Information-analytical systems for supporting scientific research in Ukraine: development and applications

Volodymyr V. Kamyshyn[1], Anna V. Iatsyshyn[1,2], Oleksii L. Sukhyi[1], Oleg M. Spirin[2], Serhiy O. Semerikov[3,2,4,5,6], Iryna S. Balanchuk[1] and Andrii V. Iatsyshyn[7,8]

[1]*State Scientific Organization "Ukrainian Institute of Scientific Technical and Expertise and Information", 180 Antonovycha Str., Kiev, 03150, Ukraine*

[2]*Institute for Digitalisation of Education of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine*

[3]*Kryvyi Rih State Pedagogical University, 54 Universytetskyi Ave., Kryvyi Rih, 50086, Ukraine*

[4]*Zhytomyr Polytechnic State University, 103 Chudnivsyka Str., Zhytomyr, 10005, Ukraine*

[5]*Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine*

[6]*Academy of Cognitive and Natural Sciences, 54 Universytetskyi Ave., Kryvyi Rih, 50086, Ukraine*

[7]*Center for Information-analytical and Technical Support of Nuclear Power Facilities Monitoring of the NAS of Ukraine, 34a Palladin Ave., Kyiv, 03142, Ukraine*

[8]*G.E. Pukhov Institute for Modelling in Energy Engineering of NAS of Ukraine, 15 General Naumova Str., Kyiv, 03164, Ukraine*

Abstract

Information-analytical systems (IAS) are essential for conducting scientific research in the digital era. They enable researchers to access, analyze, and process information, collaborate and share knowledge, optimize information retrieval and update, and support decision-making processes. In this paper, we examine the concept of "IAS for supporting scientific activities" and present some examples of IAS developed by Ukrainian scientists for various research domains. These IAS help researchers store, organize, and analyze information on the scientific research outcomes in Ukraine, which improves the efficiency and effectiveness of scientific activities. We also discuss the benefits of using IAS for scientific research, such as accelerating the pace of scientific discoveries, providing wide access to scientific information, facilitating knowledge exchange, and contributing to collaborative solutions for complex problems.

Keywords

information-analytical systems, scientific research, digital era, case study, Ukraine

1. Introduction

Currently, digital technologies provide support across all areas of scientific activity, offering a wide range of instrumental tools and services. Mastering these technologies is essential for the information-analytical support of scientific endeavors [1].

There is also a growing interest in scientometric research from government institutions, as the optimization of mechanisms for allocating state budget funds and accelerating Ukraine's transition to an innovative development model require the implementation of bibliometric and scientometric analysis methods in management practices to analyze information flows [2].

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kvv@ukrintei.ua (V. V. Kamyshyn); anna13.00.10@gmail.com (A. V. Iatsyshyn); su@ukrintei.ua (O. L. Sukhyi); oleg.spirin@gmail.com (O. M. Spirin); semerikov@gmail.com (S. O. Semerikov); slavira218@gmail.com (I. S. Balanchuk); iatsyshyn.andriy@gmail.com (A. V. Iatsyshyn)

http://www.uintei.kiev.ua/page/kerivnyctvo (V. V. Kamyshyn); https://www.scopus.com/authid/detail.uri?authorId=57211134480 (A. V. Iatsyshyn); http://www.uintei.kiev.ua/page/kerivnyctvo (O. L. Sukhyi); https://iitlt.gov.ua/eng/structure/detail.php?ID=308 (O. M. Spirin); https://kdpu.edu.ua/semerikov (S. O. Semerikov); https://scholar.google.com.ua/citations?hl=uk&user=Mbp2z8wAAAAJ (I. S. Balanchuk); https://www.nas.gov.ua/EN/PersonalSite/Statuses/Pages/default.aspx?PersonID=0000015808 (A. V. Iatsyshyn)

0000-0002-8832-9470 (V. V. Kamyshyn); 0000-0001-8011-5956 (A. V. Iatsyshyn); 0000-0002-3479-4123 (O. L. Sukhyi); 0000-0002-9594-6602 (O. M. Spirin); 0000-0003-0789-0272 (S. O. Semerikov); 0000-0002-5179-7350 (I. S. Balanchuk); 0000-0001-5508-7017 (A. V. Iatsyshyn)

Overall, information-analytical systems (IAS) are an integral component of scientific research, facilitating the effective execution of scientific tasks, stimulating innovation, and fostering the growth of scientific knowledge. The using of these systems assists researchers in understanding complex problems and provides them with prompt access to the necessary information. The application of IAS in scientific research contributes to accelerating the pace of scientific discoveries, ensuring broad access to scientific information, facilitating knowledge exchange, and promoting collaborative problem-solving. The outlined advantages of utilizing IAS make them indispensable tools for the scientific community.

The development of national IAS for scientific purposes holds an extremely significant value and is a pertinent task in the modern world. Such systems are directed towards supporting scientific research, fostering the development of the scientific community, and obtaining essential scientific outcomes. Let's point out a few aspects that emphasize the importance of developing national IAS for scientific purposes.

