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University Libraries of Ukraine as Key Stakeholders in Developing the Open Science Ecosystem

Objective. The purpose of the study is to elaborate on the conceptual foundations for the effective development of the open Science ecosystem by university libraries in Ukraine. The research demonstrates that the unique potential of university libraries enables them to effectively shape all components of the Open Science ecosystem, thereby promoting Ukraine's accelerated integration into the European Research Area. **Methods.** The study employed the methods of observation, generalization, comparison, content analysis of the official websites of leading Ukrainian universities and their libraries, statistical and mathematical methods, as well as systemic and socio-communicative approaches. **Results.** The study identified the incorporation status of the highest-ranking universities of Ukraine into the European Research Area through the effectiveness of their libraries in developing basic components of the Open Science ecosystem. The research clarified the necessity to intensify activities of the university libraries in creating research data repositories and forming a data management culture among scientists as a crucial element of Open Science. **Conclusions.** University libraries possess strong resources and human potential to enhance the effectiveness for developing the core components of the Open Science ecosystem (i.e., open access to publications; open research data; education and skills; research responsibility and integrity; research performance evaluation; citizen science). Systematic formation, promotion, and use of the Open Science resources and tools by university libraries are essential conditions for the effective development of their ecosystem and for the improvement of Ukrainian higher education institutions' productivity and quality of research activities.

Keywords: university libraries; Ukraine; Open Science; open data; repositories; citizen science; scientometrics

Introduction

On November 23, 2021, at the 41st session of the UNESCO General Conference on Education, Science and Culture, the "UNESCO Recommendation on Open Science" was adopted and supported by 193 UNESCO Member States. Open Science was officially recognized as an innovative social phenomenon directed towards significant acceleration of scientific and technological progress through the creation of conditions for rapid dissemination and reuse of scientific knowledge. For the successful implementation of the values and principles of Open Science, the states were advised to undertake coordinated actions in the following seven areas:

- promotion of a common understanding of Open Science, its related benefits and challenges, and raising awareness of various pathways for its implementation;
- formation of a favorable political environment for Open Science;
- investments in infrastructure and support services for Open Science;

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- investments in human capital, training, education, digital literacy, and capacity building for the benefit of Open Science;
- formation of Open Science culture and alignment of incentives for its implementation;
- encouraging application of innovative approaches to Open Science at different stages of the scientific process;
- promotion of international and multilateral cooperation in the context of Open Science to reduce gaps in the digital and technological environment, as well as in knowledge (UNESCO, 2021).

All of the mentioned actions relate not only to states as a whole, but also to institutions that are subjects of scientific activity, in particular, higher education institutions (HEIs). Analysis of the actual state of Open Science ecosystem development in leading Ukrainian universities makes it possible to identify the achievements, challenges, and prospects for implementing the values and principles of Open Science within the scientific communication space of the national higher education system, as well as to clarify the role and potential of university libraries in this process.

Active research of the mission and functions of university libraries in the movement for Open Access to scientific resources, as the first stage in developing the Open Science ecosystem, began in Ukraine in the second half of the 2000s. The first library scientists who revealed the essence, resource capacity, and service potential of university libraries in establishing Open Access infrastructure as a component of Open Science were O. Brui (2007), T. Yaroshenko (2015), S. Nazarovets (2012, 2015), and T. Kolesnykova (2023). These authors elaborated theoretical, methodological, and organizational foundations for creating institutional repositories in Ukrainian universities, substantiating new models of digital communication in the "researcher-open information resources" system. A meaningful factor that fostered the increased flow of scientific publications on the role of Ukrainian university libraries in promoting the values and tools of Open Science is the Ministry of Education and Science of Ukraine's intensified efforts, from the late 2010s into the early 2020s, aimed at the development of regulatory and methodological frameworks for integrating university research into the European and global research space.

