Impressum

ISSN 1450-9687 (print edition)
ISSN 2217-9461 (online edition)

Belgrade, Vol. 23, No. 2, February 2024

JOURNAL REDACTION:
Journal Info*theca*
11000 Belgrade, Bulevar kralja Aleksandra 71

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PRINTED BY:
Mamigo plus
Belgrade

Journal is published twice a year

eScience Information System
Register of Researchers and Register of Scientific Research Organizations

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PAPER SUBMITTED: 25 October 2023
PAPER ACCEPTED: 25 November 2023

In the first quarter of 2023, the publicly available eScience[1] information system began to work, displaying current information, i.e. data on accredited scientific research organizations (hereinafter referred to as SRO), researchers and their scientific results. The eScience information system consists of electronic databases that are kept as registers - the Register of Researchers and the Register of Scientific Research Organizations in the Republic of Serbia.

Within the eScience system, data is exchanged between all actors involved in the scientific research work system: researchers, scientific research organizations and the Ministry of Science, Technological Development and Innovation (hereinafter: the Ministry), as well as other important institutions. It is envisaged that the system will maximally automate the data transfer process between all relevant actors, which will significantly increase the efficiency of administration and focus on scientific research activity and its improvement. The existence of such a business-information system enables, in the long term, to raise the quality of scientific research activity, greater visibility and availability of scientific production in accordance with the principles of "Open Science"[2]. Also, the networking and centralization of available digital institutional repositories, ie the scientific production of scientific research organizations, the development of their digital infrastructure, research, professional and library-information staff and the promotion of the principles of open science are encouraged. Raising the visibility of the results of scientific research leads to greater citation of works, better evaluation of researchers, and therefore greater international recognition of domestic scientific production.

1. eScience, accessed 15.10.2023.
2. Open Science, accessed 15.10.2023.

The Ministry planned and operationally managed the preparation for the implementation of the eScience information system. During this process, it was necessary to harmonize the system with all key legal and planning documents at the national and international level.

The umbrella document that governs the system of science and research in the Republic of Serbia is the Law on Science and Research ("Sl. glasnik RS", No. 49/2019)[3] through planning and realization of general interest in science and research, ensuring the quality and development of scientific research work , legal position of the institute, establishment of the institute and its management, obtaining the title of researcher, institutional financing and financing of other programs of general social interest, keeping records, etc.

Another important planning document mentioned in Article 10 of the mentioned Law was adopted in February 2021: "Strategy of scientific and technological development of the Republic of Serbia for the period from 2021 to 2025 - Power of knowledge"[4] (hereinafter the Strategy). In this planning document, within the Special Objective 1. Provide the necessary conditions for the dynamic development of science, technological development and innovation and Measure 1.4: Development of digital infrastructure, activity 1.4.1 is defined. Establishing a unified national eScience system. Also, the Strategy is in line with the general tendencies of the economic and social development of the Republic of Serbia, as well as other national, regional and European strategies, including the "Strategy of smart specialization in the Republic of Serbia for the period from 2020 to 2027".[5]

According to the Strategy, the main objective of the European Union's policy in the field of science and research is to strengthen the scientific and technological system as one of the key factors of sustainable economic development, which ensures a quality framework for the implementation of scientific research and the development of innovations, while consequently striving to encourage competitiveness and the growth of economic activities . The Republic of Serbia, as a candidate country for membership in the European Union, follows the legal acquis of the EU and implements the necessary reforms and activities in this area in order to join the European Research Area (ERA).[6] The first negotiation chapter that the Republic of

3. Закон о науци и истраживањима, accessed 15.10.2023.

4. Strategy of scientific and technological development of the Republic of Serbia for the period from 2021 to 2025 - Power of knowledge, accessed 15. 10. 2023

5. Strategy of smart specialization in the Republic of Serbia for the period from 2020 to 2027, accessed 15.10.2023

6. European research area (ERA), accessed 15.10.2023

Serbia opened and temporarily closed was Chapter 25 (science and research), which happened at the Intergovernmental Conference on the accession of the Republic of Serbia to the European Union[7] held in 2016, and indicates the organization and degree of development of the scientific research and innovation system.

Recognizing the importance of the principle of openness in science, as a process that should be implemented as soon as possible in the Republic of Serbia, in 2018 the "Platform for Open Science"[8] was adopted, the National Open Science Portal[9] was created, while all state universities and several scientific institutes adopted open infrastructure policies.

Bearing in mind that in the eScience system, researchers log in to their profile using their personal ORCID credentials, the Ministry, in particular, in order to further develop the national portal, in May 2023 achieved full membership in the ORCID[10] (Open Researcher and Contributor ID) organization, which deals with the development of research data infrastructure based on the researcher identifier. In this way, the scientific research community in the Republic of Serbia has access to additional options that are made possible through membership in our institutions. A large number of researchers in the Republic of Serbia already have registered ORCID profiles, given that it is a mandatory part of the procedure for applying for projects financed by the European Commission, as well as for publishing papers in domestic and foreign journals.

The eScience information system itself is divided into two interconnected segments: administrative and scientific, between which data is exchanged daily.

Within the administrative part, the fully digitized process of accreditation of scientific research organizations, as well as the selection process for scientific positions, is successfully implemented, while the scientific part unites the entire scientific production, on the basis of which the work of institutions and researchers is further evaluated.

In order to avoid multiple entry of the same scientific results from different systems and to ensure bibliographic accuracy, the eScience information system is networked with existing institutional repositories, the number of

7. Republic of Serbia negotiation position for Intergovernmental Conference on the accession of the Republic of Serbia to the European Union, accessed 15.10.2023

8. Platform for Open Science, accessed 15.10.2023.

9. National Open Science Portal, accessed 15.10.2023.

10. Ministry of Science, Technological Development and Innovation of the Republic of Serbia, accessed 15.10.2023.

which is constantly increasing. The two most important steps in the process of unifying data were realized in cooperation with the "Svetozar Marković" University Library and the National Library of Serbia, eScience has been successfully connected to the COBISS (Co-operative Online Bibliographic System and Services) library system since May 2023, the data is on are downloaded weekly from the Mutual Catalog COBIB.SR[11], and from mid-October data on the works of our authors are downloaded from the "Ours in Wos"[12] (Web of Science, WoS) service. Continuous work is being done on the development of data download tools, data standardization and their deduplication.

The eScience portal in full capacity was opened on July 3, 2023 for all active researchers in the Republic of Serbia. The Ministry continuously provides previously established professional and technical support to users for the administrative and scientific subsystem of the eScience information system and will continue to introduce good international practices in the exchange of scientific information.

In the coming period, it is planned to upgrade the system in the form of the introduction of new functionalities, both in the digitalization of the evaluation of the results of scientific research work and the enrichment of registers with additional data on scientific research equipment, specialized laboratories, which will certainly contribute to the application of science in the economy, through the transfer of knowledge and technology, i.e. connecting science and economy.

11. Mutual Catalog COBIB.SR, accessed 15.10.2023.
12. Ours in Wos, accessed 15.10.2023.

Evaluation and Fertility: eScience as a Pledge for the Development of Science and a Democratic Society - Transparency as a Basis for the Development of Science and Society -

UDC 001.818:001.89(497.11)
DOI 10.18485/infotheca.2023.23.2.1

ABSTRACT: This paper discusses the importance of establishing eScience in the context of the transparency of science, the potential scope and reach of Serbian scientific endeavors, and increasing its influence in the international scientific arena. In this paper, we will reflect on certain technical solutions related to eScience project, pointing out potential problems and benefits, all related to the developments of digital aspects of society,, with an emphasis on the concept of "open science" and the role of libraries and librarians in this ecosystem.

KEYWORDS: eScience, open science, transparency, libraries, science evaluation, knowledge society

PAPER SUBMITTED: 2 November 2023
PAPER ACCEPTED: 14 November 2023

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1 Context

With the increase in the importance given to science and technology in the study of the economic development of a country, research attention has been extended to the scientific capacities of countries and, more narrowly – to the possibilities and efficiency of the implementation of scientific achievements in the economy. Therefore, in many developed countries, the ministries of science and economy are often integrated into a common organizational unit. The phrase "scientific wealth of the people" was introduced, as well as "evaluative state". It is about interdisciplinary research (scientific performance, contribution, development, and, more recently, effectiveness), the

ultimate goal of which is improving and rationalizing scientific activity in the countries under analysis.

In other words, money gradually took center stage in discussions about science – a space once reserved for great scientific discoveries – so economic reasons overrode political ones in formulating national science strategies. The former "sociology of science" has given way to the "economics of research", so science has moved from its former involuntary privileged position in terms of budgeting to the domain of real project financing, which is based on what was first called the *Logical Framework Approach* (LFA) in America. This form implies a certain "project matrix logic", which means clear indicators of results, specific objectives, and the sustainability of scientific projects. Since recent times, there has been an insistence on the networking of public, private, and non-governmental units of society, which is related to the implementation of science in something most often called fertility or "social utility." All this implies a way of monitoring researchers or projects, i.e., their evaluation, which becomes the basic tool of scientific research development at the individual and national level.

This type of transformation of scientific sectors in developed countries has occurred, first of all, for two basic groups of reasons, which we can call: internal and external. The internal reasons concern the integrity of science itself because, at some point, it became clear that the scientific community cannot deal with ethical problems: it is about the expediency of the peer review procedure as the basic evaluation mechanism in science. When money is involved in this story, the integrity of science is usually called into question. In this sense, the reviews of magazine articles were not the focus of attention to that extent, as much as participation in high-budget scientific projects, within which there were often affairs in which, sometimes, renowned names of world science, even Nobel Prize winners, took part. Of course, the funds immediately approached scientific projects with a greater reserve and approved their financing.

When it comes to external reasons, science has failed even more. The social usefulness of scientific results has remained under question due to various interest manipulations, regardless of whether we are talking about financial or political motives. Although we have witnessed a great increase in scientific achievements in the past century, social circumstances call for more caution and care. Phenomena such as they were – the problem of the third world, the multiplication of the lumpen-proletariat, the increased gap between rich and poor societies and individuals, the rise of extreme ideas and ideologies, and migration of the population – were not in accordance

with the general proclaimed progress of science and scientific achievements. Therefore, something serious had to change.

The informal "social contract" when it comes to investments in science after the Second World War. functioned according to the principle of social obligation to direct the "surplus" of material resources to science. All "funding policy" in the context of science was, with the exception of military or politically confidential state science, entrusted to the scientists themselves. Nevertheless, the first post-war financial crises influenced the fact that economic reasons figure primarily in the adoption of science policy strategies, rather than political ones. That's how people started talking about the "economics of research" and evaluation, and therefore also about fertility. In the context of the present moment and modern digital technologies, this often includes portals, that is, repositories based on the principle of transparency.

The fact that the principle of LFA and the doctrine of evaluation is extremely important for Serbian science is best shown by the fact that in the process of accession to European integration, it is necessary to join and adapt to the principles of project financing, already long ago adopted by the most important international institutions, from the International Monetary Fund and the World banks, through institutions and programs of the European Commission, all the way to tenders and programs of individual European institutions and international corporations. However, while transparency is essential to good governance and an excellent starting point, it does not in itself get the job done. It is only one of the key elements of a system of oversight, accountability or potential sanctions. It reduces the potential for waste, mismanagement, or corruption and generally improves macroeconomic management.

In such a context, the need to establish a quality and efficient model for monitoring scientific production in the Republic of Serbia is urgent and necessary. The reasons are more than obvious: a clear overview and monitoring of current scientific production, huge savings, tying funding to the success of scientific research organizations and individuals, creating a competitive scientific environment, and creating a young, highly profiled scientific staff. There have already been attempts to establish a transparent digital system in the field of science evaluation in Serbia. The RIS (Repository of Serbian Researchers) and Dositej projects are a very good starting point, not only in terms of first steps, but also in terms of all the problems and technical solutions that would have to be corrected in the eScience system. Also, BISIS systems, especially COBISS, where the largest Serbian scientific and library hubs function, are an exceptional basis for creating a superior digital science

evaluation system. Nonetheless, successful state projects such as eGovernment and cooperation between the state and the private sector are also a kind of guarantor in the process of establishing this system. Finally, there are significant examples from abroad, such as SICRIS in Slovenia, eNauka in Poland, or Manara in Qatar.

2 The role of libraries

In the creation of the concept of eScience, the role of librarians was initially absent. Libraries were understood as services that were supposed to perform parts of technical work. However, during the implementation of eScience itself, it became unequivocally clear that a more significant involvement of libraries and librarians is necessary, not only in the sense of the so-called editors or referees in scientific research organizations, but also in terms of establishing the architecture of eScience itself. Actually, from this distance of time, it seems logical that the greatest ally of eScience are libraries. Librares are the places of the future "knowledge society" representing essential innovation "hubs", where new technologies and platforms are implemented and researched. Furthermore, large libraries (especially academic ones) have resources – human and technological (digital), which can be put to the service of eScience. Therefore, the only valid way to approach the problem is one that involves engaging, reorganizing, and integrating what the library already owns. This is only possible if one wants to achieve a quick, comprehensive, efficient, and, most importantly, sustainable response to the demands of eScience.

In other words, instead of building from scratch, it was necessary to actually use the existing systems, in order to achieve the desired result. And that is the crucial difference of eScience compared to all previous attempts – it should not become a repository in which everything will be entered again, and the work will be done from the beginning. It should be an aggregator that draws on all existing resources and obtains information from existing systems and platforms, regardless of whether they are individual institutional repositories or larger systems like COBISS.