One of the main benefits of national IAS is the collection and aggregation of national data. National IAS can provide centralized access to essential national data, such as scientific publications, statistical information, geographical distribution, socio-cultural data, and more. This simplifies the work of researchers, enabling them to focus on analyzing and interpreting this data. Moreover, for leaders in the scientific field, this data serves as a basis for making informed decisions regarding further funding of research in specific regions (cities). National IAS can help identify the most promising areas of research and innovation in Ukraine, as well as the gaps and challenges that need to be addressed.

Another advantage of national IAS is the support for national research. National IAS can become central hubs for conducting scientific research, bringing together data and resources from various sources. They assist researchers in developing and conducting studies aimed at addressing national challenges and issues. For instance, national IAS can enable the integration and interoperability of different databases and platforms that store and process scientific data, such as biobanks, genomic databases, environmental monitoring systems, etc. This can foster multidisciplinary and collaborative research that can generate novel insights and solutions for the country's development. Also, national IAS can facilitate the compliance with ethical and legal standards for data processing in the context of biobanking and medical research.

A third benefit of national IAS is the ensuring access to scientific information. The development of national IAS contributes to the dissemination of scientific information among researchers and the public. This enhances the visibility of national achievements in scientific research and fosters collaboration among scientists. For example, national IAS can provide open access to scientific publications and data that are relevant for the national context, as well as promote their citation and recognition by the international scientific community. National IAS can also increase the awareness and engagement of the public in scientific activities and events, such as conferences, workshops, exhibitions, etc.

A fourth benefit of national IAS is the fostering of innovation. National IAS can stimulate the development of innovative technologies and solutions based on scientific research. They help identify new opportunities and pave the way for the implementation of scientific findings into practice. For instance, national IAS can support the transfer of knowledge and technology from academia to industry, as well as facilitate the creation and growth of start-ups and spin-offs that can commercialize scientific products and services. National IAS can also encourage the participation of researchers in national and international innovation competitions and programs that can provide funding and recognition for their innovative ideas.

A fifth benefit of national IAS is the preservation of national scientific heritage. National IAS can serve as digital archives where national scientific achievements are stored and organized. This enables the preservation of scientific heritage for future generations and ensures access to historical scientific sources. This is especially crucial during the digitization of old prints, archival documents, and more, as ancient documents, manuscripts, maps, photographs, audio recordings, and others can deteriorate over time and be lost forever. For example, national IAS can help maintain and update the accounting standards and practices that reflect the historical and cultural context of a country.

A sixth benefit of national IAS is the strengthening of national identity. The development of national IAS can contribute to the preservation and study of national cultural heritage, ethnographic data, and

other nationally significant aspects. For example, national IAS can enable the documentation and analysis of various forms of intangible cultural heritage, such as languages, folklore, traditions, rituals, etc., that are unique to a country or a region. National IAS can also support the education and promotion of national values and identity among citizens.

Therefore, national IAS have the potential to become a significant tool for supporting scientific research, discovering new knowledge, and contributing to the national development of Ukraine. They promote the collaboration of researchers, provide access to scientific information, and contribute to the country's innovative growth. Thus, the development of domestic IAS that are suitable for conducting scientific research and subsequent monitoring of their performance is one of the priority tasks that require resolution.

2. Literature review and problem statement

Through the analysis of scientific literature, it has been determined that the issues related to the use of digital technologies to enhance the efficiency of scientific activities have been the subject of investigation by researchers:

- the implementation of the principles of open science discussed in the studies [3, 4];
- the application of digital technologies for evaluating the performance of scientific research [5, 6, 7, 8, 9, 10, 11, 12];
- the implementation of digital systems in the management of universities and research institutions [13, 14, 15, 16, 17, 18];
- the information-analytical support for scientific research is described in publications [19, 20, 21, 22, 23];

The experience of the Italian Open Science Support Group (IOSSG) in promoting the development and dissemination of open science in Italy is described in publications by Gargiulo [3], Ciriminna and Pagliaro [24].

The experience of Ukraine in using tools such as the European Open Science Cloud (EOSC) and other cloud-based instruments to enhance the qualification of teachers is presented in the research study [25]. Furthermore, the results of the conducted research have confirmed the significant development of teachers' digital competencies in utilizing open science tools. The publication [26] describes the advantages of using cloud services for teacher preparation, including resource savings, mobile accessibility, elasticity, and more. Recommendations for the implementation of EOSC in the educational process are proposed.

Yang et al. [6] describes the results of a conducted study on the evaluation of the efficiency of the scientific research system in Chinese universities. It is indicated that the effectiveness of the scientific research system is a key element in assessing universities. Emphasis is placed on the two aspects of the research system: obtaining scientific results and the transformation (implementation into practice) of these results.

