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Neurotechnologies and Artificial Intelligence in Public Administration: Application Practice and Possible Ways of Development

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ABSTRACT

Over the past few years, the field of artificial intelligence and neurotechnology has moved beyond the scope of exclusive scientific discussion to the realm of public policy. The state is an important participant in technological progress, which allows us to consider in detail the connection between government officials and neurosciences, because, according to a large number of scientists, it is this segment of sciences that will allow humanity to transition to a new technological order. **The purpose** of this study is to consider the theoretical foundations of the interaction of the subjects of the public administration system with end-to-end technologies and to search for practical examples of the implementation of this interaction. In the course of the work such **methods** as theoretical analysis, comparison and contrast, cognitive method, system analysis, and analysis of statistical data were used. The theoretical foundations of the study of neurotechnologies, as well as the market of the existing neuroprosthetics products, were considered. The authors of the research studied and compared examples of the development of plans and the application of artificial intelligence and neurotechnologies in such countries as Russia, the United States, and the United Kingdom, and analysed global rankings of digitalisation of public administration. Based on this, it was **concluded** that countries are actively participating in a new technological race, trying to introduce artificial intelligence in the field of public administration in order to gain their own advantage, however the sluggishness of states in the development of neurotechnologies, with subsequent implementation in the public sector, was noted, and the fact of significant differences in the understanding of artificial intelligence in public administration around the world was revealed. This fact creates a field for further research and discussion. The results of the research can be used in the framework of further study of the analyzed aspects by scientific and research organizations, within the framework of the activities of federal authorities, as well as private companies.

Keywords: artificial intelligence; neurotechnologies; neural interface; digital technologies; public administration; public service; public sector; end-to-end technologies

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INTRODUCTION

Public administration in the 21st century has entered a period of structural transformation, which is manifested both in the rethinking of its modern methods and in the modernisation of the existing management system at the state and municipal levels of government. One of the important links in this process is the development and use of neurotechnologies and artificial intelligence (AI) in public administration. All over the world the problem of modernisation of administrative and management processes is increasingly considered through the prism of brain-computer interface (BCI) and AI technologies (which is reflected in this article), but the actual application of theoretical and research developments in this area is still an open issue. In this regard, the analysis of the relationship between the state and new technologies, as well as the formation of proposals for the introduction of such technologies in the future are becoming the most relevant today. The novelty of the work done by the authors of the article lies in the selection of the technologies under study, as well as in the conclusion regarding their use in the implementation of several possible ways of development of state and society management.

In doing so, they analysed both scientific works devoted to haptic research and ethical problems (early works of foreign scientists) and modern publications that focus on the present and future of neurotechnologies.

Artificial intelligence and the results of its exploitation are described in the textbook by E.V. Borovskaya and N.A. Davydova.[1] The application of neurotechnology and AI in the public sphere is an open field of study, but already now foreign and domestic researchers are trying to study it as deeply as possible. By collecting different points of view and approaches to analysing the development of digital technologies and their application in public administration, it is possible to approach a comprehensive consideration of the issue of implementing state transformations within the framework of digitalisation of decision-making and service delivery processes.

The aim of this research is to study the general trends in the development of neurotechnology and AI and the practice of implementing artificial intelligence and neurointerfaces in public administration, as well as to analyse the future of this direction.

To achieve the goal, the following tasks were set:

- to review current trends in the development of neurotechnology and AI and the potential for their relevance to humans in the future;
- to find out which of these technologies are already used in public administration in Russia and the world, and how they may change in the near future;
- identify the main factors that may slow down the introduction of neurotechnologies in the public sector in each of the countries considered in the study;
- on the basis of the analyses conducted, propose new ways of developing this area, which could have a structural impact on public administration in the future.

RESEARCH METHODOLOGY

This article considers the possibility of introducing artificial intelligence and neurotechnology into the public sector. This can be achieved with the help of cybernetics (as well as neurocybernetics [1]), which allows to identify the most effective actions to control certain elements of the system, and neuroscience, which studies brain structures and neural connections (*Fig. 1*). The interrelation of AI and neurotechnologies is expressed in their

[1] Borovskaya E.V., Davydova N.A. Fundamentals of Artificial Intelligence. Textbook. 4th ed., electronic. Moscow: Laboratory of Knowledge; 2020. 130 p.

common orientation related to the cognition of human intellect and brain — a biosocial and multifaceted being [2]. Many specialists use artificial intelligence as a tool: modern AI perceives the results of neuroresearch, possessing advanced perceptual and cognitive abilities of biological systems, including object recognition capabilities and decision-making functions [3]. Based on the application of AI and other tools, neurointerfaces are created, which, in turn, are divided into invasive (interacting directly with the subject) and non-invasive (not penetrating the body). The number of neurotechnologies is enormous, but this article will touch upon only those in which the state can see the greatest benefit for the implementation of its functions.

APPLICATION OF NEUROTECHNOLOGY AND AI IN VARIOUS FIELDS

The trend towards neurotechnology and AI is evident everywhere: artificial intelligence analyses security threats for financial institutions and neural networks analyse the credit histories of banking customers; neural interfaces enable medical professionals to perform complex operations; the world's major universities use neurotechnology for adaptive learning for students; the Moscow Metro uses facial recognition for fare payment; and the United Nations (UN) studies migration flows through automated analyses of data on the geolocation of migrants across the planet [4].

Neurotechnology is defined by most scientists as a set of methods and tools that provide a direct connection between technical components and the nervous system [5]. Artificial intelligence is a programme that imitates the human thinking process with the help of a computer [6]. When considering neurotechnologies and AI, it should be noted that there are many approaches to their implementation, each of which involves a different view of the development of the human brain and its behaviour. The main methods of applying neurotechnologies are invasive and non-invasive [7]. The former is exemplified by implant chips,[2] and the latter includes virtual reality glasses.[3] In the scientific community, neurotechnologies and neurointerfaces have historically been generalised and referred to by the term 'brain-computer interface', which refers to a device that uses neural activity recorded by the brain to establish direct communication with external actuators, such as, for example, prosthetic hands. [8, 9].

