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# Development of Research e-Infrastructure in Ukraine: Creation of the National Repository of Academic Texts

Issues of developing e-infrastructures and research data storages are investigated in the context of digitalization processes. The present-day scientific literature has great many publications on technical, legal and organizational issues of repository creation, reviews of relevant practices in various countries, descriptions of new services, assessment of the open access effectiveness etc. However, scientific, methodological and practical aspects of creating the national Ukrainian archive of scientific and education information are for the most part overlooked. The article proposes a review of crucial components in the e-infrastructure of EU like EOSC and OpenAIRE, with outlining their objectives, general characteristics and phases of creation. It is important because the course on integration in the European Union, formulated in the strategic documents of Ukraine, involves the development of the Ukrainian eco-system of research, education and innovation in compliance with the European standards. A brief review of data about the performance and dynamics of repositories across the world is made with emphasis on their structure, country of location, software and sectoral profile. Data on the number of institutional repositories in Ukraine and their availability in domestic higher education establishments are presented. The need for developing a system of information repositories and creating the National Repository of Academic Texts is justified in view of the data demonstrating the existing research and education capacities in Ukraine. The key characteristics of the National Repository are described: its contents, functionality, goal, objectives, structure, phases of creation, development prospects. Their relevance to the tasks set in the Action Program of the Cabinet of Ministers of Ukraine on line of the objectives 1.4 and 1.5 of the Ministry for Education and Sciences of Ukraine is shown.

NRAT has to be a really demanded and very useful resource capable of making the research sector transparent and accessible, notably accelerating exchange of research and education information, stimulating scientific progress and innovation activity in Ukraine. This will make the research financing more effective.

**Key words:** *National Repository of Academic Texts, electronic archive, e-infrastructure, research, education, research and development, academic text, EOSC, OpenAIRE.*

**Introduction.** Digitalization processes in the modern world cover almost all the spheres of human activities. This tendency has clear manifestations in the sectors sensitive to innovation such as R&D and education. Information and communication technologies make national borders transparent for research and education exchange, essentially reduce the time for information communication, offer convenient platforms for online communications, enabling one to seek for associates or form creative teams, discuss hypotheses, exchange opinions, hold lectures or scientific conferences, save results. In this way, e-infrastructures are created with digital archives as its constituent part. In the latest decade they have got an additional impulse to development due to the technological advance and adoption of the new policy for treatment of R&D results that are becoming maximally public for the benefit of developing science, education and the whole society.

The above issues are widely discussed in the professional community, being in focus of great many works of domestic and foreign authors. Special emphasis should be made on the publications devoted to various aspects of creation and development of digital archives or repositories (see, for example, [1–10]. However, important problems related with creating the domestic e-infrastructure and one of its central components, the national repository of research and education information, still remain unsolved. This article is devoted to their elaboration.

**Results and discussion.** The first phase of the National Repository of Academic Texts (NRAT) will launched in December 2019. It is an important event in the scientific life of Ukraine, as the principle of science openness can be implemented at a new level. A key component of the research infrastructure is being created, intended to provide support for research, education and innovation activities, which can be subsequently integrated in analogous European structures.

The decision on the NRAT creation was taken in 2016, with issuance of the respective Decree of the Cabinet of Ministers of Ukraine [11]. The Government actually supported the proposal to create the NRAT as an electronic base of texts of dissertations, works of higher education seekers and other research works. The Ministry for Education and Science of Ukraine (MES) was commissioned to work out and approve the action plan on creating and launching the NRAT, to elaborate the regulations on the NRAT and provide the project financing from the total budgetary appropriations of the MES for 2016 and subsequent years.

As the resulting document was concise, it could not specify even the principal features of the future repository. At the same time, the decision taken by the Cabinet of Ministers of Ukraine was timely and, as life had demonstrated, expected by the scientific community, lecturers and broader public [12; 13]. It gave the start to creating the NRAT, a project designed to meet the needs of the domestic R&D and education systems, on the one hand, and implement best foreign practices, on the other hand, opening wider opportunities for Ukraine's interactions with European Open Science Cloud (EOSC), a large strategic project of EU [14], and its key component, OpenAIRE [15].

The EOSC is a cloud initiative of the European Commission, founded in 2016, aimed at practical implementation of the open science principle as a driving force of science development and accelerator of innovation, based on the openness of research data. EOSC is supposed to provide the virtual environment with uninterrupted access to services on storage, management, analysis and repeated use of research data for 1.7 million of European researchers and 70 million of specialists in social sciences and humanities, irrespective of national borders and scientific disciplines [14]. Roadmap for the EOSC [16; 17] is focused on the following key points: architecture, data, services, access & interface, rules, and governance.

