with different needs and tasks takes place at the operational level. Consequently, an organization working with corporate customers should first of all analyze and systematize production processes to streamline and simplify the process of interaction with customers. Working more effectively in this area will save time for the company's employees responsible for interacting with customers. As a consequence, this time can be allocated for closer formal and informal interaction with individual customer employees who can influence decision-making.

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Import Substitution and Export Potential of Regions: Balance in Industrial Development Strategies

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Abstract. Stabilization of the Russian market and reduction of dependence on imports in the conditions of shock impact of external restrictive factors in the form of sanctions and disruptions of export logistics processes due to geopolitical transformation are challenges for the existing economic system in our country. The sustainability of the domestic market and national sovereignty of the Russian economy are currently being tested for strength in search of development vectors and issues of acquiring autonomy, independence from imported products. A competent import substitution policy in various sectors of the economy in recent years has helped to stabilize the market. However, in the industrial sphere, there are still differences in the synergy of import substitution processes and possibilities of realizing the export potential. The purpose of this study is to analyze and assess the current state of import substitution and export potential in various regions of the country, identify problems and development prospects, as well as develop recommendations for the formation of balanced industrial development strategies that take into account the interests of the regions and the country as a whole. The authors consider key concepts, the essence of import substitution processes and the export potential of regions, highlight effective types of strategic planning of industrial development taking into account the import-export balance of territorially isolated economic systems. The role of small and medium entrepreneurship on the way to a balance between import substitution in industry and its export capabilities is identified and proven.

Keywords: Development Strategy · Export · Import · Industry · Import Substitution · Regional Economy · Regional Export Potential

1 Introduction

In the modern world, where globalization and international competition are intensifying, countries seek to develop their industrial sectors, relying on their own resources and capabilities. Key aspects of this process are import substitution and the export potential of regions. Import substitution is the process of replacing imported goods and services with domestic products, aimed at reducing dependence on imports, strengthening the

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national economy and ensuring economic security. It plays an important role in the development of industrial regions, allowing local producers to expand their markets and increase their share in them. The export potential of regions is the ability of local enterprises to enter foreign markets with competitive products and services. It depends on the quality of products, the effectiveness of regional authorities and government support. The Russian Federation, whose economy largely depends on the industrial sector, has faced the negative consequences of the deterioration of foreign economic activity and sanctions restrictions from developed countries, such as European countries, Japan and the United States. This has led to a reduction in transport and logistics chains and difficulties in the import and export processes. The purpose of this study is to analyze the current state of import substitution and export potential in the regions of Russia, identify problems and development prospects, and develop recommendations for the formation of balanced strategies for industrial development. Russian researchers are faced with the task of developing a methodological base that would take into account the complex characteristics for successful strategic planning and development of the country's industrial complex, providing domestic markets with competitive products and supporting export orientation.

2 Methodology

The authors used statistical and empirical analysis methods, which allowed them to conduct the study at a high level. The work evaluates the contribution of Russian scientists to identifying the shortcomings of strategic decisions in industry, improving the import substitution system and increasing the export potential of regions where the main type of economic activity is industrial production. The scientific works of Russian economists devoted to the issues of implementing promising solutions for developing key areas of import substitution policy and increasing the export potential of industrially oriented subjects of the Russian Federation in order to achieve economic and technological sovereignty are analyzed. The materials of reports and economic reports published by Rosstat and the National Research University Higher School of Economics concerning the activity of small and medium-sized enterprises are studied. An abstract logical method is used to identify factors influencing structural changes in the economy and market of Russia. The inductive method is used as the main method for determining the key vectors and trends of regional industrial development strategies. For the visual presentation of statistical data, performance indicators of enterprises and comparative analysis of the innovative activity of small enterprises, the method of visualizing information in the form of diagrams and tables was used.

3 Results

The modern economy of our country in the context of its development and functioning, taking place in the conditions of existing external and internal social, trade, economic, financial and technological challenges, is implemented through increasing the efficiency criteria at industrial enterprises. Due to the territorial and spatial specifics of business entities and the state of the economy of the Russian Federation can be characterized

as stable. In 2023, the country's GDP grew by 3.5% compared to a decline of 1.2% in 2022. Russia's external debt decreased, and the unemployment rate reached a historic low. Inflation increased to 7.42%, but this was caused by objective factors such as growing consumer demand and changing supply chains [1]. Import substitution and export potential of the region are the main areas that can be regulated in order to stimulate the economic growth of the entity, which can be recorded by a number of indicators. Many Russian economists are conducting studies of the mutual influence of stimulating and practically oriented measures carried out within the framework of the implementation and development of these areas in relation to industry. The issue of acquiring sustainable technological and economic sovereignty, the integrity of the Russian economy and its self-sufficiency remain the most pressing issues over the past decade. Import substitution to reduce the dependence of the national economy on the share of foreign-made goods along with increasing the export potential of regional industry are the main areas of regulation that are subject to close attention from both the state and external economic partners, investors and the population of our country.

Summarizing the results of theoretical and practical research, the authors identified effective types of strategic planning for industrial development taking into account the import-export balance in the regions:

1) Profiling the region's industry. For example, in the Southern Federal District, the most promising industries are the agro-industrial complex and agricultural engineering, in the Tyumen Region – petrochemistry and mechanical engineering, and in the Urals Federal District – metallurgy, fuel, chemical industry and mechanical engineering [2, 3].
2) Transformation of industrial enterprises into large corporate structures. This includes the development of enterprises and sub-sectors that act as «growth points» for industry.
3) Development of small businesses and support for small and medium-sized industrial enterprises. Small enterprises focused on export receive an incentive for development due to the expansion of the consumer audience, the development of new business methods and brand growth. They are also becoming an important driver of non-resource non-energy exports, increasing their contribution to the country's economy and strengthening the international presence of Russian goods and services.
4) Overcoming deformations in industry, intra-industry and production structures. This includes eliminating the technical and technological lag of domestic production.
5) Development of auxiliary production and a subcontracting system. This promotes import substitution by activating production, allowing large companies to focus on core processes, and small and medium-sized enterprises to produce components, which stimulates the development of domestic production.

Since the end of 2019, due to the coronavirus pandemic and the tightening of foreign economic sanctions, the small and medium-sized business sector has been subject to the following impacts: a decrease in product profitability, a change in regulatory mechanisms regarding taxation. There was a decline in turnover indicators with a simultaneous increase in the number of people employed in the sector. This caused dissonance, which can be justified by a decrease in household income, worsening expectations for the duration of the pandemic and restrictive measures introduced due to the coronavirus. This

led to a decrease in the number of small and medium-sized enterprises, especially in the regions. State support for the sector has led to positive results, which can be tracked by the main indicators of economic activity of small and medium-sized enterprises in the Russian Federation for 2021–2023 (Table 1):

Table 1. Key indicators of economic activity of small and medium-sized businesses in the Russian Federation for 2021–2023.

Key economic indicators	Small enterprises			Medium-sized enterprises		
	2021	2022	2023	2021	2022	2023
Average number of employees, thousand people	10652,4	10587,1	10772,6	1599,7	1678,5	1696,9
Average monthly accrued wages of employees, rubles	37743	42293	49654	54627	63833	73775
Turnover of enterprises, billion rubles	57197,2	60946,7	67024,6	12094,6	12564,3	14891,3
Non-current assets, billion rubles	90041,5	45994,5	53302,5	3931,9	5050,6	5709,7
Current assets, billion rubles	63702,5	80722,4	101080,4	8217,8	9369,4	10736,5
Capital and reserves, billion rubles	81810,4	48147,7	60667,0	3557,2	4442,9	5236,6
Balanced financial result (profit minus loss), billion rubles	5242,4	6012,6	11598,6	886,8	1122,5	1315,1
Profitability of sold goods, products (works, services), %	8,3	9,5	13,0	8,1	9,7	9,9
Return on assets of enterprises, %	3,4	5,4	8,4	7,3	8,2	8,5

Source: authors based on [4]

There is an increase in all key economic indicators for the specified period, with the exception of non-current assets of small businesses. Non-current assets of small businesses decreased in 2022, but showed growth in 2023. The decline in 2022 was caused by a decrease in business profitability, an increase in interest rates on loans, a disruption in supply chains, and a decrease in sales of fixed assets by large and medium-sized enterprises. The decrease in revenue from the sale of assets is determined by structural restructuring of the country's industry and economy, the departure of large foreign companies from the Russian market. The growth of other economic indicators of small and medium-sized enterprises in 2021–2023 is explained by the high adaptability of the sector to market changes. This growth was made possible an increase in the volume of government purchases from small and medium-sized enterprises, as well as the successful implementation of preferential lending programs, including regulatory concessions and support for investment projects.

According to [4], the volume of innovative goods and services produced by small businesses increased in key areas of industry: in mining (by 426.98% in 2023 compared to 2021) and manufacturing (by 167.06% over the same period). This growth is associated with the implementation of measures provided for in the Consolidated Strategy for the Development of the Manufacturing Industry of the Russian Federation until 2024 and for the period until 2035. These measures have a positive effect on the country's economy, contributing not only to the stable functioning, but also to the accelerated development of the manufacturing sector [5]. It is inappropriate to consider the prospects for the development of small businesses in other types of industrial activity due to their sporadic presence in the regions and the lack of consolidated statistics for the country. It should be noted that in recent years, the trend of the prevalence of innovative activity in the manufacturing industry has persisted. However, this is not enough to accelerate the development and stabilization of the economy [6]. Restricting the access of Russian companies to high-tech imported developments in 2021–2022 has slowed down progress. Small businesses can play a key role in stimulating the development and implementation of innovations in the manufacturing industry, which will help ensure the country's technological sovereignty.

In 2023, the decline in innovation activity of a number of medium-sized enterprises was caused by the following reasons: decreased demand for innovations, lack of financial resources for their implementation, difficulty in assessing the effectiveness of innovation projects, outflow of highly qualified personnel abroad and insufficient coordination of government support measures in the context of sanctions.

Small businesses play a key role in the development of import substitution and increasing export potential. They regulate the balance between the region's export capabilities, the level of import substitution and the territorial specifics of production, which directly affects the competitiveness of industrial products. The advantages of small businesses in stimulating production activities and achieving a balance between export potential and import substitution are as follows:

1) Flexibility and adaptability. Small businesses respond faster to market changes and adapt to new conditions, which allows them to quickly develop and implement new products and technologies. This is especially important in the context of sanctions and economic transformation. In addition, small businesses are more resilient to crises due to their flexible management structure.
2) High potential for innovation development. Small businesses contribute to the creation of new products and technologies, which is critical for import substitution. This allows developing competitive products that are not inferior to foreign analogues [6].
3) Focus on local production. Small businesses better understand the needs of the local market and respond to them faster, which reduces logistics costs and contributes to the development of the regional economy.
4) Job creation. The development of small businesses helps reduce unemployment and improve the quality of life of the population, which is especially important in conditions of economic instability.

The export potential of a region is a complex characteristic reflecting the interaction of production, scientific, social and infrastructure facilities. To stabilize the economy, improve its quality, GDP growth and achieve technological sovereignty, the following

key areas for the development of export potential in the regions of the Russian Federation can be identified:

1) Development of infrastructure and logistics. Improvement of transport, logistics and information infrastructure to simplify the export of goods and services.
2) Attracting investment. Creating favorable conditions for attracting foreign and domestic investment that promotes the development of export production.
3) Improving product quality. Implementing modern technologies and quality standards to enhance the competitiveness of export goods in the world market.
4) Developing education and integrating it with industry. Training qualified personnel for export industries and raising the level of education in the region.
5) State financial support and tax incentives. Providing subsidies, grants and tax incentives to stimulate export activities and attract new companies.
6) Developing international cooperation. Establishing partnerships with foreign companies and organizations to exchange experience and expand sales markets. This helps strengthen interstate cooperation within regional associations, taking into account global production and distribution chains [7].
7) Information support and product promotion. Organizing information campaigns, marketing research and advertising campaigns to increase awareness of regional export goods and services.

These measures contribute not only to strengthening export potential, but also to the integration of regions into the global economy.

4 Discussion

For the successful development of import substitution and export potential in the regions that are the main subjects of the implementation of industrial development strategies, it is necessary to take into account a number of aspects. First of all, it is important to develop a network infrastructure for interaction between participants in production and economic relations and optimize logistics processes. This will speed up trade turnover, reduce transportation costs and increase the competitiveness of domestic goods in foreign markets. Small and medium-sized enterprises play a key role in the production of export-oriented goods that can replace imported ones. They are more flexible and mobile than large companies, which is especially important for countries with export-oriented economies at the transformation stage. The state should support them through preferential lending, training and advisory assistance. These measures are reflected in the Strategy development of small and medium entrepreneurship in the Russian Federation for the period up to 2030 [8].

One of the key areas for increasing the competitiveness of Russian industrial products is the development of innovative technologies in the manufacturing, digital and IT spheres. Large Russian companies actively cooperate with small and medium-sized enterprises to accelerate the digitalization of production, creating digital products themselves. This stimulates the emergence of high-quality developments that can replace expensive imported software and ensure the efficient operation of enterprises, their branches and clusters. The growing number of industrial clusters in various industries confirms the active development of this area.

Interaction with foreign partners and participation in international projects contribute to the exchange of experience, attracting investment and expanding sales markets. The reorientation of export activities to new directions, which has proven sustainable, allows us to consolidate domestic products on international trading platforms, increase their competitiveness and attract foreign investment to the regions. Until 2020–2022, Russian industry was characterized by high dependence on imports and a lack of its own scientific and technical base in a number of industries. Cooperation with foreign partners is becoming a necessary and effective tool for overcoming the technological gap with leading countries. This creates prospects for Russia to take a leading position in the production of highly competitive industrial products and maintain it in the long term.

The authors of the study have developed recommendations for the formation of balanced industrial development strategies that take into account the interests of the regions and the country as a whole: increasing the role of industrial production in the economy, competent investment policy, export-oriented development and import substitution, technological policy, control over territorial planning and logistics, government regulation. These measures are aimed at creating a sustainable and competitive industrial system capable of meeting modern challenges.

It is worth considering that export potential and import substitution are closely interrelated and cannot be considered as isolated processes. To achieve a balance between them in regional industrial development strategies, it is necessary to determine priority industries for import substitution, identify their competitive advantages and capabilities, and communicate this information to society and potential partners.

The key industries in Russia are mechanical engineering, electric power, chemical, manufacturing and mining industries. Their development should be stimulated taking into account the preservation of export potential, since these industries determine the production capabilities of the regions and are closely linked to other sectors of the economy. Regions are interested in creating sites for the production of import-substituting products, as well as in their orientation towards sustainable export.

The specificity of regional industry contributes to the construction of effective mechanisms of interaction between import-dependent and import-substituting entities. At the same time, state investment activity should be aimed at supporting industries with prospects for development and entry into export markets. This will allow the formation of an optimal import substitution structure and strengthening the regional economy.

5 Conclusion

Import substitution and export potential of regions are important components of their industrial development strategies. They allow countries and regions to strengthen their economies, improve the well-being of the population and ensure national security, which are the main conditions for maintaining the technological sovereignty of the state. The study offers recommendations for the formation of balanced industrial development strategies that take into account the specifics of the regional industry and its impact on the state economy.

Based on the results of the study, the following conclusions were formulated:

1) Import substitution is a controlled process aimed at ensuring the growth of socio-economic indicators of the country and its regions.
2) Import substitution replaces imported goods and services with domestic analogues, reducing dependence on imports, supporting domestic producers and creating jobs.
3) The export potential of a region lies in the ability of local producers to successfully compete in global markets. This helps strengthen the national currency, create jobs and attract investment.
4) It is necessary to strictly adhere to the strategic goals of industrial development, including the creation of regulatory and legal conditions for effective import substitution.
5) For successful industrial development, regions need to find a balance between import substitution and export potential. Strategies should take into account the development of both domestic production and export opportunities, regional specifics.
6) Finding a balance between import substitution and export potential is one of the most significant aspects in implementing strategies for industrial development of regional economic systems. A successful combination of these two areas ensure sustainable development of the regional economy, create new jobs, and increase the competitiveness of the country's economy in the global economic space.

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Digitalization of Traffic Management

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Abstract. A lot of drivers use GPS or GLONASS based tools to plan their routes in order to choose the optimal one. These GLONASS devices can work both in offline and online mode. In offline mode, when the device has a GIS database installed and there is no information about the actual traffic flow, the program always calculates the same route between two places. With access to up-to-date traffic flow information, it is possible to calculate the optimal route in real time. Based on the above parameters, the driver's decision to choose a route can be static, dynamic or informed. Static decision means that the driver always follows the same route: either without using a GLONASS device (choosing the usual path) or with an autonomous device. Dynamic decision means that the driver chooses a route according to only visual information on the spot in real time without navigation aids or external information and makes a decision according to traffic density. Informed decision means that the GLONASS device calculates the optimal route according to current traffic flow information. The aim of this study is to present the impact of the ratio of different route choice decision making methods.

Keywords: Innovative Technologies · Transport Flows · Social Effect · Socio-Economic Relations · Traffic Management · Quality of Service

1 Introduction

Modern route selection methods integrate elements of machine learning and big data analytics, which allows taking into account a lot of factors that affect the efficiency of a trip. For example, the use of algorithms trained on historical traffic data allows predicting the most likely congestion and delays on the route, which in turn contributes to a more informed choice. In addition, modern technologies such as GPS and mobile applications provide users with up-to-date information in real time. This creates new opportunities for adapting routes on the go, which significantly increases the flexibility and efficiency of traffic flows. Research shows that when drivers have access to information about the current traffic situation, they are more likely to choose alternative routes, which helps reduce the load on congested areas. Social networks and information sharing platforms play an important role in route formation. Users can share their impressions and recommendations, which helps to create a more adaptive and dynamic route selection model. As a result, routes become not only more optimal in terms of travel time, but also take into account preferences and habits of travelers.

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It is worth paying attention to the influence of cultural and social factors on route selection, as well as the possibility of creating multimodal transport systems that take into account different modes of transport and their interaction. This will not only optimize route selection, but also improve the overall quality of transport services, which, in turn, will contribute to the sustainable development of urban infrastructures.

As a result, an improved route selection model was created, based on the theory of cumulative perspective. This model is able to adequately reflect the attitude to risk and reliability requirements in the time perspective. Idealized general and special dynamic models were proposed, taking into account daily route changes and real-time response. A route choice modeling application using global positioning system (GPS) data was tested, focusing on heavy vehicles that typically have longer trips and make decisions based on different priorities than car drivers. The temporal aspects of the route choice model also take into account human cognitive abilities, memory, and preferences. The importance of metric, topological, and geographic distance in the context of travelers' route choices depending on the mode of transport used was also investigated. This study is based on data that allowed tracking real-life travelers' movements using mobile GIS applications. Nowadays, car manufacturers offer built-in navigation devices for all new cars. In addition, drivers can use portable navigation devices, and mobile phones often come with a variety of navigation applications that facilitate optimal route planning based on various criteria. These devices are able to calculate route length, estimated travel and arrival times, track the vehicle while driving, and update the data as needed. Navigation devices are classified into three categories depending on their purpose:

1. Offline mode means storing the data needed for navigation directly on the device, but there is no access to online information about the current traffic situation, which makes it difficult to calculate the optimal route.
2. Semi-online mode includes storing data about the road network on the device, while information about the real situation on the roads is received online via GSM or RDS.
3. Online mode means that the service provider calculates the optimal route and transmits it to the driver's mobile device, where the appropriate application is installed, allowing the data to be displayed and used for navigation.

The purpose of this work is to study the practical approach to the methods and process of route selection using different navigation devices and their service levels, as well as the impact of different distributions of route selection methods on traffic flow and travel time.

2 Methodology

One of the most suitable methods for studying the influence of route choice, traffic flow and travel time is computer simulation, since we can collect data on an additional road network with different traffic volumes and the ratio of different route choice methods. The two main elements of the simulation model – the road network and the vehicle (including the driver) – have a number of general and specific characteristics. The applied model includes only the most important characteristics and maneuvers from the examination point of view. Detailed simulation is not required to determine the average travel time

of a vehicle, there is no need to determine the detailed movement of all vehicles (e.g. acceleration) in accordance with the simulation cycle, as well as to record overtaking and lane changes for each vehicle. The considered road network includes only two parallel routes that have approximately the same length and the same average throughput (A and B). The routes consist of such road sections, the throughput and technological characteristics of traffic (number of lanes, road width, etc.) of which can be considered homogeneous (Fig. 1).

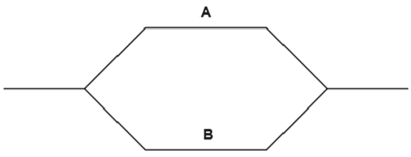


Fig. 1. Transport network (Source: authors).

In the study, only one-way traffic is considered, assuming that the impact of traffic in the opposite direction on the road network is insignificant from the experimental point of view. The road network parameter is the maximum speed limit on each road section. For clarity, the length of the road sections is the same – 500 m.

The driver's route selection methods can be divided into the following groups:

A) Static route selection: drivers in this category use their usual route (shorter, faster), as well as those drivers who have autonomous navigation, which does not provide up-to-date traffic information.
B) Dynamic route selection: drivers in this category make a decision when approaching an intersection and choose one of the additional routes, taking into account the traffic density visible directly in front of them.
C) Route selection based on actual traffic information: Drivers in this category use online navigation devices or variable message signs near the road that provide information about actual traffic, which drivers take into account when choosing a route.

Drivers make a decision on the choice of route based on their personal characteristics and the information available at the intersection. The internal activity of public transport participants consists of three periodically repeating stages: perception of fragments of information from the environment, formation of a decision-making strategy based on the processed information and personal characteristics, as well as the individual's goals, and implementation of what has been decided.

3 Results

On each section of the road, the speed of the vehicle is a function of traffic density – Eq. (1):

$$v = f(D) \tag{1}$$

The mean part of the function can be approximated by a straight line, the slope of which corresponds to the traffic mode on the given road section. The time interval of vehicle movement is determined using stochastic numbers obeying the Poisson distribution. The expected value of this distribution, representing the average travel time (proportional to the volume of traffic flow), is a variable parameter. The driver's route selection mode is calculated based on the ratio of categories and a random number at the input. The input parameters include the speed limits on the route, the traffic volume at the departure point, and the distribution of drivers among different route selection methods. The stored evaluation data include the actual traffic volume, the ratio of route selection categories and route selection method categories for each vehicle, the chosen route, the travel time, and the actual number of vehicles on the route per second.

Due to the fact that the speed of vehicles decreases on the road section before the traffic restriction, the traffic density increases, which can reach the intersection before choosing a route. Thus, drivers could feel not the factor of the decrease in traffic intensity, but the resulting traffic jam. During the simulation, the qualitative characteristics of the traffic flow were in the range from 600 to 1800 vehicles per hour (Fig. 2).

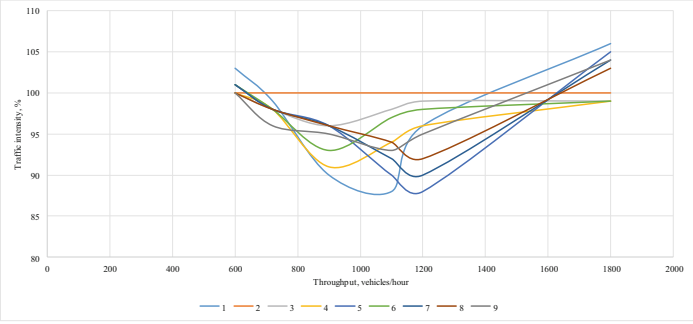


Fig. 2. The effect of traffic intensity on throughput (Source: authors).

It is worth considering travel times from a broader perspective: the average travel time is primarily important for the optimal operation of the road network. Comparing travel times depending on route selection methods is necessary, as it can motivate drivers to change their driving habits in order to reduce their own travel time and improve traffic quality. The simulation results show that on a road network without a speed limit, an increase in the number of informed drivers does not lead to a reduction in travel times at low or high traffic volumes. In the first case, there is no traffic congestion, in the second case, both routes are congested. A reduction in average travel time is observed in the range of 900–1500 vehicles per hour, with the maximum time savings achieved at 1200 vehicles per hour.