MODERN METHODS AND PERSPECTIVES OF BCI DEVELOPMENT

In order to understand what brain-computer interfaces are, it is necessary to consider the main ways of development of this direction. Neurotechnologies are aimed at studying the brain and its interaction with the created neurodevices. However, it should be understood that this is not always done with the help of a chip implanted in the human brain. For example, at this stage of neuroscience development, brain imitation methods are actively used. The fact is that the classical way of using an invasive (implantable) neurointerface (based on reading brain activity) can actually be equated to experiments on animals or humans. Such 'live' research often leads to increased costliness of experiments and ethical as well as reputational losses, which increases the risks of failure of any scientific project in this field. However, in the last ten years, the implementation of neurotechnology and artificial intelligence has been based on mathematical modelling of the brain. A new research paradigm has emerged, aimed at creating a comprehensive digital model or copy of the brain. In other words, the neurointerface executes the host's commands based on

[2] The development of Neuralink (an American neurotechnology company founded by Ilon Musk).

[3] The Apple Company's product.

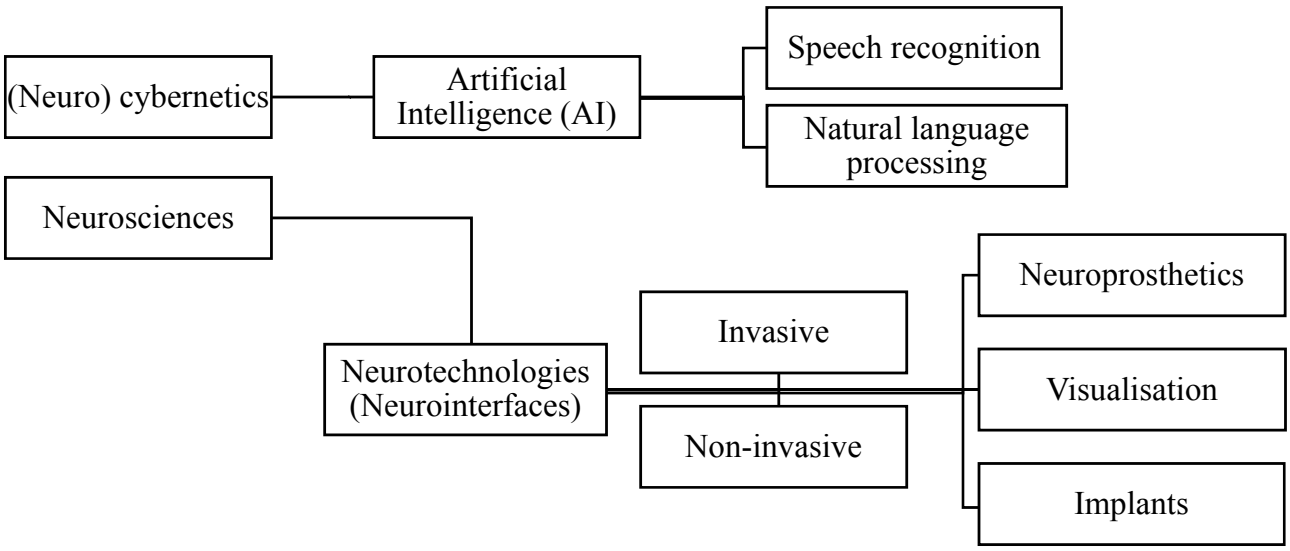

Fig. 1. **The relationship between neurotechnology and artificial intelligence**

Source: compiled by the authors.

a simulation of the brain, which is the safest and most practical method of study. But even the presence of significant computing power does not guarantee the accuracy of the transmission of neuronal activity, as technical capabilities are still limited [10].

Another area of neurotechnology development in recent years is the combination of neural recording and brain stimulation. The former is based on recording (reading) brain activity and analysing it, while stimulation allows a neurointerface to activate or inhibit certain areas of the brain using electrical impulses. While previously these methods of interaction were used separately, now many BCIs can influence brain activity while simultaneously reading it, which allows for future consideration of such technology as communication between individuals' thought centres and the like [10].

AI is more popular than neurotechnology, but often many civil servants do not have a clear understanding of it. The task of artificial intelligence is to replicate the brain's neural network to make logical inferences and decisions. Neurons are nerve cells that transmit information to their counterparts for the brain to perform its functions. The idea of AI involves the creation of artificial neurons in the form of mathematical functions and models, and its main goals are to automate human labour, further research to understand the essence of decision-making processes and, finally, to create an amplifier of human intelligence, which faces more and more problems every year [11].

The main approaches to AI research are divided into symbolic and connectionist approaches. Symbolic seeks to reproduce intelligence by analysing cognition independently of the biological structure of the brain in terms of symbol processing — its essence is learning based on the sequential demonstration of symbols or learning goals. The second approach involves the formation of artificial neural networks that mimic the structure of the brain. In other words, a program is created that is able to analyse different objects to obtain a result [12]. Neural networks, in fact, are the result of the second approach.

Thus, the theoretical basis and the main directions of development of neurotechnology and AI in the modern world allow us to understand most precisely what achievements

of this scientific direction can be applied to public administration and public service. To relate theoretical data to the results of this study, general scientific methods (comparison, analysis, generalisation), as well as statistical data comparison, benchmarking, forecasting, and cognitive method were used.

RESEARCH RESULTS

In recent decades, the popularity of such products as prostheses, virtual reality glasses, implants — has been growing; the concepts of 'neural networks', 'artificial intelligence', etc. have firmly entered our lives. This is primarily due to the potential revolutionary nature of these technologies, the existence of interest in the research of neurotechnologies and their simplification to the level when the results of this work become available to the mass consumer. On the basis of such a breakthrough the products appear (which can be bought by anyone) which are related to virtual (VR) and augmented (AR) realities.[4] Invasive and non-invasive technologies allow us to learn more about brain function and behaviour when interacting with virtual reality glasses or neuroprostheses.

The global interest in end-to-end neurotechnologies by private companies and governments is encouraging more focused research (which has been done in the last few years) thanks, for example, to programmes such as the BRAIN Initiative, organised in the United States in 2013 as part of the study of the brain through innovative technologies,[5] or the Human Brain Project, set up by the countries of the European Union.[6] This kind of projects allow us to introduce neurotechnologies into almost any sphere of society's life; therefore, they are called "end-to-end" projects [13]. Their necessity and popularity are explained by the fact that the political will of various subjects of public administration is growing every year. Technogenic catastrophes, epidemics of new viruses, population aging, and other factors cause increased human interest in neurotechnologies as a means of solving many problems [14]. However, it should be noted that the results of research can be considered relevant if the main market participants and states receive economic benefits from them — in this case, modern science has the best chance of development. Therefore, in order to analyse the prospects of this scientific direction in public administration, we should not forget about the economic attractiveness of neurotechnologies (*Fig. 2*).