The experience of implementing digital analytical systems in the management of al-Farabi Kazakh National University is described by Mamykova et al. [27]. The paper discusses the analysis of information systems, comparison of business analytics platforms, and approaches to designing the information and analytical system in the university as one of the key elements of the university's information infrastructure.

Mustafee et al. [28] conducted an analysis of co-citation patterns in the literature related to e-science and e-infrastructures. E-Science refers to the science of this era, which is realized through collaborative research and relies on the utilization of large datasets. E-infrastructures play a crucial role in conducting scientific research. The study identified research clusters based on Web of Science data. The analysis results serve as an important reference for aspiring researchers and students who are beginning their scientific investigations.

The research study conducted by Devarakonda et al. [29] involved analyzing a large sample of literature in the field of computer science from the DBLP database. The analysis revealed inter-category clusters, some of which interact with external fields while others remain internally oriented.

Timóteo et al. [14] describes the identification of digital tools for managing health sciences. The analysis was conducted using the PUBMED, Web of Science, and Health Virtual Library databases. Most of the studies focused on describing the functional capabilities of software. Overall, the research indicates the contribution of digital laboratory management systems to various management issues related to Good Laboratory Practice (GLP) principles. The findings suggest that digital laboratory management systems can be important tools for adhering to the principles of good practice in experimental medicine and healthcare research.

The literature review has shown that digital technologies have a positive impact on the efficiency of scientific activities in various domains and contexts. However, there are also some challenges and limitations that need to be addressed, such as ethical, legal, technical, and organizational issues. Therefore, further research is needed to explore the best practices and solutions for using digital technologies to support scientific research and innovation.

The authors of this article have partially described digital systems for informational and analytical support of scientific research in their previous publications. However, they have not analyzed and systematized the domestic informational and analytical systems that are used for conducting and managing scientific research.

3. The aim and objectives of the study

The aim of this article is to explore how Ukrainian informational and analytical systems contribute to the digitalization of science and the organizational support of research activities. The objectives of this study are to:

- Explain the concept and functions of informational and analytical systems for scientific activity.
- Examine the role of informational and analytical systems in facilitating research processes and outcomes.
- Describe the features and capabilities of informational and analytical systems developed in Ukraine for scientific activities and the organizational support of research.

4. Research results

4.1. The role of informational and analytical systems in conducting research

The primary focus of our research is the analysis of the concept of "informational-analytical system for supporting scientific activities." In [30], the concept of an "informational-analytical system" is defined as a computer system that enables the retrieval, creation, processing, and analysis of information. Informational-analytical systems are built based on real-time operational data obtained from operational systems that automate the organization's core activities, as well as other available data sources that may be relevant for making strategic decisions. In [31], the concept of "informational-analytical system" refers to a "distinct class of information systems designed for the analytical processing of data rather than for the automation of routine organizational activities". IAS integrate, analyze, and store information as a unified entity. The data repositories within IAS facilitate the transformation of large volumes of detailed data into aggregated, verified information suitable for making informed decisions [31].

Spirin et al. [19] provide the following definition for the concept of "information-analytical support of pedagogical research": it is assistance and facilitation provided to the subjects of scientific research in obtaining and analytically processing information and data related to the processes of planning, organizing, conducting, and implementing the results of pedagogical research through the use of information and communication technologies. The "system of information-analytical support for pedagogical

research" itself involves the application of statistical and information-analytical scientometric services in electronic open systems.

The next step for our research is to determine the role of IAS in conducting scientific research. In the publication [20], it is emphasized that scientific activities, including the processes of searching, analyzing, and utilizing scientific achievements, should be supported by appropriate information-analytical assistance. Therefore, the selection of digital tools to enhance the efficiency of scientific activities becomes relevant.

The study by Spirin et al. [19] is dedicated to the application of open access electronic systems for supporting scientific research. The study highlights the main directions of using such systems to support psychological and pedagogical research. It is noted that the information-analytical support system for scientific research based on open access electronic systems consists of statistical and information-analytical scientometric services. The main criteria for selecting open access electronic systems are identified as openness, functionality, and suitability for use in scientific institutions and higher education establishments in Ukraine.

To create information-analytical support for scientific activities, it is important to address the following tasks [21]:

- formation of a database of information and data for conducting scientific activities;
- systematization and preservation of key innovative developments;
- identification of promising research directions;
- evaluation of scientific research in accordance with societal development;
- monitoring of scientific output;
- exchange of scientific information and data, including publication, dissemination, and utilization of scientific output (articles, monographs, manuals, etc.), participation in conferences, webinars, forums, etc;
- ensuring free access to information and data for conducting scientific research.

For example, in the publication [21], it is stated that information-analytical support for scientific and pedagogical research based on open access electronic systems consists of statistical and information-analytical scientometric services. These services include open journal systems built on the Open Journal Systems (OJS) platform, scientific electronic libraries built on the EPrints platform, programs for plagiarism checking such as eTXT, webinar and conference platforms, and website monitoring systems like Google Analytics. The main criteria for selecting open access electronic systems are their openness, functionality, and suitability for use in scientific institutions and educational establishments in Ukraine.