For example, in the main higher education and largest academic library of the Republic of Serbia – the University Library of the University of Belgrade – certain systems are already in place. We will mention three crucial ones for eScience:

1. COBISS – This system has been in Serbia since 1989 and is our first mutual cataloging system. Since 2002, local library databases have been

integrated into the COBISS.SR system, and since 2003, all systems have been integrated into the regional COBISS.Net system. Before the founding of eScience – in the COBISS.SR system, about 250 libraries of all types functioned, and the number of records was about 4 million unique bibliographic records in the COBIB.SR catalog, with about 300,000 normative records for persons. The University Library "Svetozar Marković" in Belgrade is one of the founders of the Virtual Library of Serbia and the bearer of the development of the COBISS.SR system, especially in the field of scientific and research work. A local database with around 370,000 bibliographic records, as well as highly qualified experts – librarians, editors of both the mutual catalog and catalog of normative records, and members of the Commission for the allocation of licenses for mutual cataloging in the COBISS.SR system – are the best quality guarantors to implement eScience.

2. E-CRIS.SR – the web application E-CRIS.SR is an information system about research activity in the Republic of Serbia, and it was developed in accordance with the CRIS (Current Research Information Systems) systems that have been developed in Europe for many years. The data structure on research activity is internationally standardized, compatible, and generally accepted in the form of CERIF (Common European Research Project Information Format). The essence of the E-CRIS.SR system consists of databases of researchers, research organizations, and research projects. The databases are interconnected, and most of the data is in Serbian and English languages. It is also possible to search in all key fields, and it is important to note that this system is connected to the COBISS.SR system, for printing personal bibliographies of researchers so that users are provided with immediate insight into the bibliographies of research papers. University Library Belgrade is an institution that manages and maintains the E-CRIS.SR database of researchers and scientific workers of Serbia, scientific research organizations, and the projects they work on. Before eScience was installed in E-CRIS, 309 research organizations, 12,917 researchers, and 777 domestic projects (together with European ones – 3,477) were represented. These data became an essential source for the eScience system, and they included the addition of new functions within the E-CRIS system itself. In cooperation with eScience, there are currenlty 25,893 researchers and 325 organizations in E-CRIS. Also, as in the case of the COBISS.SR system – the control of the data entered into the system is performed by highly qualified experts.

3. PHAIDRA – digital repository of the University of Belgrade, established in 2011 for the purposes of depositing the works of professors and associates of the University. It was developed at the University of Vienna as part of the Tempus project and was also established at the Universities of Niš and Kragujevac. The basis of this repository is the Fedora system. The Phaidra repository (Permanent Hosting, Archiving and Indexing of Digital Resources and Assets) enables researchers to: deposit various types of documents (text, images, video and audio files), as well as groups of documents and data sets, deposit documents with a unique identifier – with a permanent, stable link, as well as depositing different versions of the same document, where each new version is linked to the previous one, and their changes can easily be followed. The repository contains a standardized metadata scheme (Dublin Core) – a series of repeatable fields that describe an object. The visibility of objects that are primarily in open access is implied, with the possibility of simple "locking": viewing can be disabled if the object cannot be accessible in open access for some reason. Since the Creative Commons standard is part of this system, adequate legal protection of the material is ensured, because the choice of one of the licenses is a mandatory field among the metadata. There is the possibility of organizing objects into collections, which achieves easier access and review of materials, and of course, data transfer via the OAI-PMH protocol is enabled. Before setting up eScience – PHAIDRA had more than 15,000 digital objects, most of which were doctoral dissertations. Now, there are currently around 19,000 digital objects.

At the same time, it should be emphasized that the COBISS.SR system with its bibliographic database COBIB.SR and the normative file of personal names CONOR.SR is based on international standards for creating and transferring records. For the purposes of creating a researcher's bibliography, this system enables:

1. Creation of bibliographic records for various materials – monographic and serial publications, articles from scientific and professional journals and anthologies, non-book materials, events (e.g. lectures, presentations at conferences), even projects, protocols, patents – with all associated metadata.
2. Creation of normative records for author-researchers that contain the researcher's code that connects the record to the E-CRIS.SR database

and the ORCID research number for researchers who are registered in that database.
3. Input of verified data and creation of complete records, which are worked on by trained and experienced librarians.
4. Data and publications consolidation according to different criteria (authors, years, subject specification...).
5. Prints of bibliographies in different formats and citation styles.
6. The possibility of transferring data to other systems via the OAI-PMH protocol.

All the mentioned possibilities, especially in the context of the typology of the bibliographic unit, will prove to be crucial for the quality and sustainability of eScience. The advantages of relying on this system for the needs of eScience are reflected in the fact that there is already an integrated system that includes the creation of researchers' bibliographies and the depositing of works in full text in the dCOBISS sub-application, which is a kind of a digital repository. This sub-application includes both text processing and word-by-word search as it applies OCR when retrieving a digital document. The transfer of bibliographic metadata is done directly from COBISS, and administrative metadata is assigned in the *dCOBISS* application itself based on the copyright and permission of the author. Also, what will be shown in the implementation of eScience as a crucial quality of this entire system is the ability to export data in different formats, as well as a special quality automatic transfer and synchronization via the OAI-PMH protocol from the level of local databases.

One of the many examples of this preferred symbiosis could concern our scientists, as they are monitored by the Institute for Scientific Information within the international base called the Web of Science (WoS), which is probably the most important scientific worldwide bibliometric database. Since the leadership of its founder, Eugene Garfield, this Institute has been collecting publications and citations for more than half a century and processing them for scientific and statistical purposes. For the needs of Serbian science, the achievements of Serbian researchers within the "Ours in WoS" application were selected from this database, which is relevant for eScience. However, in order to avoid the creation of "dirty" or unprocessed data, librarians' proposal at meetings related to eScience always read: data transfer from "Our in WoS" to the Mutual Bibliographic-Catalog Database COBIB (IZUM from Maribor proposed for this the purpose of using the SRU protocol), then processing and extracting "clean" data into the National Bibliography of Researchers within the COBISS.SR system, and only then will that data be

transferred via the OAI-PMH protocol to eScience (1). This proposal was partially accepted due to the "timeline" of the project itself, but it should be borne in mind that its sustainability is sometimes more important than the "timeline".

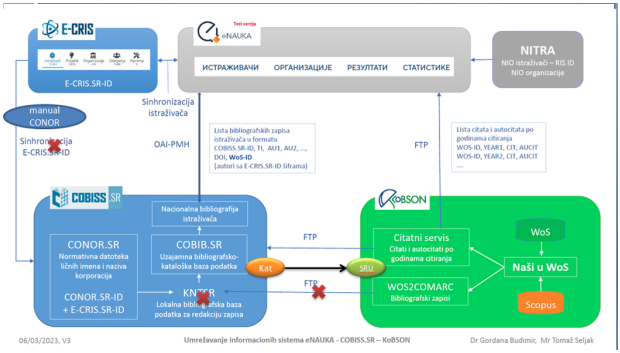

Figure 1. Data download scheme from "Ours in WoS" in eScience

In fact, this entire process should naturally be two-way in terms of general quality improvement – not only would COBISS with its associated entities help the sustainability and quality of eScience, but eScience should also initiate the improvement of the quality of records in the central library and information system of the Republic of Serbia and additional filling of those records in terms of document typology and complete validation of all scientific workers and scientific research organizations in the E-CRIS.SR database. The same applies to individual scientific research organizations' repositories because the eScience system would have to lead to an increase in their up-to-dateness, as well as an increase in the quality of the repositories themselves.

3 Open science as a prerequisite of the principle of transparency

Referring to the Open Science movement as an ecosystem is becoming common. This suggests a closer look at the basic characteristics of ecosystems. The basic definition says that it is a community or group of living organisms that live and interact with each other in a certain environment.

Natural ecosystems are balanced systems in which interactions between different organisms contribute to a certain stability. Also, natural imbalances tend to permanently offset each other. Some ecosystems develop slowly, while others can transform very quickly. In extreme cases, they may even disappear. Natural ecosystems do not have their own finitude or purpose.

This approach is an inclusive way to engage, think systematically, imagine a better future, and create it together. The modularity of Open Science enables ecosystems to emerge because it allows different but interdependent organizations to coordinate without full hierarchical agreement. Interactions and coexistence of different types of complementarity make them particularly interesting. This ecosystem's isolated parts represent organizations separated by "thin intersection points." The rules of engagement and the nature of standards influence behavior in the ecosystem and its success (Jacobides, Cennamo, and Gawer 2018).

Who decides the quality of a scientific article? Are these impact factors, which have themselves been challenged in numerous professional and scientific works? Although researchers largely believe that Open Institutional Publishing (for example – repositories or the Open Journal System (OJS) platform) is a waste of time, the harsh reality is that their articles – even those published in prestigious journals of major publishers – remain largely unread. So why do we pay for access to extremely expensive journals – mostly with taxpayers' money – when they don't provide real sustainability or increase the readability of scientific papers? Of course, it is one of the biggest businesses in the world, and every researcher cares about publishing something in a prestigious journal that belongs to one of the big publishers. However, is it only a matter of political will to support "open science" and the principle of transparency?

The industry's total revenue is huge. Before Corona, annual revenues were 19,000 million USD. The market is dominated by five large publishers: *Elsevier, Black & Wiley, Taylor & Francis, Springer Nature, and SAGE.* Elsevier is the largest, with a 16% market share: around 3000 journals, with a profit margin of 40%[1]. This means that this company is bigger than those known to the general public, such as Microsoft, Apple, and Coca-Cola.

Moreover, from 2010 to 2014, so-called predatory publishers took about 75 million USD and published almost half a million articles in about 8,000 journals (Shen and Bjork 2015). As of 2022, almost one-third of the top 100 publishers (by number of journals) could be considered predatory (Nishikawa-Pacher 2022).

1. Elsevier profit margin

Therefore, the process of transforming Open Access into Open Science is underway. In this sense, the following quote is very significant:

„The data Ecosystem appears to be moving away from centralization, it is becoming more diverse, and less integrated, thereby exacerbating the discovery and re-usability problem for both human and computational stakeholders (...) All research objects should be Findable, Accessible, Interoperable and Reusable both for machines and for people (...) The FAIR Data principles... help researchers adhere to the expectations and requirments of their funding agencies“ (Wilkinson 2016).

That is why there is currently a kind of movement away from profit-making business models that worsen inequality and are in contradiction with the UNESCO principles and values of Open Science, which are basically based on: 1. quality and integrity; 2. collective benefit; 3. fairness and equity and 4. diversity and inclusiveness. In the implementation of these values, significant – albeit uneven – progress has been observed in policy adoption and the creation of Open Access and Open Science infrastructure. But the main challenges remain:

- Changing the conventional scientific culture,
- Building the necessary human and institutional capacities,
- Establishment of adequate infrastructure (including connectivity),
- Review of criteria for assessment of scientific quality,
- Addressing negative or unintended consequences of Open Science practice.

The main function of Open Science is to ensure not only that scientific knowledge is available but also that the production of that knowledge itself is inclusive, equitable, and sustainable. Open Science is, therefore, not an end in itself but a means for fairer, more diverse, and inclusive research systems better directed towards the production, dissemination, and use of scientific knowledge that helps solve societal challenges for the benefit of all. Also, Open Science improves the quality of research: transparent, accessible methods and reusable results – facilitate the verifiability and reproducibility of research results – leading to greater quantification and reliability. Research efficiency is accelerated: the sharing and reuse of methods and results, which allows researchers to build on the work of others more easily and quickly, and this in turn, leads to faster research progress. At the same time, the impact of research increases: research methods and results are visible and accessible to the public and private sectors, and their inclusivity, valorization, and

practical application are facilitated – leading to improved trust and increased acceptance and use of research results.

What is necessary to implement all this is political support. In this sense, a positive example is the activity of the European Commission, which has been trying for years to increase and improve the share of Open Access in Europe. Nevertheless, the experts there know that it is necessary to speed up the entire process because the challenges we face as a society are so great that quick action is necessary. Ever since the Berlin Declaration, signed on October 22, 2003, the Open Science movement has continuously developed, facing various obstacles. Thus, in 2016, it was officially confirmed that scientific data desperately needs openness, better handling, careful management, the possibility of machine operation, and clean reuse[2]. Already in 2015, the Commission proposed to the EU Competitiveness Council the formation of the EOSC, which was followed by the Commission's initiative to form the Cloud in 2016 and the adoption of the Working Document on the EOSC Roadmap 2018-2020. This was followed by the Horizon 2020 project and an investment of 250 million euros by the European Commission for the creation of a prototype. The next phase should cover the period 2021-2027 and it envisages more active participation of EOSC member states, including Serbia, in the "opening" of national sciences.

In addition, in 2021, UNESCO adopted recommendations for Open Science[3] and immediately afterward proposed specific tools (UNESCO Open Science Toolkit[4]), which should facilitate the mentioned "opening" for all interested parties. In the period 2021-22, new Horizon projects have been approved, which concern Open Science infrastructure or regulations, such as the DIAMAS[5] or CRAFT-OA[6] projects. In 2022, the "Action Plan for Diamond Open Access"[7] was adopted, and last year, the conclusions of the Council of Europe on school publishing were also adopted[8]. Without going into the significant details of these documents, which are not the topic here, the essence of this acceleration is the following: to provide European

2. Realizing the European Open Science Cloud (EOSC) – a study commissioned by the European Commission to initiate the EOSC, accessed 20.10.2023
3. Recommendations for Open Science, accessed 20.10.2023
4. UNESCO Open Science Toolkit, accessed 20. 10. 2023
5. DIAMAS, accessed 20.10.2023
6. CRAFT-OA, accessed 20.10.2023
7. Action Plan for Diamond Open Access, accessed 20.10.2023
8. The conclusions of the Council of Europe on school publishing, accessed 20.10.2023

researchers in the first phase, and then innovators, companies, and citizens, an accessible, reliable and open distributed environment in which they can publish, find and re-use data and tools with each other for research, innovation and educational purposes, as well as access to relevant services. It is a long-term effort towards European harmonization and coordination between multiple research actors in Europe, including ministries and research funders, research organizations – meaning universities, academic libraries, research infrastructures and e-infrastructures – and other providers of life-related services. research data cycle.

