Key Digital Technologies for National Business Environment

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Abstract. Digitalization is an important trend in all spheres of life and in all countries of the world. Digital technology is widely used to increase the productivity and efficiency of all processes. It is important to correctly determine the role and place of digital technologies in order to use them most effectively. This article analyzes the role of digital technologies in economic development using the method of expert assessments and identifying the main trends and influencing factors for key digital technologies. The selected set of variables was included in the questionnaires, which were filled out by experts. A procedure to summarize the opinions of experts using the capabilities of augmented intelligence for processing expert survey data was conducted. Of further interest is the analysis of expert responses to understand the degree of technology appreciation. Based on the analysis, it is planned to build a model to align the requirements of key sectors of the Russian business to digital technologies.

Keywords: Digitalization, Digital technologies, Augmented Intelligence, Expert assessments.

1 Introduction

The digital economy is positioned as a system of economic, social and cultural relations based on the use of digital information and communication technologies. Countries that are world economic leaders are actively using digital technology to increase productivity and efficiency of the economy as a whole and individual enterprises. Digitalization is becoming an integral part of all processes of public life and determines the change of basic technologies used to implement business activities [1, 2].

Gradually, digital technologies become a reality in the economies of countries, everyday life, various fields of economic activity, in international relations (examples are in the researches of the authors [3]). The widespread adoption of digital technologies (the Internet of things, the Industrial Internet, big data, blockchain, cloud computing, machine learning, artificial intelligence, mobile communications, etc.) is one of the most important conditions for the development of national economies of all countries [4, 5].

Plans for the development of the Russian economy until 2020 have not been fully implemented [6]. Currently, a new stage of planning is underway, identifying promising areas and activities that ensure stable development in the future.

Digitalization is becoming the main trend in the world [7]. Thus, for the development of the Russian economy, it is important to determine the role of various digital technologies, and for the correct distribution of resources to support them, one should take into account not only the current state of the phenomena studied, but also the prospects for the development of economic sectors in the future.

Therefore, determining the importance of digital technology for the Russian economy is not an easy complex task, for the solution of which expert methods are mainly suitable. They are very diverse [8]. It is known that traditional statistical methods for determining the average score and building the confidence interval are unsuitable here [9-11]. Due to the complexity of such tasks and their multifactorial nature [12-14], there is no single method applicable for all situations. Therefore, it is proposed to use a general approach.

The task arises of developing an expert survey procedure that would extract useful information from these surveys at a certain level of confidence in the results. This task itself can be attributed to one of the new digital technologies – Augmented Intelligence, which takes on the intellectualized routine work of processing information for decision-making.

This article is devoted to the description of expert interviewing procedures for obtaining an assessment of the importance of the digital technologies development in the Russian Federation for a period of medium-term planning of approximately 3 years. The objective of the study is to highlight the spectrum of digital technologies that are most significant, according to experts, for the development of the digital environment of Russian business.

2 Methodology

The proposed method for assessing the importance of digital technologies for the Russian economy is based on expert assessments of the components of the cognitive model. Based on the study results, the features of the method application are discussed.

Approach tested in Pavlov's dissertation [15, 16].

At the first stage, the task of determining the importance of digital technology is decomposed into a cognitive map of the Fig. 1 form. The construction of such a map is not difficult, since its components are quite obvious, and their interconnection is stable.

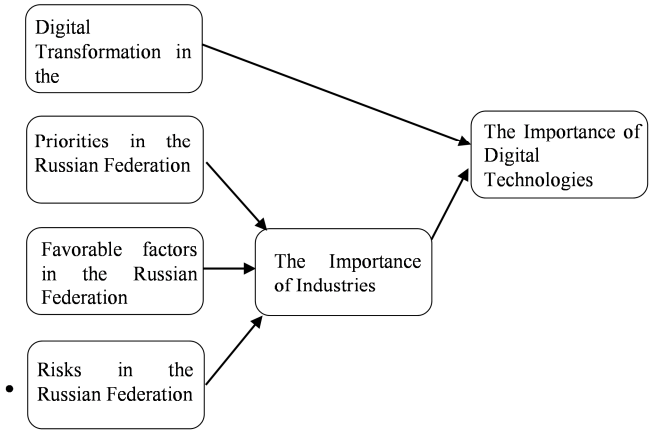

Fig. 1. Cognitive map of the digital technology importance.