The architecture involves: creation of the federating core (platform, shared resources, single structure and rules of compliance) by the stakeholder integration of national, sectoral and horizontal infrastructures: developing of single requirements to the cloud components on the basis of accreditation and certification; creation and permanent updating of the register of infrastructures with their constant monitoring. EOSC Hub, OpenAIRE, FREYA, EOSC pilot, MERIL and RICH projects are defined as the basic components of the EOSC architecture.

FAIR principles are referred to in the EOSC as the key point in the work with data [18]. FAIR is an English acronym defining four basic principles: Findability; Accessibility; Interoperability; Reusability. These principles, first published in 2016, are supposed to serve as guidance for ones who generate, collect, process and publish primary data, in order to maximize the value added of official scientific digital editions. FAIR is expected to lay the basis for the following operations:

– develop the single data structure resulting from system analysis of the legal landscape with respect to repeated use of data;

– prepare the accreditation scheme / certification of data;

– formulate the interdisciplinary policy for the permanent unique data identifier;

– develop the catalogue of data standards. Key projects here are FREYA, OpenAIRE, RDA Europe, eInfraCentral, EOSC Hub, etc.

The following problems are consistently implemented for the EOSC services: analyzing the existing and potential user needs; auditing the services provided presently by the available e-infrastructure; creating the single catalogue of such services, their provision model, the register of participants and resources; identifying the gaps in needs; assessing the use; creating new prototypes and testing new services. The abovementioned problems are solved by the EOSC with reliance on projects like eInfraCentral, OpenAIRE and EOSC Hub.

Problems of access to the EOSC platforms are solved consistently through specifying general metadata for data sets, which will enable to simplify data search, cross-references and compatibility between catalogues of data by field of knowledge and discipline for placing data sets of the platform in the catalogue, and the analogous operations for services. Besides that, the EOSC portal is being developed. The basic projects in this area are INFRAEOSC, e-InfraCentral, EOSC Hub.

The rules of participation and the EOSC Guiding Principles are defined through consultations with all the stakeholders, the single set of rules is elaborated on the basis of the project objectives and the achieved consensus and the system for their continuing monitoring and fulfillment is subsequently organized.

The governance system is developed by considering respective models proposed by stakeholders, consulting, elaborating the acceptable governance structure, making the strategy and operation plans, specifying the financial component.

An approximate chronology of EOSC creation is given in Figure 1 ([14]).

Now there exist 42 projects supporting EOSC:

AENEAS (Advanced European Network of E-infrastructures for Astronomy);

AGINFRA+ (support to the development of data infrastructure of AGINFRA, covering related, but not totally linked user communities in the field of agriculture and food);

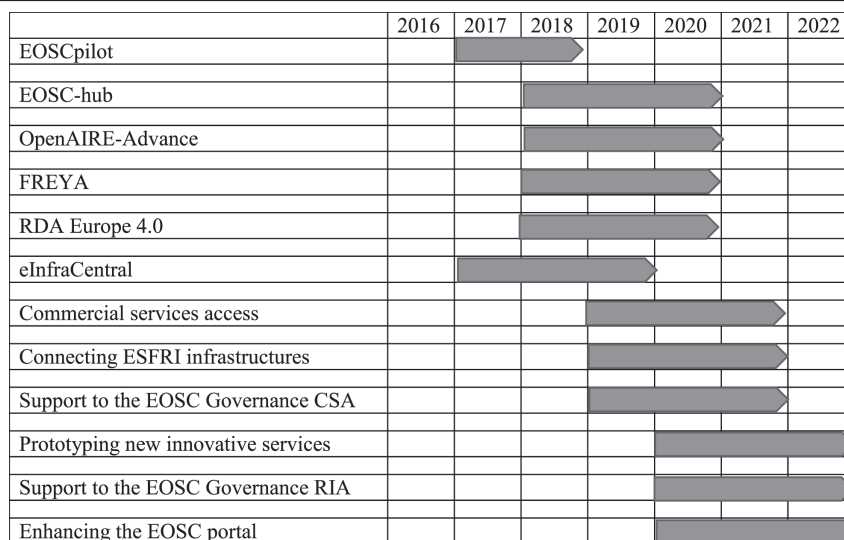ARCHIVER (the association of information and communication technologies, including extreme

| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| EOSCpilot | | ▬ | ▬ | | | | |
| EOSC-hub | | | ▬ | ▬ | ▬ | | |
| OpenAIRE-Advance | | | ▬ | ▬ | ▬ | | |
| FREYA | | | ▬ | ▬ | ▬ | | |
| RDA Europe 4.0 | | | ▬ | ▬ | ▬ | | |
| eInfraCentral | | ▬ | ▬ | ▬ | | | |
| Commercial services access | | | | ▬ | ▬ | ▬ | |
| Connecting ESFRI infrastructures | | | | ▬ | ▬ | ▬ | |
| Support to the EOSC Governance CSA | | | | ▬ | ▬ | ▬ | |
| Prototyping new innovative services | | | | | ▬ | ▬ | ▬ |
| Support to the EOSC Governance RIA | | | | | ▬ | ▬ | ▬ |
| Enhancing the EOSC portal | | | | | ▬ | ▬ | ▬ |

**Fig. 1. The timeline for creating the European Open Science Cloud**

scaling of data, network connection, functional compatibility of services and business model in the hybrid cloud environment for providing complex archiving services covering the full life cycle of research);

BE OPEN (aims to promote Open Science in transport research (Figure) and assist in regulating and standardizing it);

Blue-Cloud (bringing together and piloting of innovation services for sea research and "blue economy");

CINECA (support to genomic and biomolecular data to accelerate research and improve human health);

COS4CLOUD (support to civil R&D, collection and providing for the accessibility of data collected by non-professionals);

DARE (delivering Agile Research Excellence on European e-Infrastructures);

DEEP-Hybrid-DataCloud (supports artificial intelligence (machine learning and deep learning), parallel post-processing of very large data, and analysis of massive online data streams over distributed e-Infrastructures);

eInfraCentral (the European catalogue of services and resources of e-infrastuctures, simplifying search and access to EOSC services and resources);

e-IRGSP6 (supports e-IRG in its activities producing high-level policy recommendations towards the implementation of EOSC, EDI and the e-Infrastructure Commons overall);

ENVRI-FAIR (a virtual, federated machine-to-machine interface to access environmental data and services provided by the contributing research institutes);

EOSC Synergy (expands the Capacity and Capabilities of EOSC by leveraging the experience, effort and resources of national publicly-funded digital infrastructures);

EOSC-Life (brings together the 13 biological and medical research infrastructures in Europe to create an open, collaborative space for digital biology);

EOSC-Nordic (aims to facilitate the coordination of EOSC relevant initiatives within the Nordic and Baltic countries);

EOSC-Pillar (brings together the representatives of the fast-growing national initiatives for the coordination of data infrastructures and services in Italy, France, Germany, Austria and Belgium);

EOSCpilot (supporting the definition, management and coordination of EOSC components and service providers without imposing a strict hierarchical model or supply chain);

EOSC-hub (brings together multiple service providers to create the Hub: a single contact point for European researchers and innovators to discover, access, use and reuse a broad spectrum of resources for advanced data-driven research);

ESCAPE (supports open science of Pan-European research infrastructures in astronomy and physics of elementary particles);

ExPaNDS (a federation of 10 European national Photon and Neutron research infrastructures, and the e-infrastructure. The goal of the project is to set-up a platform for data analysis, as a service for users from research institutes, universities, industry, etc., thus enabling EOSC services, and providing coherent FAIR data services to the scientific users);

eXtreme DataCloud (develops scalable technologies for federating storage resources and managing data in highly distributed computing environments);

FAIR4Fusion (makes data financed by EU more accessible for research communities, investment organization and broader public);

FAIR4Health (facilitates and encourages the EU health research community to FAIR principles, share and reuse their datasets derived from publicly funded research initiatives);

FAIRplus (aims to develop tools and guidelines for making life science data based on FAIR principes);

FAIRsFAIR (assists the European Open Science Cloud (EOSC) governance bodies to deliver FAIR-aligned Rules of Participation in the EOSC);

FNS-Cloud (overcoming fragmentation problems by integrating existing food and nutrition data, which is essential for high-end, pan-European food and nutrition research, addressing diet, health, and consumer behaviors as well as on sustainable agriculture and the bio-economy);

FREYA (extends the infrastructure for persistent identifiers (PIDs) as a core component of open research, in the EU and globally, improves discovery, navigation, retrieval, and access to research resources);

G ANT (the Pan-European network for research, education and innovations);