Serbia started to follow the recommendations of the Berlin Declaration very early, so, for example, already on December 14, 2011, the University of Belgrade adopted a document approving the establishment of a repository of doctoral dissertations. Thus, since May 2012, it has been possible to deposit doctoral dissertations in electronic form in the Fedra repository (PHAIDRA), within which the E-THESIS subsystem was soon developed for the Universities of Belgrade, Niš, Kragujevac, and Priština (Kosovska Mitrovica). The Amendment of the Law on Higher Education (2014) removed legal obstacles to placing works in open access. In 2018, the then Ministry of Education, Science and Technological Development adopted the Platform for Open Science[9], and soon the University of Belgrade adopted its Platform[10] at the Senate session on March 13, 2019. Point 4 of this platform says:

1. It is necessary to change the awareness and current practices based on the "proprietary" attitude towards research results and primary data. The transition to a culture of open science implies the adoption of another system of values and incentives, which at the same time ensures greater transparency of science, reduces costs of dissemination of scientific research results, and contributes to fairer evaluation of researchers and their institutions.
2. It is necessary to optimize the organization of the publishing activity at the University of Belgrade, and adapt it to operate in the open access regime on a rational basis. In parallel, it is necessary to develop the modern IT infrastructure required by open science.
3. It is necessary to review the existing system of rewards and incentives in the career development of teachers and researchers, as well as the existing criteria for the evaluation of scientific contributions, in order to

9. Platform for Open Science, Ministry of Education, Science and Technological Development, accessed 20.10.2023

10. Platform for Open Science University of Belgrade, accessed 20.10.2023

integrate the values and good practice of open science into them, and to eliminate or make less important what is in conflict with open science."

On the basis of these documents (and even before that), a kind of repositorization began, both at the University of Belgrade and throughout Serbia and other scientific research organizations, and the central library and information system of the Republic of Serbia, COBISS, installed an extension of its system – *dCOBISS*, for depositing documents. In this way, all members of the University of Belgrade got, in a way, access to the infrastructure to provide open access. Numerous projects, events, conferences and days dedicated to open science followed, and the eScience project – crowns this multi-year effort and establishes a platform on the basis of which the entire society can profit, and the scientific community and its results – if certain technical shortcomings are eliminated and sustainable system is established – can become highly visible in the European context, fitting perfectly into existing European infrastructures, strategies and laws.

4 Transparency and what to do with it?

In the book Transparency or concern for taxpayers' money, the author Franci Demšar, former director of the Public Agency for Scientific Activity of the Republic of Slovenia, shows how the rapid growth of Slovenian science took place after the introduction and harmonization of the COBISS system, as a mandatory tool.

"In 1997, as a mandatory tool, we introduced, namely, the COBISS system, which today the majority accepts as something self-evident (...) I am personally convinced that it was this change that encouraged Slovenian researchers to start working for his publications more than before (...) Suddenly the 'weight' of a certain scientist became more concrete. Based on the review of published scientific articles, COBISS enabled a quick, transparent and reliable assessment of the importance of scientists in their own circle" (Демшар 2014, 62).

Therefore, the introduction of a transparent system – in a similar environment close to Serbia – caused a real small revolution, primarily in the attitude of researchers towards publication, as well as towards the evaluation and analysis of scientists in relation to the works they published. However, this is still not enough for an essential breakthrough and progress of national science. What is the essence – is the harmonization of funding of scientific research organizations and individuals with the results visible on

the portal. This is exactly what the eScience project expects at the next level. If, namely, the transparency of data is not coordinated with the holders of research projects and the priority of funding – then the system is worth nothing and is only a window into the happenings in a national science. This would then mean that the best researchers are not necessarily the holders of projects and financial resources and that academic careers in some cases continue to be "given away", regardless of scientific research results.

Mandatory registration of researchers' bibliographies in eScience (that is, master repositories and systems from which eScience will pull data), as a basis for evaluation and obtaining financial resources, in combination with better technical solutions (for example – a greater number of editors with full powers, preferably librarians, like to the COBISS system) – would lead to fundamental changes in the way and scope of publication, as well as in the general progress of national science, because the best would be supported in accordance with their results.

Only then will the introduction of such a transparent system – without any relation to vanity and academic positions – in which all essential information is available in a standardized and easy-to-understand manner bring the possibility of insight into the work of each individual researcher, and thus the establishment of a clear picture within the scientific research community. Of course, this will lead to a certain hierarchization among scientific workers but also encourages competition, as well as a kind of acceleration of national science in general, which will naturally lead to an increase in both the quantity and quality of scientific results. All this is because, in that case, the positioning of researchers and the evaluation of their scientific quality would not be based on lump sum ratings and "connections" in the academic community, but on reliable and standardized qualitative data.

Also, the long-term saving of funds invested in the field of science would be huge and evident, because today – let's admit it – still a very large percentage of invested funds does not bring any benefit to the growth of the influence of Serbian science and its progress in comparison with other regional scientific results. Again, the example of Slovenia is close to us and applicable in our framework:

"Considering that in Slovenia, as well as in the world, we have been happy to look through the eyes of taxpayers for some time, we can safely say that by introducing transparency in the field of scientific research, we saved 100 million euros of taxpayers' money in 2007 alone (...) In 2006, researchers spent 86 million euros less than they would have done according to the former logic, and if we add 100 million euros from 2007, taxpayers

could breathe a sigh of relief for a change when they hear that the Public agency for research activities in nine years (not at the expense of quality or quantity) saved several million euros of their money" (Демшар 2014, 66–67).

However, the essence of this saving would not be possible without the obligation to enter data into a transparent system (in the Slovenian case – COBISS and especially a little later SICRIS), nor – what is even more important – would there be increased scientific productivity and acceleration. In the mentioned book, it is clearly indicated that according to the old logic of things, the level of scientific production in the Republic of Slovenia from 2007 would be reached only in 2016.

If, therefore, through eScience, such or a similar transparent system is established in the Republic of Serbia, the publication of scientific works would no longer be taken lightly by anyone, and the Republic of Serbia, with its resources and the number of scientific workers, could make more than a significant step forward in the field of science in relation to the entire region.

To avoid confusion, the potential increased efficiency of Serbian science does not mean only an increased number of publications, but also a higher quality of them, as well as a greater involvement of science in the economy, more agile and better university curricula, and therefore professors. Namely, in the media we can often hear platitudes like "knowledge society", "cooperation between science and business", "greater investments in research and development," and the like, but we forget that science and research play a central role in achieving these goals. This should not be forgotten in the next phase of eScience implementation.

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Transfer of Metadata into the National Information System of Scientific Research Activities with Automatic Authorship Association

UDC 655.411(0.034.2):004.65]:378.4(497.11)
DOI 10.18485/infotheca.2023.23.2.2

ABSTRACT: Existing and alternative CRIS (Current Research Information System) systems, which deal with solving the problem of tracking scientific research productivity in Serbia, have proven to be incomplete. The new national information system for scientific research activities, named eNauka (eScience), through the application of modern methodologies, integration of external services, and process automation, should provide higher quality metadata and efficiency in the work of all its users. To save time in downloading and assigning records to research profiles and research organizations, eNauka utilizes techniques of automatic association and authorship recognition using persistent identifiers and similarity algorithms.

KEYWORDS: automatic authorship association, persistent identifiers, metadata validation, metadata deduplication, OAI-PMH protocol

PAPER SUBMITTED: 21 October 2023
PAPER ACCEPTED: 14 December 2023

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1 Introduction

The eNauka system is a publicly accessible portal for tracking scientific research results, researchers, and institutions in the Republic of Serbia and it is designed for the unified presentation of scientific output, research areas,

and achievements of the scientific research community[1]. The system is based on open-source software - DSpace-CRIS[2], which enables the maintenance of researcher profiles and research organizations, the collection of various research results, and tracking of citations, and more.

The main focus of eNauka is on saving time for all end users, regardless of their role in the system. From the perspective of researchers, time savings translate to the time spent entering all references and results they have published so far, while from the system administrator's perspective, it pertains to the time required to verify and validate all results reported by the researcher. For decision-makers, time savings translate to a more comprehensive overview of scientific productivity. At the data level, time savings will be achieved by not easily discarding available data sources that have already consumed researchers' time or administrators' time for verification and data entry. The eNauka system is open to downloading all metadata about scientific results that can meet the international standard for library information exchange, which implies the implementation of the OAI-PMH protocol (Lagoze et al. 2015). Time savings will be realized if metadata sources can provide authorship transfer. Authorship transfer implies that author names resolved by a persistent identifier at the data source can be transferred as such into the eNauka system.

The eNauka system allows for the transfer of metadata via the OAI-PMH protocol. Any information system, database, or internal infrastructure within any institution that can support the OAI-PMH protocol can potentially be integrated into eNauka. For eNauka, OAI-PMH represents a standard in terms of technical characteristics that need to be implemented. In addition to the technical correctness of the server implementing the OAI-PMH protocol, metadata must meet minimum requirements in terms of quality and availability for the results to be transferred to the eNauka system. Therefore, as part of the eNauka development, a separate service called OAIValidator has been created, which allows for transparent, public, and free semantic and syntactic validation of the correctness of metadata downloaded through the OAI-PMH protocol. Syntactic validation is most commonly applied to check identifiers and numerical values such as publication year. Semantic validation is used when recognizing the category of scientific result (e.g., article, conference paper, monograph, patent, technical solution, doctoral dissertation, etc.). The recognized categories of scientific results are aligned with the applicable regulations of the competent ministry (PC 2020). The OAIVal-

1. eNauka System
2. GitHub - 4Science/DSpace at Dspace-6_x_x-Cris

idator service supports authorship recognition and can be used to verify the accuracy of transferring researchers' persistent identifiers.[3]

One of the innovations that eNauka introduces compared to previous systems or alternative solutions is openness. Openness provides the opportunity for metadata about scientific research work to be more visible to all end users, regardless of whether they perform any of the roles recognized by eNauka. Openness enables easier verification of the correctness and accuracy of results because researchers are more cautious when submitting scientific results, while system administrators feel responsible for verifying every publication they must check. Logged-in users of the system have no privilege over anonymous users except in terms of functionality. Transparency towards users allows them to be free to write criticisms and praises of the system. Additionally, such an approach has proven to be very successful in collecting ORCID (Open Researcher and Contributor ID)[4] numbers of researchers. For the development team of eNauka, transparency towards users enables them to understand the needs of the scientific research community and to implement additional functionalities that could not have been foreseen in the system design process, but which can significantly contribute to improving the platform's quality and facilitate the work of all participants in the system.

Downloading metadata into the eNauka system is not dependent on the platform on which this metadata was created. Some institutions have been building their local infrastructure based on their knowledge for years, without relying on international standards, while others have opted for the implementation of ready-made (out-of-the-box) solutions. In this way, every publication, regardless of the institutional policy of depositing records, is a candidate for downloading. This means that an institution can continue the independent development of its infrastructure and adapt it to its needs without radically changing the way data is deposited. Institutions that have recognized the importance of information systems and have developed infrastructure for storing scientific research results can continue to work on their system as before, while eNauka will continue to collect results from institutional information systems by regular downloading. Certain institutions have shown a high level of interest in improving their infrastructure and supporting greater transfer of metadata, especially when it comes to transferring

3. The latest version of the OAIValidator service is available at https://proref.rcub.bg.ac.rs/OAIValidator/

4. ORCID

authorship through ORCID or other persistent identifiers (Haak et al. 2012; Otašević and Kosanović 2022).

The system design is based on the CRIS data model, which has been present and applied in various systems for many years (Jeffery and Asserson 2009). The eNauka portal consists of three entities: Research Organizations, Researchers, and Results. Additionally, the portal has been expanded with a statistics module, with the idea of providing continuous monitoring of scientific research productivity and other parameters relevant to science. The data model is created so that each entity can be maintained independently, but relationships can also be established between multiple instances of the same entity or between different types of entities. The presence of persistent identifiers for researchers plays a significant role in the accuracy of relationships. The data model is dynamically expandable, allowing for easier system upgrades with new entities if the need arises.

One of the main ideas behind creating the eNauka system is to gather all information related to the overall scientific productivity of researchers and institutions in the Republic of Serbia in one place. This implies that eNauka periodically collects results from other systems as well as from external services such as the ORCID platform, keeping track of where the results originated from. The eNauka system deduplicates and consolidates scientific research results in one place. In addition, the consolidated data is automatically checked for syntactic and semantic correctness. Furthermore, it allows for the enrichment of results with additional metadata, providing end users with a better understanding of scientific productivity.

The system is designed to support two processes that are very significant for every researcher and SRO (scientific research organization)(srb. *NIO - naučnoistraživačka organizacija*). Those processes are institutional scientific accreditation and selection for scientific research positions. The system aims to achieve a high degree of transparency in these processes because one of the main principles of this system is openness.

To ensure sustainability, eNauka relies on international standards and best practices in a technical sense, while also being aligned with legal regulations that define scientific research activities more closely. By listening to the needs of the scientific community, eNauka considers new solutions to make it easier for users to navigate the system. Additionally, eNauka strives to educate and inform end users through its functionalities and the implementation of new services, providing them with the opportunity to acquire new knowledge and skills (for example, the importance of an ORCID profile and international visibility (Arunachalam and Madhan 2016)).