Then, using the brainstorming method on the basis of literature analysis [17-19], sets of variables characterizing each factor are determined. As a result, the following analysis sections were identified:

Trends:

- Integration of economic, cultural, R&D areas
- Disaggregated data aggregation
- Strengthening security, network localization
- Analytics - a source of competitive advantage
- Different human-machine interface
- Improving Cloud Strategies
- Development of social networks
- Personification
- Personnel training in digital technology
- The role of leadership in digital transformation

Adverse factors:

- Raw material model of the economy
- Level of corruption
- Low domestic demand
- Centralization of management and distribution of finance
- Pandemic
- Slowdown of the global economy; global crisis forecast
- Decrease in private investment
- Sanction pressure
- Instability of the energy market

Favorable factors:

— Stability of the domestic political situation
— Export potential (agriculture)
— Implementation of national projects
— Low external debt
— Stimulating role of counter sanctions

Digital technology considered:

— Machine learning and deep learning
— Edge Analytics
— PaaS
— Augmented Reality
— Augmented Intelligence
— Immersive Workspace
— Synthetics Data
— Digital Ops
— Blockchain
— IoT
— Drones
— 3D printing
— 5G

The choice of industries was made on the basis of data on the share in the turnover of the Federal State Statistics Service of the Russian Federation.

— Agriculture, forestry, hunting, fishing and fish farming
— Mining
— Manufacturing
— Production and distribution of electricity, gas and water
— Construction
— Wholesale and retail trade; repair of motor vehicles, motorcycles, household goods and personal items
— Hotels and restaurants
— Transport and communications
— Financial activities
— Operations with real estate, rental and provision of services
— Public administration and military security; social insurance
— Education
— Health and social services
— Provision of other utility, social and personal services
— Household activities
— Priorities for the development of the Russian economy are reflected in [20].
— Relaxation of tax pressure on small and medium-sized businesses
— Supporting domestic demand
— Decrease in state regulation in production
— Attracting large investors

- Refusal of excess budget surplus
- Sustainable natural population growth
- Acceleration of technological development of the country
- Ensuring accelerated implementation of digital technologies in the economy and social sphere

An expert survey consists in filling out survey tables:

1. The levels of development of digital technologies in the Russian Federation at the present stage are indicated on a scale from 0 (the technology is completely absent) to 1 (the technology is maximally developed).
2. The degree of manifestation of digital technology trends in the Russian Federation is indicated from 0 (does not appear) to 1 (appears to the maximum extent).
3. The degree of manifestation of adverse factors is indicated from 0 (not manifested) to 1 (manifested as much as possible).
4. The degree of manifestation of favorable factors is indicated from 0 (not manifested) to 1 (manifested as much as possible)
5. The importance of economic development priorities is indicated from 0 (completely unimportant) to 1 (importance is maximum). It can be seen that the estimates are classical fuzzy quantities.
6. A table is filled out to assess the impact of digitalization trends on popularity and adherence to one or another digital technology on a scale of -1 (strong negative impact) to 1 (strong positive).
7. A table is filled out of the influence of adverse factors on the importance of economic sectors on a similar scale. It is appropriate to explain here that unfavorable factors (for example, a pandemic) can have both an adverse effect (on tourism) and a stimulating effect (on medicine).
8. A table is filled out of the influence of adverse factors on the importance of economic sectors on a similar scale.
9. A table of the influence of the priorities of the Russian economy development on the importance of economic sectors on a similar scale is being filled out.
10. Finally, a table is filled out of the role of digital technologies in the sectors of the Russian economy.

Thus, the impact estimates are extended fuzzy values ranging from -1 to 1. Although the estimates are matrix-like and have a rather large dimension, filling them out does not take much time, since the presentation used is clear and allows to cover the whole problem as a whole, comparing the power of various bonds.