INODE (Intelligent Open Data Exploration aimed at simplifying access to data);

NEANIAS (drives the co-design and delivery of innovative thematic services, derived from state-of-the-art research assets and practices in three major sectors: Underwater research, Atmospheric research and Space research);

NI4OS Europe (supports the global open science and innovation growth);

OCRE (give the European research community access to commercial digital services (IaaS, SaaS and PaaS cloud services), as well as Earth Observation (EO) services);

OpenAIRE-Advance (supports the transition to more open and reproducible research environment);

OpenRiskNet (develop an *open e-Infrastructure* providing resources and services to a variety of communities requiring risk assessment, including chemicals, cosmetic ingredients, therapeutic agents and nanomaterials);

PaNOSC (a cluster of ESFRI Research Institutes which proposes to make FAIR data a reality);

PRIMAGE (an open cloud-based platform to support decision making in the clinical management of malignant solid tumours);

PROCESS (support to the new ecosystem of data management);

RDA Europe 4.0 (contributes to interoperable exchange of research data, expands social, technical and interdisciplinary networks for promoting this exchange worldwide);

SSHOC (a scalable and *flexible* model of *access to research data* and related services adapted to the needs of the SSH scientific community);

TRIPLE (helps social sciences and humanities research in Europe to gain visibility, to be more efficient and effective, to improve its reuse within the SSH and beyond, and to dramatically increase its societal impact);

VirtualBrainCloud (develops of a cloud-based platform for biomedical research and clinical decision-making);

EOSC Secretariat (delivers 360° support to the EOSC Governance) [14].

OpenAIRE is a constituent part of EOSC representing a non-commercial partnership that supports the shared e-infrastructure for the e-science in Europe. It is a network of organizations and private persons engaged in e-science in Europe, a European network for cooperation. The goal of OpenAIRE is to assure the principles of openness and transparency in the research community, to give full support for innovative means of researchers' communications and provide accessibility of research. This goal is based on the understanding that transformation of the society is achieved through the scientific knowledge. It follows that the OpenAIRE objective is to make science useful for the society, lecturers, government bodies, business, financing organizations. For this, the policy of open science is elaborated and promoted in every way, including 34 national points.

OpenAIRE activities aim at the following:

– transform the research system towards openness and transparency for researchers representing all the fields of knowledge;

– rethink the social significance of the confirmed knowledge through open science; allow citizens, educators, funders, civil servants and industry find ways to make science useful for themselves, their working environments, the society;

– create the European open system for monitoring of science as the base for the Pan-European research information required for optimal use of resources and improvement of the decision making policy.

OpenAIRE implements the abovementioned aims in the following ways:

1) introduces Open Science in work processes of researchers, to help link research and find information sources and content suppliers;

2) creates single standards for promoting research results (publications, data, software) and interactions with their producers (researchers, research institutions, higher education establishments, sponsors) on the basis of FAIR principles;

3) sets the transparence in assessing the impact of research through the Common European Research Information Format, and through the system of monitoring and analysis;

4) provides full support to the change in the research culture following the open science principles, which is achieved by training of researchers, content providers, managers, so as they could acquire skills and competencies of open science;

5) creates the system of interactions with the global open research environments through

promoting common policies and protocols of access to R&D results, data standards, context exchange procedures etc., to build the effective and open global research eco-system;

6) promotes open innovations, making accessible all the research information for outside providers of services.

OpenAIRE partners are 65 European universities, research centers and institutions [15].

The system for archiving and providing open access to research and education information is based on repositories, i. e. data warehouses enabling for not only accumulation or saving of information, but for its extraction and delivery by external user request, with filtering it by the preset criteria depending on user demands and keeping intact the integrity of archive.

According to the Ranking Web of World repositories from Cybermetrics Lab, there are 3206 repositories of all types worldwide, which core is institutional repositories (3106). A special category of repositories are platforms or archives of scientific journals, which number is 251 [19].