2 Existing Solutions

So far, there have been several attempts and ideas on how to implement and technically support a system that would collect scientific research results and could support various processes. Each previous solution has not been able to fully meet the needs of the scientific research community. There has been room for improvement in the process, especially if the focus is on saving time. Each of the mentioned solutions has served as an example from which good and bad practices could be drawn. Identified practices have influenced eNauka in such a way that it does not neglect known and previously encountered problems, but actively works on resolving them.

Looking at sustainability, implementation, and development of other software, there are several different solutions. One technical implementation of a system could be ready-made solutions like Pure[5]. On the other hand, some solutions are implemented entirely independently or rely significantly on independent development. Such a system is the RIS - Serbian Researcher Registry[6]. Another similar example is the Novi Sad CRIS-UNS[7] used at the Faculty of Sciences in Novi Sad (Ivanović et al. 2017). Yet another possible solution is the eCRIS system based on data from the COBISS database, a commercial solution maintained and developed by IZUM (Institute of Information Science in Maribor), actively used in several scientific research libraries as well as university libraries, such as the University Library "Svetozar Marković" (Tomic and Ljubišić 2020).

The eNauka system is a kind of combination of various implementations, but its foundation is based on open-source software. However, eNauka significantly deviates from the original initial open-source code, and the entire system upgrade represents independent development. For eNauka, it is very important that previous results, previous development, and data collected through other systems are not discarded, and that redundant data entry is avoided.

The RIS system, in its structure, closely resembles the CRIS model to a significant extent. The system represents independent development, meaning it relies less on the implementation and integration of existing software solutions. During its active use and application period, a significant number of various references on scientific research results have been collected. When considering the level of information availability and open data, the

5. Pure | The World's Leading RIMS or CRIS | Elsevier
6. RIS – Registar Istraživača Srbije
7. CRIS-UNS

RIS system is largely implemented as a closed system. This closed nature also extends to the data, as researchers are identified based on RIS IDs, internal identifiers within the system. The lower transparency and visibility of this system reduce the accountability of various users towards the accuracy of the collected data. RIS represents one of the main sources of data initially incorporated into eNauka, for the following reasons:

- It contains references to scientific research results that were exclusively available within the RIS system,
- In the RIS system, researchers typically enter references themselves. This means that results could only be associated with individuals through manual entry,
- In addition to research references, the RIS system contains other administrative data that are important for establishing and identifying other entities.

The Pure platform is another possible technical solution that supports the CRIS data model and relationships between entities. It is a commercial solution developed and maintained by Elsevier. Pure is a modern system based on contemporary information technologies, which utilizes data available in the Scopus database[8] as its foundation. One of the main challenges for such a system would be expanding the data model because scientific research productivity, primarily its evaluation, is primarily based on data available in the Web of Science[9], and to a lesser extent on Scopus data (Kosanović 2004). Another challenge for this system would be incorporating domestic productivity. Research results from social sciences and humanities are less visible and available in international databases, but significantly more present in domestic index databases.

The solution that is commercial, but understands much better how scientific research productivity emerges when published in domestic journals or by domestic publishers, is the COBISS system. The system recognizes several different user roles depending on the level of responsibility and capabilities associated with each role. Data in the system are publicly available, which significantly adds another level of responsibility towards the data. For eNauka, COBISS is a significant source of metadata, primarily because it represents the main source of metadata on published and released results by domestic publishers. In combination with the eCRIS system, it is possible to establish the transfer of metadata along with authorship information.

8. More about Scopus https://www.elsevier.com/products/scopus
9. Web of Science

A good example of how it's possible to implement a CRIS system as a reliable solution in the work of a scientific research organization (SRO) is CRIS-UNS. The CRIS-UNS system was developed as an independent solution. However, this solution is primarily designed and applied for operation at the level of a single institution. The primary role of such solutions is to support the work of individual SROs and enable the introduction of reference input procedures simply. This solution is recognized as an example of best practice that has been applied in several other SROs as well. In technical terms, the system meets the requirements to be integrated into eNauka.

3 Implementation of the data model and infrastructure of the eNauka system

The eNauka system is based on the open-source software solution Dspace-CRIS. Dspace-CRIS software was developed by 4Science but heavily relies on the community and individuals who continuously contribute to its improvement (Mornati and Bollini 2013). Additionally, Dspace-CRIS is based on another open-source software solution, namely the Dspace platform (2017). As of the time of writing this paper, there are 206 accredited SROs. Out of this number, 111 have locally developed or utilized shared infrastructure that meets the minimum technical requirements for integration with eNauka. Out of the 111 registered sources harvested via the OAI-PMH protocol, a significant number are based on Dspace or Dspace-CRIS platforms (64%), which are easily extensible to support authorship transfer (Kosanović et al. 2019; Smederevac et al. 2020).

As a well-established data model due to its significant prevalence, eNauka is based on the Dspace-CRIS 6.3 data model as well as a major portion of the source code. The reason for choosing version 6.3 is that at the time when the eNauka project was initiated, there was no international stable production version of Dspace 7.X or Dspace-CRIS 7.X. Most production instances are based on versions 6.X or 5.X, which are very similar to each other. These versions differ drastically, both technologically and in terms of data model, from version 7.X.

Dspace-CRIS 6.3 represents an upgrade from Dspace 6.X, which was developed using two different technologies. One is based on the XMLUI technology (Sarang 2006), which is flexible, extensible, and easily applicable, but faces a significant sustainability issue as the technology has long been considered outdated and surpassed. On the other hand, Dspace offers an implementation developed in JSPUI technology (JCP 2000). A solution

based on Java programming language is highly popular among applications that have been present and active for a long time. Dspace-CRIS 6.3. was developed as an upgrade from Dspace 6.X, specifically in JSPUI technology. Therefore, eNauka's main component (core) is based on JSPUI technologies. The eNauka system aims to develop its enhancements primarily related to expanding existing functionalities or introducing new components using more modern technologies. Additional tools, scripts, and add-ons, depending on the needs, utilize development frameworks such as Angular (Google 2024) and Spring (Deinum et al. 2012), REST API structure (Fielding 2000), and other technologies commonly found in modern software solutions. Special attention is given to writing scripts and designing tools that are periodically executed, including scripts that generate variants of names (e.g., permutations, transliterations, etc.) and tools for automatically associating works with researchers.

The eNauka system recognizes several different user roles. Anonymous users represent the largest group. The system aims to be open and transparent in every aspect, allowing end-users to be the main controllers of the system's work quality and displayed data. Regarding the group of researchers, eNauka strives to simplify work processes within the system. In addition to the ability to edit additional personal data and manually input their references solely through external services, researchers are gradually informed and educated through the system. The biggest novelty for researchers is the ORCID profile, whose representation was very low (<15%) before the introduction of eNauka, reaching 83,24% four months after production release. This percentage will be higher when eNauka starts to be promoted within the research community. The third very important role in the eNauka system is the NIO editor. NIO editors are recognized as individuals engaged by SRO and represent the main guardians of the quality of metadata about research results. Most functionalities related to verification, approval, and editing of records are tailored to the work of NIO editors, saving them time needed for record review and authorship assignment.

In technical terms, eNauka, through its enhancement, should support process automation in every segment. The main component of the CRIS system is entities. The main entities in eNauka are research results, researchers, and SRO. The goal is to automate every process using information technology that would lead to saving time for researchers and NIO editors. The main challenge lies in automatically recognizing PIDs (persistent identifiers). PIDs are applied to all entities, like publications, researchers, and organizations. Their application provides unique identification of each entity and their con-

tinuous integration with external services. Since the main data in eNauka is scientific research results, i.e., their affiliation to individual researchers or SRO, the main challenge is achieving automation in establishing relationships between entities (Figure 1).

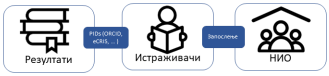

Figure 1. Representation of three entities in eNauka and the data defining direct and indirect relationships

Each of the entities has the characteristic of a strong entity, which allows them to exist independently. This implies that it is possible to edit, add, or remove each of them regardless of other entities. However, besides entities, CRIS systems also consist of relationships that exist between them. Therefore, regardless of their independence, every change to the data should be made carefully and cautiously to avoid disrupting other entities. In addition to research data, eNauka also includes other data that more closely describe or uniquely identify each researcher or research organization. Such data represent administrative data and are recognized as a separate entity within the system. Therefore, the data in eNauka should be divided into two groups:

1. Research Data - Metadata about references. Publicly visible and accessible to everyone after approval by NIO editors or downloading from reliable sources.
2. Administrative Data - Managed by NIO referents. A separate closed module with authorized access rights. Contains a larger amount of data about researchers and SROs (e.g., ORCID and employment). Important for starting procedures for academic promotion or accreditation.

4 Sources of Metadata

Researchers and SROs as entities in eNauka are defined by administrative data. If a specific researcher or institution cannot be found in eNauka, or if there is an error in administrative data such as names, surnames, employment, titles, ORCID, etc., then the NIO referent within their institution should enter, modify, or delete individual researchers or specific data through the administrative module. Data between the public eNauka portal and the administrative data editing module are synchronized daily. This synchronization model was chosen because changes in administrative data are not massive or frequent now when establishing relationships between entities.

For the public part of eNauka, in addition to administrative data, metadata about scientific research results also play a significant role. Additionally, each record that is regularly downloaded from existing sources, carries metadata (`dc.identifier.uri`), which represents a permanent link to the source from which the record was downloaded. Such an approach ensures the verifiability of available information and authorship verification. Two important factors that influenced the selection should be considered: with what priority the metadata sources will be integrated and in what manner:

1. Reliability of metadata sources - if the data comes from sources where someone responsible and qualified has already reviewed the metadata, then there is no need to verify such records at those sources. However, if the data was entered solely by the researcher, then the NIO editor must verify them before assigning them to the author.
2. Importance of metadata sources - if the metadata source has been previously used as an information system for tracking scientific productivity or contains a large number of significant publications, then such sources were prioritized during integration and this is because the availability of such metadata would significantly save time for researchers and NIO editors.

Metadata sources can be categorized based on the type of results they collect. The first group comprises information systems and databases that collect results with a common attribute of publication. Such sources can gather metadata records published by domestic publishers or those published solely in Web of Science, etc. On the other hand, there are infrastructures developed within individual SROs that collect all metadata on the scientific research results of their employees. The problem is that certain SROs cannot develop their infrastructure, so they opt for shared repositories. According

to the acquisition model, eNauka enriches its records by regularly harvesting reliable sources that do not need to be verified or by researchers initiating the download of publications from external sources, which NIO editors then verify.

Various software solutions enable the implementation of the OAI-PMH protocol. In technical terms, to support the OAI-PMH protocol, there must be a software solution (referred to as an OAI-PMH server) capable of sending data in the expected format, and there must be another software solution on the receiving end capable of fetching that data. Each SRO has the freedom to choose a software solution that facilitates sending metadata. Correct implementation of the OAI-PMH protocol has been established by 111 SROs, and this number of implementations is expected to continue growing. An increase in servers implementing the OAI-PMH protocol is anticipated as the system is promoted within the scientific research community. Recognized implementations of servers implementing the OAI-PMH protocol are listed in Table 1.

Table 1. Types of software solutions used as sources from which metadata is retrieved

Software Solution	Description
Institutional Repository	Repository the importance of repositories, whose application extends far beyond integration into eNauka.
Shared Repository	The common infrastructure of universities or libraries
International Repository	International infrastructure
Independent Development	Some institutions have mastered the OAI-PMH standard and have managed to independently develop an OAI-PMH server
External Services	Researchers can only retrieve metadata from external services. SRO does not support any infrastructure.

SROs that have recognized the importance of their infrastructure have mostly opted to establish institutional repositories. Institutional repositories are used and exist independently of eNauka. As another option, some SROs have chosen to collaborate, usually at the university level, and utilize shared infrastructure. Universities such as the University of Kragujevac and the University of Criminalistics and Police Studies have university repositories. Additionally, libraries like the University Library "Svetozar Marković" provide their infrastructure and support to SROs to join the shared repository[10]. As a third option, SROs aspiring to establish repositories may opt for international infrastructure. So far, Zenodo[11] has been recognized as an international repository. From a metadata perspective, Zenodo collects all types of results (a catch-all repository). Some SROs had local databases and information systems even before eNauka, which they managed to advance to support an OAI-PMH server. The Faculty of Sciences in Novi Sad, through CRIS-UNS, integrated into eNauka and helped other SROs to integrate into eNauka following a similar model. The Faculty of Electrical Engineering in Belgrade also upgraded its information system and met the technical requirements for integration into eNauka, assisting other SROs using the same information system to integrate into the eNauka system. Institutions have begun to recognize the importance of ORCID and are expanding their databases with new data, knowing that transferring them to eNauka will save time on record editing.

The metadata available in the COBISS database is also downloaded into eNauka using the OAI-PMH protocol. For records downloaded from the COBISS database, it is important to have a certain typology. When eNauka downloads records from the COBISS database, it automatically recognizes the category of the scientific result. The OAI-PMH implemented to disseminate records from the COBISS database has been expanded so that downloading is done according to the COMARC specification (IZUM 2023a, 2023b). The visibility and transparency of records that have arrived in eNauka from the COBISS database have made it easier to identify and correct errors at the metadata level at the source.

5 The system infrastructure

The public portal of the eNauka system was developed in an environment commonly found in non-commercial information systems. Ubuntu operating

10. PHAIDRA, Digital Repository Of University of Belgrade.
11. Zenodo

system was used as the operating system. Apache Tomcat® 9.x was utilized as the web server (The Apache Software Foundation, 2017). The foundation of the eNauka public portal is the Dspace-CRIS 6.3 platform based on the Java programming language and implemented as a Maven project. Apache Tomcat® 9.x server is suitable and compatible with Dspace-CRIS version 6.3. PostgreSQL was used as the relational database management system (PostgreSQL Global Development Group, 2023), and Apache Solr was used for indexing and search (The Apache Software Foundation, 2014).