The benefits of awareness are particularly noticeable when there is a temporary speed limit on the road network. In our study, we examined the effects of a 20 km/h speed limit in the middle of route A. Figure 3 shows the effectiveness of dynamic route selection when traffic information is not provided, with and without speed limitation on the road network. On the road network without speed limitation, the most favorable values were

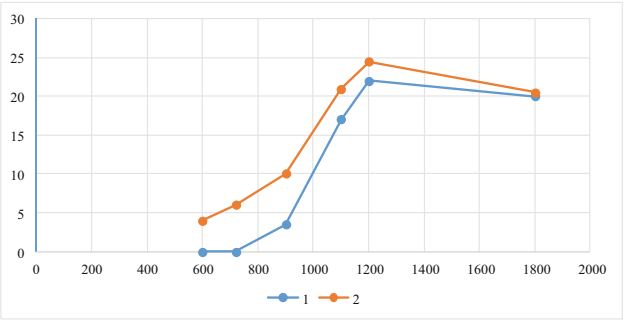


Fig. 3. The effect of throughput on the average flow rate (Source: authors).

at a traffic intensity of 1200–1400 vehicles per hour; in the case of an increase in traffic intensity than on the longer route B, the average speed of vehicles decreases without speed limitation. On the road network with speed limitation, the advantage of dynamic route selection can be realized at almost any permissible speed.

By examining the increase in average travel time in the case of a temporary speed restriction, it is clear that until the traffic volume reaches 900 veh/h, an increase in the proportion of drivers actively choosing a route has a positive effect on the average travel time; when the traffic volume increases, these benefits cannot be realized because the routes become congested.

4 Discussion

An increasing proportion of informed drivers and drivers actively choosing their route has a positive effect on average travel time. Obviously, the benefits decrease with increasing traffic volume. On this basic road network, which includes only one decision point, the maximum difference is about 5% (Figs. 4 and 5).

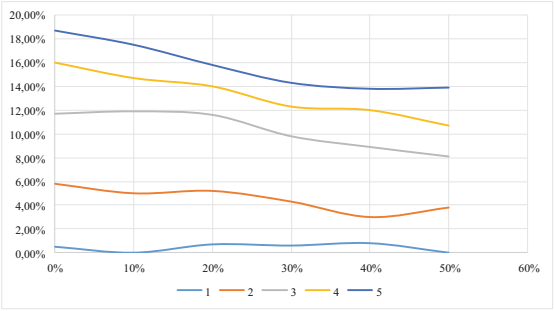


Fig. 4. Increasing the time on the driver's awareness (Source: authors).

When assessing traffic flow, it is also important to consider the use of different routes. Simulation data allows us to assess how much the use of routes changes and how the

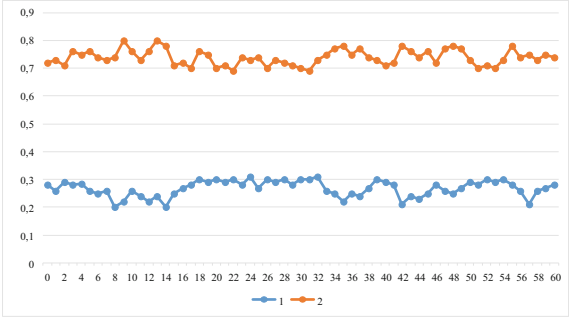


Fig. 5. Informed route range usage (1), not informed route range (2) (Source: authors).

traffic intensity on two parallel roads changes. Time fluctuations in traffic and constant changes in the traffic mode along the route directly affect the travel time of vehicles. When a driver chooses an informed route, the range of travel time fluctuations decreases from 20% to 12%, which allows a more uniform use of road sections. In order to avoid traffic jams due to speed limits, more vehicles chose a longer route, naturally mainly informed drivers.

5 Conclusion

The average travel time is of primary importance for determining the overall traffic quality, taking into account the ratio of route selection methods. The relative effectiveness of different route selection methods can influence drivers' attitudes and their choice of the method. This change in behavior subsequently invariably affects the overall traffic quality. Optimal traffic distribution is primarily ensured by drivers who have information on the congestion status of the transport network. The reduction in average travel time may not be noticeable compared to static route selection with low traffic on a road network without speed limits, but they gain increasing advantages as traffic intensity increases. The reduction in travel time, depending on traffic intensity, is 8–15%. The benefits of route selection based on constant driver information encourage drivers to use driver assistance devices. In addition to safety, the most important factors to avoid are travel time and congestion. More and more drivers are using mobile apps that provide them with real-time traffic information. However, the simulation results show that it is not necessary to inform all drivers, so the traffic flow is almost optimal in terms of average travel time within the network.

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Digital Personalization of Bank Services as a Tool for Managing Consumer Behavior

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Abstract. In the context of digitalization of socio-economic systems, personalization of banking services is considered as one of main factors in increasing consumer loyalty and engagement. This work is aimed to research digital personalization in the banking sector with a focus on its role in managing consumer behavior. The purpose of this contribution is to show how digital personalization of banking services can be an effective tool for managing consumer behavior, as well as to outline challenges and limitations that arise when implementing hyper-personalization in banking. The authors analyze the existing practices of the world's leading banks and consider the trends in the development of personalized services and loyalty programs. On the basis of statistical data and experience of digital technologies implementation in the banking industry, it is shown how personalization contributes to the growth of transactions, increase of average check and strengthening of competitive positions. The authors also discuss challenges and limitations associated with the implementation of hyper-personalization, including issues of security, privacy, regulatory compliance and the need for significant investment in infrastructure and human resources.

Keywords: Bank Services · Consumer Behavior · Digital Personalization · Digital Platforms · Hyper-Personalization · Security Compliance · Technological Innovations

1 Introduction

The digitalization of socio-economic systems is radically changing a paradigm of interaction between organizations and their customers. The banking sector is one of the most rapidly transforming segments in this environment: strong competition and high consumer expectations in terms of convenience and speed of service dictate the need for continuous improvement of digital services. Personalization becomes one of the central strategies for retaining and attracting customers, as it allows taking into account the individual characteristics, needs and preferences of each user.

Personalization of banking services is understood as a process of adapting financial products, services and interaction models based on the analysis of customers' behavioral and demographic characteristics. Personalization is based on big data processing,

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artificial intelligence and machine learning. Due to these tools, banks are able to offer customers relevant solutions in real time, timely identify new requests and needs [1].

Consumer behavior management is a complex process, including the development of such marketing and technological tools that help to influence decision-making, stimulate repeat purchases and build sustainable loyalty [2]. Personalization is becoming an important mechanism of consumer behavior management, as an individual approach increases trust and satisfaction of the client's cooperation with a financial institution [3]. The personalization of consumer behavior is becoming an important mechanism of consumer behavior management.

2 Methodology

The methodological basis of the research was the analysis of secondary data, content analysis of scientific literature and publications, comparative analysis of practical cases, synthesis of statistical data, quantitative and qualitative methods. First, we analyzed reports by Capco, McKinsey consulting companies, data from the Bank of Russia and other organizations on digital transformation and personalization in banking. Then, as part of the content analysis, articles from international scientific journals were investigated. The purpose of this analysis was to identify current trends and results of the implementation of personalized services. For comparative analysis, the cases of the largest global banks (Bank of America, HSBC, BBVA, Ping An Bank, etc.) and Russian banks (Sberbank, VTB, Alfa-Bank, Tinkoff, MKB) were studied in order to compare the effectiveness of personalization in different geographical and social conditions.

To identify the overall effect of personalization, quantitative indicators such as transaction volumes, increased sales of banking products, increased commission income, customer engagement, etc. were systematized. The qualitative part of the research was represented by a series of interviews with digital services experts from three banks (Sberbank, VTB, Kapital Bank). The quantitative part of the research includes a focus group survey involving 235 customers of these banks of different age categories. The purpose of this part of the study was to identify barriers to the introduction of digital personalization and determine factors influencing the choice of a particular banking product by customers.

3 Literature Review

The current academic debate on digital personalization of banking services and consumer behavior management mechanisms is interdisciplinary and includes research on both behavioral and technological aspects. A number of papers consider the importance of game mechanics personalized to the consumers' characteristics to improve the efficiency of banking services. For example, E. Nasirzadeh and M. Fathian [4] have shown that taking into account the demographic and personality traits of users helps to fine-tune gamification elements, increasing customer engagement and encouraging them to actively interact with the bank. This idea echoes the approaches of behavioral economics, according to which precise targeting can increase motivation and improve user experience.

At the same time, the focus of research is increasingly shifting from the initial introduction to technological solutions to consumer behavior, especially their willingness to recommend banking services to others. For example, it was examined how perceptions of resources, cybersecurity, and 'technological trustworthiness' influence the willingness of existing users to promote a bank's mobile apps [5]. The findings suggest that building trust in the digital environment and lowering barriers associated with online threats directly increase customers' willingness to recommend services to others, thereby enhancing word of mouth in digital channels.

An important contribution to the understanding of personalized pricing is made by [6], where the scientists examine the behavioral model and mechanism of customer data sharing between firms. It is found that prior consent to data sharing can mitigate competitive rivalry and improve the 'match accuracy' of offers. From the perspective of consumer behavior management, this study highlights the potential of personalized pricing strategies while pointing out risks of reduced competition, which may affect consumer welfare in the long run.

At the same time, the role of internal factors related to the management of digital transformation in banks is increasing. In particular, a study by [7] draws attention to human capital and the quality of interaction between IT and non-IT specialists.[9] The researchers stress that successful digitalization, including the introduction of personalized services, depends largely on the level of communication and common goals of different bank departments. Lack of mutual understanding generates internal conflicts and slows down innovation, while harmonized work increases the efficiency. In terms of long-term socio-economic effects, the personalization of banking products is also closely linked to issues of digital financial literacy. The development of financial and technological innovation contributes to the reduction of the digital financial divide, but the effect remains uneven in the post-pandemic period [8]. Banks that actively adopt digital channels can develop education and outreach initiatives in parallel, thereby contributing to a more even and sustainable increase in customer engagement.

The aspect of trust in AI systems designed to generate personalized recommendations is explored by [9] using medical services as an example. The transfer of the findings of this study to the banking sector points to the need to con-sider the initial level of trust and individual user characteristics when developing AI platforms, which directly affects customer decision-making. After the introduction of open APIs and integration with non-banking services, there is an increased focus on customer evaluation of usability and interaction quality [10]. Even with full-fledged personalization functionality, negative customer perceptions of navigation or insufficiently flexible interface customization can degrade the overall experience of open banking products and reduce the likelihood of their further adoption.

Examining innovative banking business models in the context of global digitalization, the researchers highlighting three main drivers (globalization, crisis and changing customer expectations) [11]. The scientists emphasize that it is digital technologies and personalization tools that are becoming a catalyst for reorganizing the banking environment: from rapid customer empowerment (stretching) and streamlining to complex synergies affecting the structure of the bank's interaction with partners and ecosystems. Researchers analyze consumer behavior in omnichannel environments, indicating that

personalization can both stimulate and constrain the shift to digital services, depending on the perception of the quality of goods and services, the availability of alternatives and the specificity of purchases [12]. Scientists note a correlation between personalized banking services and the increasing use of e-cards to pay tolls, indicating the broader effects of personalization in related industries [13]. K. Desiraju, A.N. Mishra, P. Sengupta [10] examine prospects of open banking and conclude that personalization is key to the successful adoption of such platforms, facilitating better targeting and increased engagement. Researchers also consider the role of AI and generative models in creating 'smart platforms' focused on the circular economy and individual user demands [14]. Academic research confirms that personalization has a multifaceted effect on customer satisfaction, transaction activity and retention, but also increases the risks associated with handling big data and security compliance.

4 Results

This section is the central part of the study, which presents statistical data obtained from the analysis of the customer base of three commercial banks (Sberbank, VTB, Kapital Bank), as well as the results of surveys and econometric modeling.

As a result of cluster analysis (k-means method), four main customer segments were identified:

1. 'Active digital users' (23% of the sample): customers who regularly make transactions via the mobile app (15 transactions per month on average), have a high level of income and use additional digital services (e.g. QR code payment, online currency exchange) more often than others.
2. 'Traditionalists' (27%): customers who prefer offline service channels, make no more than 3–4 transactions per month through remote channels and tend to use more conservative banking products (deposits, savings accounts).
3. 'Youth category' (20%): customers aged 18 to 25, actively using debit and virtual cards, showing interest in services with cashback, loyalty programs and discounts from partners.
4. 'Mixed segment' (30%): customers with irregular activity in mobile applications who combine online and offline channels in varying amounts, without demonstrating distinct preferences.

The level of personalization was measured by calculating a personalization index that included the following components: the number of relevant (from the model's point of view) offers per quarter, the percentage of offers converted into actual transactions (loan, deposit, account opening), and the share of unique product recommendations (as opposed to mass mailings). The average value of the index for the sample was 0.62, with a maximum of 1.0. The analysis showed that in the 'active digital users' group the AI reached 0.78, while in the 'traditionalists' category it did not exceed 0.45.

Among customers who received personalized recommendations on credit products (mortgages, consumer loans, credit cards) via a mobile app or online cabinet, the rate of applying for the relevant products increased by 28% compared to the control group, where recommendations were of a general nature. Analysis of purchase volumes (both

online and offline, based on card transaction data) showed that customers who regularly received personalized offers (cashback, increased bonuses, partner discounts) spent 12% more money per month than customers without personalized offers. The average number of transactions per month among customers who regularly received personalized reminders and offers was 9.6, compared to 7.1 in the control group. The most notable growth was in the Youth category segment (about + 38%).

The churn rate in the group of customers with a high level of personalization (AI > 0.7) was 3.2% over the year, while among customers with a low level of personalization (AI < 0.5) this figure reached 7.8%. Such a difference indicates that personalized digital offers have a meaningful impact on long-term customer relationships. In a survey of 235 banking customers, 68% of respondents said they value personalized recommendations as they help save time and money, as well as receive more relevant product information. Some 22% raised concerns about data privacy issues and felt that the bank receives an excessive amount of information about the user. Notably, this share reached 35% in the 45 + age category.

More than 70% of respondents were in favor of integrating all service channels (mobile app, website, contact center) into a single personalized ecosystem to avoid duplicating information and simplify the interaction process. 15% of survey participants admitted that they do not pay attention to personal 'offers' in the mobile app, assuming their mass nature. These customers tend to prefer more traditional communication channels and do not frequently update the banking app.

Based on interviews with experts from three banks, the key success factors for implementing digital personalization were identified:

- availability of an advanced analytical platform (Big Data, ML algorithms);
- high professional level of working with data at the level of management and rank-and-file employees;
- clear delineation of responsibility for confidentiality and protection of personal data;
- customer readiness to interact through digital channels (availability of a smartphone, internet access, trust in online transactions).

Banks that actively implement personalization (forming individual offers for at least 50% of the customer base on a monthly basis) show on average 15–20% higher retail loan portfolio growth rates and 10% higher customer retention rates.

The regression model, in which the dependent variable was the volume of monthly card transactions (in rubles), and the independent variables were the individualization index, the client's income and age, and the frequency of mobile application use, showed statistical significance of the coefficient for the individualization index ($p < 0.05$). When the individualization index increased by 0.1, the average transaction volume increased by 5.3% (all other things being equal). Cluster analysis confirmed that the most effective personalization is achieved by segmenting customers based not only on demographic but also on behavioral patterns, where the main segmentation criterion – intensity of use of digital channels – brought the bank 18% more revenue in aggregate compared to traditional age-based segmentation.

The results of the study confirm that a well-built digital personalization strategy can have a significant impact on shaping and adjusting customers' consumer behavior. Loyalty metrics are improving, churn is decreasing, and the number of transactions

and loan portfolio volume are growing. At the same time, the limitations of the study are largely determined by the fact that the analysis was conducted on data from three specific banks, which may reduce the universality of the findings. In addition, the models used in the work do not allow taking into account the whole range of determinants of consumer behavior and do not cover the impact of the macroeconomic environment and the peculiarities of competitive dynamics in full. Therefore, various statistical materials and scientific data were additionally studied. Based on the extensive materials devoted to the impact of digital personalization on consumer behavior and bank efficiency, a number of regularities were identified:

1. Activation of demand for personalized banking services.

According to Capco research [15], more than 70% of banking customers consider personalization as one of the main factors when choosing a financial institution. At the same time, only 14% of banks actively implement a full-fledged personalized service model. The gap between customers' expectations and banks' offers remains significant. McKinsey analysts [16] show that companies that succeed in personalization, on average, receive 40% more profit, and their customers are 78% more likely to make repeat purchases and recommend the brand to friends. These figures show that the demand for personalization is extremely high and provides significant commercial benefits.

2. Increase in total financial performance and operational efficiency.

Investment in personalization and AI adoption is showing a high return on investment. According to [17], the largest Russian banks collectively invest about $1 billion annually in the development of AI-based solutions, generating about $3 billion in profit. This reflects not only the high margin nature of these projects, but also the importance of personalization for customer retention in a competitive environment. In China, Ping An Bank reported a 20% increase in revenue from AI-powered personalized investment offers, while online bank WeBank increased user transaction activity by 35% after introducing personalized offers. The global banking automation market (including personalization tools) will grow from $4.41 billion in 2023 to $13.39 billion by 2030. The banking sector is expected to hold 33.2% of the global robotic process automation (RPA) market share by 2027 [18].

3. Multi-level customer segmentation and application of AI technologies.

Banks are actively adopting AI technologies to segment their customer base based on behavioral, demographic and financial parameters. For example, HSBC analyses transactions and life events (birth of a child, purchase of real estate) to tailor credit and insurance programs to the needs of specific groups. Bank of America has introduced a virtual assistant Erica, which forms personalized recommendations based on the analysis of expenses, transactions and customer habits [19]. If the user frequently makes payments related to travelling, Erica will offer a card with bonuses for airline tickets, and if the balance is low, the assistant reminds about available credit lines or opportunities to save money. Similar systems are used by Spain's BBVA, the US Capital One (chatbot Eno) and other leading global financial institutions.

In Russia, Sberbank and VTB are actively investing in big data and machine learning technologies. Sberbank has implemented more than 100 artificial intelligence models

for cybersecurity management and developed its own neural networks GigaChat and Kandinsky, whose combined audience has already reached 18 million people [20]. Due to the system integration of AI into all business processes, Sberbank was able to earn an additional RUB 350 billion in 2023, and another RUB 400-450 billion in 2024.

4. Individualization of loyalty programs and their impact on consumer behavior.

From 2019 to 2023, the share of banking programs with direct cashback decreased from 57% to 35%, while subscription models and flexible packages expanded, allowing customers to choose the most relevant reward categories for them [21]. Sberbank modernized the SberSpasibo program, allowing customers to choose cashback categories themselves and receive rewards in rubles, which increased the convenience and transparency of the service. VTB updated Multibonus, adding instant accrual of bonuses, which increased the emotional involvement of customers. Alfa-Bank introduced gamification elements (for example, the Super Cashback Drum), which led to an increase in card transactions and an increase in the average check. In six months, MKB managed to increase the average monthly turnover of POS transactions by 72%, offering clients the MKB Perspective program, which combines savings and transaction products with cashback [22].

5. Hyper-personalized approach and ecosystem strategies of interaction. Leading banks are moving from classic personalization to hyper-personalization, which takes into account not only transactional activity, but also behavior in digital channels, geolocation, socio-demographic aspects and even a forecast of life events. The bank offers the client a product «here and now», which is as relevant as possible to his current needs. At the same time, ecosystems play an increasing role, within which the client can receive not only financial, but also non-financial services: payment for goods, subscriptions to services, travel, entertainment, and so on. Tinkoff is implementing big data models to analyze client preferences in different segments and form individual offers within a single mobile application. Singapore's DBS is creating an ecosystem for entrepreneurs, offering business tools segmented for the specific needs of companies.
6. Risks and limitations in the implementation of digital personalization in the banking sector. Despite the impressive figures, the global implementation of personalization is slowed down by a number of factors. Firstly, significant financial investments are required in the development of AI solutions and human resources, which creates a technological inequality between large and small banks. Secondly, the shortage of personnel in the field of data analysis and machine learning makes it difficult to scale projects. Thirdly, there is a risk of data leaks and privacy breaches, which requires compliance with strict regulatory standards and can lead to increased mistrust on the part of customers. Finally, an excessive number of individual offers can cause so-called «digital fatigue», when the consumer begins to ignore notifications and newsletters.

The presented results indicate the high effectiveness of digital personalization for managing consumer behavior, but at the same time emphasize the need for a systematic, comprehensive approach to its implementation, taking into account technological, regulatory and psychological aspects.

5 Conclusion

The results of the study indicate that the introduction of personalized digital tools directly affects the improvement of the bank's economic performance. The efficiency factor is a comprehensive approach to personalization, which involves the simultaneous use of several components: systematic collection and analysis of transactional and behavioral data in real time, the use of flexible ML models and algorithms to generate the most relevant offers, strict adherence to data protection principles taking into account regulatory requirements and the need to maintain a high level of customer trust, as well as a focus not only on quantitative metrics, but also on the subjective aspects of consumer perception.

Along with this, the development and implementation of comprehensive omnichannel platforms that guarantee customers access to contextually relevant offers at any point of interaction, as well as ensuring ethical and legal compliance with the methods of collecting and processing personal data, are of particular importance. Promising areas for further research include the analysis of behavioral factors of resistance to personalization (digital fatigue, distrust of data processing), the development of new hyper-personalization tools (taking into account not only transaction history, but also contextual analytics), and an assessment of the impact of the ecosystem approach on the formation of loyalty. Digital personalization of banking services is a promising tool for managing consumer behavior, with a high potential for influencing financial efficiency, and if the principles of transparency and security are observed, it strengthens long-term trusting relationships between the bank and the client.

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Strategy for Sustainable Competitive Development in the Context of Economic and Geopolitical Changes

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Abstract. This work presents a perspective on the strategy of sustainable competitive development of enterprises ensuring not only a balance of economic, social, and environmental factors but also a stable competitive position in the market through continuous implementation and adoption of modern technologies, high innovative activity, digitalization, and adaptation of business processes to changes in the external environment. To assess the effectiveness of this strategy, a balanced system of indicators is proposed, covering financial, environmental, social, and innovation aspects and the enterprise's adaptability to market conditions. The indicators are structured into three management levels: strategic, tactical, and operational. The strategic level analyzes indicators characterizing long-term enterprise development, the tactical level evaluates intermediate results in achieving company goals and specific changes in operational activities, the operational level assesses and analyzes indicators directly related to specific business processes. The proposed model for evaluating a sustainable competitive development strategy is universal and applicable across different industries.

Keywords: Balanced Scorecard System · Enterprise Adaptability · Innovation · Sustainable Competitive Development

1 Introduction

In modern conditions, the development and implementation of sustainable competitive development strategies are of particular relevance. Their content is not limited to traditional tools for ensuring a company's financial stability but also considers social and environmental aspects of its activities while focusing on technological advancement. Innovations are the key to long-term effective business development today. The concept of sustainable development was introduced in 1987 in the report of the World Commission on Environment and Development, which defines it as «development that meets the needs of the present without compromising the ability of future generations to meet their own needs» [1]. From a business perspective, this means the ability of an organization to achieve its long-term goals without depleting all available resources or harming the environment and society. Competitive development, by definition, includes processes

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and strategies aimed at achieving leading positions in a particular industry or market. A company's competitiveness depends on many factors. To ensure competitive advantage, an organization should not only strive to improve its market position but also consider long-term trends in economic and societal development [2]. Within the framework of strategic leadership theory, the key aspects of competitive development are the need for company management to focus on innovative products and markets, on operational efficiency and resource management [3].

2 Methodology

In the framework of this research, methods of analytical and systems analysis, as well as comparative and structural analysis, were used. The analytical method was applied to process and interpret existing theoretical and empirical data on sustainable competitive development strategies. The systems approach made it possible to identify key strategic aspects, such as financial, environmental, social, innovative, and adaptive components. To develop a balanced system of indicators, the hierarchical structuring method was used, allowing for the classification of indicators by levels (strategic, tactical, operational).

3 Results

For a clear understanding of the essence of a sustainable competitive development strategy, it is necessary to clarify several key concepts. Firstly, it is worth noting that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. A review of scientific literature shows that sustainable development is primarily considered through the integration of economic, environmental, and social factors. However, in recent years, sustainable enterprise development is considered as a more multifaceted process, incorporating components such as digitalization, innovative activity, and the implementation of ESG principles [4]. The author of this work agrees with this perspective. Secondly, competitive development is a process aimed at enhancing a company's market competitiveness by considering factors such as innovations, operational efficiency, and the ability to adapt to external changes [1].

Sustainable competitive development refers to the process of enterprise growth in the long term, ensuring not only a balance of economic, social, and environmental factors but also the formation of a stable competitive position in the market through continuous implementation and adoption of modern technologies, high innovative activity, digitalization, and adaptation of business processes to changes in the external environment. The distinction between this concept and sustainable development lies in:

1. The focus on a company's market competitiveness, active management, and the development of competitive advantages that enable not only the stability of financial and economic indicators but also the ability to outperform industry competitors.
2. The innovation-oriented development vector: whereas in sustainable development, innovation is considered one of many factors, sustainable competitive development places innovation at the core of a company's strategy, viewing it as the key mechanism for achieving market leadership.

