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Digital technologies in the scientific and information activity system

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Abstract. The relevance of the study is determined by the need to explore options for improving the functioning of the scientific and informational activity system and its components using advanced digital technological solutions.

In this regard, the article focuses on addressing the challenges of applying digital technologies in the scientific and informational activity system and potential solutions to these issues. Notably,

these challenges include: information accessibility, the quality and reliability of information, large volumes of data, the lack of standards, and the absence of a unified information classification system.

The key approaches to studying this problem involve using methods of informational-logical analysis and a systems approach, enabling a comprehensive review of existing solutions in the field of digitalization.

The study examines the latest needs for the efficient performance of scientific and informational activities. Taking these needs into account, as well as the complex military-political situation in Ukraine caused by the armed aggression of the Russian Federation, the article proposes considering the scientific and informational activity system as a synthesis of the civilian sector and the Ministry of Defense of Ukraine. The article highlights key digital technologies that can be implemented in scientific and informational activities, including Big Data, artificial intelligence and machine learning, cloud technologies, digital repositories and databases, and visualization tools. It also recommends leveraging the National electronic system of scientific and research information (NAUKA) as an integrating link among disparate digital technologies.

The findings of this study have both theoretical and practical value for further research on the identified problem, as well as for implementing digital technologies in the activities of entities within the scientific and informational activity system. The research aims to enhance the system as a whole and foster integration with the corresponding systems of leading European and global nations.

Keywords: digital technologies, digitalization, scientific and informational activity, National electronic system of scientific and research information, NAUKA.

Introduction

Scientific and informational activity is a socially organized form of scientific labor aimed at enhancing the efficiency of research and development. It encompasses key processes such as the collection, analytical-synthetic processing, storage, and retrieval of scientific information documented in various forms, as well as the provision or dissemination of this information to researchers and specialists in a timely and convenient format (as part of information support and services) [1].

Scientific and informational activity emerged in the late 19th century within the framework of library science in response to the needs of science itself. The rapid development of science and technology led to a significant increase in the volume of scientific and technical literature and the expansion of its potential readership. By the beginning of the 21st century, libraries remained the primary means of meeting people's informational needs.

In today's world, scientific and informational activity must account for numerous requirements driven by the rapid advancement of technology, the globalization of science, and the growing volume of information (Fig. 1). Currently, some of the primary needs for the effective performance of scientific and informational activity include:

- access to high-quality information sources;
- information technologies and infrastructure;
- training and competencies of personnel;
- ethical and legal considerations;
- international collaboration and integration;
- flexibility and adaptability to change.

Some of these needs can be met through the implementation of digital technologies in the scientific and informational activity system. The transition to digital formats and the adoption of various IT solutions have transformed not only the mechanisms for accessing information but also the methods of processing, analyzing, and presenting it. This has positively impacted the speed and

efficiency of scientific research, as well as the interaction between scientists, institutions, and the broader audience [3-5]. Therefore, the search for and analysis of digital technological solutions to improve the scientific and informational activity system is a relevant scientific and practical task.



Figure 1. Modern Research Ecosystem Based on an Educational and Scientific Institution

Source: [2].

Methodological Framework

The armed aggression of the Russian Federation against Ukraine continues. The history of military conflicts across various eras vividly demonstrates the importance of technological superiority over an adversary, as opposed to mere numerical advantage [6]. Technological superiority can be achieved through scientific research that yields high-quality, verified results. One of the prerequisites for attaining such results is the implementation of scientific and informational activities.

Therefore, it is essential to consider the scientific and informational activity system in Ukraine as a synthesis of the civilian sector and the Ministry of Defense of Ukraine. This necessity arises from the need to enhance the following capabilities [7–11]:

– *synergy for national security*. Amid modern challenges, particularly in the context of military aggression, national security and defense depend not only on military technologies but also on advancements in the civilian sector, such as cybersecurity, artificial intelligence, information systems, and analytical technologies. This synthesis allows leveraging civilian research and innovation for the development of defense technologies and their adaptation to modern warfare conditions;

– *efficient resource utilization*. Ukraine has limited resources to fund science and defense. Coordination between the Ministry of Defense and the civilian sector enables optimization of available resources and unification of efforts to achieve common goals. The involvement of civilian

research institutions in projects with military or dual-use purposes reduces the costs of developing new technologies;

– *development of dual-use technologies*. Many technologies developed for the military can be adapted for civilian use (e.g., GPS, the Internet). Similarly, advancements in the civilian sector, such as drones, biometric systems, or telecommunications, hold significant potential for defense applications. Joint work on dual-use technologies enhances the innovation potential of both sectors;

– *information security and combating hybrid threats*. In modern conditions, warfare is conducted not only on the battlefield but also in the informational space. Coordinating the efforts of the civilian sector (including IT, sociology, and psychology) with defense structures is crucial for countering disinformation, cyber threats, and other forms of hybrid aggression. Civil society, media, and scientific institutions play vital roles in strengthening the informational front;