For instance, the "Roadmap for the Integration of Ukraine's Research and Innovation System into the European Research Area", adopted by the Ministry of Education and Science of Ukraine in 2021, identified "Open Science and digital innovations" as a key priority (Ministry of Education and Science of Ukraine, 2021). In 2022, the Government of Ukraine approved the "National Plan on Open Science". The directions of these initiatives were determined by the Government, and the identification of priority tasks for university libraries in building the digital infrastructure of Open Science was revealed in the works of T. Yaroshenko (2021, 2022), O. Serbin, and O. Yaroshenko, (2022), A. Zharinova, and T. Yaroshenko (2023), T. Kolesnykova (2019, 2023, 2024), T. Kolesnykova and O. Matveyeva (2021), I. Drach (2021), N. Levchenko (2020), N. Kaliuzhna (2023), S. Ivanova, A. Kilchenko, and T. Novytska (2024), S. Chukanova (2020, 2021), O. Karpenko and N. Kobyzhcha (2023), N. Kobyzhcha (2025), and others.

The most thorough results of scientific research regarding the development of the Open Science ecosystem by Ukrainian university libraries have been presented in the research study of V. Kopaneva (2020) and in the collective monograph prepared by the staff of the Institute of Higher Education of the National Academy of Pedagogical Sciences of Ukraine (2023), which proposed a conceptual model of the infrastructural components of Open Science. In her monograph "Library in the Digital Science Environment: Systemic-Integrative Interaction" (2020), V. Kopaneva substantiated theoretical foundations for the transformation of libraries from the elements of the Open Science infrastructure into active participants in the university research process at all stages of the research life cycle: from data collection and analytical processing to the preservation and dissemination of new knowledge. Nevertheless, despite a significant growth in

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library science publications devoted to Open Science, its tools are implemented by university libraries as important subjects of scientific communication only in a fragmented and unsystematic way. This circumstance highlights the relevance of the present study. The purpose of the research is to elaborate on the conceptual foundations for the effective development of the Open Science ecosystem by university libraries in Ukraine.

Methods

The research was based on the content analysis of the official websites of the leading universities of the country, which occupy the top 20 positions in the annual academic ranking of Ukrainian higher education institutions "TOP-200 Ukraine 2025" (https://osvita.ua/vnz/rating/94871/), as well as 12 additional universities that officially adopted an "Open Science Policy". To implement this research, the following procedures were applied: identification and analysis of the official websites of Ukrainian higher education institutions; content analysis of the "Science" section and library websites of these institutions; collection and generalization of data concerning the presence of infrastructural components of the Open Science ecosystem. Statistical and mathematical methods were employed to determine the ranking of universities according to the level of the development of Open Science components. The method of diagram construction was used to visualize and systematize the collected empirical data. The methodological tools of systemic and socio-communicative approaches made it possible to develop an effective communication strategy for enhancing the role of university libraries in building the Open Science ecosystem as a key condition for Ukraine's integration into the European Research Area.

Results and Discussion

The essence of the Open Science ecosystem of a modern university lies in the integration of digital infrastructure, resources, and services that increase the efficiency of research activities. Taking into account European standards and the contributions of Ukrainian scientists, the core components of this ecosystem are open access repositories for research data (open research data) and scientific publications (open access to publication); open educational resources aimed at developing researchers' competences in the field of Open Science (education and skills); tools for monitoring research responsibility and integrity (research responsibility and integrity); infrastructure for the development of citizen science (citizen science); and instruments for research performance evaluation (Luhovyi et al., 2023).

Large-scale grant projects support the implementation of national reforms in the field of Open Science. From November 1, 2023, to October 31, 2026, the National Research Foundation of Ukraine is funding the project "Open Science for Ukrainian Higher Education System" (Open4UA) (https://nrfu.org.ua/open4ua/), which brings together eight Ukrainian and six European universities. The project aims to promote the development of Ukraine's knowledge-based economy for post-war recovery through the reform of the higher education system. In the project «Open science supporting vulnerable communities: empowering university libraries in crisis response» (CAELUM) (https://caelum.ut.ee/about-us/), university libraries are placed at the forefront of crisis response through open science, supporting vulnerable communities and bolstering EU-Ukraine cooperation. The project's aim is two-fold: a) upskill university libraries' staff in innovative and interdisciplinary approaches to crisis response through EU-Ukraine universities collaboration, and b) promote and sustain university libraries-driven open knowledge and civic engagement among university students and staff for crisis response.