In addition to the technical characteristics of the environment in which eNauka was developed, the eNauka system consists of a public portal and several services. Due to the complexity of the implemented processes, as well as the multiple sources of metadata and administrative data, the eNauka system is divided into several separate units (modules). Each module is developed as a standalone application that can exist and operate independently of other modules. However, for the eNauka system to function as a service, some modules must be in frequent communication with each other. Figure 2 illustrates a simplified infrastructure model representing the eNauka system. The orange arrow shows the path of metadata movement during downloading. The blue arrow indicates synchronizations with internal and external services/modules

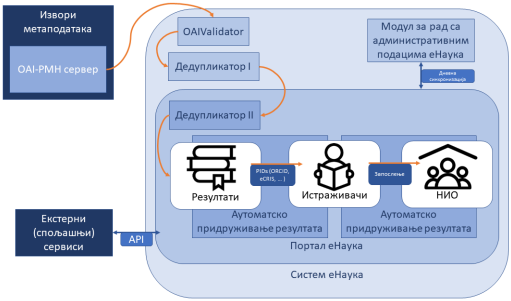

Figure 2. Presentation of the eNauka infrastructure.

In Figure 2, the eNauka portal is observed. It represents the main segment of the eNauka system, as this segment is publicly accessible and serves as the main component that integrates all other modules. The eNauka portal

consolidates administrative data about researchers and research organizations, as well as metadata about scientific research results. Additionally, the eNauka portal serves as the main hub for other external services integrated within it. Table 2 provides an overview of external services that are significant for authorship affiliation in eNauka.

Table 2. List of external services that are integrated into eNauka, and are important for the transfer and association of authorships.

External Service	Application
ORCID	Authentication; Authorization; Retrieval of works; Automatic authorship affiliation; *Submission of works(push)
CrossRef	Enrichment of records; Quality verification
KoBSoN	Automatic categorization of results; Retrieval of records
KNR	Retrieval of records; Automatic authorship affiliation; Link to researcher's profile within the KNR platform
eCRIS	Automatic authorship affiliation; Link to researcher/SRO profile within the eCRIS system
RIS	Automatic authorship affiliation

In Table 2, the most significant external services integrated with eNauka are presented. These services contribute to eNauka by regularly updating researchers and result entities with new data. From the perspective of automatic authorship affiliation, these services provide necessary data for establishing mechanisms in eNauka that automatically affiliate results with researchers, verify the accuracy of transferred authorships, and check for duplicates. There are other external services integrated with eNauka, but their application is specific and not of interest to end users. Records found on the eNauka portal are regularly enriched with data obtained from these external services. In the "Application" column, certain values are marked with an asterisk "*", indicating that the specified application is expected but not available at the time of writing this paper.

6 Metadata verification and processing phases

The metadata retrieved through regular harvesting before reaching eNauka must undergo several phases of verification and processing. The first step is the validation of the OAI-PMH server. To check the OAI-PMH server and metadata, the OAIValidator has been developed. Checking the OAI-PMH server involves verifying if the server is accessible, if it has implemented functions that return lists of sets by which records are grouped, if there is an Identify page with basic information about the metadata source, and if the expected format for transferring metadata is supported. In addition to the basic functionality of checking the validity of the OAI-PMH server, OAIValidator helps repository administrators verify the semantic and syntactic correctness of metadata in one place. Also, OAIValidator provides basic statistical indicators about records as well as detailed messages about invalid metadata. In the context of eNauka, all sources of metadata that are regularly harvested automatically undergo a validation process that will machine-recognize records/metadata that can enter the eNauka system. Figure 3 shows an example of validation of one metadata source and how eNauka views one of the retrieved records with authorships. The NIO editor has additionally reviewed the shown example to resolve the authorship request.

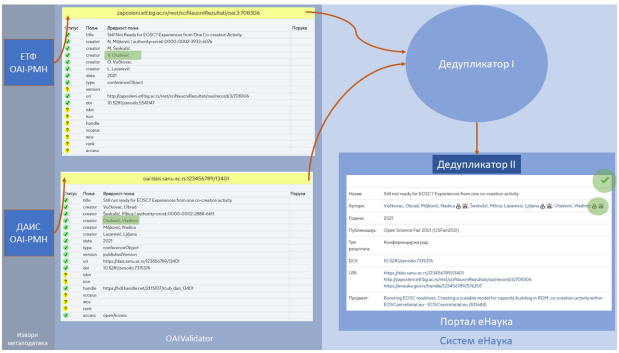

Figure 3. An example of validation, deduplication, and consolidation of records that were automatically transferred from two metadata sources.

The second step involves the deduplication of metadata. Since the deduplication process is complex and time-consuming, it takes place in a separate module. Deduplication is based on two recognition patterns:

1. Identifiers (DOI, WoS UT, Scopus ID) - the mentioned identifiers must be unique; otherwise, it's considered a duplicate. There are exceptions, but in those cases, a different pattern is applied;
2. Title, year, publication type - Not all publications have PIDs. Publications with similar normalized titles, publication years with an error of ± one year, and the same type of research result are considered duplicates.

The identified duplicate is not discarded; instead, an attempt is made to merge the records automatically. The most significant metadata in the record is authorship. The deduplicator will attempt to recognize authors who do not have assigned authorship (e.g., ORCID, eCRIS-ID, etc.) if the duplicate record contains additional identifiers. In addition to authorship, the deduplicator will merge all PIDs and URI values for recognized duplicates to permanently retain the trace of where the records were downloaded from.

The eNauka portal is continuously active, with its users constantly editing or withdrawing records from eNauka. Since the deduplication process is time-consuming, the data in the deduplicator may be not synchronized with the data in eNauka. Therefore, when transferring deduplicated records to eNauka, another automatic deduplication will be performed in real-time if it is recognized that the record already exists or is pending verification by the NIO editor. Additionally, for records that already exist in eNauka, metadata merging and enrichment will be conducted. It is essential if a duplicate record is received from other metadata sources containing new information about authorships.

7 Data Model

The data model in eNauka is based entirely on the data model existing in Dspace-CRIS 6.3., so there was no need to introduce additional tables or columns. This approach allows eNauka to remain standardized and not deviate technically from the original code when it comes to the data model. However, certain modifications have been made to accommodate values from the database. By default, Dspace-CRIS 6.3. recognizes ORCID as authorship values. On the other hand, integrated systems store authorships through other PIDs such as eCris, RISiD, Karton Vojvodine ID, and others.

Therefore, eNauka is designed to allow the storage and association of other identifiers.

The eNauka system retrieves metadata from external sources through regular harvesting via OAI-PMH servers, so it was necessary to define which standards and specifications for metadata would be applied. It is possible to download metadata about records that follow one of the following specifications:

1. Dublin Core (abbreviated as dc) - an internationally accepted standard specification for metadata exchange (DCMI 2012; Kunze and Baker 2015; ISO 2017; Хокнер and Будрони 2011);
2. DSpace Intermediate Format (dim) - a non-standardized metadata specification primarily designed for data exchange within the DSpace platform itself.

The Dublin Core specification was easier to apply and integrate because it is a widely adopted metadata schema that can be propagated through the OAI-PMH server (Jackson et al. 2008). However, such an approach also carries certain limitations. According to the dc specification, it is not possible to transmit authorship (e.g., ORCID). To overcome this issue, eNauka followed the guidelines of international organizations and best practices by implementing a solution that extends the authorship label to include an additional attribute (`"id"`) where the OAI-PMH server can place the authorship value (2018). Other alternative solutions can be applied for transmitting authorship, which were considered when extending the OAI-PMH metadata transmission that implements the `dc` specification (BASE 2023). Another significant drawback of this specification is the limitation in recognizing labels. Each label consists of two parts, `"schema"` and `"element,"` which serve for recognition. This problem arises when transmitting PID values, which is a major issue for eNauka as most operations are based on these values. For example, a record may have a DOI, WoS UT, Scopus ID, PMID, COBISS ID, and an internal numerical identifier. All these PID values will arrive through the `"dc.identifier"` field, which means that recognized identifiers exist but it is not known for a specific value which identifier it represents. Of course, eNauka has mechanisms for semantic recognition and syntactic verification of PID values and will attempt to categorize values according to precisely determined identifiers, but there is a possibility that a NIO editor will have to subsequently correct such a record.

On the other hand, eNauka offers the possibility of downloading data according to the `dim` specification. Since this specification is non-standardized,

it is possible to make all kinds of modifications to it. There is no problem with identifiers and their recognition because each label can be defined with a maximum of three segments, i.e., besides "`dc`" and "`element`," there is the "`qualifier`" attribute. Additionally, the dim specification supports the transmission of authorship values on all labels without additional modifications. The only difference is that the attribute is called "`authority`." By applying XSLT (Extensible Stylesheet Language Transformations) transformation (W3C 1999), it is possible to translate `dim` into the `dc` specification unambiguously. XSLT is a language for transforming XML documents. It can be concluded that `dc` represents a subset of the dim specification. It is possible to transform dc into dim specification using XSLT, but such transformation is not straightforward or reliable, especially if the record is rich in identifiers.

The eNauka portal has been enhanced with additional mechanisms that facilitate the work of NIO editors and researchers when checking the quality of metadata. In real-time, the eNauka portal will flag potential duplicates based on titles that could not be automatically deduplicated because a sufficient level of confidence that they are genuine duplicates has not been achieved. These are situations where human review of the record is necessary. In addition to recognizing duplicate titles, eNauka will perform a check during record editing if additional identifiers are added to verify if a record with such identifiers already exists. A problem has been observed with records that have invalid or non-existent DOI numbers. The eNauka system automatically checks each DOI number and marks those that are not valid.

8 Conclusion

The eNauka system represents a significant advancement compared to existing alternative solutions. It is tailored to the work of NIO editors and researchers. The automatic assignment of authorship significantly saves time for all users. If metadata sources meet technical requirements, meaning they have an OAI-PMH server and their metadata meets syntactic and semantic correctness criteria, then eNauka will support the integration of such sources. Centralizing data collection, while preserving links to original sources, allows for the review of individual records in eNauka and the verification of the same records in the original sources from which they were retrieved. Data sources are decentralized, allowing each SRO to continue using their information systems as they have done before. On the other hand, the eNauka system

will automatically perform validation, deduplication, verification, and enrichment of records through regular data retrieval, providing end users with better insights into the records.

Furthermore, anonymous users are recognized as having a distinct role in this system, and their contribution through continuous quality checks of available information enables this system to be better. Transparency in information introduces a new level of accountability and reduces the possibility of (un)intentional errors slipping through.

Regarding the infrastructure, it is designed to achieve maximum modularity. Such an approach ensures that each module can be developed and maintained independently of others. Additionally, modules can operate independently of each other, but for the entire system to function, the modules must be accessible and for there to be mutual synchronization. With its innovation and advancement compared to alternative solutions, the eNauka system has become a source of scientific information. End users have the opportunity to acquire new skills that are necessary for anyone who wants to be part of the modern international scientific research community.

The eNauka system with entities of researchers, SROs, and scientific research results represents a CRIS system. The next step for eNauka would be to add projects as a new entity, in addition to the existing ones. Projects would contribute to opening up a new perspective on monitoring scientific research productivity.

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COBISS.SR and E-CRIS.SR as Support for the eScience System

UDC 655.411:004.42COBISS (497.11)
DOI 10.18485/infotheca.2023.23.2.3

ABSTRACT: The paper presents the role of the COBISS.SR and E-CRIS.SR systems in constructing the Register of Researchers and the Register of Scientific Research Work in the Republic of Serbia - eScience. The eScience system, as a national aggregator of metadata on the results of scientific research work in Serbia, firmly relies on the library system COBISS.SR in terms of the direct transmission of data on papers that are part of the scientific production of domestic researchers. The selection of records from the COBISS.SR system is based on a set of records containing the document typology and personal identifier, that is, the researcher's code from the E-CRIS.SR database. The University Library "Svetozar Marković", as the parent library of academic and scientific libraries, together with the National Library of Serbia, successfully performs the task of providing support for the transparent presentation of the results of scientific research work in Serbia, thereby fulfilling its obligations at a high level, which was also recognized by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia.

KEYWORDS: COBISS.SR, E-CRIS.SR, eScience, harvesting, identifiers, typology of documents

PAPER SUBMITTED: 30 December 2023
PAPER ACCEPTED: 30 January 2024

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1 Introduction

The need for the existence of a unified system of scientific information was perceived in the mid-80s of the 20th century in the former Yugoslavia. The Scientific and Technological Information System of Yugoslavia (SNTIJ) project was launched in 1987. Already in 1988, a feasibility study of SNTIJ was published in which, among other things, the institutional structure of the system was prescribed. The project envisaged that the system would consist of libraries - special, higher education, university and national, INDOK and information units (services, centers), referral centers, specialized centers of scientific and technological information, specialized systems of scientific and technical information, archives and museums, Yugoslav bibliographic agency (Yugoslav Bibliographic Institute), and computer services - hosts. The same project defined the introduction of shared cataloging in the libraries of Yugoslavia within the framework of a centralized computer network (SNTIJ 1988, 12–15).

One of the central supporters of this project and scientific research work was the University Library "Svetozar Marković" as a library, information-documentation, and referral center of the University of Belgrade. From its foundation until today, for almost a whole century, the Library has been carrying out its basic activity continuously, trying to provide the best possible support and assistance to the work of academic libraries and their librarians on the one hand, and on the other hand, to offer its users, in the first place researchers, university professors and students, assistance in their scientific research work through adequate services.The development of new technologies and the application of technological innovations have also found their place in the library world, and the Library tries to keep up with them, while its employees improve their skills and develop new knowledge and skills in their daily work and work on projects in order to respond to new challenges and meet the needs of contemporary users.