As can be seen from the diagram, the global neurotechnology market size in 2022 was USD 12.82 million. According to forecasts, it is expected to continue growing (over the next 10 years it is planned to increase by 11.53% on average). It is important to clarify that this forecast is optimistic. There are analytical reports stating that the spread of neurotechnologies will be complicated by the global economic crisis, sanctions and trade wars, and the consequences of the coronavirus epidemic.[7]

Based on economic data and the increased interest in the topic of neurotechnology research, we can conclude that neurointerfaces and AI can not only improve the life of an individual, but also transform entire spheres of social life, including public administration. This conclusion has been made by many countries, and the Russian Federation is no exception — in 2019, the President of Russia signed Decree No. 490 "On the Development of Artificial Intelligence in the Russian

[4] Apple Vision Pro. Apple. URL: https://www.apple.com/apple-vision-pro/ (accessed on 21.09.2023).

[5] The BRAIN Initiative. National institutes of Health. URL: https://braininitiative.nih.gov/ (accessed on 12.09.2023).

[6] Welcome to the Human Brain Project. HPB. URL: https://www.humanbrainproject.eu/en/ (accessed on 19.09.2023).

[7] Neurotechnology Global Market Report 2023 ReportLinker. URL: https://www.reportlinker.com/p06464230/Neurotechnology-Global-Market-Report.html?utm_source=GNW (accessed on 19.09.2023).

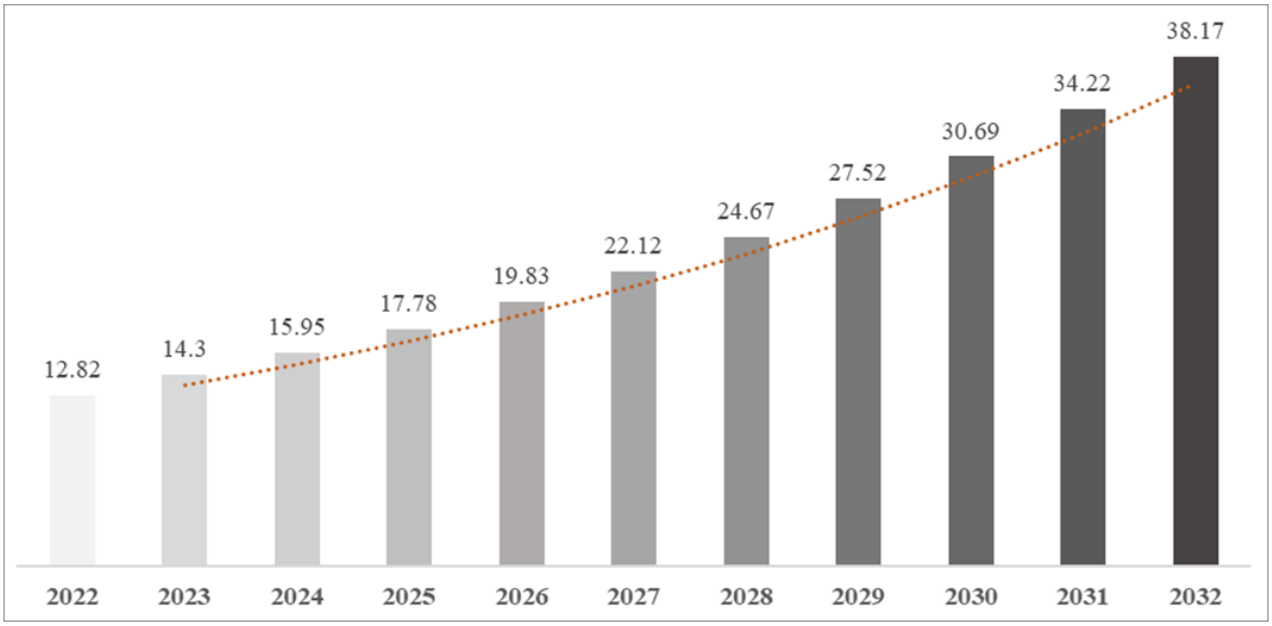

Fig. 2. **The volume of the global neurotechnologies market, USD millions**

Source: compiled by the author based on the Neurotechnology Global Market Report 2023 ReportLinker. URL: https://www.reportlinker.com/p06464230/Neurotechnology-Global-Market-Report.html?utm_source=GNW (accessed on 19.09.2023).

Federation (together with the "National Strategy for the Development of Artificial Intelligence until 2030"), according to which our country should not only support existing research, but also create all conditions for the emergence of new technological products, as well as professional staff capable of creating such products.[8] This document promotes the implementation of a roadmap for the development of "end-to-end" digital technologies,[9] which details the technological challenges that the state must address in order to succeed in technological development.[10] One of them is the digital platform for control (supervision) activities (the CSA platform), according to which artificial intelligence will connect employees of departments and law enforcement agencies with business representatives, processing all requests and applications automatically created in the database network,[11] as well as performing other departmental tasks, which in the classical management system are realised by civil servants independently. In this way, the work of several ministries is optimised, and the government can interact more effectively with private companies as well.

Despite existing documents and programmes, some authorities are only contemplating the use of AI in their activities. For example, in 2020, seven of them belonging to the federal level announced the introduction of AI to optimise

[8] Presidential Decree No. 490 of 10.10.2019 "On the Development of Artificial Intelligence in the Russian Federation (together with the "National Strategy for the Development of Artificial Intelligence for the period until 2030"). URL: https://www.consultant.ru/document/cons_doc_LAW_335184/bcc09a1a0e0ad09ec444cf158d88121676e237d0/ (accessed on 22.09.2023).

[9] It is worth noting that the goals related to the development of neurotechnology were later removed from the development strategy,

[10] Roadmap for the development of 'end-to-end' digital technology 'Neurotechnologies and Artificial Intelligence'. Ministry of Digital Development, Communications and Mass Media of the Russian Federation. URL: https://digital.gov.ru/ru/documents/6658/?utm_referrer=https%3a%2f%2fyandex.ru%2f (accessed on 17.09.2023).