Thus, DOAJ (Directory of Open Access Journals) contains 14174 journals from 130 countries [20]. OpenDOAR covers 5299 repositories, with top ten countries in this rating accounting for 2929 (55,3%) repositories, which creation has been rapidly on in the latest 15 years (Figure 2, [21]). Ukraine has the 14th rank in this rating among 29 countries. These are mostly English language (67%) and multidisciplinary (62%) archives build on various types of software (predominantly DSpace and EPrints accounting for 52%) [21].
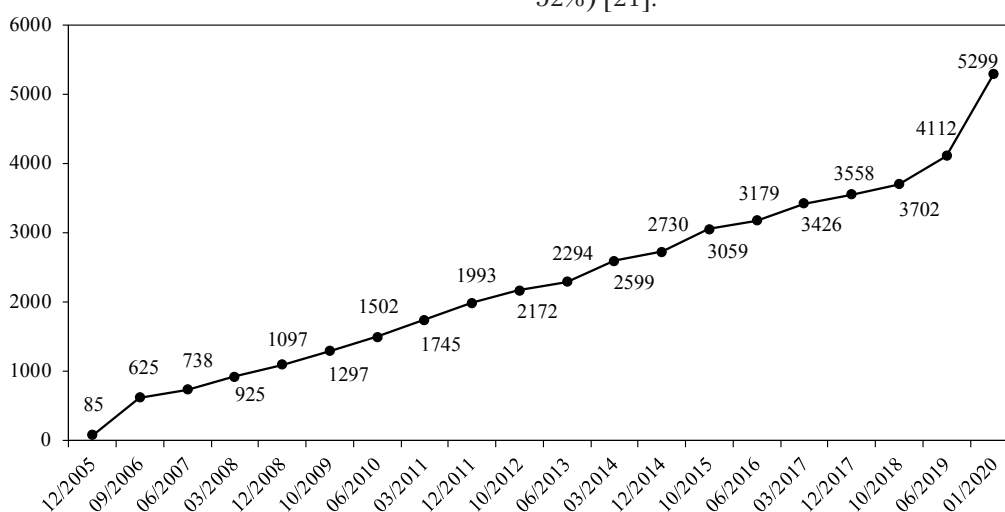


**Fig. 2. The dynamics of growth in the number of scientific archives according to the data of OpenDOAR**

According to our information, there exist 112 institutional repositories in Ukraine supported by higher education establishments (HEEs): academies, universities, institutes (not counting their autonomous structural units, affiliations etc.).

It is not sufficient, as nearly two thirds of HEEs still do not have a network scientific archive (Figure 3, constructed by the author by own data using datawrapper.de).
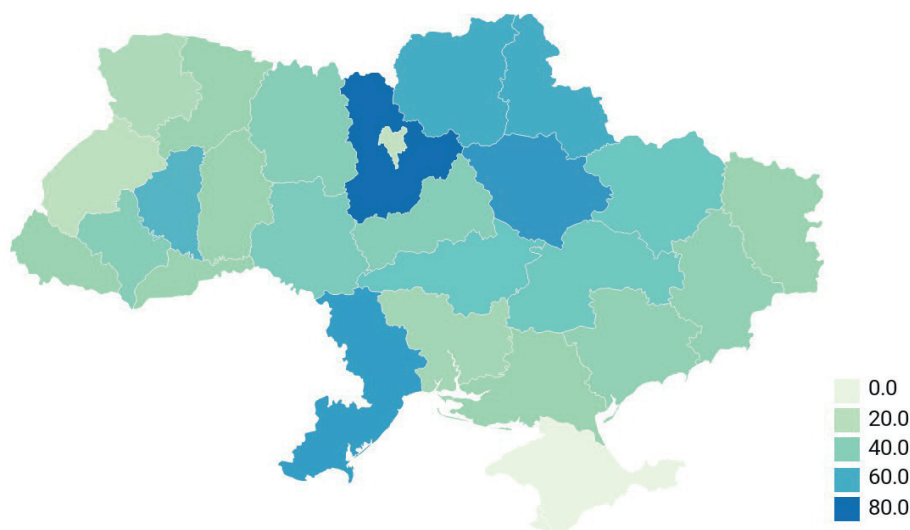


**Fig. 3. Mapping of the Ukrainian HEEs with institutional repositories, %**

It should be born in mind that research in Ukraine is performed by nearly 1,000 organizations and about 60,000 researchers, including 7,000 doctors of sciences and 19,000 candidates of sciences. The number of students obtaining higher education is 1.5 million, including 25,000 and 1,500 in post-graduate and doctoral course, respectively. 102,000 of specialists with doctoral (PhD and Dsc) diplomas are employed in various economic sectors (74% in HEEs; 17% in research and research and technical organizations and institutions, 2% in medical treatment institutions). Nearly 4,000 applications for inventions, 9,000 applications for useful models and 2,500 applications for industrial patters are submitted annually. Nearly 7,000 dissertations are defended, more than 300,000 scientific works are printed, more than 2,000 titles of scientific journals and more than 10,000 titles of scientific editions (collections, books, textbooks) are published. Apart from demonstrating the existing domestic potential, this gives evidence of the real need in access to scientific information and education literature.