Next, the results are calculated. Here are formulas for one expert:

$$Itr_i = \frac{1}{J}\sum_j Tr_j * t_{ij} \quad (1)$$

where Itr_i is i-th technology out of I, determined by the development trend of the Russian economy; Tr_j – importance j-th trend out of J, t_{ij} – influence matrix values.

$$Ineg_k = \frac{1}{L}\sum_l Neg_l * n_{lk}, \quad (2)$$

where $Ineg_k$ – importance of the k-th sectors of the Russian economy out of K, determined by the adverse factors; Pos_j – importance of the first factor out of L, n_{lk} – influence matrix values.

$$Ipos_k = \frac{1}{R}\sum_r Pos_r * p_{rk}, \quad (3)$$

where $Ipos_m$ – importance of economic sectors of the Russian Federation, determined by the favorable factors; Pos_r – importance of the r-th factor out of R, p_{nr} – influence matrix values.

$$Ipr_k = \frac{1}{S}\sum_s Pr_j * r_{is}, \quad (4)$$

where Ipr_k – importance of economic sectors of the Russian Federation, determined by the priorities of its development; Pr_s – importance of the s-th priority out of S, r_{is} – influence matrix values.

The total importance of industries is defined as

$$Iotr_k = \frac{1}{3}(Ineg_k + Ipos_k + Ipr_k) \quad (5)$$

The importance of digital technology, determined by the importance of industries, is defined as

$$Ito_i = \frac{1}{K}\sum_k Iotr_j * o_{ik} \quad (6)$$

where $Itech_i$ – importance of digital technology is determined by the importance of the Russian economy; $Tech_j$ – current level of digital technologies development in the Russian Federation, j-th out of J,er_{ij} – influence matrix values.

The resulting importance of digital technology is defined as

$$It_i = \frac{1}{2}(Itr_i + Ito_i) \quad (7)$$

These are absolute values. Since the ultimate goal of the study is the distribution of resources according to the priorities of the development of digital technologies, we should move on to relative importance indicators in the range from 0 to 1, which can be interpreted as follows: values from 0 to 0,25 are or low importance; from 0,25 to 0,5 – medium importance, from 0,5 to 0,75 – high importance, from 0,75 to 1 – key importance.

$$Is_i = \frac{It_i}{\max(It_i)} \quad (8)$$

Thus, we got fuzzy estimates of the relative importance of the digital technologies development in the Russian Federation, according to one expert. To summarize the estimates at each step, average estimates were used. This is due to the fact that they are less susceptible to random deviations of estimates and, accordingly, are more reliable.

The next step is to summarize the opinions of experts.

In fig. 2. shows the ranges of Isi values for 11 experts surveyed.

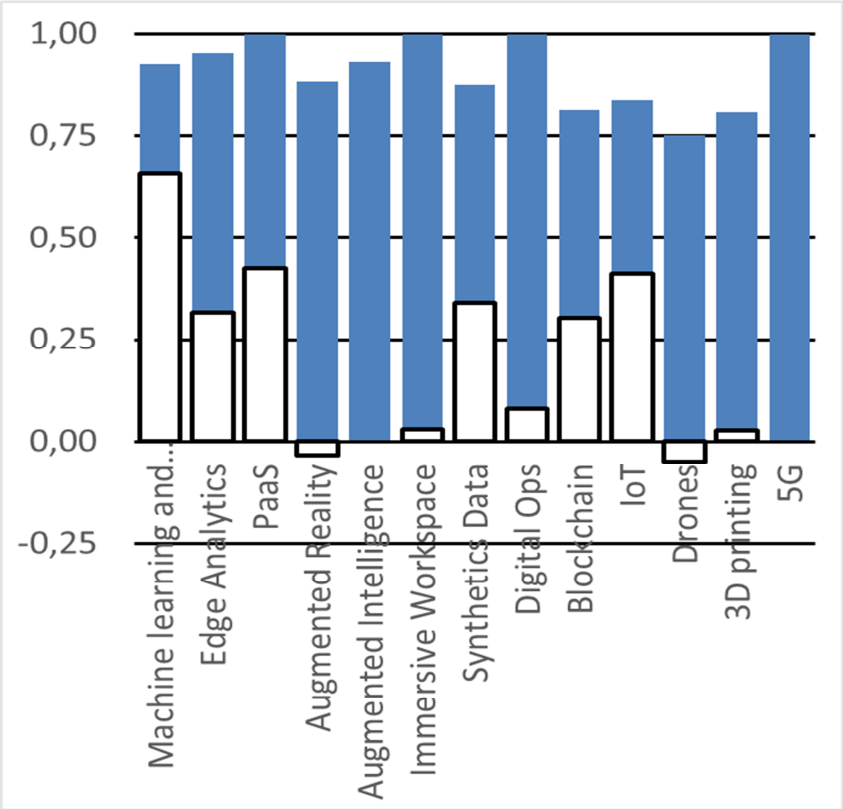

Fig. 2. Summary of responses from all experts.