As the University Library "Svetozar Marković" has been one of the leaders in the development of the shared cataloging system since 1987 in the former Yugoslavia,[1] that activity spilled over into the development of the CO-

1. The shared cataloging system was established at the level of the entire former Yugoslavia in 1987. The bearer of the development of organizational solutions and software was the Computer Center of the University of Maribor (today the Institute of Information Sciences - IZUM). In 1991, IZUM promoted the COBISS system. Due to social and political changes, COBISS continued to develop as a Slovenian

BISS.SR system,in cooperation with the National Library of Serbia (NBS)[2] and the Library of Matica Srpska (BMS)[3]. In cooperation with the NBS, in 2001, the University Library implemented the projects "Establishment of the Center of the Virtual Library of Serbia (VBS)" and "Building a cooperative network of higher education libraries in Serbia", which were financed by the Open Society Fund and the European Commission within the TEMPUS program (Филипи-Матутиновић 2001). After the implementation of the projects, the VBS center was established with its headquarters in the National Library of Serbia (Grujić, Čano-Tomić, and Ljubišić 2016, 5) with a common host server, and in 2003 the shared cataloging system in Serbia started to operate, based on the COBISS platform (Cooperative online library systems and services)[4] (Filipi-Matutinović 2010, 95), which has been developed from the late eighties of the 20th century by the Computer Center of the University of Maribor (today the Institute of Information Sciences - IZUM)[5] (Popović-Bošković and Filipi-Matutinović 2001). The shared catalog was established by connecting the databases with the electronic catalog of the BMS (which was the most comprehensive in Serbia in terms of the number of records), the Yugoslav Bibliographic Information Institute (YUBIN), the University Library "Svetozar Marković" and the National Library of Serbia. Also, cooperation was achieved with the newly formed countries on the territory of the former Yugoslavia and the COBISS.Net network was established, which meant connecting the national databases of the five countries of the former Yugoslavia that were part of the system at the beginning (Slovenia, Serbia, Bosnia and Herzegovina, Macedonia and Montenegro). From that moment, the University Library provides continuous assistance and support to all scientific research libraries that are part of the system and their librarians, in terms of creating records and maintaining their quality.

In 2018, within the COBISS.SR system, the CONOR.SR[6] authority file became active which, after more than a decade since the initiation of the normative control project proposal in the COBISS.SR system, enabled the normative control of personal names (Савић 2017, 103). The project was imple-

library and information system, while affiliated libraries in Serbia continued to work with the same software locally without further improvement until 2003.

2. National Library of Serbia
3. Matica Srpska Library
4. COBISS.SR
5. Institut of Information Sciences (IZUM)
6. CONOR.SR–Authority file of personal and corporative names

mented by the National Library of Serbia, the University Library "Svetozar Marković" and the Matica Srpska Library. As the CONOR.SR database is an integral part of the COBISS system (Тртовац and Дакић 2020, 76), it represents a significant resource for the eScience[7] system in the sense that the normative records for researchers contain the necessary personal identifiers that are also used in the eScience system.

The University Library "Svetozar Marković", in addition to its core activity and providing services to students and the scientific and research community, also performs the role of an educational center. Over the years, the Library, following its legal obligations, has undertaken the organization and implementation of various forms of professional training for librarians employed in all higher education institutions. Back in 2003, within the framework of its Statute, the Library prescribed in Article 10 the obligation to organize professional development of personnel for the performance of library activities (УБСМ 2003). In the past two decades, various trainings have been organized for employees in academic and special libraries (in the form of lectures, workshops, seminars, etc.), covering all the most important segments of library work (Дакић, Тртовац, and Андоновски 2020, 32–33). Given all of the above, the University Library "Svetozar Marković", together with the National Library of Serbia and the Matica Srpska Library, is a key actor in the process of unifying data on scientific and research work in the COBISS system for the eScience system, providing technical support and assistance to scientific and research organizations and researchers individually. Thus, it has the opportunity to support the implementation of a new system for monitoring and evaluating the results of scientific work in Serbia - eScience.

2 COBISS and SICRIS (E-CRIS) – a model of the optimal scientific information system

If we consider the development of the scientific information system in the countries of the former Yugoslavia, we can state that the COBISS system is used as a preferred library-information system in Slovenia, Serbia, Bosnia and Herzegovina (Republic of Srpska and the Federation of Bosnia and Herzegovina), Montenegro and North Macedonia. Croatia remained outside this system and developed its own resources and platforms for the presentation, evaluation and promotion of the results of scientific research work.

7. Register of Researchers and the Register of Scientific Research Work in the Republic of Serbia - eScience

2.1 Slovenia

At the beginning of the 1990s, when mutual cataloging gained momentum and more libraries were included in the common system, the political situation in the former Yugoslavia changed. Consequently, due to socio-political circumstances, shared cataloging and further construction of a common system were interrupted. Libraries in Serbia began to work separately, each in its own local base until 2003. The COBISS system continued to be developed individually in the Republic of Slovenia as a generally accepted national integrated library and information system. As part of that development, in addition to the improvement of modules and segments for basic library operations - cataloging, procurement, and lending - SICRIS [8] (Slovenian Current Research Information System) was launched in the second half of 1999 as a national information system that initially contained databases on researchers, research organizations and research projects.

After more than 20 years of successful application, "today, this system contains data on scientific research organizations, departments, research projects and programs, researchers, as well as research equipment. Data on the papers of Slovenian researchers is contained in the library and information system COBISS.SI[9], that is, its bibliographic database COBIB.SI[10], with which SICRIS is connected, thus enabling immediate insight into the researchers' bibliographies.

The researcher database contains the most basic data (name, surname, unique code of the researcher, area of scientific research work, etc.). Additional data (education, language skills, employment, etc.) are available only for researchers who have permitted the publishing of their personal data. This database contains data on all researchers who participated in the projects of the Research Agency of the Republic of Slovenia (ARRS[11]) from 1998 until today that were registered by Slovenian scientific research organizations. The organization database contains data on scientific research institutions that participated in projects that were, at least partially, financed by the Slovenian Ministry of Science from 1995 to the present day. Complete data are available only for those institutions that responded to the call from 1999 (when SICRIS was launched) and submitted all the requested data. In addition to the institutions that participate in the projects,

8. SICRIS
9. COBISS.SI
10. COBIB.SI
11. Research Agency of the Republic of Slovenia - ARRS

the database also includes institutions that do not participate in ARRS projects but have informed the Statistical Office of the Republic of Slovenia that they are engaged in scientific research work and that they want to be represented in the SICRIS system. Apart from these two databases (on researchers and organizations), the database on projects financed by ARRS, that is, the Slovenian ministry that was in charge of science from 1998 to the present, is particularly interesting. Other projects in which Slovenian researchers participate are also presented if the researchers and institutions themselves wish to present them through SICRIS. An important prerequisite for the development of this system is the cooperation of the Institute of Information Sciences from Maribor with the Agency for Research Activities of the Republic of Slovenia.

It is safe to say that the key moment happened in 1997 when Slovenia introduced the COBISS system as a mandatory system for displaying bibliographic data and creating researcher bibliographies. This led Slovenian researchers to take more interest in their publications and to publish them more actively. The introduction of COBISS clarified the approach to cataloging and evaluating scientific papers in Slovenian academic circles. This led to the fact that the importance of a specific scientist became more concrete because, based on the review of published scientific papers in COBISS, a comprehensive and reliable assessment of the value of the scientist's work was obtained. IZUM and ARRS are responsible for entering and updating data in the system. Slovenian legislation stipulates that each library in a scientific research organization has at least one librarian who is engaged exclusively in managing the bibliographies of researchers employed in the specific institution and their scientific production.

2.2 Bosnia and Herzegovina

After the signing of the Agreement on the establishment of the COBISS.Net network at the end of February 2003, which foresees the free flow of bibliographic records created in the autonomous library and information systems of Bosnia and Herzegovina (BiH), Montenegro, North Macedonia, Slovenia, and Serbia, two important dates for the implementation of the COBISS system within Bosnia and Herzegovina can be highlighted. The first is March 9, 2005, when the umbrella Agreement on the implementation of the COBISS system in BiH was signed between IZUM and the National and University Library in Sarajevo. The second is February 6, 2006, when the National and University Library of the Republic of Srpska from Banja

Luka was included in the COBISS.BH system. In this way, both entities of Bosnia and Herzegovina (Federation and Republika Srpska) started using the COBISS system.

The test version of the system on research activity in Bosnia and Herzegovina, E-CRIS.BH, was launched in March 2006. The institution in charge of entering and updating already entered data is the National and University Library of Bosnia and Herzegovina.

In the Republic of Srpska, there was no database of researchers and research organizations containing data on researchers, institutions, published papers, current and completed projects, or their results. Such a situation greatly hampered the work of the Ministry of Science and Technology, which, for this reason, decided to accept the offered web application and launch E-CRIS.RS, an information system on research activity in the Republic of Srpska in order to improve cooperation and promotion both at the national and the international level. The management of the E-CRIS.RS system and the function of the national E-CRIS center was taken over by the Ministry of Science and Technology in December 2010.

The conditions for research institutions or researchers remain the same as in previous cases, and all those involved in research and development activities in the Republic of Srpska should be included. The National E-CRIS Center takes care of the organization and coordination of data collection, checks the conditions for enrollment (registration), and monitors the quality of data sent to it by research organizations and researchers (Стијеповић, Кринуловић, and Поповић 2017, 182–183).

2.3 Montenegro

The common cataloging system COBISS.CG, which included the Central National Library 'ĐurđeCrnojević' and the Podgorica University Library, was established in December 2001. In the experimental period from 2006 to 2008, the work of entering data into E-CRIS.CG was performed by the University Library in Podgorica. Since 2009, the management of the E-CRIS.CG system has been taken over by the Ministry of Education and Science (MPIN), and at the same time, the methodology of data collection and updating has been changed. Letters have been sent to scientific research institutions and researchers, requiring them to register in the E-CRIS.CG system if they participate in research projects financed by public funds. All those involved in research and development activities in Montenegro should beregistered in the E-CRIS.CG system, and thus contribute to the promotion and cooperation at the national and international levels. A research

organization can be a university or an organizational unit of a university (faculty, institute...), but also any other legal entity in the public or private sector with a registered research or development activity and at least one employed researcher. A researcher is a natural person who has at least a university education (university degree), performs research or development activities, and undertakes to maintain their bibliography in the COBISS.CG system (Стијеповић, Кринуловић, and Поповић 2017, 180–181).

2.4 North Macedonia

At the end of 2003, the implementation of the COBISS.MK system began in North Macedonia. As in other countries participating in the COBISS.Net project, an information system on research activity called E-CRIS.MK was launched there. The task of running this system was entrusted to the National and University Library "St. Kliment Ohridski", which also performs the function of the national E-CRIS center. From March 2012, the methodology of data collection and updating was changed. Researchers who were already registered in the ECRIS.MK system were invited to submit an e-mail address to which they were sent a username and code for authorized access to the system so that they could complete their data. Researchers who were not yet registered in the system but met the requirements for enrollment (higher education, engagement in scientific research, and the obligation to maintain a bibliography in the COBISS.MK system) should fill out form EV-03/2008, send it to the address of the national E-CRIS center and when the responsible person determines that the researcher meets the requirements for registration in the system, the data becomes public, and the researcher is informed about it and can update his data with the help of a username and password. The same methodology was applied in research organizations (181–182).

2.5 Croatia

As the libraries in Croatia do not utilize a unique software that supports the library-information system, data on scientific research work and researchers in this country are most comprehensively kept in the Science Information System of the Republic of Croatia - CroRIS and the Croatian Scientific Bibliography - CROSBI. CroRIS is the central place for the scientific research work of Croatian researchers because it contains reliable data about researchers, institutions, projects, research, patents, equipment, and its use[12]. CROSBI contains comprehensive bibliographic data on the scien-

12. CroRIS

tific and professional work of over 46,000 individuals working in science and higher education with more than 815,000 publications and 9,100 projects[13]. These two systems have been developed and maintained by the Computing Center of the University of Zagreb (Srce[14]).

The need to enable open access to scientific information and the presentation of the results of scientific research led to the creation and establishment of Dabar[15] (Digital Academic Archives and Repositories) in Croatia in 2014, which is also maintained and managed by the computing center of the University of Zagreb (Srce). Dabar includes interoperable institutional and thematic repositories. Since 2015, doctoral dissertations, final and graduate theses, contributions since 2016, and papers published in magazines and anthologies, as well as chapters in monographs since 2017, have been deposited there (Macan, n.d.). Dabar is a metadata aggregator for 172 repositories, it contains over 250 thousand results of scientific research, more than half of which are in open access[16].

The development of the system in Serbia will be outlined and explained in detail in the following chapters.

3 E-CRIS.SR and researchers' bibliographies

Based on the efficient model established in Slovenia, which involves communication, exchange of research data, and the creation of bibliographies using the COBISS.SI and SICRIS systems, at the end of 2005, at the initiative of the University Library "Svetozar Marković", in cooperation with the Institute of Information Sciences from Maribor (IZUM) the web application E-CRIS.SR[17] was launched with the aim of establishing an information system on research activity in Serbia. Sixteen files with data on teachers and faculty associates of the University of Belgrade, prepared by the University Library, were initially converted into the system. The E-CRIS.SR system contains four interconnected databases on research activities in Serbia. These are databases about researchers, projects, organizations, and departments (Стијеповић 2016).