No doubt that the abovementioned Government Decree "Creation of the National Repository of Academic Texts" from 22.07.2016 [11] was a timely measure. It opened the door to creating a national scientific archive of Ukraine, which would comply with best European practices. The following steps were taken in 2016–2019 to implement this decision:

– the working group was created [22]; its joint effort resulted in the preparation of the common NRAT concept laid in the foundation of the subsequently approved documents regulating creation and operation of the repository;

– the Action Plan was elaborated and approved [23];

– the Regulations on the NRAT were approved [24];

– the Rules of Procedure of the NRAT were approved [25].

The MES, embodying the Government as the NRAT owner, specified the principal characteristics of the National Repository project [26] and appointed its manager, the State Scientific Organization "Ukrainian Institute for Scientific Technical Expertise and Information" (UkrISTEI) [27]. The abovementioned decisions were taken with consideration to the strategic vision of the development of domestic R&D and education systems, formulated in the medium-term plan and priority actions of the Government till 2020 [28], and in action plans on its implementation for 2017–2019 [28–31], as well as in the Initiative "Partnership 'Open Government'" [32] and the Roadmap for Ukraine's integration in the European Research Area (ERA-UA) [33].

The last of the abovementioned documents is worth special attention, because its purpose is to set priorities, objectives, instruments and measures supposed to ensure creation of the modern national research system of Ukraine and its integration with the European one. The fifth priority declared in the Roadmap is associated with setting up transfer of scientific knowledge. Its implementation is supposed to enable the development of e-infrastructure and services for research and innovation, to promote open access to publications and research data. This priority is divided into two priorities of lower level: "5a. Transfer of Knowledge and Open Innovations", and "5b. Open Science and Digital Innovations".

The measures envisaged on line of the priority 5b include:

1) build the infrastructure for open access to scientific publications: create and develop the NRAT, institutional repositories of HEEs and research institutions, open access journals; create the NRAT-based national system of information and analytical support for science & technology and innovation activities;

2) participate in creating the European Cloud of Open Science and the European Digital Market with the need to digitalize all the industries;

3) provide government support to participation of Ukrainian research centers and researchers in national and European digital infrastructures;

4) promote participation of research institutions in implementation of the European Cloud Initiative in coordination with programs of international technical assistance.

Basically, the research system of Ukraine as a whole and the NRAT in particular as its integral part is expected to rely on these approaches, with consideration given to the principles of open science, open access, digitalization, FAIR. The abovementioned approaches are being implemented in the draft Guidelines of Government Policy for Development of Research Infrastructures and the National Roadmap of Research Infrastructures, elaborated under the MES auspices [34; 35]. It is envisaged to provide comprehensive support to the plans of creating new and modernizing existing e-infrastructures that are supposed to open access to convenient and reliable digital services for researches, lecturers, innovators, and businessmen. Among the components of the domestic e-infrastructure, the Guidelines refer to the National Digital Infrastructure for Shared Computations, the NRAT, the Ukrainian Research and Education Telecommunication Network and the Ukrainian Academic and Research Network of the Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine [35].

We are going to elaborate on what is the NRAT and what opportunities it opens for its users. The National Repository of Ukraine is a national shared electronic database providing for accumulation, storage and systematization of academic texts, i. e. original works of scientific, science & technology and

education character. It refers to the following types of academic texts:

—PhD and doctoral theses and abstracts of these theses;

—graduation works of students obtaining higher education;

—articles in scientific editions, including all the articles (the set of articles) qualifying for the scientific degree;

—monographs, including ones qualifying for the scientific degree;

—scientific editions;

—reports in R&D and science & technology fields;

—deposited scientific works;

—textbooks, manuals and other scientific and training courseware;

—publications placed by authors on Internet platforms for exchange of scientific publications.

The goal of the National Repository is to promote the development of educational, research, science & technology and innovation activities through the improved access to academic texts, and to encourage academic decency, and its purpose is to make scientific information of Ukraine and the world maximally accessible for broader public. From now and on, the academic texts, especially ones nicknamed as "grey literature" traditionally accessible only in a physical point of access, i. e. archive of a given institution or a library, will be visible and accessible for learning to everyone 24/7. The ones who wish only need to have Internet access and skills of work with electronic systems of information search.