Ensuring sustainable competitive development requires consideration of several key components, which are presented in Table 1.

Table 1. Key components of sustainable competitive development of an enterprise.

Component	Description	Example
Innovation and Technological Leadership	Continuous regular renewal (modernization) of products and services, use of new technologies to improve quality and reduce enterprise costs	Automation and digitalization of business processes
Environmental Sustainability	Focus on reducing negative environmental impact, energy conservation, use of renewable energy sources	Implementation of a carbon footprint management system, transition to environmentally friendly technologies
Social Responsibility	Interaction with society and ensuring employee well-being, support of social infrastructure, compliance with human rights and labor standards	Investments in improving working conditions and employees' quality of life
Adaptability and Flexibility	The ability of a company to quickly respond to changes in the external environment, optimize production lines, and shift production to different product types	Rapid adaptation of business processes, the ability to flexibly change production volumes, transition to remote work, online sales, etc
Corporate Governance	Effective management structure, business processes, clear development goals, proper delegation of authority, and distribution of responsibilities and risks	Implementation of corporate governance principles and process management tools

Source: author

To assess the effectiveness of a sustainable competitive development strategy, the proposed balanced scorecard system can be used, which takes into account both financial and non-financial aspects of enterprise activity (Table 2).

The balanced scorecard system enables a comprehensive assessment of a company's effectiveness from the perspective of sustainable development. At the strategic level, the focus is on long-term business development prospects, evaluating overall financial stability, investment efficiency, R&D expenses, compliance with international CO_2 emission

Table 2. Balanced scorecard system for assessing the effectiveness of a sustainable competitive development strategy.

Level	Aspect	Indicator	Calculation Formula
Strategic	Financial Indicators	Return on Investment (ROI)	(Net Profit / Total Investments) × 100
		Financial Stability Ratio	(Equity / Total Assets) × 100
	Environmental Indicators	CO_2 Emissions per Unit of Production	Total CO_2 Emissions / Production Volume
	Social Indicators	Employee Satisfaction Index	($\sum$ Employee Satisfaction Ratings) / n
	Innovation Indicators	Number of New Products or Technologies	Count of new products or technologies
		R&D Expenditure Share	(R&D Expenses / Total Expenses) × 100
	Adaptability and Flexibility	Business Flexibility Ratio	(Number of Successful Adaptations / Total Changes)
Tactical	Financial Indicators	Operating Margin	(Operating Profit / Revenue) × 100
		Debt Load	(Debt / Equity) × 100
	Environmental Indicators	Energy Efficiency	(Energy Consumption / Production Volume)
		Percentage of Recycled Materials Used	(Recycled Materials Used / Total Materials) × 100
	Social Indicators	Corporate Social Responsibility Programs	(Budget for Social Programs / Total Company Budget)
	Innovation Indicators	Level of New Technology Adoption	(Number of Implemented Technologies / Total Projects)
		Patent Activity	(Number of Patents / Total Innovations) × 100
	Adaptability and Flexibility	Changes in Business Processes	(Number of Business Process Changes / Total Changes)
Operational	Financial Indicators	Asset Turnover	(Revenue / Average Asset Value)
		Liquidity Ratio	(Current Assets / Short-Term Liabilities)

(*continued*)

Table 2. (*continued*)

Level	Aspect	Indicator	Calculation Formula
	Environmental Indicators	Use of Renewable Energy Sources	(Renewable Energy Use / Total Energy Consumption) × 100
	Social Indicators	Employee Training and Development Level	(Training Hours / Number of Employees)
	Innovation Indicators	Time to Market for a New Product	(Days from Idea to Implementation / Total Products)
		Innovation Effectiveness	(Revenue from New Products / Total Revenue) × 100
	Adaptability and Flexibility	Market Response Time	(Time to Adapt to Market Demand Changes / Total Changes)

Source: author

standards, and employee satisfaction. At the tactical level, intermediate results in achieving corporate goals and specific operational changes are assessed. At the operational level, indicators directly related to business processes are analyzed [5].

4 Discussion

The proposed model for evaluating a sustainable competitive development strategy is universal and applicable across various industries. However, it should be noted that the actual effectiveness of the strategy depends on a variety of external factors [6]. McKinsey study [7] shows that companies investing in long-term development strategies including digital transformation and the implementation of sustainability principles: generate higher profits, achieve greater returns and market capitalization compared to competitors focused on short-term results. Moreover, these strategies yield not only economic benefits but also other positive outcomes. Digitalization helps address workforce shortages, optimize internal business processes, and improve the quality of operations, products, and services. Adhering to sustainability principles enables a company to remain competitive in the global market regardless of sanctions policies and to efficiently reorient its export strategies.

5 Conclusion

Today, a sustainable competitive development strategy involves not only traditional elements of market competition but also environmental, social aspects of the company's operations, and the degree of adaptability to external factors. To assess the effectiveness of a company's sustainable competitive development strategy, it is advisable to

use a custom-designed balanced scorecard system. The proposed set of indicators integrates financial, environmental, social, and innovation-related aspects into a unified multi-level model for evaluating sustainable competitive development. Unlike traditional approaches, this system considers business adaptability as a key factor for successful development under conditions of external instability. The presented balanced scorecard system allows not only for diagnosing the current state of the company but also for forecasting its long-term sustainability. All indicators are structured across three levels of management: strategic, tactical, and operational. We believe that this system of indicators can be valuable for company executives and strategic development managers seeking a comprehensive assessment of business sustainability.

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Applying a Bionic Approach (with AI Integration) to Talent Management in Project Implementation

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Abstract. This work presents possibilities of applying the bionic approach in working with personnel. Theoretical aspects of the possibility of applying the bionic approach are based on the ability to achieve a synergistic effect from the use of AI and talent development in project activities, which initiated the research of domestic and foreign scientists, were confirmed in this study. The authors analyzed studies on the bionic approach in various scientific fields. A survey was conducted on the relevance of the bionic approach in project activities and talent management of the organization. The authors propose own definition of the bionic approach in personnel management with an emphasis on talent development. Advantages and risks of applying the bionic approach in working with personnel are considered. The authors analyze areas for improving management and personnel development taking into account the bionic approach. The bionic approach contributes to the creation of diverse teams, including employees with different skills, experience and abilities. Bionics is not only a technological trend, but also a philosophy that changes the way companies think. Bionic organizations strive for innovations, diversity, and flexibility, which makes them successful in modern business. The contribution presents the main advantages of implementing AI in talent management.

Keywords: Artificial Intelligence · Bionic Approach · Neural Networks · Talent Management

1 Introduction

The relevance of integrating the bionic approach into educational activities in the formation of project competencies is determined by the fact that it creates opportunities to successfully combine personnel and technological competencies, obtaining ideally focused results at the output, allows increasing the productivity of operational activities and increasing the implementation of innovations and managing talents.

The bionic approach is one of the most modern and promising areas of research and is increasingly used in a variety of scientific fields. Of course, the logic of applying the bionic approach is obvious in the field of natural and technical sciences, such as biophysics, biochemistry and bioinformatics. However, recently there have been results

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of interdisciplinary research based on this approach in the field of social sciences. There are results of studies on the application of this approach in management. It has become possible to apply this approach in pedagogical research in the development of innovative educational technologies.

2 Methodology

In our study, we will focus on considering the possibilities of using neural networks in order to optimize the costs of routine work and focus on retaining and developing talents, unique competencies of personnel to implement the strategic tasks of organizations to ensure sustainable development. Currently, almost every company creates projects and forms project teams. But it is not so easy to form an effective project team in which each participant will be at the same level of development. An important factor in the formation of a team is the level of development of all team members, otherwise the productivity of the entire team will fall, and this can also affect the quality of decisions made.

3 Literature Review

A.P. Karpenko and I.N. Sinitsyn [1] attempted not only to analyze the current state of bionics and the prospects for its development, but also to consider trends in its application in the social and technological spheres in Russia and abroad. From the point of view of updating the bionic approach to smart city management, a study was conducted by A.M. Pishchik [3]. In our opinion, a breakthrough was the study of BCG consultants, the results of which presented various aspects of the interaction of personnel and the capabilities of technology [4]. Recently, so-called bionic companies have begun to appear. Today this term is used by companies such as PwC and BCG, describing the interaction of people and technology in the form of a dialogue, and not according to the scheme of people using technology. Companies in different industries use artificial intelligence and machine learning to optimize internal processes and build relationships with clients. The idea of combining machines and people is also enshrined in the new superteam concept developed by the Deloitte team [5]. Researchers emphasize that the bionic approach is aimed at creating sustainable and effective teaching methods, similar to how nature evolves and adapts [6]. In turn, scientists note that the bionic approach is an innovative methodology that uses analogies with biological systems to develop personnel skills. It allows transferring successful strategies from nature to the field of personnel management [7]. Integrating and developing approaches to defining the bionic approach in labor economics and personnel management, O.L. Chulanova, E.V. Konovalova and E.V. Kupriyanova [8] defined the bionic approach in project activities. Under the bionic approach they mean the unification of human and technological capabilities, modern educational technologies to achieve a synergistic effect, optimization of costs for many processes of project activities, a «nature-like» approach to the formation and development of talents in the process of project implementation.

4 Results

In the context of the «new normal», personnel management is of particular importance. By taking into account the individual characteristics of employees and effectively using their strengths, companies can succeed in a competitive environment. Therefore, the bionic approach to personnel management is becoming increasingly popular. This is a more flexible option, focused on the specific skills of employees and their development prospects. With this approach, employees are much freer to develop their talents [10], and the organization receives versatile and easily adaptable personnel [11]. The authors conducted a survey on the relevance of the bionic approach to managing the organization's talents. To the question «Are you familiar with the concepts of «Bionics», «Bionic approach», «Bionic company»?, 50% of respondents answered that they did not know these concepts and could not name their definitions. 26% are familiar with some of them, 20% are not familiar, but are interested, and 4% knew all the definitions. The following results were obtained when asked about the most important advantage of using the bionic approach: 47% of respondents believed that the most important advantage of the bionic approach is the development of innovations, 25% believe that employee efficiency will improve, 19% are sure that with the bionic approach the company will come to a personalized approach to management and 9% think that communication will improve.

When answering the question about the possibility of using the bionic approach by industries, the following results were obtained: 40% of respondents believed that the most suitable industry for using the bionic approach is IT, 30% of respondents chose medicine, 10% each chose education and finance, 6% of respondents believed that another industry (not presented) is most suitable, and 2% of respondents each chose the aviation and agricultural industries. Our study confirms the fact that the topic of the bionic approach is unknown in wide circles, this direction is just gaining popularity. Respondents most often encountered the concept of «bionics» in the medical field, and therefore it was difficult for them to quickly switch to the topic of management. Therefore, it becomes clear that this technology can not only be applied in various fields, but must be used and developed.

The modern era, characterized by rapid technological advances, is witnessing a growing interest in bionics in the corporate world. Bionics, a field at the intersection of biology and technology, facilitates the creation of innovative solutions inspired by the natural world. This integration goes beyond traditional approaches, allowing companies to develop products and services with enhanced functionality. An example of this trend is bionic companies such as Yandex, Amazon, and Sberbank, which strategically incorporate bionic elements into their offerings. This integration increases customer appeal and creates a more attractive work environment for potential employees. Moreover, the interaction between people and technology within these organizations is moving beyond a one-way model of user dependence. Instead, a collaborative dialogue is emerging, marking a paradigm shift in the interaction between people and technology. The proliferation of artificial intelligence (AI) and machine learning is going beyond bionic integration. These technologies, along with augmented reality (AR) and virtual reality (VR), are actively shaping the future of corporate learning across industries. The

idea of converging human and machine intelligence is further embodied in a new concept pioneered by Deloitte called «super teams». This concept stands in stark contrast to the common dystopian narratives of AI-driven workforce displacement. According to Deloitte research [5], leading organizations are actively taking a more granular approach by strategically integrating AI into existing teams. This collaborative model, called «super teams», promises to transform businesses. The core principle of «super teams» is to enable organizations to undergo a process of reinvention, facilitating the creation of new value propositions and enriching meaning in the workplace. Additionally, this structure empowers workers to undertake career change initiatives that enhance their value proposition to the organization and strengthen their long-term employability.

A paradigm shift is needed for organizations that have a narrow view of AI as a simple automation tool to cut costs [12]. The first step towards developing productive human-machine collaboration is to strategically align AI initiatives with efforts to build more effective teams [13]. Bionic companies understand that employee diversity is a key success factor. They actively engage people with different skills and experiences to build strong teams. Bionic organizations value the flexibility and adaptability of employees, which helps them respond quickly to change. Thus, the bionic approach to talent management is an innovative and promising method that brings significant benefits to companies. The bionic approach promotes the creation of diverse teams, including employees with different skills, experiences, and abilities. Bionics is not only a technology trend, but also a philosophy that changes the way companies think.

The implementation of AI has become a game changer in the world of talent management. It is changing the way we recruit, develop, and retain talented employees. AI is able to analyze huge amounts of data and identify patterns. As a result, AI can help companies make more informed and effective decisions [14]. Some of the key benefits of implementing AI in talent management include: improved decision-making efficiency, improved member experience, automation of time-consuming tasks and processes, discovery of patterns in data and insights, detection and reduction of unconscious biases. For example, technology such as AI chatbots, by automating tedious HR tasks, frees up recruiters' time to focus on what matters most: finding qualified candidates and building relationships with them. With AI-powered recruiting tools, employers are better positioned to find high-quality candidates quickly and efficiently. And for existing employees, AI can be a powerful engagement and development tool. Managers are using AI bots to optimize employee performance. Bots can provide real-time feedback and personalized coaching advice tailored to each employee's goals. Here's how AI is transforming talent management in three key areas: recruiting, performance management, and retention.

Finding the right person for a position can be incredibly labor-intensive. Often, inefficiencies and biases add to the complexity. Recruiters have to create and manage job postings, screen resumes, schedule interviews, and send follow-up emails. Each of these steps is time-consuming. Sometimes bottlenecks along the way can delay the recruiting and hiring process. As a result, it's likely that several promising candidates could be missed. Besides, companies typically don't have processes in place to match candidates with other positions beyond the one they first applied for. The result of this

confusion is wasted potential for candidates who want to get hired and for organizations that want their positions filled.

AI-powered recruitment management can help. Using AI bots to create more accurate job postings will help you reach the best potential candidates, thereby narrowing the search field from the very beginning of the hiring process. HR leaders should invest in candidate screening processes that limit human bias. AI-powered assessment tools help measure the true skill set. They reduce discriminatory behavior during the screening stage. Using AI will reduce recruiters' time by automatically switching potential candidates who may be a better fit elsewhere in the organization.

Attracting talent is one thing, but developing talent within an organization is equally challenging. To ensure that a company gets the best from its employees, management must offer them ongoing training and development. The pain point in performance management is keeping employees motivated and involved in growth opportunities. Sometimes employees need a little push to get started. Or managers may need their own training on how to coach employees. And organizations may struggle to figure out how to find or create quality content for growth.

AI can offer real solutions to these problems. AI-powered talent management tools provide employees with recommendations based on their performance and engagement metrics. Managers or HR leaders can use reporting tools to create micro-learning content. And bots facilitate real-time coaching for struggling employees. AI tools can suggest possible training materials from an internal knowledge base or intranet. So if an employee needs to brush up on a specific skill, a bot can suggest helpful tips or an article to read.

Retaining key employees is very difficult. Employee engagement plays a central role in retention. Employee engagement measures their commitment and connection to your organization. Engaged employees also outperform their peers as they tend to be more innovative, effective, and have higher customer retention rates. However, tracking employee engagement is not easy. Employers often have trouble getting accurate engagement metrics or understanding when employees are burning out and ready to leave. AI tools can help by accurately capturing employee engagement metrics in real time. And AI in talent management can create employee-focused solutions that promote employee well-being. By combining sentiment analysis, employee KPIs, and collaboration data, AI tools can paint a fairly accurate picture of employee engagement and well-being. The study concludes that in the context of rapidly evolving technologies and a dynamically changing business environment, modern organizations need to adapt their approaches to talent management. The bionic approach, based on the use of AI, offers a number of advantages that can improve the efficiency of personnel management and provide a competitive advantage.

5 Conclusion

In today's dynamic business environment, human capital is becoming a determining factor for the success of organizations. Investing in the professional development of employees goes beyond simple professional development, becoming a strategic tool for achieving long-term goals. Developing employee competencies through training programs, seminars and specialized courses ensures that they meet current market requirements

and facilitates the effective performance of tasks within their current positions. Increasing employee adaptability to the changing industry landscape by creating a culture of continuous learning and professional growth. Thus, investing in employee development demonstrates concern for them, increasing their engagement and job satisfaction, which, in turn, leads to the creation of a positive working atmosphere. Talent management of employees serves as an incentive for their long-term stay in the organization, reducing staff turnover and optimizing recruiting costs. Employee development programs act as a «magnet» for attracting valuable specialists in the competitive labor market, enhancing the company's image as an attractive employer. In our study, we propose actively using AI capabilities to solve these problems. Our earlier publications present the results of applying the bionic approach to the formation and development of project competencies of university graduates in all areas of training (using the example of the implementation of the project «Cross-cutting competencies of project activities» and «Office of initiative and project management» of Surgut State University). Our study of the application of the bionic approach to managing the organization's talents (including in the implementation of projects) is planned to be continued by developing a model and mechanism for applying the bionic approach to talent management in project activities. It is planned to analyze the possibility of using various neural network tools to optimize tasks during project implementation and the use of neural network tools for talent development.

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Problems of Innovative Development of Regional Restaurant Marketing

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Abstract. The study shows the Volga region restaurant services market, on the one hand, the openness of business to innovations, on the other hand, a lack of understanding of its own marketing potential and priority areas for improvement. The situation is aggravated by the proliferation of restaurant chains, as a result of which perfect competition in the market is turning into an oligopoly. The problems of marketing innovations are becoming particularly relevant for non-chain restaurants. The survey of industry experts allowed us to determine the importance of certain areas of marketing activity for their business and assess the marketing potential of the leading players in the regional restaurant services market. Interviews with representatives of the regional restaurant business confirmed that most of them associate innovations with the company?s software and technical equipment and digital marketing technologies. At the same time, organizational aspects and innovative marketing management remain overlooked, ensuring the effectiveness of activities not only at the micro level, but also in the macro environment. In this regard, it is proposed to structure innovative marketing solutions that meet the best international practices within the framework of individual components of an expanded marketing mix. The degree of dissemination of innovative marketing solutions is determined by the expediency and specifics of the restaurant service format.

Keywords: Competitiveness · Digitalization · Innovative Development · Marketing · Restaurant Business

1 Introduction

The innovative development of a territory involves the transformation of all the subjects interacting on it, the synergy of whose efforts supports the high economic and sociocultural status of the region. The uniqueness of the restaurant business as a branch of the economy is determined by its versatility: from catering and leisure activities to the formation of a favorable image and cultural background of a region, solving unemployment problems and supporting the local food industry. Territory marketing as a multidimensional concept involves not only the promotion of specific geographical spaces, but also the achievement of a high degree of consumer satisfaction with goods and services provided in these territories. The restaurant business is an integral element

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of providing and accompanying incoming tourist flows, it creates jobs and is a source of replenishment of the regional budget. Innovative development at the microlevel of one institution or an entire restaurant company forms the overall attractiveness of the region, its unique external and internal image.

2 Methodology

As part of the marketing approach to highlighting the identified problems, desk studies of the Russian restaurant services market have been carried out, as well as field studies of regional restaurant companies leading in the Volga Federal District of Russia. The expert assessment of the marketing potential of the leading market players was carried out using the Delphi method. It is impossible to determine the key directions of the restaurant business development in the region without taking into account the accumulated experience in this field. Accordingly, in the process of benchmarking, the best global practices of innovative development of the restaurant marketing system are summarized and systematized.

3 Literature Review

Given the universality of the definition of marketing given [1], in this study we will shift the focus of management to achieving a high degree of satisfaction with the results of the company?s activities by all interested parties. The works of modern scientists emphasize the importance of innovations in the restaurant business in general, without classifying them from the standpoint of the marketing complex. Researchers study «inspiring» innovative restaurant technologies in a developing economy, indicating their value in increasing the efficiency of the resources used [2]. Scientists draw attention to the problems of implementing intelligent technologies in the hospitality industry and suggest ways to overcome the corresponding barriers, including continuous training of the organization [3]. The main idea of this study, linking the innovative development of the territory and the modernization of the restaurant business in the context of the internal and external marketing environment, is also reflected in another work [4]. N.A. Voskolovich writes about the role of the transforming restaurant business in improving the level and quality of life of the region?s population in his research [5].

Interesting from the point of view of substantiating the degree of innovative transformations of the restaurant business is the study by [6] which traces the relationship between tradition, modernity and innovation in the small and medium business sector in the restaurant services market. Differentiation of the coverage of business processes by innovations allowed scientists to identify the features of a traditional, modern and hybrid restaurant for their more effective positioning and increased competitiveness.

Researchers argue that innovative business will not be effective enough without a creative component [7]. Innovations should also be in the marketing management system, since there is staff resistance to change and customer non-acceptance of new innovations. In the classical sense, as applied to the industry under study, the marketing approach to managing the development of its entities means using the entire toolkit of the restaurant marketing complex in order to ensure the maximum degree of consumer satisfaction

with the services of a catering establishment. At the same time, the effectiveness of the restaurant business should be considered more broadly. The satisfaction of all actors of this industry should be taken into account.

4 Results

The current state of the Volga regional market of restaurant business services is determined by the increasing or decreasing influence of many factors of the external macro environment. The key trigger that negatively affected all the business processes of restaurant companies was the sanctions restrictions. However, despite the long-term problems with logistics, the industry continues to grow, seeking non-standard, innovative solutions [8]. Business takes advantage of the opportunities created by such factors as the extremely active development of domestic tourism, the course towards import substitution both in the field of material resources and technical equipment, the changing culture of consumer eating behavior, the popularity of delivery services, the creation of conditions for family holidays, the training of professional personnel with the support of educational institutions [9]. Representatives of the regional restaurant business note the importance of innovative development, but their vision is limited to a greater extent by digital marketing tools (Fig. 1).

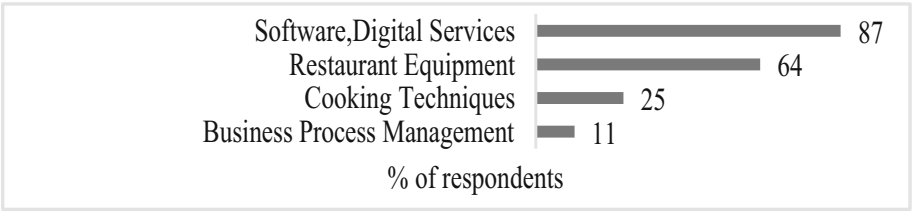


Fig. 1. The frequency of mentions of the subject of innovative transformation in the regional restaurant business (Source: author).

In an effort to «digitize» the restaurant business as much as possible, other areas of innovation application are overlooked. Equally important are the optimization of all types of resources for the organization of business processes, the organization of the restaurant space based on the principles of merchandising, and the correct handling of consumer reviews. Business meetings with industry representatives made it possible to determine the high importance in terms of competitive advantages not only the scale and regularity of marketing research, but also the quality, variety of dishes offered, the external attractiveness of the restaurant, the interior design and the quality of the design and functioning of the restaurant?s digital environment.

We selected large restaurant companies of the Volga region with similar characteristics in terms of elements of the restaurant marketing complex for purposes of comparability of objects for comparison of the degree of achievement of multi-level satisfaction, reflecting the quality of marketing management of the restaurant business (Fig. 2).

Research has identified two key players in the Volga region?s restaurant services market: Polayna Group and Milimon Family. They have demonstrated high performance

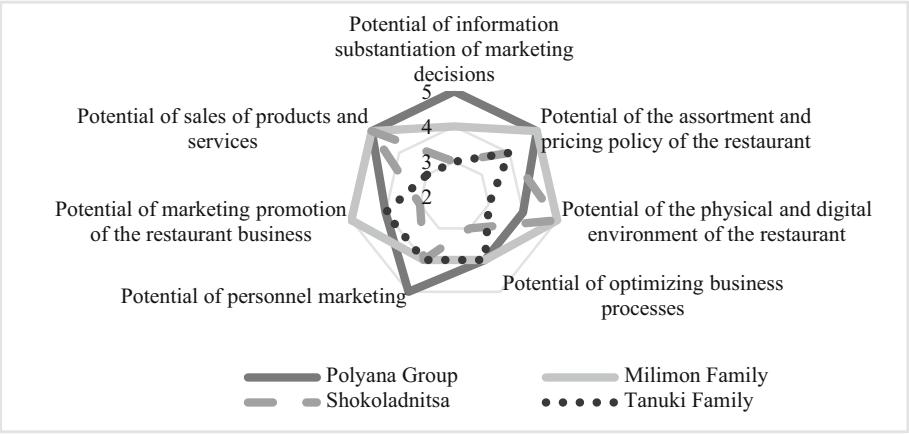


Fig. 2. Assessment of the marketing potential of regional restaurant companies (Source: author).

in almost all areas of marketing assessment. At the same time, it is noted that great efforts should be made to optimize business processes and organize restaurant merchandising. In our opinion, the most logical is the systematization of restaurant innovations in the context of the marketing mix (Table 1).