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The systemic development of such a powerful ecosystem for research performance evaluation at universities should include adopting an Open Science Policy, which, in the context of Ukraine's European integration, needs be one of their main priorities. According to the results of a content analysis of the official websites of the highest-ranked Ukrainian universities, only 16 out of 32 institutions under research have currently introduced an "Open Science Policy" (or a concept for its implementation). Among them, 84% hold the status of national universities, and 62% are within the top twenty positions of the annual academic ranking of Ukrainian higher education institutions "TOP-200 Ukraine 2025." Of the specified 16 universities, the first to adopt an "Open Science Policy" in 2022 were the National Technical University of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute" and Uzhhorod National University; 75% of the universities introduced this policy in 2024, and two more institutions followed it in 2025 (Fig. 1).

Fig. 1. The status of the "Open Science Policy" adoption by leading Ukrainian universities

	HEI without "Open Science Policy"
	HEI that adopted "Open Science Policy" in 2022
	HEI that adopted "Open Science Policy" in 2024
	HEI that adopted "Open Science Policy" in 2025

The findings indicate that even the leading Ukrainian universities remain at an early stage in implementing the principles and values of Open Science. Unfortunately, the majority of Ukrainian higher education institutions demonstrate a low level of understanding of the essence and strategic advantages of the Open Science movement, despite the existence of the "National Plan for Open Science" (Cabinet of Ministers of Ukraine, 2022) and the requirement to adhere to Open Science principles in grant applications and state-funded research programs.

The current state of the development of the Open Science ecosystem's basic components in the country's leading universities is illustrated in Table 1.

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Table 1

Availability of the Open Science basic components in leading Ukrainian universities

The place of HEI in the ra-ting	Name of HEI	Availability of open access to publication	Availability of open research data	Availability of education and skills	Availability of research responsibility and integrity	Availability of research performance evaluation	Availability of citizen science
1	Taras Shevchenko Kyiv National University	+	—	+	+	+	—
2	Lviv Polytechnic National University	+	+	+	+	+	—
3	National Technical University of Ukraine “Ihor Sikorskyi Kyiv Polytechnic Institute”	+	—	+	+	+	—
4	Sumy State University	+	—	—	+	+	—
5	Ivan Franko Lviv National University	+	—	—	+	—	—
6	Kharkiv V. N. Karazin National University	+	—	+	+	+	—
7	National University of Bioresources and Nature Management of Ukraine	+	—	+	+	+	—
8	Vasyl Stefanyk Carpathian National University	+	—	—	+	+	—
9	National Technical University “Kharkiv Polytechnic Institute”	+	—	+	+	+	—
10	Odesa I. Mechnikov National University	+	—	—	+	+	—
11	National Technical University “Dnipro Polytechnic”	+	—	—	+	—	—
12	Yuriy Fedkovich Chernivtsi National University	+	—	—	+	+	—

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13	Dnipro Oles Honchar National University	+	+	+	+	+	—
14	National University “Kyiv-Mohyla Academy”	+	—	+	+	+	—
15	Uzhhorod National University	+	—	+	+	+	—
16	Interregional Academy of Personnel Management	—	—	—	+	—	—
17	O.O. Bogomolets National Medical University	+	—	+	+	+	—
18	National University of Water Management and Nature Management	+	—	+	+	+	—
19	Western Ukrainian National University	+	—	—	+	+	—
20	Ukrainian State University of Science and Technology	+	—	+	+	+	—
23	Volyn Lesya Ukrainka National University	+	—	—	+	—	—
25	National Aerospace University “Kharkiv Aviation Institute”	+	—	—	+	+	—
32	Kyiv Metropolitan University named after Borys Grinchenko	+	—	+	+	+	—
39	Kremenchuk National University named after Mykhailo Ostrohradskyi	+	—	—	+	+	—
43	Zaporizhzhya National University	+	—	—	+	+	—