Bykov et al. [12] propose a specific "scientific approach to the impact factor of scientific production" based on the functioning of scientific repositories as IAS. For example, the impact of a particular scientific result/publication (monograph) can be determined as the ratio of downloads of a specific monograph to the downloads of all monographs over a specific period or overall. This approach can be extended to other types of information resources, including social-humanitarian, particularly pedagogical, research by establishing a general or time-based factor of impact on scientific production, distinct from scientific articles in journals, conference abstracts, and proceedings.

In April 2023, the resolution of the Cabinet of Ministers of Ukraine "On the implementation of an experimental project for the introduction of an information-analytical system for external assessment and self-assessment of educational and managerial processes in educational institutions 'EvaluEd"' was approved [32]. At the same time, the authors of this publication raise the question: "Will the developed 'EvaluEd' system include data on the implementation of scientific research in higher education institutions?" as scientific activity is also an integral part of the work of higher education and the training of professionals, including postgraduates and doctoral students.

Therefore, IAS play an important role in conducting scientific research by providing researchers with access to necessary information and tools for data analysis. Let us further justify the role of IAS in the implementation of scientific research by summarizing the conclusions made in scientific publications [3, 24, 12, 19, 20, 21]:

1. *Data collection* (enables gathering large volumes of data from various sources such as scientific journals, databases, conferences, the Internet, etc. This helps find important publications, research findings, statistical data, and other information that can be used for conducting scientific research).
2. *Data analysis and processing* (provide researchers with tools for analyzing and processing data. This may include statistical analysis, identifying dependencies, data visualization, modeling, and other analytical methods. These tools help derive new discoveries from the collected data and confirm or refute hypotheses).
3. *Collaboration and information exchange* (allow researchers to communicate, exchange information, and collaborate. They provide opportunities to discuss research, share findings, work on joint projects, provide feedback on colleagues' work, and more. This contributes to the growth of collective knowledge and promotes interaction among researchers).
4. *Information retrieval and knowledge updating* (provide fast and efficient access to up-to-date information. These systems can be used to search for relevant research, articles, documents, or other materials related to their research topic. They can also track updates in their areas of interest and provide current data on scientific advancements).
5. *Modeling and simulation* (provide capabilities for modeling and simulating scientific processes or phenomena. They allow researchers to create virtual models, conduct experiments, analyze results, and make predictions. This helps identify patterns, understand complex systems, and forecast their behavior).
6. *Decision support* (provide researchers with information and analytical tools to support the decision-making process. They help assess risks, make forecasts, conduct efficiency analysis, and evaluate options. This allows researchers to make informed decisions based on scientific data and analysis).

Additionally, IAS contribute to innovation development. They create a conducive environment for searching new ideas, identifying trends, and driving transformations in the scientific world. Researchers can use these systems to identify new research directions, identify important issues, and explore better ways to address them.

4.2. Ukraine's experience in the digital era

The digital transformation of society aims to fundamentally change the way scientific and research activities are organized and conducted. The use of digital technologies for supporting and performing scientific research can significantly reduce both time and financial costs. The development of IAS is very important and relevant for conducting scientific research, especially for addressing a range of tasks, such as: fast access to information, processing large volumes of data, data integration, decision support, data visualization, generating new knowledge and identifying patterns, interdisciplinary approach, collaboration stimulation, personalized approach, forecasting and modeling, fostering innovation. Therefore, the use of IAS in scientific research can increase the productivity of scientific processes, the development of new analytical methods, and the collaboration among researchers from different countries.

According to the [31], at the national level in Ukraine, the provision of scientific and technical information is carried out by the State Scientific Organization "Ukrainian Institute of Scientific Technical and Expertise and Information" (UkrISTEI). At the regional level, it is managed by centers of scientific and technical information under the Ministry of Education and Science of Ukraine, such as the "Kharkiv CNTEI", the Odessa Innovation and Information Center and departments of five higher education institutions.

We believe that the development of domestic information-analytical and reference systems is currently relevant and in demand, as they contribute to enhancing the effectiveness of scientific research and further monitoring of their performance. To partially address the outlined tasks and functions, UkrISTEI operates in Ukraine. It was created to ensure the implementation and scientific support of measures related to the implementation of state policies in the fields of scientific, scientific-technical, innovative activities, and technology transfer. It also serves as a scientific support for the fulfillment of tasks and

functions in the aforementioned areas entrusted to the governing body. The mission of UkrISTEI is to ensure scientific, scientific-technical, and innovative development through expert, informational, and consulting support (based on the website http://www.uintei.kiev.ua).