Table 1. Innovative restaurant marketing tools.

Element of the marketing mix	Innovative solutions
Product	Innovative recipes, technologies for cooking and preserving the quality of dishes, adapting the menu to market trends, food design, reconstruction of authentic recipes for the region
Price	Dynamic pricing, revenue management, contactless payment systems
Place	Mastering the segments of fast food, fast-casual, free flow/grab&go, wellness, retail outlets, tact&time technology
Promotion	Influencer marketing, food blogging, Wi-Fi marketing, CDR, AI, interactive menu
People	The concept of sustainable development, partnership programs with educational institutions
Process	The concept of lean manufacturing, Internet of things
Physical environment	Digital and traditional restaurant merchandising, VR, AR

Source: author.

The innovative solutions listed above are the result of the accumulation of information obtained from studying the best global practices in the restaurant business. Most of these recommendations are related to the use of digital technologies. It should be noted that in an effort to meet the trends of the digital economy, restaurants may lose their identity

and conceptuality. And this may become one of the problems of innovative development of territories, which should be unique in terms of increasing the tourist flow, and, with it, financial revenues to the regional budget.

5 Conclusion

Innovative development of regions is largely determined by the state and synergy of industries that make up the territory?s economy. Innovations in restaurant marketing ensure the attractiveness of the territory, and the subsequent influx of financial resources. Innovative restaurant marketing tools are determined by the total digitalization of the economy and the change in the paradigm of restaurant service, satisfying not only the need for high-quality food, but also forming an increased level of customer loyalty.

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Theoretical Foundations of National Characteristics of Entrepreneurial Structures in West Africa

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Abstract. This contribution investigates how national specificities shape entrepreneurship patterns in West Africa. The focus is on the relationship between regional formal frameworks such as laws, economic policies, and informal frameworks such as social networks and cultural traditions. According to comparative studies in Senegal, Ghana, Mali and Ivory Coast, there are differences in how institutional reforms and socio-cultural dynamics affect the business ecosystem. Realization of export potential of domestic enterprises, intensification of import of competitive goods of foreign production and provision on this basis of high quality of consumption of citizens and economic entities directly depend on the efficiency of organization and implementation of international cargo transportation. The basic principles and directions of interaction of logistics of international multimodal transportations with other basic types of logistics, such as production logistics, military logistics, logistics of organizations of social sphere, logistics of objects of innovative infrastructure of economy are researched in this work. The main possible contradictions between these areas of logistics activity are highlighted. The risks of activity of the companies of the sphere of international multimodal transportations are systematized, including three groups: risks of use of separate kinds of transport, modified for the sub-branch of international multimodal transportations, general risks of entrepreneurial activity (operational, financial, commercial, personnel, risk of digitalization), specific risks for the given sphere of the international contracts, including those connected with complexity of definition of an optimum route of transportation of cargoes through several countries.

Keywords: Entrepreneurial Ecosystem · Formal and Informal Institutions · Ghana · Institutional Modernization · Ivory Coast · Mali · Senegal · West Africa

1 Introduction

West Africa is a complex region for entrepreneurs, where social, economic and political dynamics have a profound impact on business creation and management. In this region, entrepreneurial structures are characterized by considerable institutional diversity due

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to the coexistence of formal institutions (economic and legal regulations) and informal institutions (social networks, traditional customs). This interaction between institutions and the behavior of local entrepreneurs raises crucial questions about the theoretical basis for taking national characteristics into account in structuring entrepreneurial activities [1].

West African countries, with their historical, cultural and institutional characteristics, provide a unique framework for analyzing how social rules and norms shape entrepreneurial practices. The theories of institutionalism, particularly those developed by D.C. North [2], provide a relevant tool for understanding these phenomena. In this study, we examine local institutional influences on entrepreneurship in West Africa, focusing on how national characteristics affect entrepreneurial structures. Through a literature review and a case study of representative countries, we will attempt to shed light on the impact of these characteristics on the growth and sustainability of enterprises.

2 Methodology

For this study, we used a predominantly qualitative methodology combining an in-depth literature review and a comparative analysis of available data on entrepreneurship in West Africa. The main objective was to understand how the institutional and social characteristics of a particular country affect entrepreneurial structures and firm performance. In addition to secondary data, qualitative interviews were conducted with economic development experts to gather information on entrepreneurial practices, institutional challenges and cultural factors affecting their success or failure. These interviews provided contextual information on local legislation, market access, and social networks.

3 Literature Review

Institutions play a crucial role in economic efficiency by establishing the rules that govern economic interaction. According to [2], institutions are divided into formal institutions, such as laws and economic policies, and informal institutions, which include social customs, cultural norms and support networks. These institutions directly influence the decisions of entrepreneurs, whether it is the way they obtain financing, the rules they must follow, or the networks they use to grow their business.

M. Dia [3] notes that entrepreneurial structures in West Africa are often hybrid, combining formal logics (derived from colonial institutions) and informal logics (family networks, community solidarity, etc.). The researcher believes that entrepreneurial structures in West Africa are shaped by a mixture of colonial legacies (formal) and local traditions (informal).

In West Africa, the coexistence of formal and informal institutions is a striking feature. In countries such as Senegal, Mali and Côte d'Ivoire, social networks and traditional practices (such as tontines and community mutual aid) play an important role in overcoming the weaknesses of formal institutions, which are often characterized by strong bureaucracies or unstable politics. These informal institutions, while effective in the local context, can also limit access to wider financial capital or international markets.

4 Results

As part of our research, we selected several West African countries for comparison, taking into account their specific institutional, social and economic characteristics. The countries chosen were Senegal, Ghana, Mali and Côte d'Ivoire, each of which has followed different trajectories in terms of economic reforms and institutional development.

- Senegal and Ghana have undertaken significant reforms in governance and business infrastructure, with marked improvements in ease of doing business indices;
- Mali and Côte d'Ivoire, while showing sustained economic growth, face political instability and institutional difficulties that hinder the emergence of a more structured private sector.

This comparative approach highlights differences in the impact of public policies and institutional reforms on the business sector. The results of this study show that the national characteristics of entrepreneurial structures in West Africa are strongly influenced by the interaction of formal and informal institutions. Here are some of the key trends that emerged from the data analysis:

1. Impact of formal and informal institutions.

   Countries with recent institutional reforms, such as Senegal and Ghana, show improved entrepreneurship performance. These reforms have improved the legal and regulatory framework, reduced administrative costs and increased access to finance for small businesses. On the other hand, countries such as Mali and Côte d'Ivoire continue to suffer from bureaucratic slowness and persistent corruption that limit business opportunities (Table 1).

2. The role of culture and social networks.

   Social networks and informal cultural traditions play an important role in structuring business. For example, tontines and family networks overcome the lack of finance in countries where access to banks is limited. However, this reliance on informal networks limits opportunities for national and international expansion, as entrepreneurs are often locked into closed relationships. Social entrepreneurs also use these networks to raise funds or find partners, but reliance on these informal practices can limit their flexibility and access to wider markets.

3. Impact of institutional reforms on entrepreneurship.

   Countries such as Ghana have seen rapid growth in the SME sector due to tax reforms and related digital infrastructure. These reforms have led to increased transparency, improved investor protection and reduced administrative obstacles. In contrast, in countries such as Côte d'Ivoire, reforms have been more fragmented and less effective, hindering the harmonious development of entrepreneurial structures (Fig. 1).

Table 1. Comparison of ease of doing business indicators.

Country	Company Creation	Access to finance	Time taken to set up the business (in days)	Doing Business 2020 Global Indicator
Senegal	80	65	7	52,1
Ghana	85	75	5	58,4
Côte d'Ivoire	65	60	10	50,6
Mali	60	50	12	48,3

Source: authors based on [4].

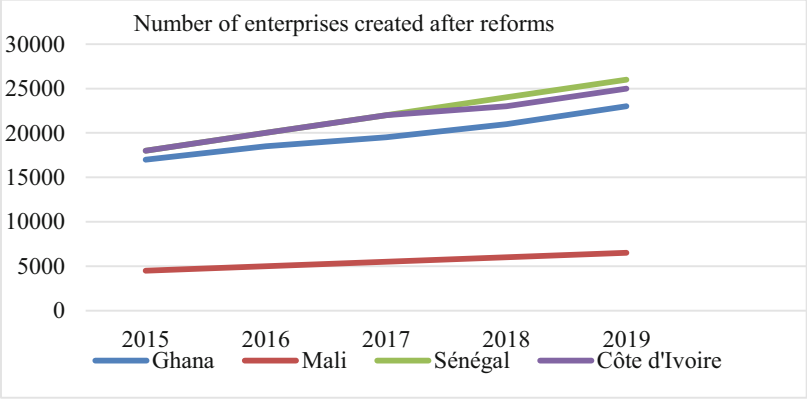


Fig. 1. Change in the number of enterprises created after reforms *(Source: authors based on* [5]*).*

This strong growth can be attributed to policies that favour entrepreneurship, as well as improved access to finance and the country's desire to position itself as an investment hub in West Africa. However, despite the increase in the number of formal enterprises, a large proportion of new businesses remain informal.

5 Conclusion

This study highlights the critical importance of local institutions and social networks in structuring business in West Africa. On the one hand, countries with significant economic reforms, such as Senegal and Ghana, show positive results in terms of business creation, access to finance and economic growth. On the other hand, countries where reforms have been slow or ineffective, such as Mali and Côte d'Ivoire, continue to face numerous obstacles to business development. Thus, the national characteristics of entrepreneurial structures are determined by a complex set of formal and informal institutions, as well as cultural and social traditions that shape the way business is conducted. To foster sustainable and inclusive growth, institutional reforms need to go beyond simple legislative changes and take into account local dynamics that have a profound impact on the private sector.

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Tools for a Sustainable Competitive Development Strategy for an Aerospace Enterprise

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Abstract. The aerospace industry is a vital sector of the Russian economy, ensuring national security, technological sovereignty, and sustainable development of the country. However, in recent years, enterprises in this sector have been facing sanctions restrictions, increasing R&D costs, as well as specific and unique challenges related to the lengthy product development and market launch cycles, dependence on government contracts, and the need to comply with strict quality and safety standards. The work is devoted to the development of tools for shaping a sustainable competitive strategy for the development of aerospace enterprises in modern conditions. The aim of the study is to substantiate tools for forming a sustainable competitive strategy for the development of aerospace enterprises, taking into account contemporary challenges. The authors apply a comprehensive approach, including a theoretical analysis of modern concepts of strategic management, digital transformation, and sustainable development. Methods of system and comparative analysis are applied. The analysis is based on the works of Russian and foreign scholars. The study presents tools for shaping a sustainable competitive strategy that enable aerospace enterprises to enhance their competitiveness by optimizing business processes, reducing costs, and accelerating product market entry. The research findings can be used for strategic planning in aerospace enterprises, as well as in other high-tech industries.

Keywords: Aerospace Industry · Digital Transformation · Innovative Technologies · Public-Private Partnership · Sustainable Competitive Strategy

1 Introduction

The modern aerospace industry is one of the most knowledge-intensive and capital-intensive sectors of the global economy, playing a key role in ensuring national security, technological sovereignty, and sustainable development of the state. The development of high-tech industries serves as a foundation for effective structural transformation, economic modernization, and overall balance [1–3]. As a driver of innovations, the aerospace industry simultaneously faces numerous challenges and complex tasks – primarily, high

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R&D costs, long product development and market entry cycles, dependence on government contracts, and the need to comply with strict quality and safety standards. The formation of a sustainable competitive development strategy for an aerospace enterprise is impossible without considering industry specifics, analyzing external and internal factors, and implementing modern managerial and technological solutions. This work investigates key tools that can be used to achieve this goal, ranging from strategic analysis and planning methods to the implementation of innovative technologies and digital transformation of business processes. The relevance of the research topic is driven by the need to find a balance between traditional management approaches and innovative solutions that will enable aerospace enterprises to remain competitive in today's environment.

Current research is primarily focused on adapting traditional strategic approaches to new realities, emphasizing digitalization, compliance with environmental standards and international requirements, and increasing market competition, including due to the rise of private companies. The role of scientific and technological progress in the reproduction process is well explained by M.E. Konovalova [4]. One of the key trends today is the study of digital transformation's role in enhancing enterprise competitiveness. Scientists outlined its key elements and the impact of digital technologies on enterprise efficiency [5]. D.E. Morkovkin [6] identified digital transformation tools for industrial businesses, key digital trends in Russian and global industries, and concluded that digital transformation should become a key strategic priority for Russian enterprises. Another crucial aspect of increasing the competitiveness of aerospace enterprises is cooperation with the government. Forms of public-private and municipal-private partnerships are thoroughly discussed by researchers [7, 8]. K.V. Krasheninnikov [8] notes that successful development strategies for high-tech enterprises often include a combination of public investment and private initiatives, which helps reduce financial risks and accelerate innovation implementation.

A lot of researchers emphasize management approaches. For instance, I.A. Naugolnova [9] argues that a process-oriented management approach is the most effective in terms of cost optimization and production flexibility, thereby contributing to increased enterprise competitiveness in the market. At the same time, the researcher does not dismiss the effectiveness of a project-based approach, acknowledging prospects for developing process-based project management [10]. This perspective is shared by other scientists [11]. Another widely recognized aspect of strategic development and technological sovereignty is import substitution [12]. Any projects within the framework of development strategy, especially competitive ones, are associated with significant investments. Here, enterprises face another challenge – the assessment and forecasting of their effectiveness [13]. This work presents an analysis of modern tools for strategy formation and offers recommendations for their application, considering industry specifics and current global economic trends.

2 Methodology

The research is based on the scientific works of Russian and foreign authors dedicated to strategic management, digital transformation, innovative activity, and public-private partnerships. The study was conducted with system analysis methods to study the interconnections between various aspects of a sustainable competitive strategy, comparative analysis to identify common and specific features of strategic management approaches in the aerospace industry, and tabular methods for presenting research results, among others.

3 Results

The key aspects of a sustainable competitive development strategy for an aerospace enterprise are illustrated in Fig. 1.

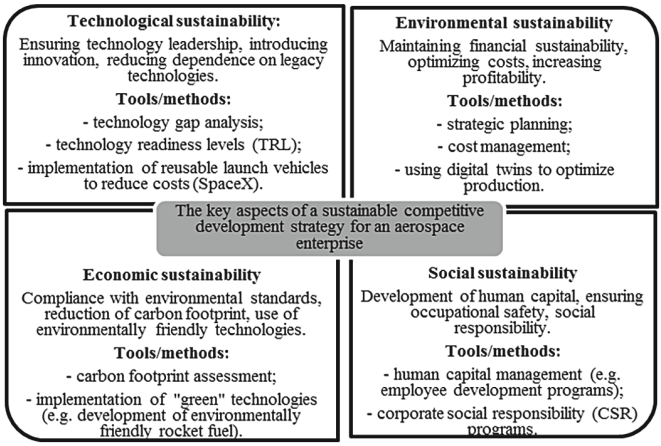


Fig. 1. Key aspects of a sustainable competitive development strategy for a rocket and space industry enterprise (Source: authors).

The key tools of a sustainable competitive development strategy for an aerospace enterprise are presented in Table 1.

Digital transformation and the implementation of innovative technologies are becoming priority factors in enhancing the competitiveness of aerospace enterprises. These measures enable process optimization, cost reduction, and improved product quality. Public-private partnerships play a crucial role in mitigating financial risks and ensuring access to new technologies. Environmental and social aspects are gaining increasing importance in the face of global challenges. Today, adherence to ESG principles is a prerequisite for international companies. The effectiveness of each tool for forming a sustainable competitive development strategy for an aerospace enterprise can be assessed using an indicator system (Table 2).

Table 1. The main instruments for forming a sustainable competitive strategy for the development of an enterprise in the rocket and space industry.

Aspect	Description	Tools/Methods
Innovation Activity	Continuous implementation of new technologies, products, and processes to maintain competitiveness	- Innovation management (e.g., development of new engines to reduce launch costs);
		- Analysis of innovation activity;
Digital Transformation	Implementation of digital technologies to optimize business processes, improve efficiency, and reduce costs	- Use of big data, AI, IoT;
		- Use of digital twins for structural testing
Public-Private Partnership (PPP)	Cooperation with the state to mitigate risks, obtain financing, and access new markets	- Participation in government programs;
		- Joint projects (collaboration with private companies)
Risk Management	Identification, assessment, and minimization of risks associated with technological, economic, and environmental factors	- Scenario planning;
		- Stress testing
International Cooperation	Expanding partnerships with foreign companies and participating in international projects to exchange technologies and access new markets	- Joint ventures (e.g., the International Space Station (ISS));
		- Participation in international projects (e.g., Lunar Gateway)

Source: author.

The proposed indicators provide a comprehensive assessment of the effectiveness of key strategic management tools in the aerospace industry. They cover both quantitative and qualitative aspects, making them a universal framework for analyzing development strategies.

4 Discussion

Most researchers agree that strategic planning should be based on an in-depth analysis of internal and external factors [14–16]. Particular attention is given to innovation management, which is considered a key driver of enterprise competitiveness in the market. The analysis of technological gaps and the assessment of innovative activity allow enterprises to identify weaknesses and develop strategies to address them. Digital transformation is recognized as another important tool, actively discussed in the scientific works. Public-private partnership (PPP) is also considered an effective tool for shaping a

Table 2. System of indicators for assessing the effectiveness of tools for forming a sustainable competitive strategy for developing an enterprise in the rocket and space industry.

Tool	Indicators	Calculation Explanation
Innovative Activity	1. Number of implemented innovations	Counting the number of new technologies, products, or processes introduced during the reporting period
	2. Share of innovative products in total production	(Volume of innovative products / Total production volume) * 100%
	3. R&D expenditure level (% of revenue)	(R&D expenditures / Revenue) * 100%
	4. Number of patents and licenses	Counting the number of registered patents and licenses
Digital Transformation	1. Level of production automation (%)	(Volume of automated processes / Total number of processes) * 100%
	2. Number of implemented digital solutions	Counting the number of implemented digital technologies (AI, IoT, Big Data)
	3. Cost savings due to digitalization	Costs before implementation – Costs after implementation
	4. Data processing speed (task execution time)	Measuring task execution time before and after the introduction of digital solutions
Public-Private Partnership (PPP)	1. Amount of attracted funding	Total amount of funding received from the government
	2. Number of joint projects	Counting the number of projects implemented under PPP
	3. Share of government contracts in revenue (%)	(Volume of government contracts / Revenue) * 100%
	4. Economic impact of PPP	Income from PPP projects – Implementation costs
Risk Management	1. Number of identified risks	Counting the number of risks identified during the analysis
	2. Risk reduction level (%)	(Number of mitigated risks / Total number of risks) * 100%
	3. Cost savings due to risk minimization	Potential losses before minimization – Actual losses

(*continued*)

competitive strategy. It is emphasized that cooperation with the state enables enterprises

Table 2. (*continued*)

Tool	Indicators	Calculation Explanation
	4. Number of implemented scenarios	Counting the number of scenarios developed and implemented for risk mitigation
International Cooperation	1. Number of international projects	Counting projects implemented with foreign partners
	2. Volume of exported products (%)	(Export volume / Total production volume) * 100%
	3. Share of revenue from international projects (%)	(Revenue from international projects / Total revenue) * 100%
	4. Number of new sales markets	Counting the number of new countries or regions where products are exported

Source: authors.

to reduce financial risks, gain access to new technologies and markets, and participate in large-scale infrastructure projects [17].

5 Conclusion

The analysis of modern strategic management tools has shown that the key elements of a successful strategy include innovation management, digital transformation, public-private partnerships, and consideration of sustainability factors. The study of the role of digital transformation and innovative technologies has confirmed their crucial importance in enhancing enterprise competitiveness. The implementation of digital twins, big data, artificial intelligence, and additive technologies enables process optimization, cost reduction, and faster product market entry. The research results can be used to develop development strategies for aerospace enterprises, as well as for further exploration of sustainability and competitiveness issues in high-tech industries.

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Ethical Issues of AI Application

Problem of Responsible Artificial Intelligence Gap Between Countries

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Abstract. This contribution addresses the pressing issue of the responsible artificial intelligence (RAI) gap between countries. To do this, the author uses the methodology of a qualitative analysis of scientific literature and the results of the 2024 country rankings by overall artificial intelligence (AI) development level and responsible AI development level. The evolution of AI indicates its increasing power and potential to perform an increasingly wide range of tasks, replacing humans. As AI grows in power, the problem of the RAI gap between countries becomes more acute. Perhaps, countries are thinking more about creating and improving their AI models first than about the AI responsibility. The results show that the world is currently at a turning point, the gap between countries in AI models may cause a new wave of global instability, since world leaders in the AI development do not always demonstrate a high level of the RAI. To prevent potential global instability, it is necessary to address the issues of the RAI gap between countries, such as differences in ethical and value approaches, regulatory approaches, the level of AI development and the availability of resources for its creation, geopolitical interests and competition, and the level of awareness and education in the field of AI. The work offers recommendations for a continuous and open dialogue between countries to strengthen international cooperation in the field of responsible AI.

Keywords: Artificial Intelligence · Risks of Artificial Intelligence · Problems of Artificial Intelligence · Problems of Innovative Development · Supranational Regulation of Artificial Intelligence

1 Introduction

The problem of the RAI gap between countries is global in nature, and it is becoming increasingly relevant. AI technology has been implemented in many areas of human activity, including industry, agriculture, public administration, culture, social services and many others. There is no longer any doubt that artificial intelligence is capable of providing significant growth in economic productivity, as well as contributing to positive social changes both in individual countries and around the world. Currently, the world is at a turning point when artificial intelligence, especially generative artificial intelligence

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(gen AI), begins to bring real benefits. In 2024, the number of companies that regularly use gen AI doubled, reaching 65% [1]. At the same time, the gap between countries in the level of AI development is high, which can lead to significant economic inequality between countries. Concerns about responsible artificial intelligence are discussed within international expert groups. International groups have been created to jointly address global issues of a responsible approach to artificial intelligence. Thus, the OECD has created an Artificial Intelligence Governance Group (AIGO), whose task is to provide recommendations on defining principles for the application of artificial intelligence in our society [2]. The UN report of September 2024 stated the need to create an independent International Scientific Group on AI, whose activities will be aimed at understanding the opportunities and challenges associated with AI technology [3]. Thus, studying the problem of the gap in the RAI development between countries is an important issue for understanding and managing global processes related, first of all, to the economy, security and social justice.

2 Methodology

This work is based on a qualitative analysis, which first identified the main categories of artificial intelligence and its capabilities in relation to the potential risk of negative impact on humanity. A review of the scientific literature showed that the Global AI Index [4] and the Global Index on Responsible AI (GIRAI) [5] rating approach can serve as a methodological basis for assessing the gap in the level of AI development between countries. While the first rating is aimed at assessing the level of AI development, the second assesses the commitments of governments and the capabilities of countries in the field of responsible AI development from technical, social and political points of view. The multidimensional structure of the index allows us to go beyond purely economic parameters and cover such important parameters for forming trust in AI as the responsibility of AI ecosystem participants for the ability to influence their decisions on people, society and the environment. To assess the gap in the level of responsible AI development, the author uses the Global Index on Responsible AI 2024 database.

3 Literature Review

Responsible artificial intelligence (AI) is an emerging concept that focuses on the ethical development and deployment of AI systems. It aims to ensure that AI is consistent with human values, social principles, the legal and regulatory framework [6, 7]. The concept goes beyond technical considerations to encompass social, institutional, and legal aspects [6]. Responsible AI advocates a human-centered approach with an emphasis on ethics, model explainability, privacy, security, and trust [8]. It requires the involvement of multiple stakeholders in the development and deployment of AI to ensure alignment with societal values [9, 10]. As the influence of AI grows, there is a growing need for international regulations and mechanisms to help companies develop AI responsibly [11]. This multifaceted approach aims to leverage the benefits of AI while mitigating potential risks and addressing ethical concerns.