[11] Control (supervisory) activities. CSA Portal. URL: https://knd.gov.ru/main (accessed on 24.09.2023).

tasks.[12] In 2023, the topic of AI development was raised by the Ministry of Economic Development of the Russian Federation — its representatives reported that AI can be used to assess the investment attractiveness of regions [15].

One of the important tools actively used in Russian state administration is the Vera (Faith) robot, which allows hundreds of applications to be automatically processed in the relevant departments. The robot is combined with the voice assistant Marusya from VK and is a full-fledged neurosystem with a recommendation component. This integration makes it possible to analyse the flow of documentation in the most competent and functional way and offer the best management solutions to the authorities [16].

The Federal State Autonomous Institution Research Institute 'Voskhod', responsible for the development of such products as the State Automated System of the Russian Federation 'Elections'; JSC National Certification Centre (NCC); National Data Management System (Federal State Information System 'Single Information Space NDMS'), etc., are actively cooperating with the state. These products contain AI technologies that automate the work of all levels and branches of government in Russia.[13] Non-invasive neuro-interfaces as a separate type of technology are actively used at the University of the Moscow City Government, and the university uses VR-technologies to train civil servants, prefects, employees of city administrations and registries.[14]

The above-mentioned programmes and practical examples of AI and VR applications suggest that Russia as a state mechanism is considering the spread of end-to-end technologies in the sphere of governance; however, the authors of the study concluded that there are almost no practical examples of implementing complex neurotechnologies (e.g., implants or motor neurointerfaces).

The reason for this is several factors. On the one hand, with all the variety of technologies, public administration is an area where only some of them can be applied, most of which are directly related to virtual assistants and neurotechnologies related to data visualisation [16]. Thus, due to the relatively small choice of products of scientific progress, the state is limited in the possibilities of realising innovative projects and does not always ensure the promotion of effective technologies. It also explains why neurotechnologies with invasive implementation and motor neurointerfaces are still not so actively used in public administration. On the other hand, the Russian economy is under sanctions restrictions, which makes the expert community have doubts about the effectiveness of AI exploitation in the public service in the near future [17]. Sceptical forecasts are also based on the poor results of the 2019 programme implementation. Thus, in 2012–2019 (according to the report of the National Research University Higher School of Economics), 660.26 billion roubles were allocated for the informatisation and digitalisation of federal executive bodies (FEBs).[15] At the same time, the number of FEBs staff gradually continued to increase, although the purpose of the spread of new technologies is to automate and simplify the decision-making structure in the management system. It is also worth noting that the number of staff grew (even despite the

[12] Seven agencies were caught in the neural network. RBC. 16.12.2020. URL: https://www.rbc.ru/newspaper/2020/12/16/5fd774869a7947c27f22fe25 (accessed on 18.09.2023).

[13] System innovations. Research Institute Voskhod. URL: https://www.voskhod.ru/ (accessed on 18.09.2023).

[14] From marriage ceremonies to public speeches: how VR-technologies help civil servants. Official portal of the Mayor and Government of Moscow. URL: https://www.mos.ru/news/item/93351073/ (accessed on 07.01.2024).

[15] Responding to the challenges of digitalisation: data-driven public administration, the ''headquarters'' model of management and structural manoeuvre in the number of civil servants. Report of the National Research University Higher School of Economics. MOSCOW: NATIONAL RESEARCH UNIVERSITY HIGHER SCHOOL OF ECONOMICS; 2020.

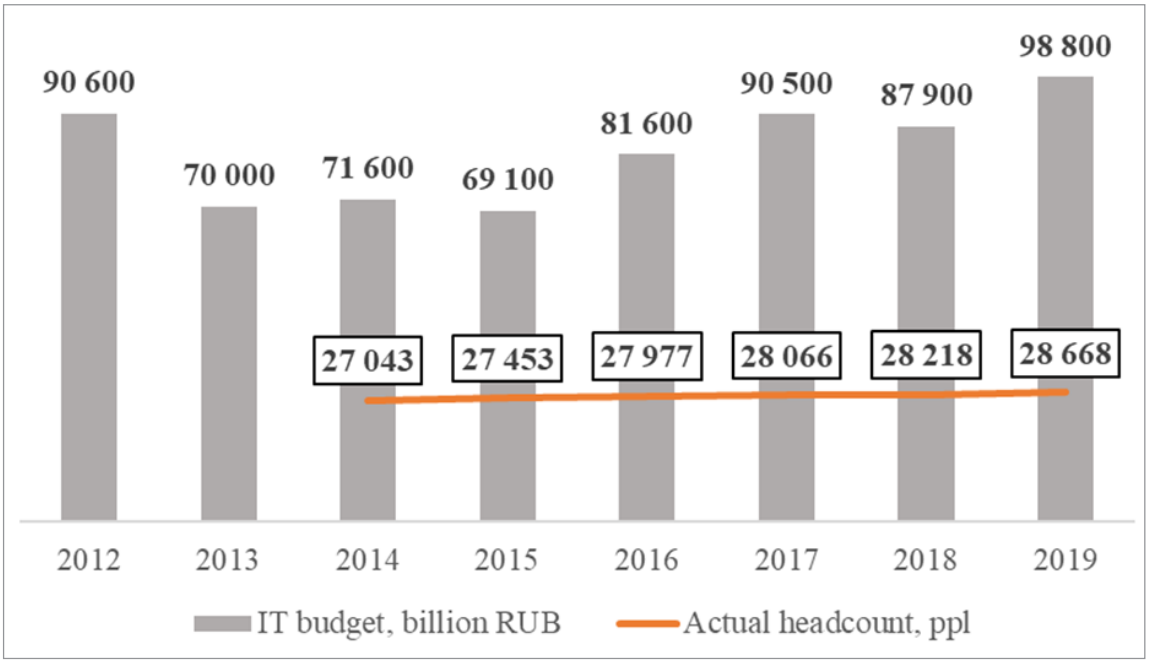

Fig. 3. **Costs of informatization in comparison with the actual number of personnel, 2012–2019**

Source: compiled by the author on the basis of the NRU HSE report "Responding to the Challenges of Digitalization: Data-Driven Public Administration, the "Headquarters" Management Model and Structural Maneuver in the Number of Civil Servants". Moscow: HSE; 2020.

reduction in staffing levels of federal agencies) by an average of 85% (*Fig. 3*).