According to the regulatory documents concerned with the NRAT [24; 25], free and open access of the National Repository users to the information it contains, to the register of academic texts in particular, and to their online versions and other related data placed on the conditions of open access is provided via the official web-portal of the repository.

The National Repository consists of the central repository that is maintained by the NRAT administrator, and local repositories maintained by the institutional participators, i. e. legal persons transferring academic texts to the NRAT (HEEs, research institutions, scientific publishers, organizations, libraries). The NRAT includes, in electronic form, the academic texts published on the conditions of open data (they contain information without limitations on public access and presented in the format enabling for its computerized processing by electronic means), with open access to them and further use. The central repository places online versions of academic texts published on the conditions of open access, which are subject to official registration in accordance to the current law (except for the cases when the author is not the copyright holder and such placement is prohibited by the copyright holder requirements).

The institutional participants transfer to the central repository bibliographic information envisaged by the law, descriptions of academic texts, including abstracts and lists of references contained in academic texts, with link to the main text. These data are used to systematize academic texts, create their registers, enhance search capacities of the National Repository, and perform analytical works.

Following the regulatory requirements, the NRAT must have the capacities for:

– making comprehensive analyses of user requests with respect to academic texts (by theme, authorship, affiliation to HEEs and research institutions, practical implementation, international cooperation etc.);

– making comprehensive assessments of academic texts (including their use in PhD theses and graduation works of students obtaining higher education) by the criteria of consultation, downloading, citing, user recommendations; by type, thematic coverage, category; by separate academic text or a set of academic texts, by link to authors, research institutions, HEEs etc.; their results can be used by the MES or other concerned entities for performance assessment of HEEs, research institutions, libraries, scientific publishers, organizations;

– constructing scientometric databases;

– analyzing citations of academic texts;

– system analysis of the research area and monitoring of its transformation;

– verification of academic texts for the occurrence of coincidences of text (alphabetical and numerical characters) and graphic fragments;

– making up ratings showing the performance and trends in the research, education and innovation activities in Ukraine and their infrastructures;

– monitoring, by request of authors or copyright holders of academic texts, of the new revenues of the National Repository for the occurrence of coincidences of text (alphabetical and numerical characters) and graphic fragments;

– providing access to the National Repository resources, in particular to the register of academic texts and their online versions, and to special software systems (robots), for indexation and analysis of these texts' metadata and their dissemination with the obligatory reference to their source, i. e. the official web-portal of the National Repository.

It is supposed that the NRAT operation can involve legally permitted informational integration with other databases, in particular with open data resources of Ukraine and other countries, databases of the central executive power bodies.

The project for creation of the National Repository is being implemented by modular approach. The first phase consists of works on creating a model of the hardware and software system for the central reposi-

tory, the second one involves connection of local repositories of institutional participants and creating tools for their support, at the third phase a complex analytical subsystem will be built, and tools for work with local repositories and users will continue to be improved [26]. Each phase involves coherent procedures of testing and trial exploitation, and only after this the system will move to full-scale exploitation. The scopes and contents of work at each phase are fixed by the NRAT managers by coordination with the MES.

Given the abovementioned sequence of actions, the first phase of the NRAT was prepared for commercial exploitation in 2019. It means that:

– the official web-portal of the NRAT has been created, temporarily (during trial and experimental exploitation) placed on the resources of the UkrISTEI [36], which will have the domain name nrat.gov.ua since the start of its full-scale exploitation;

– reports on R&D and science & technology activities, PhD and doctoral theses and their abstracts have been transferred from the R&D Fund managed by UkrISTEI to the central repository;

– the search system for academic texts and the tools for interactions with NRAT visitors and users have been built;

– technical support for visitor access to the register of academic texts and user access to the register and full text versions of academic texts stored in the repository had been provided;

– continually updated reference and information materials that can be useful for researchers, lecturers and innovators are placed on the web-portal.

All who wish had an opportunity to learn about the NRAT operation and submit their proposals on system improvement in time of its testing and trial exploitation (January – December 2019). We expect that once the first phase of the NRAT is launched at full scale, its visitors and users will submit their comments and recommendations on its development. An interactive tool for feedback has been created for this purpose. All the forthcoming messages from NRAT visitors and users will be necessarily considered in course of works on system improvement.

Following the decisions taken by the Cabinet of Ministers of Ukraine and the MES [37–39], the information on the NRAT content is placed on the open data portal [40], along with the information about the official register of research institutions entitled for government support, the register of technologies created or acquired with public funds, the nomenclature of institutions involved in technology transfer, the register of professional editions etc.