The web application E-CRIS.SR (Figure 1) belongs to the category of information systems known as CRIS (Current Research Information Sys-

13. Information provided on 1.2.2024, source: https://www.croris.hr/
14. SRCE - Computing Center of the University of Zagreb
15. DABAR - Digital Academic Archives and Repositories
16. Information provided on 1.2.2024, source: https://dabar.srce.hr/repozitoriji
17. E-CRIS.SR

tems), which have been developed in Europe for decades. A significant step in the development of CRIS systems is their transfer to the Internet, which additionally motivates researchers, that is, contributors to make their data transparent, thus making them more visible to the wider research population. In addition to moving to the Internet, an important step in the popularization of the CRIS system is the generally accepted recommendation CERIF[18] (Common European Research Information Format), which standardizes data by prescribing the structure of data on research projects, along with recommendations related to research organizations, departments, and researchers.

Figure 1. E-CRIS.SR web application

Recognizing the recommendations of CERIF, IZUM developed the web application E-CRIS and offered it free of charge to users of COBISS applications in the COBISS.Net network with the aim of establishing records of researchers and institutions, which is a prerequisite for keeping bibliographies of researchers (scientific workers) and institutions. At the beginning of February 2023, a new version of the E-CRIS software, V2.0, was installed, which brought many improvements compared to the previous version. Researchers can register themselves in the E-CRIS system by entering their data. After verification by the administrator from the national E-CRIS center, their data becomes publicly available.

Researchers who are already registered in the E-CRIS system can update some of their biographical data themselves, provided that their email address is entered in their profile. If the e-mail address is not entered in the E-CRIS

18. CERIF - Common European Research Information Format

presentation or is not valid, the researcher is obliged to enter a valid e-mail address through the national E-CRIS center. The procedure is similar for the registration of research organizations, but it is necessary to specify the e-mail address of the contact person who will take care of the organization's E-CRIS presentation.

The National E-CRIS Center, located in the University Library in Belgrade, is responsible for organizing and coordinating the collection of data in the system by researchers and research organizations, as well as for checking its quality. A new possibility is the addition of a fifth database on research equipment that is standardized according to the appropriate classification, but for now this database is not being filled.

An important moment for replenishing the database of researchers in the E-CRIS system occurred in March 2023, when data on all active researchers registered by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia who did not have an E-CRIS code were submitted. Thanks to that data, in July 2023 codes were assigned to almost 13,000 new researchers.

At the end of October 2023, the following data are represented in the databases of the E-CRIS system:

- 25,879 researchers,
- 3,477 projects (2,697 international),
- 325 organizations,
- 1,166 departments.

In the following period, the national E-CRIS center, in cooperation with research organizations, will pay special attention to the entry of data on research projects that are not currently in the records of the E-CRIS system. Additionally, they will focus on entering data on research equipment. Researchers' bibliographies are printed from the COBIB.SR bibliographic database of the COBISS.SR system using the Personal Bibliography segment, and the prerequisite for this is that the data on the researcher's E-CRIS code has been entered into the CONOR.SR normative database of personal names.

It is important to note that the data in the COBIB.SR and CONOR.SR databases are entered by trained librarians in libraries and specialized information centers who are full members of the COBISS.SR system. In essence, the researcher can choose which library or specialized information center will take care of their personal bibliography, and there they obtain information about what data they need to submit in order for the bibliography to

be complete.Registered researchers are required to enter typology information (document/paper types for maintaining bibliographies in the COBISS[19] system) in the bibliographic records to ensure the bibliography is sorted accordingly. The researcher's typology and code are necessary data that determine the papers from the COBIB.SR database that are transferred to the papers in the Results segment of the eScience portal. During 2022, 21,486 bibliographies were downloaded from the COBISS.SR system.

4 COBISS.SR as a data source for the eScience portal

Although the COBISS.SR and E-CRIS systems have all the good features and functionalities of the COBISS.SI and SICRIS systems, they have failed to become the preferred scientific information system in Serbia. Although it is based on transparency and the possibility of including evaluation and review of citations of scientific works, the COBISS system has not been implemented in many research and academic libraries in Serbia. The reason for this lies in the fact that for many libraries this system is expensive because the competent ministries do not finance its implementation and maintenance, but also in the fact that in addition to the COBISS.SR system, other systems were developed in Serbia - primarily BISIS[20], which now has a long tradition of use not only in public libraries but also in academic ones.

Additionally, many Serbian academic and research libraries are not included in COBISS or BISIS, and many of them also work in their local systems (e.g. libraries of the Faculty of Electrical Engineering and Faculty of Mathematics of the University of Belgrade, libraries of most institutes of the Serbian Academy of Sciences and Arts, etc.). Additionally, the compulsory recommendation of the Ministry of Education and Science is that every scientific research organization has its own institutional repository, so it was decided when establishing and developing the architecture of the eScience system, that this system would be an aggregator for metadata coming from institutional repositories, the repository of doctoral dissertations NaRDuS[21], the database Ours in WoS[22] and ORCID[23] researcher profiles. In its initial version and implementation, the eScience system did not foresee the transfer

19. More about document type in the chapter 6
20. BISIS
21. National Repositiry of Dissertations in Serbia – NaRDuS
22. KoBSON, Ours in WoS
23. Open Researcher and Contributor

of metadata from the COBISS.SR system. Subsequently, with the intervention of the library community, particularly the representatives of the University Library "Svetozar Marković" and in cooperation with high-ranking representatives of the Ministry of Science, Technological Development and Innovation[24], a series of meetings were held with the National Library of Serbia and IZUM, where the issue of transferring records from the COBISS.SR system to the eScience system was discussed.

Despite all the previously mentioned problems related to its implementation, the COBISS.SR system is the most comprehensive library and information system used by libraries in the Republic of Serbia. After twenty years of existence of the system of mutual cataloging and the Virtual Library of Serbia, 262 libraries (of which 109 are academic and institutional[25]) are actively working in this system today, and have created close to 4 million records in the mutual catalog COBIB.SR[26]. Analysis of the database by including the criteria that the records contain the code of the researcher from the E-CRIS.SR system (E-CRIS ID) and the code for the typology of the document entered in the bibliographic data format COMARC/B in field `001$t` results in 294,670 records[27]. All those records are potential candidates for the database of scientific results displayed on the eScience portal.

Testing of the transmission of the given set of records (query as=* and td=*[28]) via the OAI-PMH protocol was performed in May 2022 from the local database of the University Library "Svetozar Marković". Since the testing was successful, the authorities responsible for the development of the eScience system - Computing Center of the University of Belgrade (RCUB)[29] decided that the format for data transmission should be COMARC.XML as the richest in metadata because it simultaneously includes bibliographic and authority data, as well as all entered identifiers that are the base for connecting the profiles of researchers and the results of their scientific research work in the eScience system. The final initial transfer of all records containing the necessary data (researcher code and document typology) from the mutual catalog COBIB.SR was completed on April 24, 2023. To that end, IZUM de-

24. Republic of Serbia, Ministry of Science, Technological Development and Innovation

25. Information provided on 20.12.2023.

26. COBIB.SR

27. Information provided on 25.12.2023.

28. The query involves finding all records that contain the researcher's code and document type, regardless of the type of publication

29. Belgrade University Computer Centre

veloped a special application that allows the harvesting of record sets via the OAI-PMH protocol from the mutual catalog level. At that moment, there were over 250,000 potential results for transfer to the eScience system.

By additional filtering, supplementing the criteria for records, and checking for duplicates in the current state of the eScience system, as well as by rejecting certain types of publications (final papers, master's and doctoral theses[30]), about 90,000 records from the COBISS.SR system were transferred to eScience (Косановић 2023). Following the initial transfer, records were regularly harvested into the eScience system once a week, specifically, every Thursday. Each new transfer implies the creation of new records, as well as the addition of existing records with researcher codes and/or document typology. For example, in 2023, libraries created a total of about 15,000 records that were candidates for results displayed in the eScience system, of which about 1,400 records in December 2023 only.

Considering that highly educated librarians with many years of experience work in academic and institute libraries within the COBISS system, and that they receive additional education through basic and advanced courses for working with the system[31], those responsible for the development of the eScience system have decided that records from the COBISS system should be directly imported into the eScience system without further verification or confirmation. This approach mirrors that of other systems, such as institutional repositories of scientific research organizations, Ours in WoS, and NaRDuS, where librarians used to monitor the inputted metadata before its transfer to the eScience system.

5 Identifiers in the COBISS and eScience systems

Three types of personal identifiers (PID) are used in the COBISS system for stable and unique determination of authorship and linking of bibliographic records with their relevant authority records. The authority database of personal names CONOR.SR has its own identifier CONOR ID, which each record created for each individual person receives. Within the COMARC/A[32] format itself, the entry of the identifier ORCID ID in field `017$a$2` and E-CRIS.SR ID in field `200$r` is provided. In this way, the

30. Doctoral dissertations are transferred to the eScience system from the National Repository of Dissertations in Serbia - NaRDuS

31. Portal education, courses, presentations

32. COMARC/A –Authority data format in the COBISS sysstem

connection of the COBIB database with the researcher's bibliographies and the uniqueness and unequivocal authorship of a specific publication or work that is an integral part of a specific publication are achieved. The following figure (2) shows the entry of the identifier in the COMARC/A format.

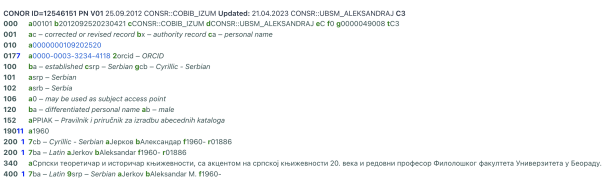


Figure 2. Identifiers in the COMARC/A format

Connecting the profile of researchers with the results of their scientific research work in the eScience system is done through personal identifiers. The identifiers provided for researchers in the mentioned system are IBI[33], ORCID ID[34], E-CRIS.SR ID[35], APVNT ID[36]. Using the identifier E-CRIS.SR ID, researchers' profiles are automatically connected with their results that are harvested from the COBISS system, and via ORCID ID, they are automatically connected with results that come to eScience from institutional repositories, database Ours in WoS, and the author's ORCID profile. Figure 3 shows the researcher's profile in the eScience system with the associated identifiers.

The use of identifiers allows the researcher's works to be unambiguously linked to the corresponding profile, thus avoiding potential errors. This is especially important for authors who have non-specific names and surnames, and who often deal with the same field of research or are employed in the same institution. We will cite the example where in the list of researchers on the eScience portal, 22 people with the same first and last name appear – Jelena Petrović. Without the use of identifiers, it would be impossible to precisely classify their published research results, especially among female researchers who deal with similar fields of research. Also, eScience records

33. Identification number of the researcher in the Register of Researchers of the Republic of Serbia

34. Open Researcher and Contributor ID

35. E-CRIS.SR ID

36. Identifier in the Database of researchers of Vojvodina

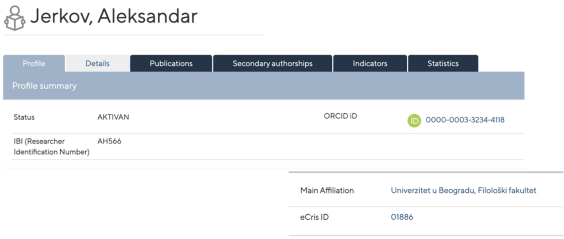


Figure 3. Identifiers in the eScience system

the profiles of two authors whose names are identical – Lidija Radulović, and both of whom are employed at the Faculty of Philosophy of the University of Belgrade. In such cases, personal identifiers are the only reliable way to link author results. Identifiers make it possible to gather all papers under one profile, regardless of the form of the author's name, which is especially important for authors who have changed their name or surname during their professional work.

Bearing in mind all these circumstances, the recommendations of the editorial team of the University Library "Svetozar Marković" to the librarians of higher education and institute libraries was to regularly enter the aforementioned personal identifiers even before the eScience system was established. With the introduction of the eScience system, the reasons for entering personal identifiers have only been further confirmed.

6 Harvesting, classifying and connecting records from the COBISS.SR system to the eScience system

As previously emphasized, records containing a personal identifier in the form of an E-CRIS.SR ID, as well as the typology of the document entered in the field provided for this - `001$t`, are included in the corpus of records that are transferred from the COBISS.SR system to the eScience system through a regular harvest.

The identifier enables the direct and automatic connection of the researcher's profile in eScience with the specific paper that comes from the COBISS.SR system in eScience. The typology of the document is mandatory data in eScience records as well. The typology assigned to documents

in the COBISS system is detailed in Appendix F6 of the COMARC/B manual (IZUM 1991–2023, F6) and provides a clear and very detailed overview of document types from scientific articles, through scientific monographs, textbooks, collections of papers from various types of scientific conferences, patents, technical solutions to performed works and events (more in the paper (Андоновски, Ђурђулов, and Кринуловић 2023)). The typology of documents in the eScience system is not so elaborate and includes a narrow number of types (shown in Figure 4) with which different types of documents are compared in the transfer of records as they are managed in the COBISS system.

Figure 4. Document typein the eScience system

The typology of documents in the eScience system is based on international guidelines for repositories (OpenAIRE typology[37]), and in the last iteration, which was carried out in November 2023, it was supplemented with document types for textbooks and patents. Document types for technical solutions and various types of short scientific articles (case studies, case reports, final report, etc.) are still missing.