The above factors do not allow us to assess the level of development of neurotechnologies and artificial intelligence in the public service in Russia as unambiguously high. There are no statistical data on this topic in sufficient volume for the analysis, but attempts to introduce neurotechnologies and AI into public administration are constantly being made.

COMPARATIVE ANALYSIS OF AI AND NEUROTECHNOLOGY APPLICATIONS IN THE PUBLIC SECTOR

As it was mentioned earlier, Russia is actively participating in the technological race along with other countries. It is worth paying attention to the UK as one of the main contenders for the title of the country that sets the main trends in the development of artificial intelligence and neurotechnology [18]. To achieve this goal, over the past few years the UK government has been approving strategic documents that define the ways of development of the digital economy and e-government. The peculiarity of these programmes is the active involvement of business in them, funding of scientific start-ups and compliance with international standards, so that talents from all over the world could get a job in the country [19]. In addition, the UK is involved in training for civil servants. For example, in 2022, a 5-part DDaT Essentials course was created: 'Data processing Fundamentals; Technology Fundamentals; Digital Fundamentals; Users First; Innovative Mindset'.[16] Such programmes can improve the future implementation of neurotechnologies in public administration and improve the digital skills of civil servants.

[16] Supporting cross profession senior civil servants with their DDaT skills [Online]. Official website of GOV.UK. URL: https://digitalpeople.blog.gov.uk/2022/03/16/supporting-cross-profession-senior-civil-servants-with-their-ddat-skills/ (accessed on 11.09.2023).

On the practical side, in 2022 (according to IBM), the percentage of AI implementation in the UK is 26%, which is higher than in the US and South Korea.[17] For example, since 2018, artificial intelligence has been used by the country's Department for Work and Pensions to detect and eliminate cases of fraud with social and state benefits[18]; AI cameras are being installed on the streets of Birmingham to combat urban waste[19]; and the Westminster City Council intends to use AI to analyse data on offenders and issue appropriate legal orders.[20] In terms of strategic work streams, Defence Science and Technology Laboratory (Dstl)[21] and Google Cloud signed a memorandum of understanding and collaboration on artificial intelligence in 2023 as part of the UK's defence sector development — the partnership with authorities is based on accelerating technology implementation and skills development.

In this way, the Ministry of Defence is working with private companies on cybersecurity, disaster response, and improving employee productivity[22] in order to digitise public administration. Government agencies are also trying to utilise neurotechnology, particularly in the provision of medical care and social services to citizens (e.g., through the Osso VR training platform at Newcastle Hospital) [20].

As can be seen, the UK is actively trying to take the lead in the race to implement AI in vital areas (including public administration), but no significant examples of advanced neurotechnology implementation were found during this study — except for the training of medical staff. National programmes are related to the use of artificial intelligence [in contrast to Russian practice, where neurotechnologies are highlighted (albeit in limited variants) as a separate area of development]. In addition, the UK's national strategy appeared much later than in most countries interested in AI,[23] which does not correlate well with its intentions to become a technological superpower. Another problem of the country is insufficient mastery of new technologies by civil servants — this is confirmed by analytical reports that question the effectiveness of implementation of existing educational programmes.[24]

The greatest number of innovations, geopolitical and economic position determine the advantage of such a state as the USA over other participants of the neurotechnology and artificial intelligence market. This explains the fact that already in 2016, the first strategy for the development and implementation of artificial intelligence in all areas of American life was published, the basis of which consists of 23 recommendations to be implemented by the country's government structures. When it comes to public administration, the document emphasises the formation of public policies

[17] IBM Global AI Adoption Index 2022. IBM Corporation. URL: https://www.ibm.com/watson/resources/ai-adoption (accessed on 21.09.2023).

[18] How The UK Government Uses Artificial Intelligence To Identify Welfare And State Benefits Fraud. Forbes. URL: https://www.forbes.com/sites/bernardmarr/2018/10/29/how-the-uk-government-uses-artificial-intelligence-to-identify-welfare-and-state-benefits-fraud/?sh=52b792f540cb (accessed on 15.09.2023).

[19] AI cameras installed in Birmingham to catch fly-tippers. Official website of LocalGov. URL: https://www.localgov.co.uk/AI-cameras-installed-in-Birmingham-to-catch-fly-tippers/56659 (accessed on 13.09.2023).

[20] Westminster council to trial AI in fight against fly-tipping. Official website of LocalGov. URL: https://www.localgov.co.uk/Westminster-council-to-trial-AI-in-fight-against-fly-tipping-/55700 (accessed on 12.09.2023).

[21] The Defence Science and Technology Laboratory (DSTL) is a UK Ministry of Defence (MOD) science and technology centre with around 3,500 staff, including some of the country's leading scientists and engineers.

[22] Dstl and Google Cloud sign a MOU as part of new AI collaboration. Official website of GOV.UK. URL: https://www.gov.uk/government/news/dstl-and-google-cloud-sign-a-mou-as-part-of-new-ai-collaboration (accessed on 02.09.2023).

[23] AI Index Report. Chapter 6: Policy and Governance. Stanford University. URL: https://aiindex.stanford.edu/report/#individual-chapters (accessed on 19.09.2023).

[24] The challenges in implementing digital change. Official website of National Audit Office. URL: https://www.nao.org.uk/press-releases/the-challenges-in-implementing-digital-change/ (accessed on 11.09.2023).