According to the Statute of UkrISTEI, as stated on the website http://www.uintei.kiev.ua, it carries out its activities in the following directions: state registration of scientific research and design works, defended dissertations, technologies, and their components, primarily those created using budgetary funds; publication and dissemination of informational materials, journals, digests, and analytical reviews in the scientific-technical and innovative fields; organization and conduct of ongoing exhibitions of advanced technologies and developments, conferences, roundtable discussions, and other scientific and educational events; formation of funds for scientific and technical information and the results of scientific and technical activities.

In addition, UkrISTEI provides technology transfer support through the operation of the "Technology and Innovation Support Center". It organizes international and all-Ukrainian scientific events, maintains an automated information fund of scientific research, design works, and defended dissertations, which is considered a national asset of the state (comprising over 300,000 documents). UkrISTEI also establishes a School of Scientific Startups and plans to create a Science Museum.

Let's briefly describe the developed IAS in UkrISTEI. These systems have been created to support scientific activities in Ukraine and further monitor the implementation of scientific results and innovative developments.

Firstly, there is the National Repository of Academic Texts (NRAT). The NRAT is a nationwide distributed electronic database that accumulates, stores, and organizes academic texts. It provides open access to the information contained within it, particularly to the registry of academic texts, as well as their electronic versions and other related data, made available under open access conditions (based on information from the website [33]). The main purpose of NRAT is to promote the development of educational, scientific, scientific-technical, and innovative activities by improving access to academic texts and fostering academic integrity. In its operations, NRAT may, in accordance with the legislation, carry out information integration with other databases, including resources of open data in Ukraine and other countries, as well as databases of central executive authorities [34]. Figure 1 displays the main page of NRAT, which includes various sections: About the National Repository, News, For Researchers, For Educators, For Innovators, Academic Degrees, Scientific Journals, Scientific Events, Open Science, Scientific Metrics, International Support, Academic Integrity. Additionally, figure 1 presents a page featuring the search function for academic texts. For example, the NRAT portal updates its news daily, allowing scientists to stay informed about new trends in the fields of science and education, as well as various scientific events such as conferences, seminars, roundtable discussions, online courses, and more. In the "International Support" section, researchers can explore diverse opportunities offered by international organizations, such as scholarships, grants, and more. NRAT also operates a Telegram channel (https://t.me/NationalRepository) and a Facebook page (https://www.facebook.com/nrat.gov.ua), where all the news posted on the portal are regularly shared and duplicated.

Indeed, the utilization of NRAT offers a range of benefits for various user groups, including researchers, graduate students, doctoral candidates, managers of research institutions/higher education institutions, employees of the Ministry of Education and Science of Ukraine, and others. NRAT hosts dissertations, abstracts, research reports, scientific articles, and more. It stands as one of the largest resources of its kind in Ukraine, providing free 24/7 online access to academic materials for all users. NRAT was created with the purpose of preserving and popularizing Ukraine's scientific heritage, as well as ensuring accessibility to scientific research for all interested individuals.

Secondly, there is the Automated System for Formation of Interstate Information Resources (ASFIMIR). In UkrISTEI, one of the mechanisms for innovation technology transfer has been developed, which is an automated system designed to implement this mechanism and provide informational support for transfer processes – ASFIMIR [22].

The information system, which is structurally composed of a local component and an internet component, is hosted on the UkrISTEI server and is located on the "Innovation Technology Transfer" page of the UkrISTEI website. The local component consists of main and auxiliary databases (DBs).