Despite the diversity of works in the field of AI, the problem of the gap in the level of AI development between countries and its consequences remains unsolved. In the scientific literature, one can find fragmentary points of view pointing to this problem [12]. Thus, it is noted that the development of artificial intelligence (AI) creates problems in the field of legal and economic regulation in different countries. Russia faces restrictions in international cooperation in the field of AI because of sanctions, which leads to the formation of two separate AI spaces in the world [13]. This gap is exacerbated by the technological isolation between the United States and China. Legal frameworks for regulating AI are being developed in different countries, including Russia, the EU, China, the United States and other countries. The key issue is determining the legal status and potential liability of artificial intelligence systems [14]. Traditional notions of guilt and intent in criminal law may need to be revised when AI systems are involved in committing crimes, as they have a certain level of knowledge and will [15], and to provide liability for harm caused by AI systems [16]. There is a problem of the gap between the potential of AI in developing countries and its implementation [17]. Scholars draw attention to the gaps between the principles of AI ethics in the world [18], the lack of comprehensive legal and economic approaches to regulating artificial intelligence [19]. Views on the requirements for RAI to stimulate research and reduce risks to humans are presented, which do not take into account the specifics of different countries [20]. These issues highlight the need for a deeper and more comprehensive coverage of the problem of the AI gap between countries.

4 Results

There are several categories of artificial intelligence based on its capabilities: weak AI (Artificial Narrow Intelligence, ANI), strong AI (Artificial General Intelligence, AGI), and super-strong AI (Artificial Superintelligence, ASI). Currently, we are on the path of intensive development of weak AI, which in turn is divided into traditional, adaptive and generative AI. Of the above, the latter is currently the most widespread due to its ability to create new content (text, images, audio and video) upon user's requests, which is the key difference from traditional AI. The evolution of generative AI can lead to the emergence of AGI – a still hypothetical concept of an AI system capable of solving a wide range of human problems. The emergence of strong AI is predicted no earlier than 2030–2040, but today it is necessary to pay special attention to the issues of establishing the principles of responsible artificial intelligence. Despite the existing opinion about the impossibility of achieving strong AI due to the non-algorithmic and often non-verbalized nature of human thinking, which a machine is unable to accept, science distinguishes a category of super-strong AI, which significantly surpasses the human mind. The prospect of super-strong AI is even more distant and remains the subject of futuristic speculation. However, it is obvious that the risks to humanity will only increase with the growth of AI strength.

Currently, the world is at the stage of forming a basis of responsible artificial intelligence, which should be created in the next 3–5 years. The formation of such a basis should take place through collective efforts. In this regard, it is interesting to consider the gaps in the level of development of RAI. For this, we will use the Global AI Index and the

database of the GIRAI as of 2024. According to the Global AI Index methodology [4], the assessment included such pillars as Talent, Infrastructure, Operating Environment, Research, Development, Government Strategy, Commercial. In 2024, 83 countries were included in the rating, assessed by 122 indicators from 24 different public, private and government data sources. The top ten of the Global AI Index rating included the USA, China, Singapore, Great Britain, France, South Korea, Germany, Canada, and Israel. According to the GIRAI methodology [5], the scope of responsibility of participants in the responsible AI ecosystem includes the design, development, implementation and management of AI in such a way that it respects human rights and adheres to ethical principles at every stage of the AI life cycle and value chain. The conceptual basis of the index is made up of 19 thematic areas in three key components of the RAI ecosystem: government structures, government measures and non-state initiatives [5]. Table 1 shows that the integrated indicators of 138 countries surveyed by experts differ significantly from each other, and none of the countries has achieved the maximum level of development.

Table 1. Indicators of differentiation of key components of the GIRAI 2024.

Indicators	Index score	PILLAR SCORES			DIMENSION SCORES		
		Government frameworks (0–100)	Government actions (0–100)	Non-state actors (0–100)	Human Rights and AI (0–100)	Responsible AI Governance (0–100)	Responsible AI Capacities (0–100)
Max	86,2	81,7	95,5	91,2	84,1	91,1	88,6
Min	0,5	0,0	1,2	0,0	0,0	0,0	3,0
Average	19,8	18,0	21,9	19,1	18,9	19,7	22,3
Median	12,1	7,9	12,0	12,1	12,3	10,3	15,1
Standard deviation	20,3	21,9	23,0	21,1	20,2	22,3	18,3

Source: author.

Both the index as a whole and the individual indices show a median value below the average, indicating that most countries demonstrate a below-average level of responsible AI. The top ten rankings include countries such as the Netherlands, Germany, Ireland, the United Kingdom, the United States, Estonia, Italy, France, Canada, and Australia. The results of the Global AI Index and the Global Index on Responsible AI indicate that in their quest to develop artificial intelligence, even leading countries do not always maintain a balance between scientific and technological progress and a responsible approach to creating AI.

A detailed study of the individual indicators of the ranking, as well as the literature review, allowed us to identify a number of problems associated with the gap in approaches and the development of artificial intelligence between countries.

1. Differences in ethical and value approaches.

Different countries and cultures have different ethical and value guidelines, which affects their understanding of what «responsible» AI is. For example, in the European countries with an individualistic culture, the focus is on individual rights, while in China, priority is given to the public good. Different approaches between countries are observed in relation to the balance between the protection of personal data and the stimulation of innovations in AI, accepting the risk of potential negative consequences. For example, Europe has stricter rules for the protection of personal data than, for example, the USA or China.

2. Differences in regulatory approaches and legislation.

In principle, two different approaches to regulating AI can be distinguished. The first approach is based on ethical principles. The second approach involves strict legislative norms. For example, the EU has developed the AI Act [21] that will enter into force on August 2, 2026. The act establishes strict requirements for high-risk AI systems, while the USA relies more on industry self-regulation.

Despite the activities of international groups of experts in the field of AI, each country has its own approach to regulating AI, which carries potential development risks and difficulties in international cooperation. The lack of uniform international standards for responsible AI creates problems of compatibility and interaction between AI systems. However, this is a problem of the future rather than the present, since at the present stage the development of gen AI models, as a rule, does not go beyond the borders of one country.

3. Differences in the level of AI development and availability of resources.

Inequality in the level of AI development and availability of resources (funding, qualified personnel, computing power) can exacerbate the gap between countries in the level of economic development. There is increasing evidence that AI can increase labor productivity, ensure resource savings, and increase incomes. This means that countries with a higher level of AI development are in a winning position. The Global AI Index shows that the US and China currently lead other countries by a wide margin in terms of investments and the number of AI models created, which is already leading these countries to dominance and this gap is widening. The AI development gap may exacerbate the existing digital inequality between countries and regions.

4. Differences in geopolitical interests and competition.

An important issue to address is the prospect that AI may become a tool for geopolitical competition, going beyond international cooperation on responsible AI. The virtually limitless capabilities of AI may be used in the military sphere, causing countries to compete for leadership in the field of AI. Such competition may lead to an arms race and the proliferation of AI for military purposes. Differences in geopolitical interests may

hinder consensus on AI ethics and regulation. Inconsistency of interests may contribute to the fragmentation of AI ecosystems.

5. Differences in AI awareness and education.

The Global AI Index and the Global Index on Responsible AI 2024 show high differences in the level of AI awareness and education, which hinders the development and implementation of AI based on the principles of responsibility. The problems include a shortage of qualified personnel, low public awareness, and unequal access to education in the sphere of AI. In developing countries, the lack of specialists and resources makes it difficult to develop and implement ethical standards for AI. Limited and insufficiently strong AI training programs hinder the dissemination of ideas of RAI in society, increasing the risks of negative effects of AI. Insufficient awareness leads to the fact that people perceive, first of all, the positive effects of AI for them and do not think about what risks there may be.

The problem of inequality in the level of AI development between countries can have serious consequences, such as increasing inequality between countries, loss of trust in AI, and increased geopolitical instability. To solve it, it is possible to propose continuing work within the UN, OECD to unite the efforts of the international expert community and develop supranational legal acts, common standards and principles of RAI. A constant and open dialogue between countries is needed to develop a common understanding of RAI. The transfer of knowledge and technologies in the field of AI will contribute to equalizing the level of development in the field of RAI. It is also important to increase the level of awareness and education in the field of AI at all levels.

5 Conclusion

The conducted research allows us to draw the following conclusions:

– the problem of the gap in approaches to responsible AI between countries is serious and requires attention;

– manifestations of this problem are differences in ethical and value approaches, regulatory approaches and legislation, the level of AI development and resource availability, geopolitical interests and competition, the level of awareness and education in the field of AI;

– solving this problem requires efforts from the international community to ensure the development and use of AI for the benefit of all humanity, and not just individual countries or groups.

The results of the Global AI Index and the Global Index on Responsible AI indicate that in their quest to develop artificial intelligence, even leading countries do not always maintain a balance between scientific and technological progress and a responsible approach to the creation of AI. Countries leading in the AI development should take the role of a leading force in forming the basis for RAI, taking into account the opinions of countries with less developed AI.

Further research should elaborate on measures to address differences between countries in the level of development of responsible artificial intelligence.

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Artificial Intelligence in Finance: Advantages and Risks

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Abstract. For several decades, artificial intelligence (AI) technologies have been actively introduced into the financial sector, undergoing significant changes. Artificial intelligence has evolved from weak, solving only specific technological problems, to strong, which, thanks to machine learning, is able to independently cope with complex tasks without constant human intervention. Today, artificial intelligence in the financial sector is aimed at improving the efficiency of processes, promoting automation and digitalization, expanding the scale of operations and managing various economic risks. Artificial intelligence in the modern world is becoming a part of the life of any person, it helps to simplify the performance of a number of tasks, reduces the likelihood of error due to the «human factor», and also makes it possible to work with a huge amount of information. The contribution considers artificial intelligence as a catalyst for economic change and the formation of future economic trends. That is why artificial intelligence can and should be used in financial and economic analysis, but its work should be controlled by experts and specialists in this field. The main research methods include the dialectical method of cognition, methods of system-functional, comparative analysis, scientific abstraction and the economic-statistical method.

Keywords: Algorithm · Artificial Intelligence · Electronic Machines · Finance · Performance · Segment · Transformation

1 Introduction

For many years, AI was at the center of academic research, with its systems being developed primarily in research institutions. The potential for large-scale commercial applications of AI technologies was limited by insufficient computing power and data. By the 2000s and 2010s, significant increases in computing power and computer memory, along with the exponential growth of data and the ubiquity of the Internet, had already overcome the previous barriers to development in this field [1]. Today, the term «artificial intelligence» has a lot of interpretations, as the widespread adoption of AI products and services across industries changes its meaning, making it difficult to create a comprehensive and adaptive definition that would cover all approaches to implementing AI.

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2 Methodology

This work is aimed at solving practical problems of increasing the productivity of companies through the use of artificial intelligence. The objectives of the study are to analyze capabilities of artificial intelligence to improve management processes through automated collection, processing and analysis of large amounts of data with high speed and accuracy, surpassing human capabilities.

The application of artificial intelligence in the financial sector has been noted in a large number of studies. Artificial intelligence is an interdisciplinary field that is based on research in areas such as computer science, statistics, economics, neuroscience, linguistics, psychology and philosophy. Each discipline makes its own specific contribution, using unique conceptual apparatuses, subject areas of research and methodological bases.

3 Results

The implementation of AI technologies in financial processes can increase the productivity of companies by 20–30%. In the banking sector, the use of generative AI solutions can provide additional annual returns in the range of 2.8% to 4.7% [2, 3]. In addition, AI makes a significant contribution to the personalization of financial services, creating an opportunity for companies to offer their customers tailored products and services, improving their user experience and satisfaction. For example, in the context of the modern financial sector, investment platforms such as Betterment and Wealthfront are implementing artificial intelligence algorithms to analyze their clients' financial profiles in detail. These algorithms are aimed at identifying investment preferences, defining financial goals, and assessing the level of risk, that in turn makes possible the development of individualized investment strategies. These algorithms serve as tools for the automated creation and management of investment portfolios, ensuring optimization and adaptation according to the client's needs. In addition, companies such as Amazon and Netflix use machine learning algorithms to deeply analyze the behavior and preferences of their users. This use enables the development of recommendations for products and services that may potentially be of interest to consumers [4].

This approach not only increases the level of personalization, but also strengthens customer loyalty by targeting offers to the specific needs and desires of users. This helps to increase sales and improve customer experience, demonstrating how AI capabilities can be effectively used to attract and retain customers in various market segments. The generative artificial intelligence market has grown by US$70 billion over the period 2023–2024. Forecasts for 2025–2030 indicate continued positive dynamics with annual volume growth, reflecting the increasing influence of AI on the market.

Generative AI models, due to their significant performance gains, show great potential for application in various economic sectors. The impact of AI on the global economy and financial markets is as follows: the potential of generative AI is estimated at approximately US$1,040 billion, while more traditional forms of AI reach an estimate of approximately US$760 billion. The key barriers limiting the use of AI in this area include both technological and organizational barriers affecting its integration into financial systems. Although artificial intelligence has significant potential to transform

financial monitoring, its widespread adoption faces certain challenges. There are also concerns about the opaque decision-making process based on AI, which is especially important for highly regulated areas such as the financial sector. Ensuring the security and privacy of sensitive financial data remains a key challenge in the context of using AI for monitoring [5].

Despite the existing obstacles, the prospects for integrating artificial intelligence into the financial monitoring space look very promising in terms of increasing economic efficiency. Technological advances in AI, coupled with regulatory support and cross-industry collaboration, herald significant changes in the capabilities and methods of financial monitoring, which can lead to streamlined economic regulation. Developments in explainable artificial intelligence, which make algorithmic decision-making more understandable, have the potential to increase transparency and build trust in AI-based systems, which is critical for financial institutions. In addition, the implementation of federated learning methods and privacy techniques is aimed at overcoming the problems associated with data security, which allows organizations to securely exchange information while minimizing the risks of loss of privacy, and thereby maintaining the stability of the economic environment [6].

To ensure that the potential of AI is maximized while minimizing its potential negative impacts, it is vital that businesses and policymakers work together to develop and build an ethical framework for the use of AI. This includes ensuring the transparency of AI algorithmic decisions, protecting data privacy and individual rights, and addressing concerns about the potential transformation of the labor market. Furthermore, businesses and individuals should invest heavily in up-skilling and re-skilling programs to prepare for the changing skills requirements brought about by AI. Investing in education and training will ensure that every member of society has the competencies needed to participate in and benefit from the digital economy.

4 Discussion

Artificial intelligence really plays a huge role in financial and economic analysis in the modern world: it helps automate the analysis of a huge amount of data, saves the organization's finances, and increases the accuracy of the organization's action planning. The presented analysis, although it does not cover all aspects, emphasizes the critical need for a comprehensive implementation of artificial intelligence technologies to achieve the digital transformation of the economy in the context of the emergence of Industry 4.0 [7]. Without the active development and integration of AI technologies into existing business models and the creation of innovative high-tech enterprises, sustainable economic growth will be difficult.

Particular attention should be paid to state support in the field of information security, which is becoming a key factor in the process of this transformation, ensuring the protection of economic interests and stimulating trust in digital innovations [8]. State strategic initiatives in the field of information security, that support the digital transformation of industry, include careful strategic planning, as well as an assessment of the economic effectiveness of measures through updating the regulatory framework and protecting the national information space [9]. This requires the organization of continuous monitoring

of electronic threats and the improvement of the regulatory, economic, analytical and scientific-technical components of the information security system.

Additionally, economic support measures are being developed for industrial enterprises and infrastructure elements involved in the creation and application of solutions in the field of information security, as well as for educational institutions [10]. These measures provide for strengthening the management structure at all levels – from federal to municipal – and the centralization of resources in order to ensure cost-effective information security at the level of information technology facilities and operators of information systems and communication networks.

Digitalization of economic processes is a relatively new phenomenon, which causes the emergence of certain negative aspects in its implementation. However, at the global level, efforts are being made to minimize the risks associated with this.

5 Conclusion

To sum up, we can say that the digital economy is presented as an innovative economic model, the basis of which is the possibility of access to the Internet. In the conditions of the digital economy, redistribution relations are moving into virtual space, with gradual integration in the financial market. The main feature and distinctive feature of artificial intelligence from other software is the ability to develop and learn, the computer acquires the properties of memorizing information, which takes modern technologies to a new level. According to the opinion of most researchers and specialists in this field, the advantages provided by modern information technologies outweigh the costs of eliminating and minimizing the risks of their use. Negative aspects are less significant and do not cause serious damage compared to the benefits of digitalization, which makes the introduction of new technologies into the economic sphere rational and expedient.

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Digital Intelligence of Artificial Intelligence

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Abstract. The work presents the main basic principles of digital intelligence application. Artificial intelligence is currently a component of the digital transformation of enterprises. Artificial intelligence is understood as algorithms that have the ability to self-learn in order to apply the acquired knowledge to achieve human goals. Artificial intelligence is developing in all spheres of public life. The conducted analysis revealed the importance of such a new phenomenon as digital intelligence in the context of digital development of society and artificial intelligence. Digital intelligence accompanies a person in all spheres of activity. Digital intelligence is a new phenomenon in the digital society. It is a personality trait consisting in the presence of social, value, emotional, evaluative, analytical and cognitive abilities that help facilitate adaptation to new living conditions in the digital environment. Traditionally, the hierarchical structure of digital intelligence operates at the following levels: gender, age and status. The basis for the formation of digital intelligence should be: digital identity, digital security, digital literacy, digital emotionality, digital communication, digital law, digital use and digital guarantee. The formation of digital intelligence should be carried out in the training of highly professional personnel for all areas of the country's economy.

Keywords: Artificial Intelligence · Digital Etiquette · Digital Guarantee · Digital Identity · Digital Intelligence · Digital Law · Digital Use

1 Introduction

Modern organizations operate in the conditions of the strongest digital economy. The development of information technologies leads to the constant need to adapt to changing conditions. Companies that solve these problems successfully build the state of business processes and production processes, improve the quality characteristics of both variable goods, services provided, and communication links with consumers, thereby creating a unique competitive advantage for themselves and increasing their competitiveness in the market.

The most effective solution to these issues is facilitated by artificial intelligence. Artificial intelligence acts as a catalyst for the digital transformation of organizations [1]. The term itself was first used in 1956, but the origin of the idea dates back to 1935, when it was proposed to consider intelligent systems as those systems that would not differ from humans in communication.

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A qualitative leap in the development of artificial intelligence occurred in the 80s of the 20th century. Developments were mainly based on mathematical calculations that could evaluate various scenarios for the development of a situation, optimize the cost of raw materials to obtain the best result, etc. New achievements were widely implemented in the computer games industry. Smart home concepts began to emerge, based on the widespread use of the Internet of Things to ensure comfort and safety. The capabilities of artificial intelligence in the field of security were especially appreciated. The use of cameras on city streets made it possible to implement a facial recognition system and recognition of vehicle license plates.

2 Methodology

Artificial intelligence is understood as a computer program capable of learning based on the analysis of a large volume of data and information with the aim of further obtaining new analytical information for independent decision-making [2–4]. The current level of development of artificial intelligence already allows analyzing photographic images, identifying similarities in text by meaning and content, analyzing and predicting mathematical dependencies, etc. In essence, artificial intelligence is a learning information system and a decision-making system. Many advanced IT companies create their products and services in the field of artificial intelligence. Artificial intelligence has already become widespread in a large number of areas. In the banking sector, artificial intelligence evaluates borrowers and creditors, and makes decisions on issuing a loan, opens accounts, and assesses possible risks. In the field of marketing, artificial intelligence helps to assess the market capacity, defines target segments corresponding to a number of consumer characteristics. In stores, it helps to track the filling of shelves with goods, monitors the situation with queues and reports the need to get involved in solving problems. In procurement activities, it can analyze the situation with offers from suppliers, select optimal delivery options, minimize expenses. To optimize logistics activities, it selects a route, vehicle fleet, and fuel costs. It forecasts sales, tracks warehouse balances, and creates delivery plans.

The service sector is also actively attracting artificial intelligence. The activity of processing a large number of requests in call centers, working with subscribers, making calls, sending out mailings, and informing is carried out using artificial intelligence. The ability to analyze large amounts of data and generalize them allows artificial intelligence to determine the taste preferences of listeners, the frequency of their purchases in online stores, consumption patterns, and brand loyalty. Artificial intelligence in medicine deserves special attention. Currently, a number of programs have been launched to process research results to identify characteristic changes in the patient's body, allowing for a diagnosis to be made at an early stage of disease development. There is confirmed experience in using artificial intelligence in predicting the spread of infectious diseases and creating new types of drugs.

The authors applied system analysis, using the following methods: statistical, logical analysis, general scientific methods of cognition (scientific measurement, observation, analysis, synthesis, etc.), visual assessment of the research results.

3 Results

The consequence of the digitalization of life processes in society is an even deeper penetration of information and communication technologies into all spheres. Information technologies contribute to changing the essence of ongoing processes, changing the algorithms for their implementation [5]. These changes can be characterized as development. However, a person adapts to these processes at a slower pace than technologies develop [6]. Gaining experience and the consequences of using artificial intelligence requires addressing issues of the moral and ethical side, issues of responsibility for actions taken by both the developer and artificial intelligence, and issues of global responsibility for the future of humanity in the new digital reality.

Historically, this category of issues was addressed by a part of society called the intelligentsia. Modern researchers have argued for several years that the potential of intelligence in society is not in demand and is destroyed. However, the era of artificial intelligence has revealed the opposite trends, consisting in the extreme demand for personal qualities corresponding to the intelligentsia. The acceleration of the processes of high-tech foundations poses problems of balance with human factors. The personality of an intellectual always proceeds from the importance of the universal human nature and the joint self-development of individuals. In the professional activity and social status of an intellectual, especially when it comes to personal and individual characteristics, it is necessary to take into account the moral aspect of this activity, and the role of the intelligentsia in the world civilization process is largely determined by how much it is able to merge with the masses of the people, to respond to their innermost aspirations [7].

Most researchers agree that the importance of participation in the development of a digital society by the intelligentsia is determined by the fact that the opinion, thoughts, actions, and deeds of an intellectual are determined by objective factors, while the vector and direction of movement are independently determined by deep internal personal attitudes and beliefs. This approach is the basis of the concept of digital intelligentsia, which is determined by the need for intellectual activity in the context of the formation and development of artificial intelligence. Intellectual activity within the concept must be integrated into the processes of digital transformation, since the concept substantiates the essential foundations of an intellectual that remain outside of time and social transformations. Digital intelligence will ensure understanding of the processes of digital transformation of society and determine the strategy for its development.

The problem of developing digital intelligence is also clearly felt [8]. The processes of understanding, analysis, synthesis, and evaluation of what is happening, characteristic of the intelligentsia, have slowed down catastrophically in the digital environment. Self-awareness and self-identification, knowledge and critical thinking, as well as the choice of the vector of further value-based moral and ethical development are not accelerated along with the speed of transmission and receipt of information, but on the contrary, are slowed down.

The unique role of the intelligentsia has been lost, including due to the blurring of boundaries on the possession of unique and important information. The intelligentsia's ideas about the development of modern society, scientific research and cultural achievements have ceased to be a resource that was carefully and accurately protected and

guarded throughout evolutionary processes. This knowledge has become an insignificant part of the world information space. This information space has turned everything valuable into a simple storage of information. Information that has become a resource has become subject to other laws and at present the most important problem has become technical issues of storage, transmission, protection, updating, etc. Among technical specialists in the field of information technology management there is an extremely small number of representatives of the intelligentsia.

As a result, the increasingly lost social mechanism that promotes self-organization, self-awareness and self-regulation of public behavior is becoming increasingly in demand in the form of digital intelligence in the context of the development of artificial intelligence. The transition of most processes to virtual reality gives rise to the creation of digital twins. Digital twins have the ability to animate full-fledged communications, develop according to their own laws. On the one hand, it is visible to all members of the virtual society, on the other hand, the individual's personality is always hidden. It can try on many roles and act according to different behavior models, without bearing responsibility for its actions. Such impunity determines the demand from society for the existence of laws of behavioral ethics and control over its implementation, capable of ensuring a regulatory function, responsible behavior and possible punishment or censure, the requirement to recognize the erroneousness of ideas about the infinitely any possibilities in committing one's actions.

We should rely on digital intelligence and even create the necessary conditions for starting the processes of recognizing the distortions of digital reality and searching for value guidelines for digital society in general and artificial intelligence in particular. The basis for the formation of digital intelligence should be: digital identity, digital security, digital literacy, digital emotionality, digital communication, digital law, digital use and digital guarantee. It is important for humanity to have unshakable guidelines in the digital world. Artificial intelligence cannot and should not replace cognitive development and critical thinking for us, it should contribute to their development, lay an important foundation for the practice of social interaction.

4 Discussion

The following factors underlie digital intelligence:

- the ability to analyze and evaluate the substantive and semantic basis of reality;
- the ethics of interaction with information and communication technologies within the framework of interaction;
- a respectful attitude to the use of all types of resources, including time, labor, material, financial, etc.
- adoption of rules for protecting confidential information within the framework of personal and public life, respect for personal boundaries.