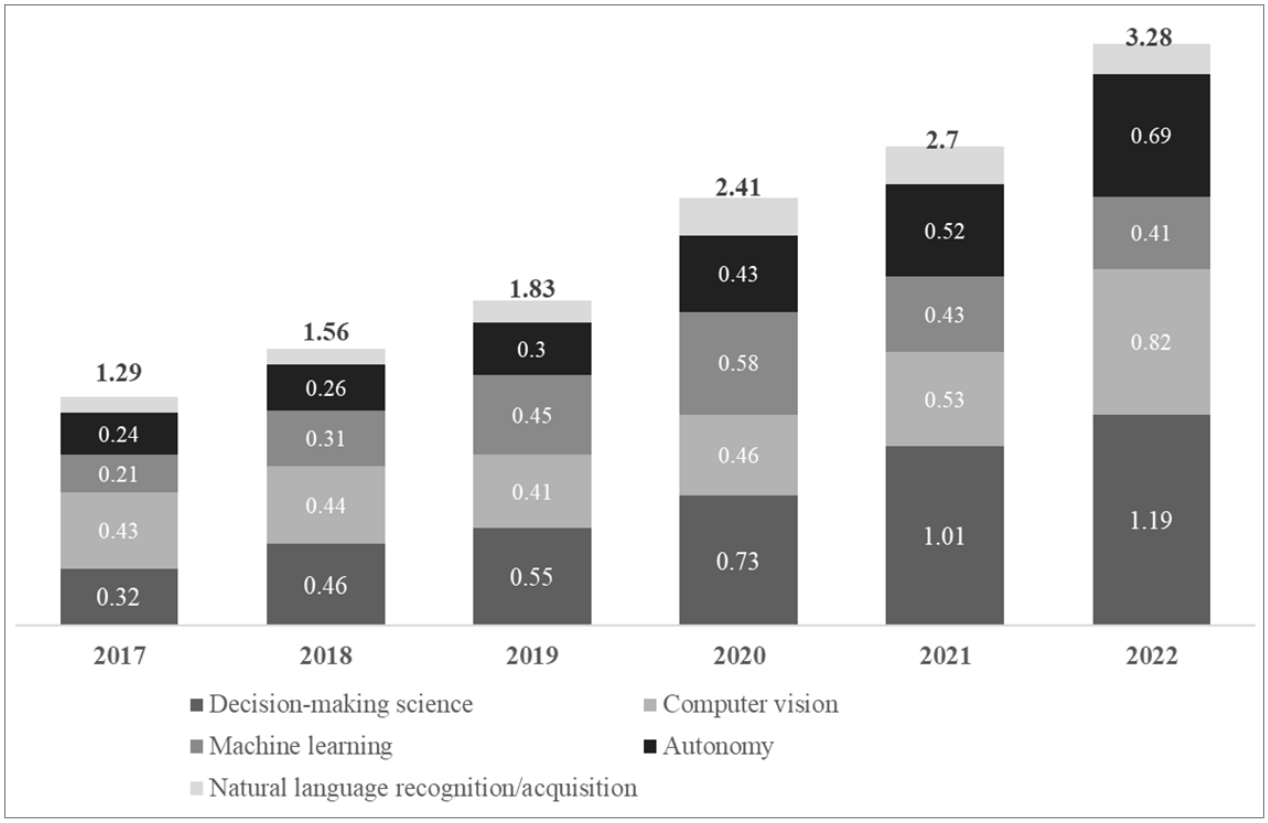

Fig. 4. **U.S. Government Spending by Segment, 2017–2022**

Source: compiled by the author based on the data of AI Index Report. Chapter 6: Policy and Governance. Stanford University. URL: https://aiindex.stanford.edu/report/#individual-chapters (accessed on 19.09.2023).

that promote the comprehensive advancement of AI in the US. A special mention should be made of Recommendation No. 4, which required the subcommittee on machine learning and artificial intelligence to create a community of public sector AI practitioners. It was to include agencies that promote educational programmes in the field of AI developed for government employees [21]. Following the recommendations allowed the United States to be one of the first to promote AI at the government level. According to the report of the United States Administrative Conference, almost half of federal agencies (45%) have experimented with artificial intelligence and related machine learning tools [22]. This paper also describes specific examples of the use of algorithmic recommendation AI systems to perform managerial and administrative tasks. For example, the Department of Housing is creating chatbots; the Transportation Security Administration is actively using facial recognition; AI tools are being implemented to protect agencies from hacker attacks, etc.

Other federal agencies using digital technologies in practice include the Office of Information Resources Management, the Office of Management Strategy and Decisions,[25] and the U.S. National Archives, among others [23]. Invasive and non-invasive neurotechnologies are being actively developed. Organisations such as the US Department of Defence's Advanced Research Projects Agency and the National Institutes

[25] Artificial Intelligence (AI). Official website of the U.S. Department of State. URL: https://www.state.gov/artificial-intelligence/ (accessed on 20.09.2023).

of Health are funding neuroscience projects. These projects are estimated to cost between US$ 5 billion and US$ 10 billion, respectively.[26] And every year, the amounts allocated to AI and neurotechnology (both in general and by segments) are only growing, although funding for some areas, on the contrary, is decreasing due to shifting priorities (*Fig. 4*). The largest and most popular programmes are the βApollo Project of the Brain [24] and the aforementioned BRAIN Initiative. The state is rather cautious in its approach to the study and application of neurotechnologies, so the work is still conducted only at the level of trials and clinical studies, but experiments with intracortical (implantable devices) and non-invasive BCIs are already underway, which can enhance human potential in the future, including in terms of making managerial decisions at the state level.[27]

However, analysing the financing of AI and neurotechnology in the US, one can identify certain problems that slow down the widespread introduction of such innovations (including in public administration). Firstly, studying the existing data, we can conclude that, unlike AI, neurotechnologies in the US are at the stage of scientific research and discussion. Second, according to the AI National Security Commission's reports on AI, there was a funding gap for the scientific field in the US (including AI and neurotechnology research projects) in 2020. According to these documents, it was not possible to hire the necessary number of specialists to implement artificial intelligence in public administration, which negatively affected the overall development of this field and reduced performance indicators. From the recommendations proposed by the commission, it can be concluded that another problem is the poor reliability and security of systems based on AI and neuro-interfaces [25].

ANALYSIS OF THE LEVEL OF DIGITALISATION OF PUBLIC ADMINISTRATION BY COUNTRY

To understand why it is necessary to embed AI and BCI in public administration, it is enough to consider one of the international indices for calculating the use of digital technologies, namely the World Bank's GovTech Maturity Index (GTMI) ranking, which reflects the level of digitalisation of public administration by country based on the following indicators: the Government Technology Maturity Index (GTMI); the Core Public Systems Index (CPSI); the Public Services Development Index (PSDI); the Citizen Engagement Index (CEI); and the Government Digitalisation Institutions Index (GDI) These parameters essentially reflect different aspects of digitalisation and allow us to conclude on the technological maturity of the public sector in the selected country (*Fig. 5*).