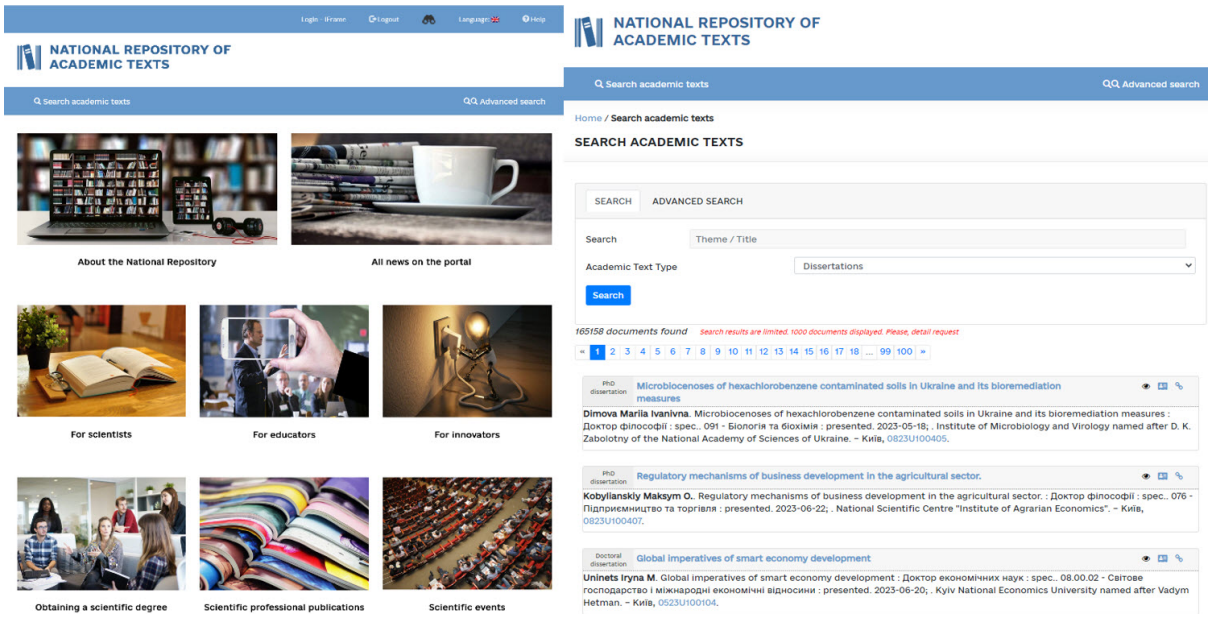

Figure 1: National Repository of Academic Texts.

The internet component hosts the DBs for “Innovative Technologies and Developments”, “Investment Projects”, and “Requests for Additional Information.” The data in the local component information arrays are populated from both traditional sources and data obtained from users via the internet. The local and internet component information arrays are in dynamic interrelation. Table 1 provides data on the content of the DBs in the ASFIMIR system [35].

Having analyzed the data in table 1, it is determined that the database that experienced the most dynamic growth is “Innovative Technologies and Developments”, as evidenced by the number of records in 2022, which increased by 86 entries to reach 191, compared to 105 records in 2021.

Table 1
Statistics of database content in the ASFIMIR system (2018-2022).

Databases	2018	2019	2020	2021	2022	Total
Innovative Technologies and Developments	364	386	229	105	191	5517
Investment Projects	1	7	3	0	2	366
Requests for Additional Information	13	2	3	1	0	286

In the context of post-war recovery in Ukraine, it is believed that the data obtained from the ASFIMIR platform will have a significant impact on the reconstruction of the country. The increased intensity of scientific research in fields such as construction, water supply and sanitation, medicine, agriculture, etc., will contribute to the emergence of new innovative solutions. These solutions will facilitate the resolution of Ukraine’s reconstruction challenges through increased cooperative links among different regional structures.

Thirdly, this is the Electronic Registration System for Open (Non-Secret) Scientific Research and Development Works (ERSOSRD). ERSOSRD provides the opportunity to register open scientific research works online free of charge. This system performs the following functions: scientific, reference-information, fund-forming, and educational. The system provides a “personal cabinet” service for NDKR performers and assists in filling out registration and accounting cards. An important function of the system is to take into account the interests of each participant and user and ensure significant cost savings from the state budget through online document registration, eliminating the need for business trips for ERSOSRD performers and expenses on postal deliveries. Confirmation of state registration is obtained by receiving registration and accounting numbers and recording them in the database.

Additionally, this system allows for instant retrieval of registration and accounting documents using the registration number or QR code, enabling their verification of availability and compliance by the employees of the State Audit Service of Ukraine at any time (https://nddkr.ukrintei.ua).

The effective functioning of this system corresponds to the actual Procedure for State Registration and Accounting of Scientific Research, Research and Development Works, and Dissertations. This electronic registration system is a complex multi-component information system that utilizes modern advancements in digital technologies. The system takes into account ergonomic requirements for interaction between users and the ERSOSRD Fund at all stages of electronic application submission and retrieval of necessary reference information.

Fourthly, there is the Electronic Registration System for Open (Non-Classified) Defended Dissertations. The system operates online (https://okd.ukrintei.ua) and is based on proven and efficient solutions. The electronic registration form is intended for supervisors in scientific institutions, higher education institutions, and other organizations involved in scientific research and development activities, where candidates for academic degrees are prepared and specialized academic councils are established for dissertation defenses. The system provides comprehensive support for the activities, management, preservation, and development of the Defended Dissertations Fund, which is a national asset. The system also ensures equal access to full-fledged services for all user categories in all regions of Ukraine. Confirmation of state registration is provided through the issuance of registration and identification numbers and recording in the database. Additionally, the system allows for obtaining registration and identification documents using the registration number or QR code, enabling staff members to verify their existence and conformity at any time.

Fifthly, there is the Remote Registration System for Technologies and their Components. This system allows for free online registration of open (non-classified) technologies. The system provides comprehensive information support for the preservation and development of the Registered Open Technologies Fund and ensures equal access to the registry in all regions of Ukraine for all users. The online registration services of the system include a personal account, assistance in filling out the registration form, a government identification number, and the ability to print an identification card. Confirmation of state registration is obtained through the issuance of registration and identification numbers and the inclusion of information in the database. Additionally, the system provides instant access to registration and identification documents using the registration number or QR code, allowing for verification of their existence and conformity at any time. The use of the Remote Registration System for Technologies and their Components facilitates the work related to scientific organizational support of prepared technologies and their components and enables 24/7 access to these materials and accompanying documents. Furthermore, the functioning of such a system supports the implementation of Open Science policies in Ukraine.