– *modernizing the defense sector through innovation*. Modern warfare requires cutting-edge technologies, from precision weapons to advanced monitoring and management systems. Innovations emerging in the civilian sector often serve as sources of revolutionary changes in defense. Modernizing the Armed Forces of Ukraine demands active involvement of the scientific potential of universities, research centers, and private companies;

– *enhancing international cooperation.* The synthesis of the civilian and defense sectors creates more opportunities for international cooperation in scientific and technological developments, including participation in NATO, EU, and other international programs. Such integration enhances Ukraine's reputation as a reliable partner and attracts foreign investments;

– *establishing a unified information space*. Effective threat mitigation requires an integrated information exchange system among research institutions, private companies, government bodies, and military structures. A unified information space facilitates quicker threat analysis, decision-making, and the implementation of new technologies.

The scientific and informational activity system in Ukraine should be built on the principles of integration between the civilian and defense sectors. This approach will ensure the effective use of the country's scientific potential, strengthen its defense capabilities, enhance national security, and foster innovative development.

According to the requirements of Ukrainian laws, including *"On Scientific and Technical Activities," "On Information," "On Scientific and Technical Information,"* and the *Regulations on the Organization of Scientific and Technical Activities within the Ministry of Defense of Ukraine* [12–15], informational support is a key element of scientific and technical activities. It is aimed at meeting the needs of military command bodies and scientific entities for the information necessary to create scientific (scientific-technical) products.

The implementation of digital technologies in the scientific and informational activity system will enable the automation and acceleration of processes, contributing to the development of the aforementioned capabilities.

Results

Digital technologies in the system of scientific and informational activity encompass a wide range of tools and methods used for the creation, processing, storage, dissemination, and analysis of scientific information.

Key Digital Technologies in Scientific and Informational Activity:

– *Big Data.* The collection, storage, and analysis of massive data volumes using cloud platforms and data processing tools (e.g., Hadoop (Fig. 2), Apache Spark). These technologies are utilized for analyzing scientific trends and conducting research in fields requiring the processing of extensive datasets (e.g., genomics, climatology);

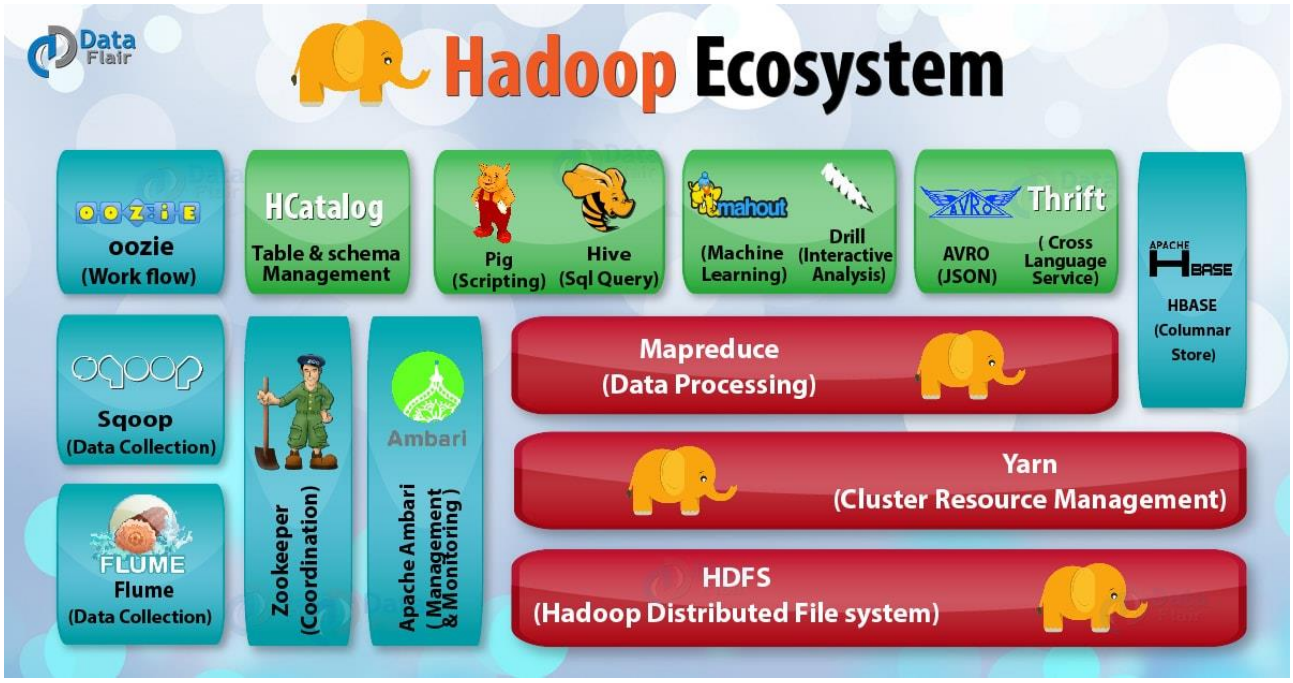


Figure 2. Components of the Hadoop Ecosystem

Source: [16].