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47	Cherkasy Bohdan Khmelnytskyi National University	+	—	+	+	+	—
55	Eastern Ukrainian National University named after Volodymyr Dahl	+	—	+	+	+	—
58	Vasyl Stus Donetsk National University	—	—	—	+	+	—
66	Yaroslav the Wise National University of Law	+	—	—	+	+	—
103	Vinnitsa National Agrarian University	+	—	—	+	+	—
116	Sumy A. S. Makarenko State Pedagogical University	+	—	—	+	+	—
	Ukrainian Catholic University	+	+	+	+	+	—
		31 (97%)	3 (9%)	18(56%)	32 (100%)	27 (84%)	0

The research data allow us to state that university libraries were the key ambassadors of the Open Access movement, having successfully implemented the first component of the Open Science ecosystem in the early 2000s - open access to publications. Almost 97% of university libraries currently create and administer institutional repositories that provide open access to the scientific and educational works of academic staff and students. As of July 1, 2025, the Registry of Open Access Repositories includes 138 Ukrainian repositories, of which 98% belong to higher education institutions in Ukraine.

However, only 13 university libraries in Ukraine have established cooperation with the National Repository of Academic Texts (NRAT) to integrate their resources into the national platform and improve their visibility within the global communication space. At the same time, university libraries do not actively promote among researchers the possibility of depositing research datasets in NRAT, which could solve the problem of the absence of open research data repositories in 93% of universities. Another significant challenge hindering the effective development of the Open Science ecosystem is the low level of user engagement with the digital resources of institutional repositories. This issue is largely explained by the inconvenient and unclear interfaces of most university library repositories, as well as by the lack of awareness-

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raising and training activities for students and faculty on how to use these resources and apply effective search strategies.

Ukrainian university libraries should more actively develop such an important component of Open Science as "education and skills", focusing on training researchers in data management throughout all stages of the research lifecycle: "collection – integration – processing – analysis – publication – archiving – preservation – sharing – discovery and reuse of research data". Research findings confirmed that only 56% of university libraries are marginally involved in developing these skills through holding webinars and training on data management issues according to FAIR principles for various groups of scientists and graduate students. It is crucial to systematically convey to scientists that all major funding agencies financing scientific research now require not only the open-access publication of research outputs without any embargo period, but also the release of primary research data in international repositories such as Zenodo, Figshare, and others. The EU Program Horizon 2020 (now Horizon Europe) demands compliance with the Open Access mandate and the Open Research Data program. The National Institute of Health (NIH, USA), the Wellcome Trust (UK), and other organizations adopted their own policies (mandates) to ensure more open and reproducible research data.

Therefore, the practice of Open Science is no longer only a voluntary initiative of individual researchers but has become a decisive requirement for funding, publishing, and evaluating research.

Following the experience of foreign university libraries, Ukrainian academic libraries should consider participating in creating open data platforms, similar to the Spatial Data Lab (SDL) project, a joint initiative of the Harvard University Center for Geographic Analysis, KNIME, Future Data Lab, China Data Institute, and George Mason University. The central objectives of this project are to encourage researchers to contribute to the development of an advanced open-source platform for data connection, analysis, and various forms of collaboration, thereby promoting applied spatiotemporal research in such fields as business, environment, health, employment, and mobility.

The SDL project is guided by an independent academic advisory committee composed of internationally recognized scientists with diverse experience and interests. Its main responsibilities include:

1. development of spatiotemporal data transfer services;
2. creation of a reproducible integrated platform and tools;
3. implementation of case studies based on the data analysis guided by FAIR principles;
4. training and education in spatial data research;
5. inter-institutional collaboration and networking.

The SDL project contributes to building the foundations of Open Science, which is essential for creating a more inclusive, ethical, efficient, and reliable scientific environment. This is achieved by developing geospatial tools and collaborative practices (Wang et al., 2025).