The shaded area shows the range of relative ratings among experts. Opinion refers to a certain category of importance if the resulting range is for the most part in one of the indicated ranges or occupies more than half of it.

It can be seen that the opinions of experts vary greatly. However, certain particular conclusions can already be drawn from these results.

Machine learning, PaaS, and IoT are of high-key importance. Blockchain technology is medium-high. Estimates for other sectors were contradictory. This may indicate an unformed understanding of the role of new technologies or a strong difference in expert opinion.

To extract additional information from the data obtained, a cluster analysis of experts is carried out according to their absolute estimates of Iti, since they summarize their opinions. Clustering is carried out by the far neighbor estimation method (with full coupling), the square of the Euclidean distance is used as a measure of distance. This allows to more clearly identify groups of similar research elements.

The result of cluster analysis is presented in Fig. 3.

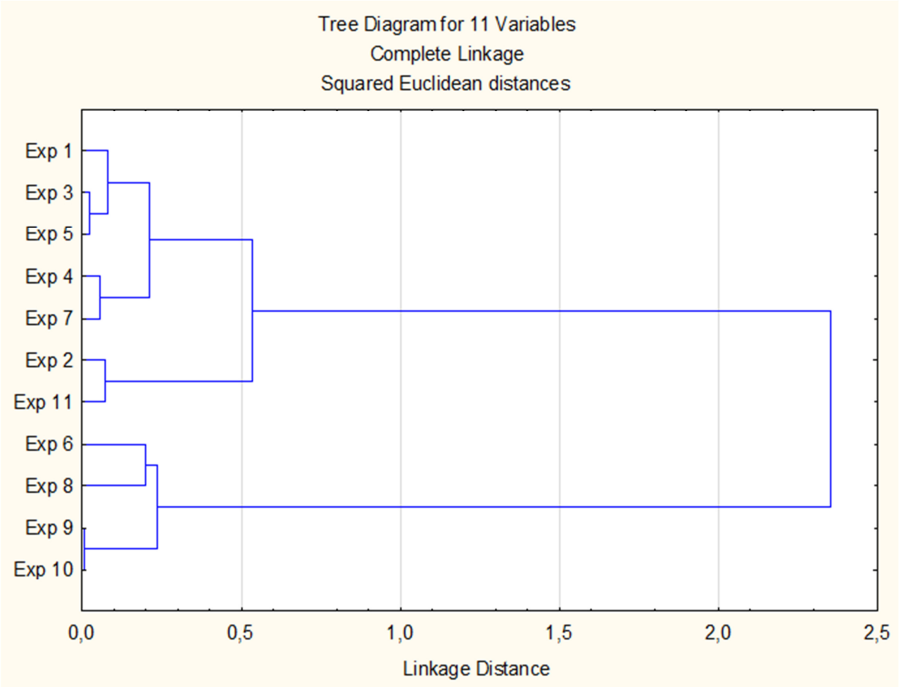

Fig. 3. The result of a cluster analysis of experts on their absolute assessments.

It can be seen that according to the similarity of answers, 2 groups stand out clearly: 1, 3, 5, 4, 7, 2, 11 and 6, 8, 9,10. However, in the first group, a rather isolated group of experts 2 and 11 can be distinguished. Therefore, three groups will be considered: 1 (1, 3, 5, 4, 7), the results of which are presented in Fig. 4; 2 (2, 11; Fig.5); 3 (6, 8, 9, 10; Fig.6).