The results expressed graphically allow us to catch some trends in the development of digitalisation of the civil service. Firstly, despite the high level of technological development, the People's Republic of China is inferior to the other countries under study in almost all parameters, except for the Citizen Engagement Index (the US is in last place). The United Kingdom is the leader in this criterion. Digital public services (including those based on AI technologies) are most effectively developed in Singapore. In other criteria, the Russian Federation has the most points.

These rankings clearly reflect the fact that Russia has the most mature technologies and the most advanced information systems. Digitalisation institutions are also, according to the presented rating, the most developed in our country.

[26] Cause Area: Differential Neurotechnology Development. EA Forum. URL: https://forum.effectivealtruism.org/posts/Qhn5nyRf93dsXodsw/cause-area-differential-neurotechnology-development (accessed on 19.09.2023).

[27] Neuralink. URL: https://neuralink.com/ (accessed on 17.09.2023).

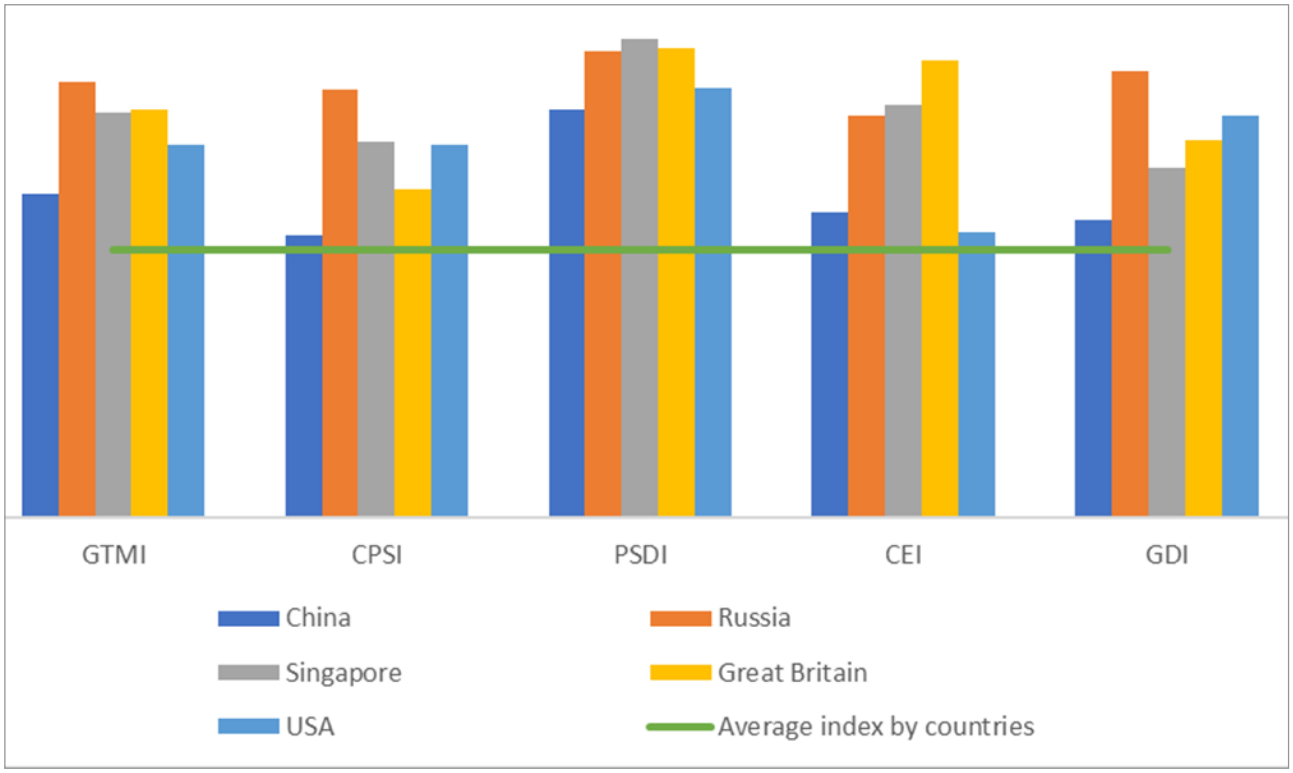

Fig. 5. **Comparison of GTMI by countries**

Source: compiled by the author based on the GovTech Maturity Index (GTMI) Data Dashboard. The World Bank (official website). URL: https://www.worldbank.org/en/data/interactive/2022/10/21/govtech-maturity-index-gtmi-data-dashboard.

RESULTS

The results of the study reveal several major trends related to the development of end-to-end technologies in public administration:

- today the market of neurotechnologies and artificial intelligence is actively developing and is capable of giving the state a competitive advantage in all spheres of society;
- due to the growing popularity and importance of new technologies, governments of all countries are actively developing regulations and long-term strategies to study and implement AI and neurotechnologies in their activities, which has led to another technological race;
- the position of each country in this race differs depending on the political, economic and technical framework, but even these factors do not always limit scientific progress in a particular state;

Examples of end-to-end technologies in almost all countries allow conclusions to be drawn about their place in public administration.

The study made it possible to compare legal documents of different states that envisage strategic development within the framework of technological progress. Of the countries represented, only the Russian Federation combined neurotechnology and artificial intelligence in one document dedicated to the digitalisation of public administration. The UK and the US have emphasised AI. However, the authors of the article revealed in the course of their work that, despite the development of the regulatory framework, at the moment developed countries are rather reluctant to consider the introduction of neurointerfaces in the public sector. Practical examples are limited to the use of virtual reality glasses and employee training, and the statisti-

cal base is either not maintained at all or relates to limited topics, which hinders future studies.

It would be wrong to say that the above-mentioned countries do not study neurotechnology — their research is conducted within the framework of medical sciences. In the course of the work, the authors of the article have identified the following trend: the state as an institution is still cautious about neurotechnology and doesn't rush to introduce the results of brain research into public administration due to ethical and legal factors, but artificial intelligence is being used everywhere. This seems to be the main problem that complicates further research on combining the spheres of public administration and neurotechnology. Government officials and scientists are still in search of ways to use neuroprostheses in the management of socio-economic processes in society. This fact confirms the relevance of this study, which is a practical reflection of the situation in which the state is now, when the unification of several sciences and a possible change in the technological mode are neither the main driver of active practical application of new technologies, nor a priority of study, although the desire for it is declared in federal strategies.