– *Artificial Intelligence and Machine Learning*. Automation of data analysis and pattern recognition, application of AI algorithms for predictive modeling, and natural language processing (e.g., article text analysis). Examples of tools include TensorFlow, PyTorch, and specialized AI assistants in bibliographic databases;

– *Cloud Technologies*. Data storage and sharing in cloud environments (e.g., Google Drive, OneDrive, AWS, Azure). Cloud platforms facilitate collaborative research efforts;

– *Digital Repositories and Databases.* Open-access repositories (e.g., ArXiv, Zenodo, DSpace (Fig. 3)) and scientific databases (e.g., Scopus, Web of Science, PubMed) provide access to peer-reviewed publications and citation metrics;

– *Visualization Tools*. Tools for creating graphs, charts, and maps (e.g., Tableau, Power BI, Python (Matplotlib, Seaborn), Gephi). Interactive dashboards are used to present research findings effectively.

All these technologies contribute to optimizing the scientific and informational activities of system participants, yet their use remains fragmented. National electronic system of scientific and research information (NAUKA) (Fig. 4) can serve as an integrating link, connecting these diverse technologies into a cohesive framework.

At present, the primary objectives of the system are:

– collecting, processing, storing, managing, visualizing, and providing access to data in the field of science;

– supplying government authorities with analytical information to support effective decision-making;

– simplifying the process of searching for information and data, including identifying qualified researchers, potential performers for knowledge-intensive projects, services, equipment, and infrastructure for conducting research;



Figure 3. Features and functionality of DSpace

Source: [17].



Figure 4. About the NAUKA project

Source: [18].

– reducing the administrative burden on scientific department staff by automating the reporting process for researchers, scientific institutions, and research projects;

– effectively representing the scientific achievements of Ukrainian institutions in the global information space;

– automating the state accreditation process for scientific institutions;

– facilitating productive collaboration between researchers, business representatives, and government entities.

The development of new functional modules for the system is ongoing.

Conclusion

The use of modern tools such as Big Data, artificial intelligence, machine learning, cloud technologies, digital repositories, and visualization tools significantly enhances the efficiency of processing, storing, and disseminating scientific information.

In the context of armed aggression against Ukraine, the integration of scientific and informational activities between the civilian sector and the Ministry of Defense is essential for strengthening national security and defense capabilities.

National electronic system of scientific and research information (NAUKA) has been proposed as an integrating platform to unify various digital technologies, creating a unified and cohesive digital research environment.

The prospect of further research lies in analyzing similar platforms in leading countries worldwide to develop recommendations for potential new functional capabilities of NAUKA.

Recommendations

The results of the above material may be useful to researchers involved in the organization of scientific and informational activities.

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Цифрові технології в системі науково-інформаційної діяльності

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Анотація. Актуальність дослідження обумовлена необхідністю пошуку варіантів удосконалення функціонування системи науково-інформаційної діяльності та її елементів, використовуючи новітні цифрові технологічні рішення.

У зв'язку з цим дана стаття спрямована на розкриття проблемних питань використання цифрових технологій в системі науково-інформаційної діяльності, можливих варіантів їх вирішення. В особливості, такими питаннями є: доступність інформації, якість і достовірність інформації, великі обсяги інформації, відсутність стандартів та єдиної системи класифікації інформації.

Провідними підходами для дослідження цієї проблеми є використання методів інформаційно-логічного аналізу та системного підходу, що дозволяють комплексно розглянути наявні рішення в області цифровізації.

Розглянуто новітні потреби для ефективного виконання науково-інформаційної діяльності. Ураховуючи них та складну воєнно-політичну обстановку в Україні через збройну агресію російської федерації, запропоновано розглядати систему науково-інформаційної діяльності в синтезі цивільного сектору та Міністерства оборони України. Показано основні цифрові технології, що можна впроваджувати у науково-інформаційну діяльність, а саме: великі дані (Big Data), штучний інтелект і машинне навчання, хмарні технології, цифрові репозитарії та бази даних, інструменти візуалізації. Запропоновано використання Національної електронної науково-інформаційної системи NAUKA як інтегруючої ланки між розрізненими цифровими технологіями.

Матеріали статті становлять теоретичну та практичну цінність для проведення подальших наукових досліджень стосовно порушеної проблеми, а також для впровадження цифрових технологій у діяльність суб'єктів системи науково-інформаційної діяльності, удосконалення системи в цілому, налагоджуючи інтеграцію з відповідними системами провідних країн Європи та світу.

Ключові слова: цифрові технології, цифровізація, науково-інформаційна діяльність, Національна електронна науково-інформаційна система, NAUKA.