Sixthly, there is the Information and Analytical System for Monitoring the Activities of Scientific Institutions in Ukraine (IASMSI). The system aims to support scientific institutions in Ukraine in creating informational materials and applications for state certification, as approved by the Ministry of Education and Science of Ukraine, as well as in populating the monitoring system with reporting data. An online dashboard is created for each scientific institution, where the responsible person fills out the forms that are processed on the server. The software complex of the system supporting the monitoring of scientific institutions' activities is developed as a continuously operating online resource, providing access to information at any time. Representatives of scientific institutions enter data into the monitoring information system, submitting informational materials and reporting data. Regular submission of information to the centralized monitoring system allows for the generation of analytical snapshots of financial and other performance indicators of the institutions. These snapshots are necessary for expert groups, commissions, and other departments of the Ministry of Education and Science of Ukraine responsible for certification and monitoring of scientific institutions' activities. The use of the Information and Analytical System for Monitoring the Activities of Scientific Institutions in Ukraine helps reduce the time spent processing large amounts of information provided in paper or electronic files for further analysis.

Seventh, the Reference and Information System "Scientific Publications of Ukraine" was

developed to address the problem of the lack of a centralized database of scientific periodicals. This system (http://nfv.ukrintei.ua) offers the following advantages:

- provides convenient access to information about scientific publications in Ukraine;
- streamlines the process of evaluating applications for granting "professional" status to scientific journals for experts of the Ministry of Education and Science of Ukraine;
- serves as a basis for the development of an effective monitoring system for scientific periodicals in Ukraine;
- facilitates interaction with the National Repository of Academic Texts for updating publication information and uploading journal archives.

In our opinion, the developed Reference and Information System "Scientific Publications of Ukraine" contributes to obtaining up-to-date information and analytical data on scientific periodicals in Ukraine, thereby enhancing the speed and quality of management decisions regarding the accreditation of scientific journals in Ukraine.

Eighth, it is the Automated Expertise System. The system is designed to improve the efficiency of state scientific and scientific-technical expertise processes by utilizing modern digital technologies. We believe that the Automated Expertise System contributes to the improvement and acceleration of state scientific and scientific-technical expertise processes, facilitating the automated organization and conduct of audits for technologies related to scientific research and their evaluations.

The publication [2] states that the presence of bibliometric profiles enables the use of a synergistic approach in constructing an information-analytical system that provides a wide range of statistical indicators regarding the state of the scientific environment in Ukraine. This approach is based on the direct involvement of researchers in creating their bibliometric profiles, their subsequent network integration, and additional processing to ensure unambiguous identification of the scientist. We propose to refer to the scientist's profile, supplemented with identifying information, as a "bibliometric portrait" of the scientist.

In Ukraine, there is also an information-analytical system called "Bibliometrics of Ukrainian Science", which was initiated in 2014 by the V.I. Vernadsky National Library of Ukraine. This system serves as a national bibliometric and scientometric service aimed at providing a comprehensive understanding of the state and dynamics of processes taking place in the scientific environment of Ukraine. The system performs the following functions: maintaining a unified registry of scientific declarations (bibliographic profiles) of researchers in systems such as Google Scholar, Scopus, Web of Science, and Scientists of Ukraine; collecting statistical information on the sectoral, departmental, and regional structure of science in Ukraine; serving as a bibliometric component of the data source for evaluating scientific performance; and being the national segment of the Ranking of Google Scholar Profiles project. (based on the website: https://nbuviap.gov.ua/bpnu/index.php?page=about).

Therefore, the aforementioned IAS perform the following key functions:

- information gathering and processing (they provide access to a wide range of information sources, such as databases, scientific articles, reports, dissertations, and other sources);
- data or research results analysis (they can analyze data and information, enabling the identification of patterns and trends in scientific research);
- dissemination of scientific information (they assist researchers in publishing their research in relevant open-access sources);
- preparation of research projects (they help scientists develop research projects and plans, assisting in identifying relevant and important research topics and selecting methods and tools for their implementation);
- researchers search and identification (facilitate finding other researchers with similar research interests, which can stimulate collaboration, exchange of experience, and sharing of research results).

- decision support (provide researchers with necessary information and analysis results, evaluate the effectiveness and performance of research, which contributes to the development of strategies and policies in scientific research and informed decision-making on scientific matters);
- research management (assist researchers in organizing and managing their scientific research/projects, including planning, coordination, and monitoring activities);
- monitoring the utilization of research results (facilitate automated collection of quantitative data on the usage/download of research results);
- provision of technological audit for state scientific and scientific-technical expertise;
- creation of a unified information space for organizing and conducting state scientific and scientific-technical expertise to comprehensively support information and analytical needs of expertise entities;
- facilitating timely exchange of scientific and technical information among users from other countries;
- assistance in promoting developments/technologies and projects to the market. The system includes a number of local databases, access to which is possible only through requests submitted via the Internet;
- data visualization (can provide graphical representation of data and information, enabling researchers to analyze and understand large amounts of data quickly and effectively).