The most developed component of the Open Science ecosystem in Ukraine is "research responsibility and integrity", which is aimed at ensuring academic responsibility and research ethics. All Ukrainian universities employ plagiarism detection systems, such as StrikePlagiarism or Unicheck, delegating to their libraries the responsibility for checking students' qualification theses as well as scientific publications of faculty members. 84% of university libraries actively adopt digital services that support research performance evaluation through the establishment of scientometric units, creation of researchers' personal profiles in ORCID and Google Scholar, their identification in the "Bibliometrics of Ukrainian Science" system, the Open Ukrainian Citation Index, as well as monitoring of rankings and citation indices of HEIs' scholars.

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At the same time, there remain significant opportunities for improving the scientometric activities of Ukrainian university libraries. These improvements should focus on maintaining up-to-date researcher profiles, as well as on developing researchers' skills in using modern tools for promoting and disseminating scientific results at the international level.

The least developed component of the Open Science ecosystem in Ukrainian universities is the creation of e-infrastructure for citizen science. According to the results of the content analysis of the websites of universities and their libraries, no information was found about the directions of public involvement in the collection of primary material for research or the evaluation of their results. Most library staff are not familiar with the potential of modern services such as Science to Business, Altmetric, and DataCite, although they are expected to promote these tools among researchers in order to help track the broader impact of their research activities on the development of society.

Conclusion

The content of the "National Plan for Open Science" (Cabinet of Ministers of Ukraine, 2022), adopted by the Government of Ukraine in 2022, makes it clear that university libraries are key subjects in implementing and developing Open Science practices within the national research communication space. They possess a unique personnel, resource, and service potential for building all basic components of the Open Science ecosystem. However, to enhance the effectiveness of this process, several important measures must be undertaken: to introduce a designated position of a data management specialist within university libraries; to establish an institutional repository or identify an international repository for storing primary research data, which constitute the empirical basis of the university research; to launch an extensive information campaign targeting academic staff and students for raising their awareness of the advantages of Open Science; to develop training video courses and methodological guidelines aimed at the formation of researchers' competences in using Open Science tools and services, in particular in managing research data according to the FAIR principles; the promotion of academic integrity throughout all stages of the research lifecycle; to support the development of citizen science initiatives by engaging volunteers in data collection, popularization of the possibilities of modern online platforms for communication between science, business, and society.

These steps would enable Ukrainian university libraries to strengthen their leading role in the Open Science institutionalization and contribute to the integration of Ukraine into the European Research Area.

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Університетські бібліотеки України як суб'єкти розбудови екосистеми відкритої науки

Мета. Мета дослідження – розроблення концептуальних засад ефективної розбудови університетськими бібліотеками України екосистеми відкритої науки. Доведено, що унікальний потенціал наукових бібліотек університетів дозволяє їм ефективно здійснювати формування всіх складових екосистеми відкритої науки, сприяючи скорішій інтеграції України до Європейського дослідницького простору. **Методика.** Використані методи: спостереження, узагальнення, порівняння, контент-аналіз вмісту офіційних вебсайтів провідних українських університетів та їх бібліотек, статистичні та математичні методи, системний та соціокомунікативний підходи. **Результати.** З'ясовано стан інкорпорованості найрентиговіших університетів України до європейського дослідницького простору через успішність розбудови університетськими бібліотеками базових складових екосистеми відкритої науки. З'ясовано необхідність активізації діяльності університетських бібліотек щодо створення репозитаріїв дослідницьких даних та формування в науковців культури управління ними як важливої складової відкритої науки. **Висновки.** Бібліотеки університетів мають потужний ресурсний та кадровий потенціал щодо підвищення ефективності розбудови базових складових екосистеми відкритої науки (відкритий доступ до публікацій; відкриті дані досліджень; освіта й навички; відповідальність та доброчесність у наукових дослідженнях; оцінка ефективності наукових досліджень; громадянська наука). Системне формування, популяризація та використання університетськими бібліотеками ресурсів та інструментів відкритої науки є умовою ефективної розбудови її екосистеми та підвищення результативності й якості науково-дослідної діяльності українських ЗВО.

Ключові слова: університетські бібліотеки; Україна; відкрита наука; відкриті дані; репозитарії; громадянська наука; наукометрія

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