Digital intelligence accompanies a person in all spheres of activity [9]. Despite the rapid development of technologies, they are still based on the process of communication between individuals. Communications ensure the achievement of goals in the most effective way. The origins of the formation of digital intelligence should be in childhood

[10]. The use of digital technologies is already actively occurring in this period of life. In the process of professional development, a different set of competencies and skills of modern digital etiquette, norms of behavior and rules are in demand, contributing to achieving competitiveness in the labor market for building a successful career.

In fact, all actions leave a digital trace that is stored, accumulated and characterize the carrier of these actions. The blurring of the boundaries of personal and work time and space in conditions when a person works remotely has led to the fact that compliance with the rules of business etiquette has become less important. Mass refusal to comply with the rules of etiquette has ultimately led to the formation of a disrespectful, uncomfortable space of interaction and has received a negative assessment from society. For harmoniously developing societies, a respectful attitude that does not affect or violate the interests of others is extremely important.

We can offer a number of rules, following which will contribute to the formation of digital intelligence. For comfortable communication and adequate interaction, it is necessary to clearly understand the position taken [11]. You should always adhere to rational thinking and so-called common sense. In the event of tension, measures should be taken to reduce it. The interlocutor should be treated with respect even if he makes mistakes, you should not point them out. You should use your time resource rationally, focus on the main thing, and respect the other person's busyness.

Intervention in personal life and personal correspondence is not allowed. There are a number of topics that are not used for public discussion. These include issues of religion, personal life, finances, and sometimes politics. Any judgments should not harm the interlocutor or affect his feelings. It is necessary to treat other opinions, other religions and cultures with utmost respect. Traditionally, there is a hierarchical structure of digital intelligence at the following levels: gender, age and status. The combination of levels can change depending on the content situation, the current conditions of communication. Business etiquette has its own peculiarities. Business communications are built on mutual benefit, taking into account the interests of each party, respect and equality. However, as a rule, they have a strictly regulated order and are based on protocols. Modern researchers believe that issues of reputation in business associated with ethical behavior have become a resource no less valuable than capital and labor [12].

In the field of education, digital intelligence is of particular importance. The use of distance technologies and the transfer of the educational process online has posed a lot of challenges for information carriers. Communication should be organized according to the rules of digital intelligence and should include rules for greeting and ending an event, opportunities for public discussion, conducting thematic chats, the ability to convey the material in the most digestible format, etc. Compliance with the requirements of digital etiquette should be combined with compliance with technical requirements, such as high-quality sound and image, the absence of extraneous irritants, and proper placement of the camera to form a perceived image on the screen [13–15]. Students who receive knowledge using distance technologies are no less responsible for the manifestation of digital intelligence. Issues of digital etiquette in the educational process should receive mandatory coverage and the formation of stable rules and norms of behavior, and most importantly, mandatory adherence to them. Training in digital etiquette should

be reflected in various educational programs for training teachers, doctors, engineers, and government students according to relevant standards.

5 Conclusions

Gaining experience and the consequences of digitalization requires addressing the issues of morality, issues of responsibility for actions taken both by the developer and by artificial intelligence, and issues of global responsibility for the future of humanity in the new digital reality. The essence of digital intelligence is to maintain a balance between the successful and effective functioning of digital systems and society, based on the manifestation of a respectful attitude and the identification of individual personality traits. It is necessary to maintain an adequate balance between the intellectual abilities of society and the digital transformation of various social systems. The formation of digital intelligence should be carried out in the preparation of highly professional personnel for all sectors of the country's economy. This branch of knowledge should be influenced by legal regulation. The development of information and communication technologies should be built in close connection with digital ethics, based on the concept of digital intelligence. The development of artificial intelligence should be assessed from the position of compliance with the current rules, norms and values of the concept of digital intelligence.

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Ethical and Legal Issues of Artificial Intelligence: Transparency, Security and Confidentiality

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Abstract. In recent decades, artificial intelligence has become an integral part of our daily lives, penetrating various fields such as medicine, finance, transportation, education, and many others. Its impact on society and the economy is increasing every year, which makes relevant issues related to the ethical aspects of its use. In the context of the rapid development of technologies and their integration into social processes, it is necessary to comprehend and analyze the ethical categories that arise in the context of the use of artificial intelligence. In this study, we will focus on key ethical issues such as transparency, security, and privacy and their legal aspects. They are becoming particularly important in light of growing concerns about the potential risks and consequences associated with the use of artificial intelligence. The relevance of this work is determined not only by the widespread use of the considered technology, but also to the fact that its use generates many ethical dilemmas. For example, how to ensure the security of data processed by artificial intelligence systems? How can we ensure the transparency of algorithms so that users can understand how decisions are made? How can we protect the confidentiality of personal information in an environment where artificial intelligence can analyze and process huge amounts of data? These issues require careful consideration and analysis, as their solution affects not only the effectiveness of the artificial intelligence application, but also public confidence in these technologies.

Keywords: Artificial Intelligence (AI) · AI Algorithms · Cybersecurity · Ethics · Information · Legal Regulation · Privacy · Responsibility · Security · Technology · Transparency

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1 Introduction

Ethical categories related to artificial intelligence (AI) are becoming increasingly important in today's digital society. Issues related to transparency, security, and privacy are at the center of research and discussions related to the introduction of AI in various areas of life.

Transparency of AI algorithms is one of the most important aspects. Users need to understand how and on the basis of what data decisions are made in order to trust these systems. Without understanding the logic of AI, it leads to distrust of technolo-gy and its developers. Transparency makes it possible to analyze and verify the work of AI systems, which is fundamental for their successful use in public and private interests [1]. The ethical codes of companies such as Microsoft emphasize the need for clarity in AI-related processes, which confirms the importance of this aspect. At the same time, it is necessary to strive for a balance between the technical complexity of algorithms and the accessibility of their understanding for users.

Data security is also a critical element of ethical AI practices. In light of the growing threats to cybersecurity, protecting user data is becoming a top priority. The development of multi-level security measures, such as encryption and identification of vulnerabilities in AI systems, is necessary to minimize potential risks. This requires both a technical approach and human involvement in ensuring information security [2]. New practices are needed that will take into account the specifics of human interaction with AI. In modern realities, it is important to integrate security at all levels of the AI development lifecycle.

Data privacy is another key aspect of the ethical category of AI. With the increasing volume of information collected about users, respecting their right to privacy be-comes an important task. Users should be sure that their data will not be used without their consent and that companies are taking all necessary measures to protect them [3]. This includes the need for strict compliance with data protection legislation and greater oversight by government authorities. Ethical codes should not only regulate the use of AI, but also contribute to the creation of norms and standards aimed at protecting user privacy [4].

The ethics of AI must take into account not only technical aspects, but also social, economic and cultural contexts. The development and implementation of AI technologies must be transparent, secure, and respect human rights and privacy. In this regard, it is necessary to conduct research and development aimed at identifying and analyzing ethical issues related to the use of AI in order to provide a better under-standing of how it can affect society as a whole. This also includes the importance of taking into account the views of different stakeholders, including the user, developers, and regulators, in order to create an integrated approach to AI ethics.

2 Methodology

The methodology of this scientific research required the use of an integrated approach. Firstly, the following methods were applied: analysis of normative legal acts, comparative legal analysis, and the dogmatic method. Finally, forecasting and modeling methods have made it possible to assess the potential risks and consequences of the introduction of

AI for human rights, privacy and security, which is necessary for the development of effective regulatory strategies. The use of all these methods combined made possible a comprehensive and objective study, the results of which can be used to develop ethical principles and legal norms that ensure the responsible development and application of AI.

3 Results

It should be noted that defining the main ethical categories in the context of AI is an important step towards understanding and solving emerging problems. These categories include concepts such as security, transparency, confidentiality, and responsibility. Each of these categories plays a key role in shaping an ethical approach to the development and implementation of AI technologies. For example, data security in AI systems is becoming critically important, as data leakage or unauthorized access can lead to serious consequences for both individual users and society as a whole. It is important to develop reliable data protection mechanisms to minimize risks and ensure user safety. Data privacy is another important issue that needs attention. The risks associated with the leakage of personal information and data manipulation are becoming increasingly apparent in the context of the active use of AI. Confidentiality guarantees should be built into the technology development process to protect user rights and prevent abuse. This requires developers not only to comply with existing norms and standards, but also to actively participate in shaping new approaches to data protection.

The responsibility of AI developers is another key aspect that needs to be considered. Developers should be aware of the consequences of their actions and take responsibility for the results of their systems. This includes both ethical and legal responsibilities, which highlights the need to create clear standards and principles for the development of AI technologies. It is important that developers are trained in the ethical aspects of their work and understand how their decisions can affect society.

The ethics of data manipulation also raises serious concerns. Using AI to manipulate data can lead to distortion of information and violation of user rights. It is important to develop clear rules and regulations that would limit such practices and ensure the ethical use of technology. This requires a collaborative effort on the part of researchers, developers, and regulators to create a safe and ethical environment for the use of AI. Thus, ethical issues related to artificial intelligence require an integrated approach and the active participation of all stakeholders. Only through joint efforts we can create a safe, transparent and ethical environment for the development and application of AI, which will ultimately lead to an improvement in the quality of life and well-being of society as a whole. It is important to continue to explore and discuss the ethical aspects of AI in order to ensure its responsible and ethical use in the future.

In the context of actively developing artificial intelligence, data privacy is becoming one of the most relevant topics. Vulnerabilities of personal information that are processed by AI systems can cause serious problems, ranging from data leakage to loss of trust on the part of users in services and organizations [5]. The process of AI operation can be divided into stages of learning and use, while the data passing through these stages can include both personal information and commercial information [6].

During the training of AI algorithms, pre-collected data is used, which makes their protection critically important. Processing large amounts of information can increase the likelihood of hacking and misuse of data, which undermines business models and leads to legal consequences for organizations [7]. In addition, the existence of privacy threats requires extensive security measures in data collection, storage, and processing [8]. The study of approaches such as MITRE ATLAS and OWASP provides developers with tools to conduct threat analysis and implement effective security management, which allows them to maintain confidentiality.

The issue of privacy requires special attention in light of the use of neural networks and machine learning, which can extract patterns and relationships from the processed data. The high level of automation is accompanied by an increase in the number of threats, which calls into question the security of users' personal information [9]. This relates not to the deliberate actions of scammers, but rather to the potential vulnerabilities of the systems themselves, which can become targets of attacks.

The development of new regulations and legislative initiatives regulating the processing of personal information is also an important step towards ensuring confidentiality [10]. Historically established practices of personal data protection once again require revision in the light of the integration of AI into various spheres of life and the economy.

The importance of legal norms becomes apparent in the context of the global use of AI. The European Convention on Human Rights and other international initiatives provide a framework for protecting citizens' rights in the field of data processing [11]. However, in practice, there are a lot of questions about the need to implement stricter measures to ensure that users are protected from possible abuse when using AI [12]. In particular, the privacy threat study mentions possible data protection options that can be implemented using new technologies such as blockchain. Such approaches can ensure transparency in the information processing process, ensuring its security at all stages – from collection and storage to analysis and use. The discussion of ethics issues in the context of AI points to the need for a comprehensive review of approaches to privacy protection, which may include both legal and technical solutions that meet the challenges of our time.

The development and implementation of artificial intelligence technologies requires a clear understanding of responsibility issues, especially when it comes to high risks and potential negative consequences [13]. The legal perspective considers the main participants in the creation, development and operation process: developers, data providers, and system owners. There is uncertainty about who should be responsible for the actions of AI in various situations, whether it is the use of copyrighted materials or accidents caused by self-driving cars [14]. The legal framework around liability has many gaps, which makes it much more difficult to establish the limits of legal liability. For example, is software used without the necessary licenses in AI training, and who can be held accountable in case of violations? [15]. These questions do not have a definite answer, as legislation in this area is still in the formative stages. The use of AI is often fraught with discussions about ethics, bias, and discrimination.

4 Discussion

Questions about the legal responsibility of developers are being raised in international initiatives, such as resolutions of the European Parliament on robotics and discussions on legislative initiatives in Russia, where new regulatory regulation in the field of AI is expected to be introduced. The development of standards and norms is becoming an urgent need to ensure user safety and minimize risks. This approach requires authorities to create a clear legal framework that takes into account the specific aspects of AI technologies and their potential consequences. The discussion of ethical responsibility includes not only the legal side, but also social aspects, such as the impact of AI on human rights. The complexity arises due to the versatility of the participants in the process, they must take into account a wide range of factors influencing the decision-making of the AI system. Decision-making that affects people should be based on principles that imply transparency and ethical validity [16]. Scientific research shows that it is necessary to apply an integrated approach to the definition of responsibility, which will take into account not only technical aspects, but also the human factor. This means the need to develop ethical standards and practices that will help developers, data providers, and others interact with AI within clear and transparent norms. The application of such standards will create safer and more predictable systems, which, in turn, will increase public confidence in AI technologies [15].

The number of cases related to errors in the operation of these systems is growing, which calls into question the fundamentals of their application. The need for ethical control is becoming more and more urgent, and this is confirmed by the adoption of a number of documents, such as the Code of Ethics in the Field of AI (the Code) in Russia, which is supported by more than 150 organizations. It is designed to prevent using malicious practices in AI systems. Its effect extends to the relationships related to the ethical aspects of the creation, implementation and use of AI technology at all stages of the life cycle of its application. The document was developed in 2021 as part of the national strategy for the development of AI in Russia. On October 20, 2021, the Code was signed by the Government of the Russian Federation, several large companies and research organizations [17]. It sets out the following principles: a human-oriented approach to the development of AI technologies, principles of data security and information security, identification in communication with a person, respect for the autonomy of the human will, responsibility for the consequences of application and others. The Code is advisory in nature. Nevertheless, it serves as a basis for the development of industry standards, educational programs and internal corporate policies, and contributes to the formation of an ethically responsible ecosystem in Russia. Its provisions are planned to be used in the development of legal acts regulating the field of artificial intelligence. Ensuring data security in the context of AI involves both technical and philosophical aspects. It is important to understand not only the risks, but also the potential benefits of using AI. Experts point out that flaws in AI systems can lead to serious errors affecting decision-making in various fields such as medicine, law, and financial services [18]. However, ethical management standards should be designed to balance possible benefits and risks, thus creating more reliable systems.

Transparency of algorithms and decision-making is one of the cornerstones of AI ethics. Algorithmic decisions made by systems often remain in an incomprehensible

state for users, which can cause distrust. To increase confidence in AI, it is necessary to consider open approaches to the development and operation of algorithms, which will allow users to have an understanding of methods and principles of the technology [19]. AI developers need to take into account the ethical context in which they work. The problem of data manipulation is also becoming a central topic of discussion. The use of big data for education threatens not only the security of users' personal information, but also the very nature of the fair use of technology. Ethics also re-quires developers to be conscious about what data is being used and how it can influence results. Discussing the need to create ethical standards in the field of AI implies an active dialogue between developers, the rules and the public [20]. The irreversible effects of AI can include increased inequality and bias. AI ethics should include measures aimed at eliminating discriminatory practices, such as unjustified attribution to certain groups based on racial, sexual, or social criteria. This requires developers to pay special attention to the diversity of data and its representativeness in order to avoid bias in judgments and results [21].

5 Conclusion

AI developments present both opportunities and new risks related to privacy. Combining the efforts of the participants in this process – from developers to legislators – can be a key factor in creating a threat-resistant data processing environment. Such an alliance will provide an opportunity to achieve harmony between innovations and user rights, protecting their interests in an era of rapid technological progress. Turning to practical issues, it is important to develop and implement recommendations on the ethical use of AI, which will be based on technology, as well as the interaction of society with these systems. By focusing on ethical aspects such as security, transparency, and privacy, it is possible to ensure a more sustainable and equitable implementation of AI technologies in social practices, thereby strengthening user trust and meeting the needs of different types of communities.

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Ethical and Legal Risks of Using AI in Education: Privacy and Accessibility

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Abstract. The use of artificial intelligence (AI) in education opens up new horizons, allowing you to personalize learning and adapt the learning process to the individual needs of each student. AI can analyze academic performance, identify knowledge gaps, and offer customized learning materials, thereby maximizing learning effectiveness. In addition, AI is able to automate routine tasks such as checking assignments and grading, freeing up teachers' time for more creative and individual work with students. Ultimately, AI in education aims to create a more effective, accessible, and personalized learning environment that promotes the harmonious development of each student. This work investigates ethical and legal risks that arise when introducing artificial intelligence into the educational environment. Special attention is paid to the issues of confidentiality of students' and teachers' data, as well as issues of ensuring equal access to educational resources supported by AI. The potential threats of privacy violations related to the collection, storage and use of personal information in AI systems are analyzed, as well as possible scenarios of discrimination and inequality when using AI to evaluate academic performance and provide educational services. Recommendations are offered on the development and implementation of ethical and legal norms aimed at minimizing these risks and ensuring responsible use of AI in the field of education.

Keywords: Algorithms · Artificial Intelligence (AI) · Data · Educational Activities · Educational Institutions · Legal Regulation · Personal Data · Privacy

1 Introduction

Artificial intelligence (AI) is increasingly being introduced into educational activities, transforming traditional approaches to learning and teaching. AI allows us to personalize the learning process by adapting the content and pace of learning to the individual needs and capabilities of each student. This is achieved by analyzing data on academic performance, learning style, and preferences, which allows you to create individual learning paths. In addition, AI can automate time-consuming tasks such as checking assignments and tests, freeing up teachers' time for more meaningful work with students, such as counseling and stimulating creative thinking. AI-enabled chat-bots and virtual assistants

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can answer students' questions, provide instant feedback, and offer additional resources for learning, providing access to knowledge around the clock. However, it is important to keep in mind the need for ethical use of AI in education to ensure fairness, transparency, and data protection. The use of AI in education involves collecting and analyzing a variety of information about students, including academic performance, behavioral patterns, personal preferences and interests, socio-economic status, and medical data. Misuse or leakage of such information can have serious consequences for students, including privacy violations, discrimination, and potential abuse.

2 Methodology

To study the ethical and legal risks of using AI in education, in particular, in the context of confidentiality and accessibility, it was advisable to use a set of scientific methods. Analysis of regulatory legal acts made it possible to identify existing requirements and regulatory gaps. The expert assessment method was used to identify and rank potential risks. The case study, which included an analysis of specific cases of AI implementation in educational institutions, helped identify practical problems related to data privacy and ensuring equal access. Finally, predictive modeling based on the analysis of trends in the development of AI and educational technologies allowed us to assess the potential long-term consequences of using AI for ethical and legal aspects in the field of education.

3 Results

The following measures can be considered to regulate the use of artificial intelligence in education in Russia:

- to adopt a federal law that sets out the general principles of using AI and the specifics of using technology in education;
- to define the scope of the use of AI in the educational process for students, teachers and other staff (for example, AI should be seen as an auxiliary tool rather than a substitute for human interaction);
- to establish requirements for the use of AI (thus, information in AI-generated materials should be checked for compliance with reality, and the use of technology should be transparent);
- to give educators the right to define special requirements for the use of AI during the implementation of courses and research projects (for example, to set the amount of permissible use of AI in work);
- to inform students and teachers about the possibilities and rules of using AI (it is possible to organize trainings for users of generative AI to ensure its competent application).

The work in this area is actively underway. So, in October 2024, GOST R 71657-2024 was approved in Russia [1]. The use of artificial intelligence (AI) in educational institutions is accompanied by processing of a significant amount of personal data of students and teachers. This data includes information about academic performance, attendance, as well as personal information such as name, age, and contact information. According

to [2], 60% of educational institutions in the world use AI to analyze student data. In the report [3] along with promising prospects, potential problems are carefully analyzed. They are related to the integration of AI into the educational sphere. Among them, the risk of increasing digital inequality stands out. If access to AI educational technologies and a high-quality Internet connection remains uneven, the gap between privileged and low-income students may widen significantly. In addition, the report highlights the need for a critical approach to the data used to train AI systems, as biased data can lead to the reproduction and perpetuation of existing biases and discrimination in the educational process. Finally, the authors express concern about the potential impact of AI on the role of teachers and the need to rethink their functions, as well as the importance of protecting the confidentiality of student data in the context of the increasingly widespread use of AI in education.

One of the main risks associated with data processing in AI systems is the possibility of data leakage. In 2023, the Basmanny Court of Moscow fined the National Research University Higher School of Economics (HSE) 60 thousand rubles for leaking personal data of students and staff [4]. On January 19, 2023, unknown intruders leaked the data of students and employees of Altai State University (Barnaul) to the public. According to [5], a total of 4,468 users of the site were in the stolen table. Such incidents cause significant damage to the reputation of educational institutions and can lead to negative consequences for students and employees, including identity theft and fraud. This highlights the need for strict security measures when working with data. To prevent data leaks and ensure their security, educational institutions are implementing advanced security measures. They cover both technical and legal aspects.

HSE has become the first Russian university to adopt a Declaration of Ethical Principles for the Creation and Use of Artificial Intelligence Systems [6]. The document was approved by the Academic Council on June 26, 2024. The Declaration covers a number of key principles aimed at the ethical and responsible use of AI:

- priority of human communication: AI should not replace the live interaction of people, its use should help strengthen interpersonal communication and collaboration;
- conscious use: HSE is committed to teaching staff and students the basics of AI, its capabilities and limitations;
- academic integrity: AI should be used as a tool to complement rather than re-place natural intelligence;
- transparency: staff and students are required to indicate where and how AI was used, especially in scientific and educational projects;
- confidentiality and intellectual property protection: AI should ensure the protection of personal data and intellectual property;
- exclusion of bias and discrimination: AI can reproduce biases and social stereo-types embedded in data;
- fair accessibility: all participants in the educational process should have equal access to AI;
- reasonable restrictions: it is important to be aware of the risks and consequences of using AI;
- responsible attitude towards AI: all developments and uses of AI must comply with the laws and internal regulations of the university.

4 Discussion

The ethical aspect of data processing includes obtaining explicit consent from students and faculty to use their data. The introduction of General Data Protection Regulation in the EU in 2018 established strict requirements for the process of obtaining such consent, which was an important step towards protecting user rights. Educational institutions should ensure transparency in explaining the purposes and methods of data processing, as well as provide an opportunity to opt out of using their data, if possible. Educational institutions and AI system developers are jointly responsible for data protection. They should work together to develop secure technologies that meet modern privacy standards. For example, developers can implement functions that ensure compliance with ethical standards, and educational institutions can monitor their proper use. Such interaction contributes to the creation of a safe educational environment based on trust.

The legal aspects of using AI in education require special attention, as legislation must take into account both the rights of users and the responsibility of developers. In 2021, the European Commission adopted the «Artificial Intelligence Act», which includes provisions on legal liability for the use of AI [7]. One of the key provisions of the AI Act was a ban on the use of artificial intelligence systems, such as neural networks, to create and analyze databases with biometric information of citizens. There is also a complete ban on the use of AI to recognize people's emotions and behavior in the workplace or during training. The use of neural networks to predict illegal behavior of individuals was banned. The document has been updated several times. The latest version of the act was published in 2023. Such legislation is aimed at ensuring the transparency of algorithms and creating mechanisms for resolving disputes related to AI solutions. Thus, the implementation of such standards helps to protect the rights of students and teachers, as well as encourages developers to create more ethical and secure systems.

Algorithmic justice is becoming another cornerstone in the application of artificial intelligence in education. It is an important aspect of the use of AI in educational activities, since algorithms can be subject to bias if they are trained on data containing «historical discrimination». Such algorithms can unevenly evaluate students depending on their social or ethnic background. This highlights the need to develop more transparent and inclusive data processing methods to minimize the impact of bias on educational processes. So, in 2020, when the COVID-19 pandemic disrupted the usual course of life in the UK, traditional formal exams were canceled due to quarantine measures. There is an urgent need for an alternative method of student assessment in order to fairly determine their suitability for admission to universities and other educational institutions. In Russia, the possibility of using artificial intelligence to check Unified State Exam papers will be studied in the near future. In this situation, it is necessary to take into account the above situation. Since 2019, the development, implementation and application of AI, including in educational processes, has been regulated by Decree of the President of the Russian Federation No. 490 dated 10.10.2019 «On the Development of Artificial Intelligence in the Russian Federation» [8]. There is no prohibition on the use of AI in the current regulatory legal acts in the field of education. Some universities independently establish rules for the use of neural networks when writing papers.