An important conclusion that follows from the results of the paper is also that sanctions pressure, foreign policy turbulence and economic situation do not always put an end to technological production. Paradoxically, according to international studies, as well as a comparison of strategies of different countries, it is the Russian Federation, rather than China and the United States, which have better resources, that is most successful in its attempt to gain technological primacy in the application of AI and is even (unlike other states) considering neurotechnology. This circumstance, however, is not a confirmation that the Russian Federation is the first in the field of end-to-end technologies, especially since it was concluded that the countries under study are on an equal position in the issue of practical application of neurotechnologies in the public sector.

A comparative analysis of the US, Russia and the UK also revealed different approaches to unlocking the potential of neurotechnologies in public administration. While the UK seeks to become a superpower in the field of AI by attracting personnel and creating educational centres, Russia focuses on the creation of information and analytical systems of artificial intelligence using neurointerfaces. At the same time, the US is preoccupied with national security and the study of various kinds of intelligent assistants. Each approach has its advantages and disadvantages, but the global trend of digitalisation and technologicalisation of public administration is noticeable.

The results of the study allow us to formulate proposals that will help the state as an institution of power and governance to make significant steps in the uptake of technology (see *Table*).

CONCLUSIONS

Neurotechnologies and artificial intelligence are a subject of study for specialists all over the world and a means of earning money for corporations due to the growing profitability of this market. However, the state, as the main beneficiary, is the first to seek to use the results of research, as the latest technologies allow it to defend its interests in the external environment and to organise management activities in the internal political and economic space. At the same time, the state is careful in its approach to complex sciences related to human nature, which is reflected in the intensity of scientific experiments.

To date, artificial intelligence is already changing public administration, while neurointerfaces are still only being discussed in scientific circles. At the same time, the available data allow us to observe the technological race,

Table

Proposals for further interaction of entities related to the development and application of end-to-end technologies in the public sector

Subject of interaction	Common communication paths
Economic set of measures — general innovative development of "end-to-end" technologies	
• State authorities at the federal and regional levels (Ministry of Finance of Russia, Ministry of Industry and Trade of Russia). • SME subjects. • Scientific start-ups. • Large businesses and their representatives (RSPP). • State companies and corporations (Rosatom, Roscosmos).	• Establishment of scientific and technological production in special economic zones. • Development of joint ventures and products through PPP-projects. (Public Private Partnership) • Development of incentives and other business support measures for products that fit the concept of "end-to-end technologies". • Development of special programmes and projects to attract investments and create scientific start-ups
Social set of measures — addressing challenges related to the use of technologies in the public service	
• State authorities at the federal and regional levels (Ministry of Labour of Russia, Ministry of Finance of Russia, Ministry of Culture of Russia). • Trade union organisations (Federation of Independent Trade Unions of Russia). • Social organisations and NGOs	• Introducing AI and neurotechnology under the auspices of social support. • Creating programmes to support socially vulnerable groups by improving their motor activity. • Popularisation of invasive and non-invasive neurointerfaces through the creation of a specialised advertising strategy and awareness training for civil servants
Statistical and legal set of measures — addressing normative, ethical, and statistical challenges	
• State authorities at the federal and regional levels (Federal Assembly, Ministry of Culture of Russia, Ministry of Education and Science of Russia). • State scientific centres (SIRIUS). • Statistical research centres (Rosstat, VCIOM (All-Russian Public Opinion Research Center), FOM (Public Opinion Foundation))	• Revision or development of a new regulatory framework for the use of AI and neurotechnologies in the government and public sectors (creation of federal laws, development of regulations and codes). • Development of an ethical framework consisting of the main provisions and principles regarding the use of «end-to-end" technologies and introduction of these provisions into the code of ethics of civil servants. • Ongoing statistical and information studies on the attitudes of citizens towards «end-to-end" technologies and the use of technologies in various spheres.
Research set of measures — addressing the lack of practical examples of "end-to-end" technologies in management processes	
• State authorities at the federal and regional levels (Ministry of Education and Science of Russia, Ministry of Culture of Russia, Ministry of Education of Russia). • Scientific state organisations (RAS). • Universities at federal and regional levels (National Research University Higher School of Economics, Moscow State University). • Private research institutes (Research Institute 'Voskhod', Autonomous Non-Commercial Organization 'Baikal Research Centre')	• Creation of a scientific base and a unified methodology for studying neurotechnologies and AI in the conditions of the Russian scientific school through clustering of existing knowledge. • Involvement of private research institutes and centres to promote innovative technologies in the public sector. • Experimental and testing application of sophisticated neurotechnologies in public authorities to improve cognitive abilities. • Conducting theoretical and practical research substantiating the usefulness and effectiveness of invasive and motor neurotechnologies for public servants. • Creation and implementation of artificial intelligence capable of independently making strategic managerial decisions at the strategic level of state forecasting and planning on the basis of processing a common system of statistical data

Source: compiled by the author.

which reflects the peculiarities of each country and makes it possible to identify the problematic and strong points of an individual state.

In the course of achieving the main objective of the study — to analyse the existing practice of neurotechnology application in the public sector — the fact of its insufficient development in general worldwide, due to both legal restrictions and scientific and financial difficulties, was revealed.

The results of the analysis made it possible to identify general trends in the development of neurotechnologies, to specify the practice of applying innovations in public administration and to draw conclusions about the interaction between public managers and neuroscience. The study confirmed the existence of a technological race and also demonstrated the difference in approaches to the application of similar products in different countries. Specific examples provided insight into the segments of governments applying AI and BCI and the goals of Western countries and Russia. Some of the challenges that governments face when trying to interact with the scientific environment were discussed.

Based on the above, the authors outlined their vision of further development of this field — from the involvement of entrepreneurs to the development of related sciences (psychology, quantum sciences).

In the author's opinion, the prospects for further work lie, first of all, in identifying and classifying existing and possible barriers to the application of neurotechnologies in the public sector. It is also worth considering the issues of strategic planning on the example of the Russian Federation and analysing the strengthening of positions in terms of digitalisation of public administration in the context of geopolitical crisis and pressure, to identify the reasons for this trend and to determine the next steps in the transition to a new technological mode.

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