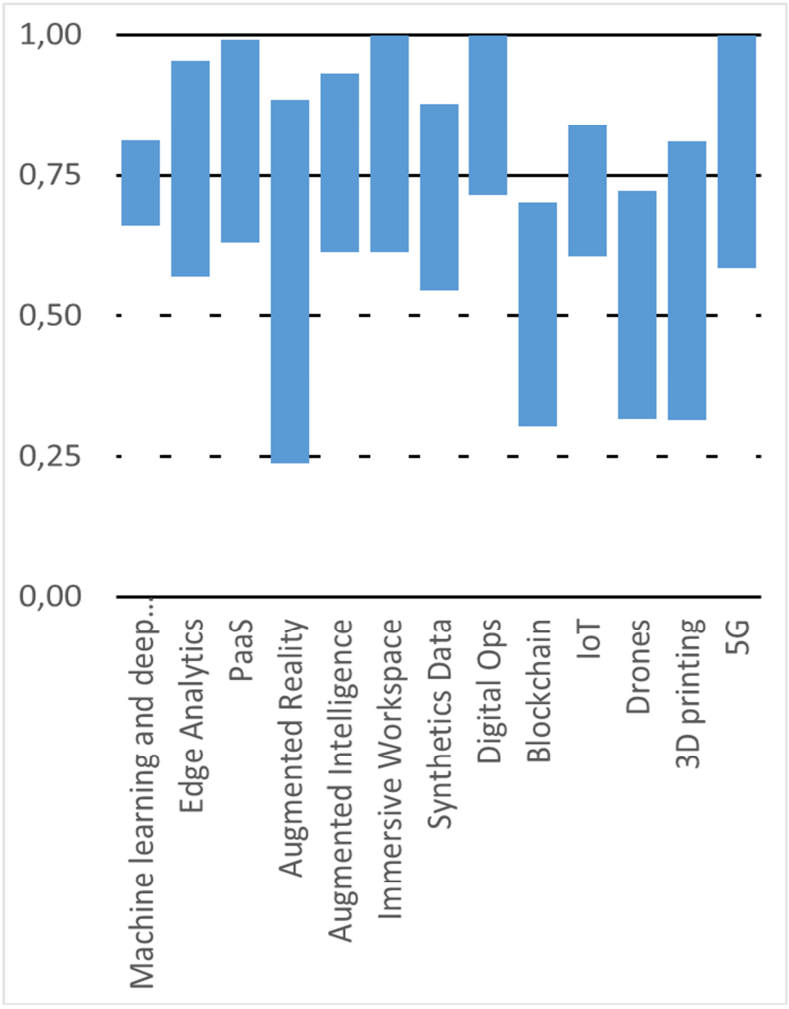

Fig. 4. Expert group 1.