5 Conclusion

The use of AI in education in Russia, despite its enormous potential, entails a number of legal problems that require careful consideration and regulation. First, there is the issue of copyright for AI-generated content, especially in the context of developing educational materials. Secondly, the problem of protecting students' personal data, collected and processed by AI tools for personalizing learning, is urgent. Thirdly, the issue of responsibility for errors or bias in the work of AI systems, which can lead to an unbiased assessment of knowledge or limited access to educational resources, has not been sufficiently resolved. Fourth, there is the problem of digital inequality related to uneven access to AI technologies in different regions and educational institutions. Finally, it is necessary to develop ethical norms and standards for the use of AI in education that would take into account the principles of fairness, transparency and respect for human rights. These standards should be fixed in regulatory legal acts and codes of ethics for educational organizations.

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Ethical Issues in Neuromarketing Research

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Abstract. Development of neurotechnologies is supported by the state and large corporations, as they are designed to solve global problems that have a wide public resonance. The development of neurotechnologies is taking place simultaneously in different sectors of the economy. Good funding, interdisciplinary basis and general interest ensure a high rate of development. The lack of generally accepted ethical norms regulating the process of cognitive sciences development makes us think about the issues of cognitive safety of society. Within the framework of this work, the authors considered issues of ethics in the sphere of organizing and conducting neuromarketing research, analyzed the concept of neuroethics. The experience of different countries has been studied and the worldwide low level of formation of the ethical base of neuroresearch has been proved. We determined the chronological sequence of neuromarketing research development and formulated the limitations arising in the realization of each of the stages. It is noted that the organics in the field of ethical regulation increases with the transition of neuroresearch development to each subsequent level. The problems of ethical regulation of neuromarketing research are systematized and described and possible ways of their solution are proposed. Theoretical significance of the work lies in the systematization of ethical problems of neuromarketing research regulation. The practical significance lies in the proposal of recommendations for determining the directions of solving the identified problems.

Keywords: Bioethics · Neuroethics · Neurointerfaces · Neuromarketing · Neuromarketing Research

1 Introduction

The first publications devoted to the issues of neurotechnology development appear in the early 1990s. We analyzed the unified abstract and bibliographic database Scopus for the period 1994–2023 (Fig. 1). The active growth of publications in this area of knowledge has been observed since 2013. The number of publications is growing rapidly over the last 10 years. This is due to both the development of neurotechnologies themselves and the interdisciplinary nature of the chosen topic.

Neurotechnologies can be actively applied in various fields of economics: medicine, neurobiology, psychology, humanities and social sciences, marketing, art, etc. (Fig. 2).

Neurosciences are well funded by governments and large corporations. This fact is explained by the number and significance of the problems they are designed to solve, as

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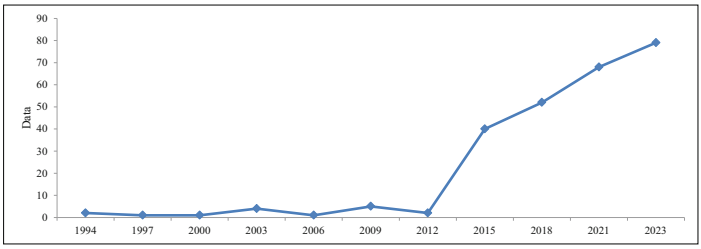


Fig. 1. Publications in the Scopus database devoted to neurotechnology, 1994–2023 (Source: authors).

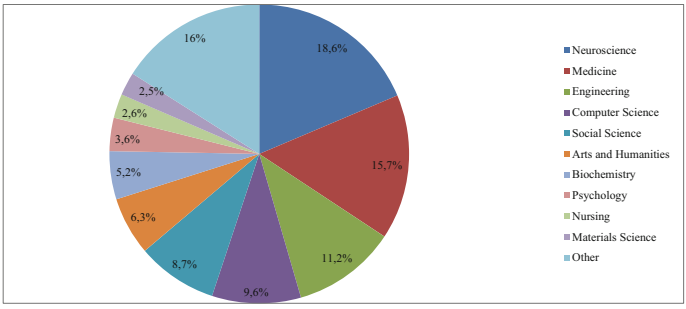


Fig. 2. Publications in the Scopus database devoted to neurotechnology, 1994–2023 (Source: authors).

well as by the wide public recognition of these problems and decent profits. The fact is that successful solutions based on neuroresearch can markedly increase the margins of corporations and the state. Therefore, today the question of whether neurotechnologies will develop is no longer a question. What is important is how rapid this development will be.

First of all, we are talking about the application of neurotechnologies in the field of marketing research. Marketing research in this area has always been in demand in the market. Over time, only some methods of conducting them have changed and improved. At the beginning of the XXI century, it became clear to marketing analysts that standard qualitative and quantitative methods are not enough to analyze consumer behavior [1]. Around the same time the issues of consumer behavior are studied, which are influenced by various incentives. Scientists come to the conclusion that the purchase process cherished by marketers for understanding occurs at the unconscious level [2–4]. All this creates prerequisites for the adaptation of neuroresearch methods, which are already being actively developed in the field of biomedicine and clinical psychology, to the sphere of marketing. Active discussions about possible directions of application of neuroresearch methods for studying consumer patterns and choice criteria are beginning. But there is another non-obvious side of the issue. Much of the criticism of neuroscience is based on ethical issues. Let us address them in more detail.

2 Methodology

For systematization we used basic methods of information collection and processing, in particular, the method of traditional (classical) analysis. To strengthen the classification, we added formalized methods: content analysis, information-target analysis. Methods of graphical interpretation of the collected information were used for visualization. As a result, we formed two summary tables. In the first table we presented a systematization of ethical problems regarding different stages of neuromarketing research development. In the second, we grouped the identified problems in relation to the participants of the neuromarketing research process. Then we proposed possible ways of solving these problems taking into account the necessary tools.

Neuromarketing research can be conducted in the direction of all elements of the 4Ps marketing mix (product, price, sales and promotion). In the field of product research with the help of neuromarketing research methods, it is possible to test consumers' perception of a new product, its packaging, name, organoleptic properties; in the field of price research – to test consumer reactions to price reduction/increase, to price promotions, to determine optimal prices; in the field of research of sales outlets – to study consumer reactions to merchandising in retail outlets (for example, to track the level of reaction to the design of product cards in online storefronts, to measure the intensity of emotional reaction when shopping in a store. In the field of communications – to test advertising creatives, communication messages, to conduct usability tests, etc.).

Today there are more than 20 companies and their affiliates operating in the foreign market (including the companies that are members of the Neuromarketing and Business Association (NMSBA). The leading countries in the field of neuromarketing research are the USA, the UK and the Netherlands. In the USA alone, $140 million was allocated in 2023 to fund 7 R&D laboratories for the development of research involving AI. There are about 10 companies operating in the Russian market that provide neuromarketing research services. The market leader is the Neurotrend company. Its value lies not only in the scale of its activities. It should be noted that the company has opened 19 laboratories with an extensive geographical coverage: Moscow, Kazan, Tomsk, Yekaterinburg, and Singapore. Along with commercial projects, the company's management is actively forming and developing a scientific research platform. Thus, the company is popularizing a direction that is still new for the Russian market [5]. Along with the development of new areas of neuromarketing research, the scenarios and methods of conducting them are developing.

3 Literature Review

Neuroethics is a subsection of bioethics. The term «neuroethics» has been used since the 1970s. During this period, neuroethics dealt exclusively with issues of medical nature, namely the issues of interaction with sick people with brain disorders. The application of the results of neuroethics research in other fields of knowledge (trade relations, development of intellectual systems, marketing, personnel management, etc.) expands the concept of neuroethics. S.J. Marcus defines neuroethics as «a discipline related to emerging technologies, in which the rights of treatment of the human brain are discussed» [6, p. 315]. M.J. Farah [7] notes that neuroethics aims to study ethical, legal,

and social implications of neuroresearch for individuals and for society as a whole. Given the innovations in the development of neurodisciplines, neuroethics in particular will lead to new thinking that goes beyond the boundaries of bioethics, which is not always able to comprehend the problems due to the wide field of view [8]. Concepts like Two-Eyed Seeing, in which people with the same neural code react differently to incentives, are developing. Such uniqueness is formed by the cultural environment in which the brain evolves, which seems to balance universal perception and diversity [9].

Among the main directions of protection of human rights and freedoms in the context of rapid development of cognitive sciences are: protection from unfair use of manipulation tools in advertising and providing the possibility to consider illegal transactions made under the influence of neuromarketing. Interdisciplinarity in neuromarketing research can be traced not only in its methodology, but also in the issues of neuroethics. This is a complex interdisciplinary problem of strategic scale. It is necessary to involve philosophers-methodologists, specialists in the field of ethics and law and representatives of neuroscience to solve this problem. In the interdisciplinary approach, neuroethics is defined as a meta-science that combines the issues of medical, neurobiological, socio-economic and socio-psychological ethics.

Today, great expectations are placed on the development of neurotechnologies in terms of solving many significant problems in various areas of the economy. But the lack of a reliable system of regulation of non-invasive methods combined with modern capabilities of artificial intelligence raises a lot of questions of ensuring cognitive safety of society. An attempt to introduce regulatory measures in the field of neuromarketing was made by the Neuromarketing and Business Association (NMSBA), the main provisions were fixed in the code of ethics of neuromarketing developed by it. The main tool for controlling non-compliance with the above code is expulsion of the offending company from the association, which, in our opinion, is an insufficient measure. Another example of an attempt to regulate neuromarketing research is the French legislation. The country's Civil Code (Articles 14–16) [10] states that brain imaging techniques may only be used for medical or research purposes, or in the context of forensic science.

To date, few countries have amended their constitutions on the ethical use of neurotechnology. Among them are France, the UK, Spain and Chile. At the 42nd session of UNESCO (held from November 7 to 22, 2023), the issue of ethical and legal aspects of neurotechnology development was raised. Participants indicated that it is urgent to create a common ethical framework at the international level, as UNESCO did for artificial intelligence in 2021. Neurodata cannot be collected without neurodiversity. A working first draft of the Recommendation on the Ethics of Neurotechnology has now been prepared by a UNESCO expert group (UNESCO report, April 22–26, 2024) [11]. Its aim is to identify and systematize all ethical issues in the regulation of neuromarketing research and to find possible ways to address them.

4 Results

The evolution of neuromarketing research is presented in chronological order. At the same time, the emerging limitations at each stage are outlined (Table 1). Neuroresearch involves the use of specialized equipment to observe brain parameters: Functional magnetic resonance imaging (fMRI), Positron emission tomography (PET) scanning, Bispectral Index (BIS), Transcranial ultrasonography (TUS), Transcranial magnetic stimulation (TMS), Electroencephalography (EEG), Magnetoencephalography (MEG), Facial Action Coding System (FACS) (face reading), heart rate variability (HRV), cutaneous galvanic response (CGR), photoplethysmogram (FPG), eye tracking. This was also taken into account in the formation of the chronology.

The common problem area for the development of all the above-mentioned areas is ethical issues. As we move from laboratory experiments to the use of neurointerfaces, the number of ethical issues is growing. Today it is a global interdisciplinary problem for all those whose activities are related to the use of neurotechnologies.

Table 1. Developments in neuromarketing research.

Development direction	Technology	Limitations
Laboratory experimentation	fMRI, PET scanning, BIS, TUS, TMS, EEG, MEG, FACS (face reading), HRV, CGR, FPG, eye tracking	1. The naturalness of the respondent's behavior is influenced by: simulation of demonstration of the stimulus material (advertising media, store window, etc.) and the respondent's tension due to the use of equipment 2. Limited sample 3. Ethical issues
Field experimentation	EEG, FPG, BCP, КГР, FACS (face reading) using high-sensitivity cameras, mobile eye tracking	1. The naturalness of the respondent's behavior is affected only by the respondent's tension due to the use of the equipment The conditions of the stimulus material demonstration become natural, but the experimentation scenarios become more complex 2. Limited sample 3. Ethical issues
Data collection involving real customers	Face reading technologies using high-sensitivity cameras that read facial expressions to identify key emotions	1. Ethical issues 2. Issues of legal regulation of customer surveillance

(*continued*)

Table 1. (*continued*)

Development direction	Technology	Limitations
VR experiments (integration of neurotechnology and virtual reality)	Combining VR headset with EEG, HRV, CGR, eye tracking, face reading devices	1. Simulation of the real environment through virtual reality approximates, but does not fully immerse the respondent in the natural environment 2. Ethical issues
Using neurogadgets and neurointerfaces	Combining gadgets (smartphones, smart TV, etc.) with neurotechnologies (eye tracking, face reading, etc.), brain-computer interfaces	1. Ethical issues 2. Legal issues 3. Cultural conservatism of clients. Distrust of devices that affect the brain So far acceptable for the field of medicine and rehabilitation of people with neurodiseases

Source: authors

As a result of analyzing the works devoted to the issue under study [12–15], the main problems of neuromarketing research lying in the plane of ethical issues were formulated. The first problem is ensuring the confidentiality of neuroresearch. This problem can be divided into two blocks: protection of information obtained in the course of neuroresearch from unfair use and issues of protection of personal data of respondents (including those obtained in the course of psychophysiological measurements). The second problem is that ethical violations of interaction with respondents may also arise in the process of measurement itself. For example, brain diseases or any abnormalities may be found, «the plan of action in such situations is not yet established by regulation» [13, p. 824]. The third problem is the potential imposition on a wide range of customers of decisions developed on the basis of analyzing the reactions of a small group. The fourth problem is the possibility of discrimination of respondents on a number of grounds. For example, people with mental or physiological disabilities are usually excluded from the sample. There are other examples of discrimination related to the requirements for the use of equipment. For example, an eye tracker does not record or does not record correctly enough the data of people with ophthalmologic diseases, etc. The fifth problem is the use of neuromarketing techniques for people with impaired ability to make rational choices due to various reasons (age, illness, mood). Thus, their vulnerability in making purchasing decisions is exploited. The sixth problem is the disruption of healthy competition. By understanding the principles of influencing consumers' unconscious purchase decision-making mechanisms, companies may focus less on developing the product itself. Also, the results of neuroresearch can be used to distribute products of inferior quality. The seventh problem is that the public is concerned about neuroscience research due to lack of public awareness.

The public is concerned about the possibility of using the results of neuromarketing research in the formation of mechanisms for controlling masses of people, which increases the cognitive vulnerability of society. To prove it, let us cite just a couple of judgments: «in the new reality there is a possibility to control masses of people, setting

not only their purchasing, but also political behavior» [12, p. 26], «with the help of knowledge revealed in the course of neuromarketing research it is possible to control public opinion, and this applies not only to marketing, but also to politics» [16, p. 67].

These issues are partly addressed by institutional regulation. The interdisciplinarity of neuroethics opens the field for the development of institutions that are already separating from biomedicine in various directions. Among them we can distinguish academic associations, for example, the International Neuroethics Society. There are also projects that are funded by the government, such as the NIH BRAIN Initiative Working Group. Finally, entire journals on neuroethics issues, such as AJOB Neuroethics, are emerging as part of academic development.

The French experience described above is an important but overly radical measure to regulate neuromarketing. The consequences of introducing such a measure in Russia may be a serious lag of Russian companies behind their foreign colleagues. The ICC/ESOMAR International Code of Practice for Marketing and Social Research, Opinion Research and Data Analysis [17] outlines the researcher's obligations to respondents (data subjects), clients (research customers), the public, and the professional community. It is possible to categorize all previously discussed ethical issues in neuromarketing research into these four groups (Table 2).

Table 2. Ethical issues in neuromarketing research.

Group	Ethical issues
Respondents (data subjects)	Ensuring confidentiality of information received Protection of personal data Possibility of discrimination of respondents on a number of grounds Problem of possible detection of brain diseases and other abnormalities during psychophysiological scanning of respondents
Client (customer of the research)	Possibility of using the results of neuromarketing research to sell goods of inappropriate quality Possibility of conscious manipulation of consumer behavior Possibility of using price discrimination
Public	Publication of unreliable results due to small samples and further imposition of decisions derived from these unrepresentative samples on a wide range of people Impact on people with impaired capacity for rational choice Inappropriate use of neuroscience research has an impact on the cognitive safety of society Public lack of understanding of the potential of neuroscience research
Professional community	Publication of unreliable results due to small samples, which may be subject to serious criticism by the public and the state

Source: authors

Let's highlight the ways of solving these ethical problems for each group.

It is important for the respondents (data subjects) to raise the level of knowledge in the issues of personal data handling. For this purpose, popularization should be carried out with the help of special literature and mass media. To increase the competence of clients (customers of neuroresearch), it is necessary not only to increase the level of knowledge, but also to develop open data policies that neuromarketing uses.

Self-regulated public organizations with the participation of non-profit organizations (NPOs) and government agencies are becoming the main tool for solving neuroethical problems in relation to the public. Together they are called upon to develop principles and policies for neuromarketing ethics.

The professional community in terms of neuroethics development also needs institutions. Among the key options are self-regulatory organizations with the participation of community representatives and the academic sector. Together they can create a basis for the introduction of neuromarketing principles and policies at the level of scientific development and implementation.

5 Conclusion

The development of an effective framework for regulating ethical issues in neuromarketing research is a complex cross-methodological and interdisciplinary task. It requires the involvement of the following specialists: philosophers-methodologists, specialists in neurobiology, law, sociology, psychology and marketing. Neuroethics has long gone beyond the problems of biomedical research. Speaking about neuroethics today, we mean issues of neuroresearch not related to human health. This includes the ethical issues of conducting and using neuromarketing research data.

Neuromarketing research provides companies with huge amounts of data on consumer reactions. If this material is properly processed and systematized, they actually receive a powerful tool to influence customer behavior. It is important for companies-customers of neuromarketing research to determine the prospects of solving ethical problems. Among them we would like to single out the development of additions to the standards of corporate and social responsibility (CSR). Of course, to support customer responsibility, it is important to reinforce industry standards, in particular, to develop and implement the provisions of the Russian Code of Neurotechnologist.

To date, the first steps have been taken in the development of basic regulations governing activities in the field of neurotechnology development and application. According to a number of studies, government agencies should be involved in the regulation of neuromarketing. They should monitor the certification of neuromarketing companies and check the companies that are members of the community for the correctness, ethics of research and the legality of the use of the data obtained through independent audit tools. Thus, for professional communities from the point of view of solving ethical problems we can emphasize the state regulation of certification. Neuroresearch companies receive control with the use of independent audit tools. The idea of independent auditing of neuromarketing companies can be found in modern literature. The idea of creating a system of self-regulatory organizations that aim to form not only rules for scientists, but also to create ethical standards and a code of neuroethics seems promising. They ensure

transparency of research, which is necessary for the development of neuromarketing. In our opinion, an important task is to find a balance between strict regulation of this issue based on the French experience and complete lack of control.

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Ethical Guidelines for the Use of Artificial Intelligence in Education

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Abstract. This work investigates ethical challenges of integrating artificial intelligence (AI) into educational processes, focusing on the Russian context. While AI offers significant benefits, such as adaptive learning systems, automated assessments, and personalized education, it also raises critical ethical concerns. These include over-reliance on technology, diminished critical thinking, plagiarism risks, digital inequality, and accountability issues. The study employs a mixed-methods approach, combining retrospective analysis of legislative frameworks, secondary data analysis, and a sociological survey of first-year management students at Kazan Federal University (KFU). Key findings reveal that 79.3% of respondents use AI tools (e.g., chatbots like GPT) for academic tasks, yet 56.5% disclose their AI usage only upon request, highlighting transparency gaps. The authors analyze existing ethical guidelines, such as Russia's 2021 AI Ethics Code and UNESCO recommendations, emphasizing principles like fairness, transparency, and accountability. Case studies from leading Russian universities, including KFU and Tomsk State University, illustrate efforts to balance AI integration with ethical safeguards. The contribution concludes with policy recommendations: establishing clear ethical standards, enhancing digital literacy programs, implementing monitoring systems, and fostering collaboration among stakeholders. Additionally, it proposes student-oriented principles (e.g., honesty, responsibility, critical engagement) to guide ethical AI use in academia. This research underscores the urgency of addressing ethical dilemmas to ensure equitable and responsible AI adoption in education, contributing to global discourse on AI governance.

Keywords: Artificial Intelligence · Artificial Intelligence Code of Ethics · Artificial Intelligence in Education · Ethics of Artificial Intelligence Use · White Paper

1 Introduction

The term «artificial intelligence» was first introduced by McCarthy during the Dartmouth Workshop in 1956 [1]. This workshop became a milestone in AI history, as it addressed key issues related to AI development, such as modeling human intelligence and creative processes through computational machines. Currently, the AI market is growing by 20% annually and is actively applied across various industries (Fig. 1).

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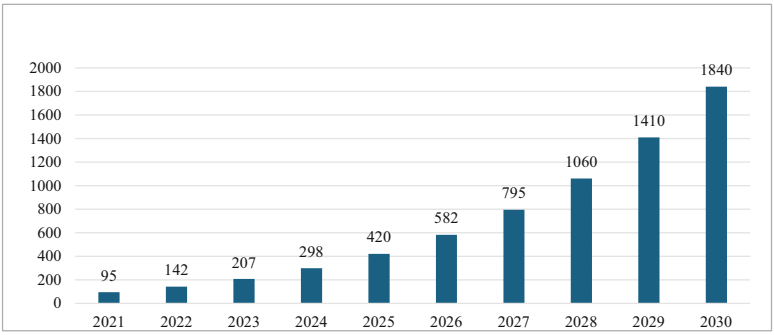


Fig. 1. International Artificial Intelligence market size (2021–2030) (Source: authors based on [2]).

For example, the financial sector, healthcare, entertainment, and media are leading in AI adoption. In education, AI is used to create adaptive learning systems that tailor educational materials to individual student needs. Platforms like Khan Academy and Coursera employ AI algorithms to personalize learning, improving student performance by 20–30%. Additionally, AI automates assignment grading, saving instructors' time. Virtual tutors and chatbots assist students in solving problems and explaining complex topics. According to HolonIQ [3], investments in AI-driven educational technologies are expected to reach $6 billion by 2025. Thus, AI is penetrating more industries, improving processes, reducing costs, and creating new opportunities for business and society. Institute for the Study of Global Markets predicts that the AI market will grow twentyfold, reaching nearly $2 trillion by 2030 [4].

2 Methodology

The study aims to explore ethical guidelines for AI use in education to develop recommendations for students. The research objective are to synthesize opinions and define ethical guidelines for students regarding AI use in education, focusing on ethical challenges in academic activities. The methodological framework includes: 1) retrospective analysis of historical data, legal norms, and trends in AI use in education; 2) hypothesis formulation and verification through logical reasoning; 3) secondary data analysis of existing research and studies; 4) systematization and evaluation of data to identify key ethical guidelines. A sociological survey was conducted among first-year students at Kazan Federal University (KFU) to deepen understanding of AI usage patterns.

3 Literature Review

In Russia, the term «artificial intelligence» is defined by Federal Law No. 123-FZ [5], as a set of technological solutions that mimic human cognitive functions (including self-learning and non-algorithmic problem-solving) to achieve results comparable to human intellectual activity [5]. Currently, 43% of Russian organizations use AI, doubling since

2021 [6]. Approximately 72% of companies apply AI for business process optimization, particularly in finance, IT, and energy sectors. AI is also being integrated into Russia's educational system, covering schools and universities. According to [7], AI will automate homework grading to reduce teacher workload and enhance efficiency. Additionally, GOST R 71657–2024 [8] establishes rules for AI use in academic research. Leading Russian universities in AI-driven adaptive learning include:

1. Moscow Institute of Physics and Technology (MIPT).
2. National Research University Higher School of Economics (HSE) which rank among the top providers of artificial intelligence expertise and actively leverage AI to optimize their educational programs.
3. ITMO University is a leader in artificial intelligence too and implements adaptive learning technologies to improve the quality of education.
4. Lomonosov Moscow State University (MSU) and Saint Petersburg State University (SPbU) actively use artificial intelligence to create personalized learning programs and analyze student performance [9].

These institutions develop AI systems for personalized learning and train specialists in AI, contributing to national technological advancement. Approximately 72% of educational institutions in Russia already apply artificial intelligence technologies. In 2024, over 10,000 schoolchildren from 80 regions of the country participated in the All-Russian Olympiad in Artificial Intelligence. There is also a growing number of bachelor's and master's programs in «Artificial Intelligence» at Russian universities. However, the implementation of artificial intelligence technologies in education faces certain challenges, the key one being the ethical application of artificial intelligence.