Therefore, IAS for scientific research and subsequent monitoring of their results help researchers enhance the efficiency of conducting scientific investigations. They provide open access to necessary information and research outcomes, thereby contributing to the development of science in Ukraine and its integration into the international research arena.

Additionally, significant expertise in the usage and implementation of IAS, both foreign and domestic, in scientific research is possessed by the staff of the Institute for Digitalisation of Education of the NAES of Ukraine. This is evidenced by a list of research works conducted by the employees of this Institute [36]. For example, we can mention several collaborative scientific research projects, the outcomes of which can be explored through the follow:

- "Information-Analytical Support System for Pedagogical Research Based on Electronic Open Access Systems," 2015-2017 (https://lib.iitta.gov.ua/view/themes/0115U002234);
- "Methodology for Using Open Electronic Scientific and Educational Systems to Develop Information and Research Competence of Researchers and Science-Educators," 2018-2020 (https://lib.iitta.gov.ua/view/themes/0118U003159);
- "Methodology for Using Cloud-Oriented Open Science Systems in Educational Institutions," 2021-2023 (https://lib.iitta.gov.ua/view/themes/0121U107673);
- "Design and Technological Support for the Operation of the Open Internet Platform 'Ukrainian Electronic Encyclopedia of Education,"' 2021-2023 (https://lib.iitta.gov.ua/view/themes/0121U108134);
- "Methodology for Using Information and Digital Technologies for Evaluating the Effectiveness of Pedagogical Research," 2021-2023 (https://lib.iitta.gov.ua/view/themes/0121U107615).

5. Conclusions

This research has shown that information and analytical systems (IAS) play a vital role in scientific research. They offer various benefits, such as: providing access to information, tools for data analysis and processing, facilitating collaboration and knowledge exchange, streamlining information retrieval and updates, and supporting the decision-making process. The use of IAS in scientific research helps improve the efficiency and quality of research work. Scientists can quickly find the necessary information, conduct analysis and interpretation of data using powerful tools, communicate with colleagues, and exchange knowledge.

The development of national IAS for scientific purposes is important for several reasons: it enables the collection and aggregation of national data, it supports national research, it ensures access to scientific information, it fosters innovation, it preserves national scientific heritage, and it enhances national identity.

The authors of this article have significant experience in the development and implementation of IAS for scientific purposes, based on numerous consultations with users. Based on this experience, we draw the following conclusions:

1. The process of implementing such systems in Ukraine is typically accompanied by a complex set of regulatory, organizational, and software-related challenges that developers must constantly overcome. There is a need for regulation of legislative and normative documents both at the state level and within research institutions and universities.
2. Users often experience social and psychological resistance to innovation, which can be attributed to the need for an increased level of digital and information analytical competence among scientific and academic staff. This issue is addressed through the consistent organization of seminars, webinars, roundtable discussions on various aspects of using IAS and developing researchers' digital competencies.
3. It has been determined that "information and analytical systems for supporting scientific activities" are understood as important tools for researchers, as they facilitate the storage and organization of large volumes of data related to scientific research and enable efficient search and statistical analysis of this data.
4. The information and analytical systems developed by UkrISTEI for conducting scientific research assist scientists in storing, organizing, and analyzing information on research outcomes conducted in Ukraine, thereby enhancing the effectiveness and productivity of scientific activities. Therefore, national IAS have the potential to become a crucial tool for supporting scientific research, discovering new knowledge, and contributing to Ukraine's national development.
5. The use of information and analytical systems for scientific research contributes to:
    - ensuring the automation of the information search and collection process, enabling researchers to utilize their time more effectively;
    - providing storage and organization of data gathered during scientific research;
    - assisting scientists in drawing conclusions and making informed decisions based on data and evidence;
    - facilitating the search and access to the works of other scientists, promoting knowledge exchange and enriching the scientific community;
    - aiding in decision-making regarding scientific and technical matters;
    - conducting monitoring of the utilization/download of scientific research results, which contributes to determining the demand for data materials among the general public;
    - evaluating the effectiveness and productivity of scientific research and developing effective strategies and policies in the scientific field.
6. To ensure effective information and analytical support for scientific research, it is crucial for scientists to possess the skills to utilize specialized information and analytical systems. Therefore, the authors of this article consistently initiate and conduct various scientific events and training sessions covering different aspects of using information and analytical systems for scientific purposes.

Considering the aforementioned, we emphasize that the development of national IAS is critically important for conducting scientific research and further monitoring of their effectiveness. These systems not only facilitate the process of data collection and analysis but also contribute to enhancing the quality, efficiency, and innovativeness of scientific endeavors across various fields of knowledge.

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