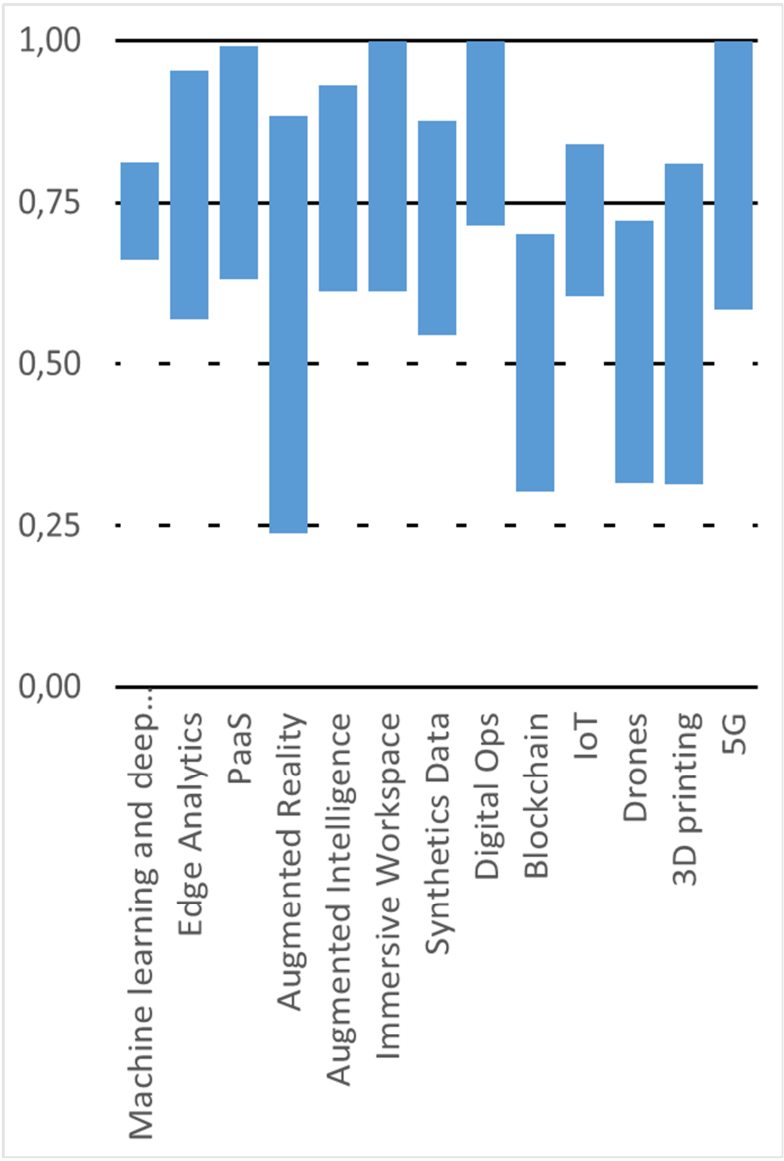

Fig. 5. Expert group 2.

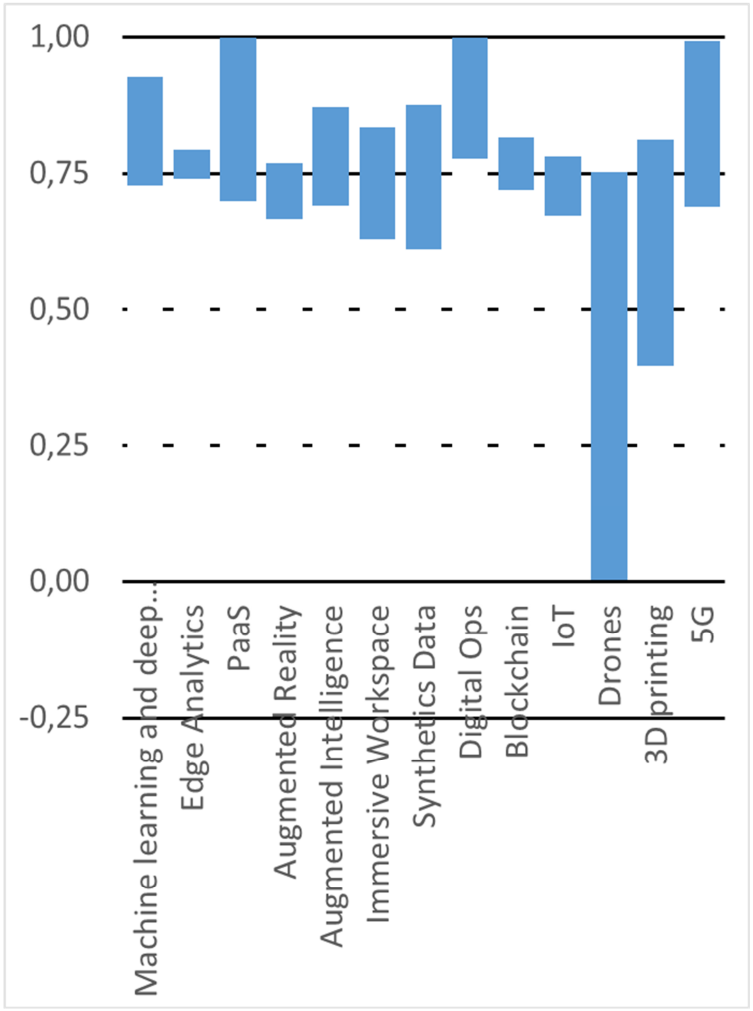

Fig. 6. Expert group 3.

It's clear that the estimates vary greatly between groups. In groups 1 and 3, high grades prevail, and in group 3 they are more uniform. Group 2 gives various assessments of the importance of different technologies.

To assess the reliability of the estimates, the absolute estimates in each group were studied. The scope of these estimates was determined. The result is shown in Fig. 7.