The UkrISTEI is planning to continue works on transforming archive files of various formats and academic texts transferred for registration on paper carriers into the format readable by machines (.pdf with the text layer). Once ready, these materials will be loaded in the NRAT, to replenish the NRAT archive.

In the perspective, beginning with the second half of 2020, the NRAT will be receiving from institutional participants academic texts in form of graduate works of students obtaining higher education, articles in scientific editions, monographs, scientific editions, textbooks, manuals and other scientific and training courseware, deposited scientific works. The first complex information and analytical system will be built, enabling to assess the research landscape of Ukraine, form the single database of authors and institutes engaged in research and education activities, practical implementation of developments, or providing grant financing etc.

The above said fully complies with the tasks set in the Action Program of the Cabinet of Ministers of Ukraine on line of the MES objectives 1.4 and 1.5 [41]. Thus, the objective 1.4 specifies the following: public funds will be received by the providers of higher education with best results in education and research activities; the effective system for quality assurance in higher education will be created; the diverse education needs of the population related with individual and professional development will be met, the conditions for recognition of training certificates obtained in informal and non-formal education sectors will be created. This has to be facilitated by openness of research results, lifting of limitations on access to research and education works, transparence in this sphere.

Implementation of the objective 1.5 is supposed to open access for researchers and research teams to transparent multichannel research financing and to research infrastructures; to create conditions for integration of researchers in the European and Global Research Area; to create the national research information system that will provide a standard instrument for collecting data required for evaluation of individual researchers and research units/institutions, an expert base for commercial enterprises and public institutions; to create conditions for wide access of citizens, business, public administration bodies to R&D results.

**Conclusions.** In the context of the outlined strategic objectives, the NRAT has to be a really demanded and very useful resource capable of making the research sector transparent and accessible, notably accelerating exchange of research and education information, stimulating scientific progress and innovation activity in Ukraine. The NRAT will offer a stimulus for adopting principles of academic decency, because in a transparent environment it is easier to analyze texts, detect violations and incorrect behavior. Another important aspect is openness of information about themes and results of the research commissioned by managers of public budget funds or performed with investment of such funds. This

information, which can be extracted from depository resources, will make the research financing more effective. Additional opportunities for essential progress of research and education activities can be created in the perspective through developing a variety of the NRAT services.

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## Розбудова наукової е-інфраструктури в Україні: створення Національного репозитарію академічних текстів

У контексті процесів цифровізації розглянуті питання розвитку електронної інфраструктури і сховищ наукових даних. Зазначено, що сучасна наукова література містить безліч публікацій із технічних, правових і організаційних питань створення репозитаріїв, оглядів досвіду різних країн, описів нових сервісів, оцінок ефективності відкритого доступу і т. ін. Разом з тим недостатньо представлені наукові, методичні та практичні аспекти формування загальнонаціонального архіву наукової та освітньої інформації України. Запропоновано огляд таких найважливіших елементів е-інфраструктури Євросоюзу, як EOSC і OpenAIRE, висвітлені їх цілі, загальна характеристика, викладена послідовність створення. Це важливо, оскільки сформульований у стратегічних документах країни курс на інтеграцію з ЄС передбачає розвиток української екосистеми науки, освіти та інновацій у рамках європейських стандартів. Представлено короткий огляд даних про стан і динаміку розвитку репозитаріїв у світі з акцентом на їх структурі, національній належності, програмному забезпеченні та галузевій спрямованості, а також інформація про кількість інституціональних репозитаріїв України та охоплені ними заклади вищої освіти країни. Обґрунтовано необхідність розвитку системи сховищ інформації, насамперед створення Національного репозитарія академічних текстів, на основі даних про наявний науковий і освітній потенціал. Описано ключові характеристики Національного репозитарія, а саме, його вміст, функціонал, мету, завдання, структуру, етапність створення, перспективи розвитку. Зазначено, що Національний репозитарій академічних текстів є затребуваним і надзвичайно корисним ресурсом, який робить наукову сферу прозорою, доступною, істотно прискорює обмін науковою та освітньою інформацією, стимулює науковий прогрес і інноваційну активність в країні, а це підвищує ефективність фінансування науки.

**Ключові слова:** *Національний репозитарій академічних текстів, електронний архів, е-інфраструктура, наука, освіта, НДДКР, академічний текст, European Open Science Cloud (EOSC), OpenAIRE.*