4 Results

The ethical concerns surrounding the advancement of artificial intelligence are profound and originated in the mid-20th century. Even then, scholars and philosophers were issuing warnings about the potential hazards and ethical quandaries in relation to the creation and application of intelligent machines. N. Wiener [10], a cybernetics pioneer, warned about automation's social and ethical consequences, including job displacement and inequality. The researcher highlighted the potential for technology to result in the dehumanization of work, widespread unemployment, and a widening gap in social equality. He also questioned who would be be responsiblefor the behavior of autonomous systems. H. Dreyfus [11] challenged the notion that machines could perfectly reproduce human intellect. J. Weizenbaum [12], creator of the ELIZA chatbot, criticized replacing human decision-making with machines in sensitive fields like healthcare, education, and the justice system. He also cautioned against the dangers of societal dehumanization and the erosion of moral accountability. Furthermore, in 1942, Isaac Asimov's Three Laws of Robotics, first presented in the short story «Runaround» [13] became a foundational basis for ethical discussions about the behavior of robots and artificial intelligence. These laws, although created within the framework of science fiction, had a significant impact on the development of modern ethical norms for artificial intelligence. Since then, several hundred different acts, guidelines, principles, and codes dedicated to the

ethics of artificial intelligence have been adopted worldwide. Currently, there are several international standards and recommendations on the ethics of artificial intelligence that have been developed by various organizations and countries. Some of the most significant documents are UNESCO Recommendations on AI Ethics, EU AI Act, IEEE P7000 Standards, Council of Europe Guidelines, Corporate AI Ethics Codes (e.g., Microsoft, Google). A lot of large companies, such as Microsoft, Google, and Sony, have developed their own corporate codes of AI ethics. These documents often include principles of transparency, accountability, and respect for human rights.

In Russia, there are several standards and codes of AI ethics that have been developed to regulate the use of artificial intelligence in various fields. In October 2021, the «Code of Ethics for Artificial Intelligence» was signed [14], developed based on the «National Strategy for the Development of Artificial Intelligence for the period up to 2030» [15]. The document was signed by members of the Alliance in the Field of Artificial Intelligence: Sberbank, Gazprom Neft, Yandex, VK, MTS, the Russian Direct Investment Fund, representatives of Skolkovo, Rostelecom, Rosatom, InfoWatch, and TsIAN. The core principles include transparency, truthfulness, responsibility, reliability, inclusiveness, impartiality, safety, and confidentiality. A year earlier, in 2020, the «White Paper» on Artificial Intelligence was published [16]. It outlined key areas for technology development, legal and ethical aspects, and measures of state support. The «Code of Ethics for Artificial Intelligence» and the «White Paper» are complementary documents, but they serve different functions. The Code focuses on ethical principles and norms that should be observed in the development and use of artificial intelligence, while the «White Paper» is an analytical document describing the state and prospects for the development of artificial intelligence in a broader context. The main differences are presented in Table 1.

Table 1. Comparative analysis of ethical documents in AI sphere.

Aspect	Code of Ethics for Artificial Intelligence	White Paper
Document Type	Recommender Principles	Analytical Report
Purpose	Establish Ethical Norms	Analysis of the current state and future prospects of AI
Content	Ethical Rules	Technology, Market, and Legal Analysis
Legal Status	Non-binding	Policy Recommendations
Signing Year	2021	2020

Source: authors.

In addition to commercial organizations, several research institutions and universities have joined the Code of Ethics for Artificial Intelligence, such as several Russian universities signing this Code. Among them, there are the Presidential Academy, St.

Petersburg State University of Economics, Moscow State Linguistic University, Financial University under the Government of the Russian Federation, Tyumen State University (TSU), Sechenov University, Plekhanov University, the University Consortium of Big Data Researchers, and Tomsk State University. These universities, as well as many other organizations, joined the code to ensure the responsible and safe use of artificial intelligence technologies in Russia. Let's highlight the ethical issues of using artificial intelligence by students:

1. Over-reliance on technology: students may become too dependent on artificial intelligence, which can hinder the development of critical thinking and problem-solving skills.
2. Impact on cognitive skills and creativity: excessive reliance on artificial intelligence can stifle students' critical thinking and creativity, which are important aspects of education.
3. Issues with plagiarism and authenticity: using artificial intelligence to complete assignments can lead to problems with plagiarism and a decrease in the quality of original work.
4. Digital divide: not all students have equal access to technology and artificial intelligence, which can exacerbate educational inequality.
5. Responsibility and transparency: It is necessary to ensure transparency in the use of artificial intelligence and to define clear boundaries of responsibility and areas for the use of artificial intelligence in the educational process.

To further develop this topic and determine the experience of using artificial intelligence in the educational process, we conducted a survey among students at Kazan Federal University. Kazan Federal University is actively developing the field of artificial intelligence through the creation of the Institute of Artificial Intelligence, Robotics and Systems Engineering.

KFU also offers a program for Artificial Intelligence Specialists, who are engaged in the design, development, and practical application of machine intelligence systems. The KFU Institute of Artificial Intelligence is working on projects within the framework of national programs and strategies for the development of artificial intelligence, which includes the implementation of projects in the field of the digital economy and unmanned aerial systems. This aims to ensure the university's competitiveness in the field of artificial intelligence and robotics. Thus, Kazan Federal University is one of the leaders in Russia in the development of artificial intelligence and robotics, offering both educational programs and practical projects in this area.

To determine how relevant the issue of regulating the use of artificial intelligence is in the learning process at the Institute of Management, Economics and Finance of KFU, it was decided to conduct a study among first-year students studying in the «Management» program. A questionnaire of 9 open-ended and closed-ended questions was compiled, and the population was defined. The total number of students is 150, and the sample size was 116 respondents. The sample was formed using a spontaneous selection method by sending a Google survey to potential respondents. For a population of 150 people with a 95% confidence interval and a 5% margin of error, the required sample size was 108 students. Since the characteristics of the sample are close to the characteristics of the population, this indicates its representativeness.

The main results showed that 79.3% of respondents use artificial intelligence in their studies. Most often, this occurs for preparing for seminars, completing project work, and preparing for tests and exams. Students commonly use artificial intelligence to complete reports, term papers, presentations, etc.

Interestingly, when answering the question: «Do you indicate in these types of work that you used artificial intelligence?», 56.5% of respondents answered «only if the teacher asks». 15 out of 116 people honestly answered that they do not indicate the help of artificial intelligence when preparing an answer at all.

As it turned out, the vast majority (77.2%) of students work with a free version of a GPT4 chat in a Telegram bot. YandexGPR is the second most popular. Free versions have certain drawbacks, such as limited features and limitations in training, which can affect the results returned in response to queries. Interestingly, most of those who answered that they do not use artificial intelligence (24 out of 116 respondents) cited «distrust in the quality of the result» as the reason.

The study confirmed that students actively use artificial intelligence in their studies, but mostly do not know how to do it ethically. In this issue, it is also interesting to consider the experience of Tomsk State University, where a flexible regulatory tool was used to create an ethical framework for the use of artificial intelligence in the educational process. It is of a recommendatory nature. In 2024, Tomsk State University (TSU) was awarded a prize for the development of artificial intelligence ethics. TSU's main task was to develop mechanisms for using artificial intelligence systems in the educational process so that they help improve the quality of educational outcomes, rather than replace them. According to the TSU website, the mechanism for considering ethical disputes at the university is planned to be built on the basis of the Research and Education Center «Institute of Law and Ethics», using the experience of the Ethical Committee for Interdisciplinary Research. The AI usage policy approved at the university is addressed to all participants in the educational process: students, teachers, administrative and managerial staff, as well as third parties who relate to the university's educational activities.

5 Conclusion

In Russia, there is currently no legislation restricting or prohibiting the use of artificial intelligence by either subjects or objects of the educational process. To address ethical problems in education, it is necessary to develop clear ethical standards for the use of artificial intelligence in education, taking into account confidentiality, fairness, and transparency; to conduct educational programs on digital literacy and ethical practices for students and teachers; to create systems for monitoring and evaluating the ethical consequences of using artificial intelligence in the learning process; to strengthen cooperation between educational institutions, research institutes, and government bodies to develop legislation and standards governing the use of artificial intelligence in education. In conclusion, we would like to present the «Principles of Ethical Use of Artificial Intelligence» by TSU students, which could serve as ethical guidelines for students of all universities in Russia:

– openness (to be open to new technologies, and therefore learn to correctly use artificial intelligence to solve educational and professional tasks, share successful experiences and work with new services, and discuss with teachers in which disciplines and for what purpose artificial intelligence can be used);
– honesty (not to hide from teachers the use of artificial intelligence to solve specific tasks);
– accuracy (generative artificial intelligence learns on outdated data, can make mistakes, and invent non-existent facts, it is worth checking the accuracy of information before further use);
– development (to use artificial intelligence to solve intermediate tasks and not to shift all tasks to it);
– responsibility (to realize that artificial intelligence is just a tool and we are responsible for the results of its use and the improvement of this technology).

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Ethics of Using AI in Writing Student Research Papers

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Abstract. The introduction of artificial intelligence (AI) tools into the educational process raises new ethical issues, especially in terms of student research papers. Students are increasingly using AI to write essays, analyze data, and even generate hypotheses for their graduation theses. However, the lack of clear rules for the use of such technologies creates risks of academic dishonesty. The study is devoted to the ethics of using artificial intelligence in writing student research papers. The aim of the study is to develop a balanced approach to assessing the ethics of using AI in the educational process. The work analyzes the key issues associated with the use of AI in higher education institutions: plagiarism, transparency of methodology, and responsibility for the reliability of data. Data and cases from Russian and international practice are provided, and recommendations for integrating ethical norms into academic standards are offered. The approach is partly innovative, as it is based on the authors' expanded interpretation of the ethics of using AI. The authors conclude that the ethical use of artificial intelligence in the educational process is possible provided that the necessary skills and competencies are developed, as well as subject to strict adherence to educational standards and principles of academic ethics. The analysis of the role of AI in writing student research papers remains the key aspect.

Keywords: Adherence to Ethical Norms · Chatbot · Ethics of Using AI. · Generated Text · Neural Network · Plagiarism · Student Research Papers · Use of AI

1 Introduction

Due to the development of programming and training of neural networks, the use of AI in various fields, such as art, science, education, etc., has recently been gaining momentum. For example, among the modern priority areas of research in the field of artificial intelligence, the following can be distinguished: architecture and algorithms for machine learning, computing and data for AI, fundamental and generative models, human-AI interaction, as well as applied research for science, education and the social sphere. The index of readiness of higher education for the implementation of AI is in the 1st place and occupies one of the leading positions in the speed of implementation of AI [1] (Table 1).

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Table 1. The place of AI in higher education among priority sectors.

	2024 (positive response, %)	Place
Total share of AI users	72	1
Readiness	72	1
Sufficiency of AI products	49	3
Availability of Russian AI products	41	4

Source: authors

The National Commission for the Implementation of the AI Ethics Code developed «The White Paper Ethics in AI» of advisory nature. Affiliating with this code is voluntary and applicable to civil projects only. Among the Commission's recommendations is the development of regulations and methodological recommendations for ethics of the use of AI for educational purposes by universities [2]. In this regard, the most important question arises about the ethics of using AI in general and the use of AI in writing student research papers (term papers, final and master's theses).Can the generated text be considered authorial, being the result of the student's creative thinking, or not? And when will the use of generated text be considered plagiarism?

2 Methodology

The methodology for studying the complex, multi-faceted problem of the ethics of using artificial intelligence in writing student research papers involves the use of both theoretical and empirical research methods. The use of AI by students is analyzed in the scope of scientific ethics, training of sought-after competitive specialists, as well as from the standpoint of identifying the points of least resistance to change, innovation, and overcoming the inertia of the education system development. Analytical methods, including conceptual analysis, statistical data analysis, content analysis, as well as expert methods – ethical expertise – are used in the study. The approach is partly innovative, as it is based on the authors' expanded interpretation of the ethics of using AI.

3 Literature Review

In one of the interviews Y. Chekhovich, the executive director of the «Antiplagiat» JSC, noted that «Technically, a text generated by a neural network cannot be considered plagiarism… The neural network does not have consciousness, intention or copyright, and, legally speaking, text generation using AI is not plagiarism» [3, p. 14]. He also notes that further use of such text «may contain signs of plagiarism or violation of academic ethics». This raises the question: How is it possible to determine when the use of generated text goes beyond the bounds of academic ethics? Would it be considered unethical to use a small amount of generated text or a full-fledged article written using a neural network?

There is still no clear answer to these questions, and there are still debates among lawyers and chatbot developers on this matter. But it is essential to recall that some chatbot developers include a clause in their user agreement stating that all texts generated by their network are the property of the company. Therefore, adding such text to one's paper is a violation of copyright. It brings us to the first ethical rule for using AI: the author must indicate that they used the generated text, and also specify the name of the neural networks and/or chatbots that were used to generate the text.

Another issue concerning the ethics of using AI in writing student reports is the reliability of the data obtained from the neural network. There is no guarantee that the texts generated by the neural network are based on the analysis of real research papers. Therefore, it is necessary to know what programs, algorithms and databases have been utilized to train the neural network which the student uses when writing their own work. The student needs to be sure that the information gained has real scientific validity and is not a figment of the neural network's «imagination». AI and its developers cannot be held responsible for the accuracy of the data. This responsibility is assumed by the student generating the texts in the chatbots. Then the student shares this responsibility, by misleading the academic advisor, the department, the university, and the community.

The use of AI raises concerns about its impact on the authenticity and credibility of academic work, as has been discussed in research papers by [4]. The researchers note the need to discuss options for using AI, consider the consequences of its use, and make some recommendations for scientists, including a call to be careful when using AI in their work. M. Khalifa and M. Albadawy [5] studied the integration of artificial intelligence in academic writing and concluded that AI helps in various research endeavors, but there are some challenges remaining, such as maintaining academic integrity and the balance between «the use of AI and human understanding». In their opinion, AI is significantly changing academic writing in various fields, so ongoing research and development is essential to address emerging issues and ethical considerations in case of applying artificial intelligence in the academic environment. D.B. Resnik and M. Hosseini [6] note that «the use of artificial intelligence in research offers many important benefits for science and society, makes new and complex ethical issues». They believe that researchers are responsible for errors that may occur when using AI, and therefore have a responsibility to indicate what data is generated. Scientists note noted that AI's ability to automate laborious tasks has opened up opportunities for unethical practices. They argue for the need for improved AI-based plagiarism detection tools, call for careful assessment of the extent to which AI is used in academic work, and an understanding of the implications of AI for scientific ethics [7].

4 Results

Developers consider AI a tool, the success and ethical use of which depend on the user, with regard to taking away routine work and leaving creative activity to the human agent. For example, AI can inspire students by offering them a number of solutions from which they can create their own later. When using it, we can talk about acquiring knowledge, skills, and abilities of a higher level. But this is a perfect application of AI. In this case, the ethical issue would be the reference to the generative model used. There is a mistake

that is common for news channels, where they state that the text was created by AI, but AI itself cannot create anything – it is a human agent that creates it using AI: a human agent sets a task, the criteria for its implementation, and chooses the best option. Therefore, there is a need to introduce parameters for AI citation. In 2024, the Higher School of Economics announced a Competition for skills of using AI tools based on machine learning in writing research papers. Experts assessed the level and complexity of the tasks to be solved, the ethics and advisability of using AI [8]. The Table 2 represents the main ethical issues of AI use by students.

Table 2. Key ethical issues of using AI in scientific reports.

Principles of academic ethics	Issues of using AI in scientific reports
Integrity	AI can submit a figment of a neural network's «imagination», distort the facts
Supremacy of scientific evidence	Ambiguity of the significance and reliability of a scientific result without additional verification
Accuracy of scientific results presentation	The use of references, fair recognition of merits and appropriate assessment of predecessors' contribution are often violated
Accuracy of publications' authorship attribution	AI is capable of generating texts that are close to human ones, which makes plagiarism tricky to detect. It is difficult to reliably determine a student's contribution to the analysis of a problem
Authenticity	AI may provide inaccurate or outdated information
Validity of a scientific discussion	The elements of a scientific discussion are not always presented correctly and reliably, verification of the scientific discussion is necessary
Training quality	If using AI, a student may not acquire all the necessary competencies
Fair scientific competition	Not all students have access to charged AI tools
Accuracy of affiliation and acknowledgements	AI uses preceding papers of many authors, it is difficult to trace the primary source
Motivation	The desire to simplify academic work often results in the «substitution» of motivation for acquiring new, more complex competencies, increasing the risks of academic dishonesty

Source: authors

Compliance with the ethical principles of using AI in the learning process begins from the moment students become aware of cause-and-effect relationships in the event of their violation. The use of AI is one of the auxiliary, but far from key modern skills. The quality of the education received, the improvement of professional knowledge, skills, and abilities are indicators of future success and demand in the labor market.

5 Conclusion

Thus, the use of AI in education is regulated by the rules of the educational institution and the general regulations of the academic community. If the skills of using AI are included in the list of acquired competencies, then AI will be used in students research papers and the main principles of academic ethics will not be violated: integrity of presenting scientific materials, accuracy of the author's own and others' scientific results presentation, accuracy of affiliation and acknowledgements – then it can be said that AI is used in an ethical manner. Here, special emphasis must be placed on what exactly the student has accomplished with the help of AI, what competencies they acquire, and what competencies they lose. For example, working with primary sources, text editing, and layout belong to one cohort of competencies. But if AI ultimately replaces the author, and the author does not verify the work, does not critically evaluate the result, the text is mostly just copied – then it is a violation of academic ethics, and the meaning of a graduation thesis as a culmination of the competencies being accomplished is lost. AI is a powerful tool for science, but its use requires rethinking of ethical standards. Only a balance between innovation and academic integrity will ensure that student research remains credible and relevant.

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Legal Aspects of Using AI in Education

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Abstract. The work is devoted to the study of legal aspects of the introduction of artificial intelligence (AI) technologies into the educational process. Some specific features o Legal Aspects of Using AI in Educationf legal regulation of relations between participants in the educational process when using AI technologies are considered, problems of law enforcement practice are highlighted and ways to solve them are proposed. International standards and legislation of the Russian Federation regarding the use of AI in educational institutions are analyzed. Artificial intelligence is becoming an integral part of modern society, penetrating almost all spheres of life, including education. The use of intelligent systems allows us to optimize learning processes, improve the quality of education, and create personalized educational trajectories. However, the introduction of AI is also accompanied by a number of legal issues related to the protection of personal data, copyright, liability for damages, ethical standards, and confidentiality. The purpose of this contribution is to identify legal risks and propose mechanisms to protect the legitimate interests of participants in the educational process when introducing AI technologies in Russian schools and universities.

Keywords: Artificial Intelligence · Digitalization · Education · Legal Aspects

1 Introduction

Today, artificial intelligence is actively being introduced into the field of education, offering unique tools to improve the quality of training specialists and improve the pedagogical process. The use of AI helps to automate routine operations, create individual learning plans and increase the level of accessibility of quality education. At the same time, important legal issues arise, such as the protection of students' personal data, liability for erroneous decisions made by the AI system, and copyrights for materials created by artificial intelligence. The main goal of this study is to identify key legal aspects accompanying the integration of AI into the education system, as well as to develop practical proposals to reduce possible negative consequences for subjects of the educational process.

The relevance of the study is determined by the rapid development of digital technologies and the need to ensure the legal security of participants in the educational process when implementing AI solutions. The issues of protecting students' personal

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data, copyright for educational materials developed using AI, as well as the distribution of responsibility between participants in the educational process are studied. Of particular interest are modern international approaches to the legal regulation of AI in education, including the European experience of standardization in the field of data processing and American initiatives to protect privacy. A conceptual solution to the problem is proposed by forming a set of organizational and legal instruments that facilitate the effective implementation of AI technologies in the Russian educational system.

The results obtained are of great practical importance, providing the necessary legal basis for the sustainable development of the domestic education system in the context of the active penetration of artificial intelligence.

2 Methodology

To achieve the set goal, the following methods of scientific knowledge were used:

- theoretical analysis of scientific literature on law and information technology;
- the normative and legal method (analysis of the current legislation of the Russian Federation);
- the comparative legal method of studying foreign experience in legal regulation of the use of AI in the educational process;
- expert assessment of the risks and benefits of using AI from a legal point of view.

The research methodology involves systematization of the obtained results and development of recommendations for improving the legislative framework. The use of an interdisciplinary approach, which involves a joint analysis of issues in pedagogy, law and technical sciences, has become methodologically significant. Of particular importance is the methodology for identifying gaps in legislation concerning the use of AI in the educational process, as well as the formation of a list of necessary changes and additions.

3 Results

The Russian Federation has significant potential for the successful implementation of AI in education, but existing legal restrictions make this process difficult. The main problem is the lack of clear regulations establishing the rules for working with personal data, the specifics of intellectual property, and the responsibility of developers and operators of AI systems.

An analysis of federal legislation has shown the presence of individual fragmentary regulations aimed at regulating the information space, but a comprehensive mechanism for integrating AI into schools and universities has not yet been created. Federal Laws No. 273-FZ «On Education in the Russian Federation» [1] and No. 152-FZ «On Personal Data» [2] contain only a limited number of regulations related to the use of AI technologies. Federal Law No. 273-FZ establishes general principles for organizing educational activities, but there are no special rules directly related to AI. Article 18 of this law provides for the protection of students' personal data, which partially overlaps with issues of processing personal information by AI algorithms. Federal Law No. 152-FZ,

despite the absence of a direct mention of AI, regulates the processing of large volumes of information received from students and teachers when interacting with intelligent systems. It is important to emphasize that this information must be used exclusively for the purposes stipulated by law.

The problem of legal qualification of copyright violations remains relevant. The issue is to determine the author of the created intellectual product, since AI systems are capable of independently generating content (for example, adaptive tasks). The need to change the legislation is obvious, especially in terms of granting exclusive rights to software developers and users who create unique educational material using AI. Another important issue is the liability of the parties in the event of failures in the functioning of AI platforms. According to the Civil Code of the Russian Federation, legal entities are liable for damages caused by the actions of employees or equipment. Consequently, schools and universities may become subjects of liability in cases of errors in AI systems.

The most important area of legal regulation should be the establishment of restrictions and requirements for ensuring confidentiality and security when processing students' personal data. It is necessary to adopt a separate regulatory act regulating the activities of organizations involved in the development and operation of educational platforms based on AI [3].

In order to minimize legal risks, it is proposed to make additions to federal laws providing for the following:

- a clear definition of the concepts of «artificial intelligence», «automated decision-making system», «personalization of educational material»;
- mandatory informing of students and parents about the procedure for collecting and processing personal data, indicating the purposes and storage periods;
- establishing the boundaries of responsibility of educational institutions for possible violations resulting from the incorrect operation of AI systems;
- defining the procedure for interaction between schools/universities and software development companies;
- regulation of the status of materials created with the participation of AI, within the framework of copyright.

In addition, it is advisable to develop recommendations for teachers on the use of AI tools that ensure safe interaction with pupils and students.

4 Discussion

Foreign experience shows various models for regulating the use of AI in educational institutions. For example, the countries of the European Union have developed the GDPR Directive on the protection of personal data, which contains strict requirements for the processing of personal information of schoolchildren and students. European practice is aimed at maximum transparency of AI actions and compliance with the principle of consent of data subjects.

The United States takes a different approach, giving preference to the development of corporate self-regulation. Developer companies undertake obligations to protect the

privacy of students, adhering to established industry standards. This approach emphasizes the role of business in shaping the rules of conduct in the digital services market in the field of education.

The Chinese authorities are developing regulations aimed at ensuring national security and limiting foreign influence on the development of national AI technologies. This creates conditions for the independent development of domestic companies in the field of production of educational platforms and knowledge management systems.

Thus, the world community seeks to create a balance between technological progress and individual rights, striving to preserve democratic values and protect the interests of all participants in the educational process [4–7]. International experience demonstrates a variety of regulatory models: some states prefer strict control over the spread of AI technologies, while others allow a free market for developments. The most promising path seems to be a compromise that combines openness of innovations with the necessary legal guarantees of citizens' rights.

5 Conclusion

Actual trends indicate the rapid development of artificial intelligence technologies, which poses an important task for legislators to adapt existing legal norms to new realities. Further in-depth research is required into the relationship between digital transformations and current legal acts regulating the educational environment. Further research includes developing strategies to prevent abuses and threats from improperly configured or malicious AI, as well as monitoring current trends in the development of the global AI product market and their impact on domestic education. The lack of proper legal regulation can significantly slow down the spread and effective use of AI potential in the educational environment, so an urgent set of measures is needed to eliminate existing gaps and create a sustainable legal framework for a successful transition to the digital education of the future.

Currently, active work is being carried out in Russia to form a regulatory framework governing the use of artificial intelligence (AI) technologies in education and related fields. The Concept of legal regulation in the field of artificial intelligence, adopted in 2025, defines the strategy for regulating the use of AI in various fields, including education. It is specifically stated that it is unacceptable to use AI technologies only to ease the academic burden on pupils and students, without focusing on their personal development and increasing cognitive activity. The principles of safe use of AI are also defined, including the responsibility of developers and implementers for potential harm from incorrect conclusions or improper functioning of systems. The government has approved a series of regulations clarifying the rules for the use of AI in the educational process. A number of state standards have been developed that establish technical and legal aspects of the use of AI in educational practice.

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