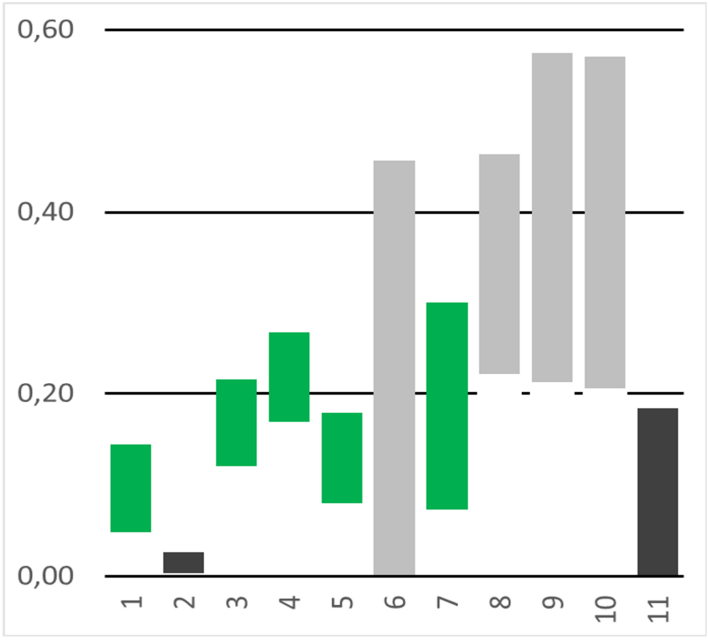

Fig. 7. The range of absolute assessments given by experts of the importance of various industries.

It can be seen that the experts of group 2 (marked in dark) showed a certain pessimism. They do not believe that digital technology is of high absolute importance. Zero ratings are especially indicative, which show the absolute unimportance of a particular technology. Thus, their relative estimates, which reflect the priorities, turned out to be just a reflection of the small difference between equally unimportant estimates, which caused their wide scatter.

Group 3 (their assessments are marked with the lightest color), on the contrary, showed excessive optimism. That is why their relative estimates are biased to key importance. Here, zero ratings may indicate a certain underestimation of certain industries.

Finally, group 1 (marked in green) occupies an intermediate position, avoiding the features noted in other groups. Therefore, we can assume that their estimates are the most reliable.

3 Results

3.1 Research Result

Thus, the final conclusion about the importance of the digital technologies development is based on Fig. 4. Table 1 shows the role determined by the analysis in the development of the economy for each digital technology considered.

Table 1. Role in the digital economy development.

Digital technologies	Role
Machine learning and deep learning	Important
Edge Analytics	Important-key
PaaS	Key
Augmented Reality	Contradictory, not low
Augmented Intelligence	Key
Immersive Workspace	Key
Synthetics Data	Important
Digital Ops	Key
Blockchain	Medium-important
IoT	Important
Drones	Medium-important
3D printing	Medium-important
5G	Important-key

It can be seen that a consensus solution has been identified for most technologies. The remaining inconsistency of estimates can be solved by the traditional Delphi method [11]. According to the results obtained, the priority of the development of digital technologies becomes visible.

3.2 Applicability of the Proposed Method

The authors think that the proposed peer review process has several advantages:

- the structure of the relationship of factors is highlighted in the problem. It is simple enough and does not cause contradictions;
- questions to experts are quite specific, which allows to hope for the reliability of answers to them;
- the apparatus of fuzzy values is used for calculations, which corresponds to a different degree of influence of variables on the result;
- using averaged estimates reduces the risk of emissions;
- absolute assessments are used to analyze experts, and relative assessments are used to identify priorities;
- the method allows to deeply analyze the results of an expert survey, extracting useful information from them.

Thus, this article is an example of the use of augmented intelligence to help process expert survey data.

3.3 Further Perspectives

To extract additional useful information from the collected data, it is possible to analyze the responses for each of the components of the cognitive map. Some estimates of both the initial values and the interaction matrices of factors may be similar, and on other particular issues a strong variety of opinions is possible. The identification of the most differing particular answers will allow to focus the Delphi method precisely on the most dissimilar particular estimates.

Having obtained the results of the proposed method, it is useful to understand the reasons for the differences of opinion. Discarding the assumption of expert incompetence, it can be assumed that the difference in the estimates is due to the novelty of the technology and the incomplete clarity of its capabilities.

4 Discussion

The results of such studies will serve as the basis for identifying end-to-end technologies for the key sectors of the economy discussed in this article. On this basis, it is proposed to build models for aligning the requirements of key sectors of Russian business with digital technologies that provide efficient digital environment for selected industries. This will allow you to target the development of technology in accordance with the requirements of stakeholders in a particular area.

5 Conclusion

In this article, the method of expert estimates of complex forecasts, which is characterized by a deeper analysis of the collected data based on modern methods of artificial intelligence was considered. The results obtained made it possible to determine an expert assessment of the importance of digital technologies used in Russia, the connection of technology applicability with the trends and development trends of the Russian business environment and with key sectors of the Russian economy.

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References

1. Ponomarev, O., Svetunkov, S.: The impact of digital economy at the entrepreneurial capital. In: Proceedings of the International Conference on Digital Technologies in Logistics and Infrastructure (ICDTLI 2019). St. Petersburg, Russia (2019). doi: 10.2991/icdtli-19.2019.75
2. De la Boutetière, H., Montagner, A., Reich, A.: Unlocking Success in Digital Transformations. McKinsey Co. (2018).

3. Zaychenko, I., Smirnova, A., Borremans, A.: Digital transformation: the case of the application of drones in construction. MATEC Web of Conferences 193, 05066 (2018).
4. Revenko, L., Revenko, N.: GLOBAL TRENDS AND NATIONAL SPECIFICS OF THE DEVELOPMENT OF A DIGITAL ECONOMY. Int. Trends Mezhdunarodnye Protsessy 15(4), (2017). doi: 10.17994/IT.2017.15.4.51.2
5. McMaster Digital Transformation Research Centre, https://mdtrc.mcmaster.ca/, last accessed 2020/04/28.
6. Khitskov, E.A., Veretekhina, S.V., Medvedeva, A.V., Mnatsakanyan, O.L., Shmakova, E.G., Kotenev, A.: Digital transformation of society: problems entering in the digital economy. Eurasian Journal of Analytical Chemistry 12(5b), 855-873 (2017).
7. Gimpel, H., Röglinger, M.: Digital transformation: changes and chances–insights based on an empirical study. (2015).
8. Divina, T.V., Petrakova, E.A., Vishnevsky, M.S.: The main methods of analysis of expert assessments analysis. (2019). doi: 10.24411/2411-0450-2019-11072
9. Churchill, G.A., Iacobucci, D.: Marketing research: methodological foundations, 10th ed. Mason, OH: South-Western/Cengage Learning, Australia (2010).
10. Malhotra, N.K.: Marketing research: an applied orientation, 6th ed. Pearson, NJ (2010).
11. Linstone, H.A., Turoff, M.: The Delphi method: Techniques and applications. Addison-Wesley (1975).
12. Bergmann, M.: An introduction to many-valued and fuzzy logic: semantics, algebras, and derivation systems. Cambridge University Press (2008).
13. Borg, I., Groenen, P.J.: Modern multidimensional scaling: Theory and applications. Springer Science & Business Media (2005).
14. Giarratano, J.C., Riley, G.: Expert systems: principles and programming. Brooks/Cole Publishing Co. (1989).
15. Pavlov, N.: Product lifecycle management. (2016).
16. Klimin, A.I., Pavlov, N.V., Efimov, A.M., Simakova, Z.L.: Forecasting the development of big data technologies in the Russian Federation on the basis of expert assessments. In: Proceedings of the 31st International Business Information Management Association Conference, IBIMA 2018: Innovation Management and Education Excellence through Vision 2020, pp. 1669-1679. (2018).
17. Ilin, I.V., Koposov, V.I., Levina, A.I.: Model of asset portfolio improvement in structured investment products. Life Science Journal 11(11), 265-269 (2014).
18. Borremans, A.D., Zaychenko, I.M., Iliashenko, O.Yu.: Digital economy. IT strategy of the company development. MATEC Web of Conferences 170, 01034 (2018).
19. Ilin, I., Iliashenko, O., Iliashenko, V.: Approach to the choice of Big Data processing methods in financial sector companies. MATEC Web of Conferences 193, 05061 (2018).
20. Kosorukov, O.: Forecast of separate indicators for socio-economic development of the Russian federation up to 2020. World Applied Sciences Journal 18(C), 18 (2012).