If we analyze the typology for a scientific article, we will find that there are three types of documents in the COBISS system:

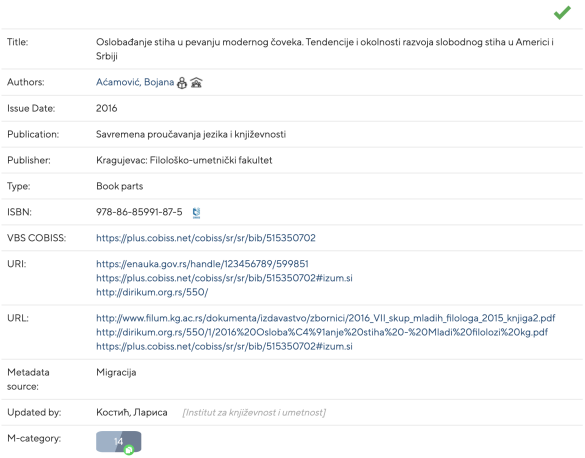
- 1.01 – original scientific article
- 1.02 – review scientific article
- 1.03 – other scientific articles.

The last mentioned type of document refers to the results of a completed original research work or a work that is still in progress, which enables a more precise typology of all potential results of scientific research work, while in the eScience system there is only one type of document - Scientific article and it refers to all the mentioned types from the COBISS system (typologies 1.01, 1.02, 1.03).

During the transfer of records from the COBISS.SR system to eScience, a check for duplicates is performed, and records from the COBISS.SR system that are duplicates of already existing records in eScience are automatically rejected. The procedure for identifying duplicates involves checking the title, DOI (digital object identifier), ISBN numbers, and ISSN numbers in the article records. Records from the COBISS.SR system that are identified as duplicates according to the records in the eScience system are assigned a stable URI from the COBIB.RS database as metadata. The following example clearly illustrates that the record was migrated from the repository and was also assigned a URI from the COBIB.RS database (see Figure 5).

In this way, it is possible that there is only one record for each result in the eScience system, and that all online sources in which the work is located, which communicate with the eScience system, are marked by a separate URI, i.e. URL.

37. OpenAIRE Guidelines for Literature Repositories v3: Publication Type (M)



Title:	Oslobađanje stiha u pevanju modernog čoveka. Tendencije i okolnosti razvoja slobodnog stiha u Americi i Srbiji
Authors:	Aćamović, Bojana
Issue Date:	2016
Publication:	Savremena proučavanja jezika i književnosti
Publisher:	Kragujevac: Filološko-umetnički fakultet
Type:	Book parts
ISBN:	978-86-85991-87-5
VBS COBISS:	https://plus.cobiss.net/cobiss/sr/sr/bib/515350702
URI:	https://enauka.gov.rs/handle/123456789/599851 https://plus.cobiss.net/cobiss/sr/sr/bib/515350702#izum.si http://dirikum.org.rs/550/
URL:	http://www.filum.kg.ac.rs/dokumenta/izdavastvo/zbornici/2016_VII_skup_mladih_filologa_2015_knjiga2.pdf http://dirikum.org.rs/550/1/2016%20Osloba%C4%91anje%20stiha%20-%20Mladi%20filolozi%20kg.pdf https://plus.cobiss.net/cobiss/sr/sr/bib/515350702#izum.si
Metadata source:	Migracija
Updated by:	Костић, Лариса *[Institut za književnost i umetnost]*
M-category:	M4

Figure 5. An example of a record found in different systems

7 Instead of a conclusion - the importance of COBISS.SR for the sustainability of the eScience system

Historically speaking, the COBISS.SR system was created before all other systems that today form the framework for eScience and from which data is transferred - Ours in WoS, institutional repositories, NaRDuS, and ORCID profiles of researchers. If we look at the twenty years of existence and efficient functioning of the Virtual Library of Serbia, the system of shared cataloging and the introduction of the regional system for the transfer and exchange of bibliographic data COBISS.Net, it is clear that the COBISS system in Serbia has been established and confirmed, and has demonstrated stability and sustainability. As such, it is an inseparable part of the eScience system because it enables the transfer and aggregation of metadata of the entire scientific production of the Republic of Serbia in the form of records for monographs, serial publications, and analytical records from journals and proceedings.

What the COBISS.SR system lacks to some extent are records of the papers of domestic researchers published in leading international scientific journals. The way to overcome that problem is a sub-application that enables

the direct transfer of records from Ours in WoS to the the COBISS.SR system based on the SRU protocol (Милновић 2023). It is planned that the authorities in the National Library of Serbia and the Center for Shared Cataloging will work on this solution together with colleagues from IZUM. Another shortcoming lies in the fact that all scientific libraries in Serbia are not members of this system, but this is not a weakness of the COBISS.SR system itself, but of the library and information system of Serbia, which in fact has no uniqueness in the entire territory of the country. Nevertheless, the development and implementation of solutions that IZUM has already tested and implemented in Slovenia and the fact that behind the development of this system stands a reliable institution with a sufficient number of highly skilled personnel provides an excellent basis for the further support of the State of Serbia to the COBISS.SR system and all its applications.

The sustainability of the COBISS.SR system is closely related to the sustainability of the eScience system because over 850 licensed catalogers, of which about 300 are in over 100 academic libraries, enrich this system with new metadata every day, a large part of which finds its place in eScience as the largest aggregator of metadata about scientific research work in Serbia. Therefore, it is no coincidence that the Ministry of Science, Technological Development and Innovation, after analyzing the work of the COBISS.SR system, unequivocally decided to include records from this system subsequently in the corpus of results that are an integral part of the eScience system. Within the COBISS.SR system, the University Library "Svetozar Marković", together with the National Library of Serbia and the Matica Srpska Library, will continue to advocate for high precision of metadata and improvement of the quality of records that reflect the scientific work of our researchers.

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Data from the Digital Repository of the Faculty of Mining and Geology in eScience (eNauka)

UDC 001.103.2:004.624(497.11)
DOI 10.18485/infotheca.2023.23.2.4

ABSTRACT: The paper describes linking the Digital Repository of the University of Belgrade, Faculty of Mining and Geology, with the eScience system in terms of transferring metadata about the results of researchers' scientific work. The steps taken to ensure a smooth harvesting of metadata are outlined. Additionally, a presentation of additional improvements to the OAI system is provided, aiming to contribute to the automatic linking of authors with their results in the eScience system.

KEYWORDS: repositories, eScience, transfer of metadata, Faculty of Mining and Geology

PAPER SUBMITTED: 25 October 2023
PAPER ACCEPTED: 24 January 2024

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1 Introduction

The Digital Repository of the University of Belgrade, Faculty of Mining and Geology[1] (FMG Repository) exists since 2019. It serves as a depository for the results of scientific and research work conducted by the faculty's staff. Starting from 2022, an additional collection named "Završni radovi" (Final Papers) is established within the repository, where all defended bachelor's and master's theses of the faculty's students are deposited.

The repository is hosted on an open-source platform for managing digital collections called Omeka[2] (OmekaS 2023). More details about the platform and its customization can be found in the work (Popović, Škorić, and Rujević 2020). The decision to choose Omeka as the platform, rather than another

1. Digital Repository of the Faculty Mining and Geology. Accessed on October 23, 2023
2. Omeka. Accessed on October 23, 2023

Current Research Information System (CRIS) platform, is a result of the development team's experience in adapting it to the specific needs of managing mining documentation (Tomašević et al. 2018), namely, for depositing documentation related to mining projects and regulations. Also, additional tools for efficient full-text search of digital objects in the Repositoryhave been developed and implemented (Tomašević et al. 2017).

Since 2023, the Repository has been integrated with the eScience system, which represents an efficient way of organizing data about the scientific results of researchers in Serbia. This integration involves the retrieval of data about these results from relevant sources andstreamlining the organization and accessibility of scientific information within the eScience framework.

2 eScience team requirements and their implementation

The eScience system enables the retrieval of metadata about scientific results according to the international standard for the exchange of library information, which involves the implementation of the OAI-PMH protocol (Lagoze et al. 2015). Any information system, database, or internal infrastructure within any institution capable of supporting the OAI-PMH protocol has the potential for integration into the eScience system. After an initial training session for metadata editors from scientific research organizations (SRO editors[3]) from which works are going to be downloaded into the eScience system, the OAI-PMH access point of the Digital Repository of the Mining and Geological Faculty was validated. The access point was implemented using the OAI-PMH Repository module for the Omeka S system[4]. The validation was conducted by the eScience development team using their OAI Validator[5], which allows for a transparent, public, and free semantic and syntactic verification of the correctness of the metadata downloaded via the OAI-PMH protocol. After the validation, the form for technical data related to the repository was completed, establishing contact between the development teams of eScience and the Mining and Geological Faculty's repository. Soon after, the process of finding a specific solution for retrieving data on

3. The term "SRO editors" refers to editors from scientific research organizations and is being used in the documentation https://enauka.gov.rs/help/index.html. Accessed on December 23, 2023

4. Omeka-S-module-OaiPmhRepository. Accessed on October 24, 2023

5. OAI Validator. Accessed on October 23, 2023

scientific results from the Mining and Geological Faculty commenced. Given the successful recognition of the existing OAI-PMH access point of the repository, the initial solution was found relatively easily. The procedure was then streamlined to fulfill three specific requirements set by the eScience development team. These requirements were aimed at achieving optimal representation of data from the repository and ensuring their effective recognition and retrieval.

The first request pertained to the existence of a unique identifier (URI) for individual works in the metadata schema of the FMG repository. As a result, in the "DC.IDENTIFIER" field, the existing path to the record on the API (Application Programming Interface) (e.g., http://dr.rgf.bg.ac.rs/api/items/8538) was replaced with the path leading directly to the record within the Repository itself (e.g., http://dr.rgf.bg.ac.rs/s/repo/item/8538).

The second step involved creating a collection for harvesting metadata in the eScience system. Initially, the repository of the Mining and Geological Faculty was designed with each employee represented as a separate collection. Each individual collection was described by metadata including the employee's name, surname, institution, section,department, and chair of employment, various identifiers on scientific social networks and databases (ORCID, ResearcherID, ScopusID, Google Scholar, E-CRIS.SR), an identification number within the employee database at the Faculty of Mining and Geology, job title, and email address. Within each collection, all the papers of an author were included[6]. However, this structure posed challenges for stable integration with the eScience system, particularly in manual corrections required for modifications, such as when opening a profile (collection) for a new employee.After testing and internal discussions within the Faculty of Mining and Geological team, a stable solution was found. This solution involved creating a new "Radovi istraživača"[7] collection encompassing all records from the Repository containing a digital object, excluding doctoral dissertations or final assignments[8]. This approach addressed the challenges of

6. Collections of employees are presented on: https://dr.rgf.bg.ac.rs/s/repo/sets. Accessed on December 23, 2023

7. Collection "Radovi istraživača"

8. Entries without digital objects are entries retrieved from the local database FoDiB (Fondovska dokumentacija ibiblioteka), which was used to collect metadata on employees' scientific research results before the establishment of the Repository. This database served as the basis for developing the Digital Repository of the Faculty of Mining and Geology. Some of these records were later supplemented with digital objects, while around half of them still lack a digital object.

the initial structure and provided a more efficient way to manage collections in the eScience system.

For the validity of metadata, it was considered better to include only verified entries in the harvesting collection "Radovi istraživača". Verified entries in that collection refer to those where the repository administrator has reviewed the content, and these entries must contain the full text of the document (digital object). Doctoral dissertations were excluded, as they are harvested from the NaRDuS repository[9] (National Repository of Dissertations in Serbia)[10] by the eScience portal. Final assignments were also omitted as they do not represent the direct results of the research.

The collection "Radovi istraživača" is continually updated with new entries added to the Repository, ensuring that it remains a comprehensive and accurate representation of the research output from the Faculty of Mining and Geology.

The third request was to align the metadata schema used in the Repository with the schema used in the eScience system. The metadata structure in the Repository is based on the Dublin Core ontology[11] (DC 2012), with minor additions of fields from other ontologies that do not exist in this one. Dublin Core is one of the default ontologies supported by the eScience system for transferring metadata from other systems, which facilitated the process but still required specific field mappings, as described in Table 1. Additionally, the document typology appearing in the DCTERMS:TYPE field in the FMG Repository in Serbian is mapped to the English terminology used in the OAI-PMH protocol, as described in Table 2.

Table 1: Mapping fields from the metadata schema of the RGF Repository to the fields of the eScience system's metadata schema.

Mapping	
Fields from the RGF Repository	**Fields from the eScience system**
dcterms:alternative	dcterms:title

9. NaRDuS repository. Accessed on October 23, 2023

10. Doctoral dissertations defended at the University of Belgrade are processed in the COBISS system, from where metadata is transferred to the PHAIDRA repository, where they are permanently stored. Subsequently, this data is transferred to NARDUS.

11. Dublin Core ontology. Accessed on December 23, 2023

Continuation of the table 1	
Fields from the RGF Repository	**Fields from the eScience system**
rgf:typeVersion	dcterms:type
dcterms:spatial	dcterms:subject
rgf:subjectUdc	dcterms:subject
rgf:identifierCategory	dcterms:description
rgf:identifierSubcategory	dcterms:description
dcterms:tableOfContents	dcterms:description
dcterms:abstract	dcterms:description
rgf:contributorAdvisor	dcterms:contributor
rgf:contributorOther	dcterms:contributor
dcterms:created	dcterms:date
dcterms:valid	dcterms:date
dcterms:available	dcterms:date
dcterms:issued	dcterms:date
dcterms:modified	dcterms:date
dcterms:dateAccepted	dcterms:date
dcterms:dateCopyrighted	dcterms:date
dcterms:dateSubmitted	dcterms:date
dcterms:extent	dcterms:format
dcterms:medium	dcterms:format
dcterms:bibliographicCitation	dcterms:relation
rgf:identifierCobissid	dcterms:identifier
dcterms:isVersionOf	dcterms:relation
dcterms:hasVersion	dcterms:relation
dcterms:isReplacedBy	dcterms:relation
dcterms:replaces	dcterms:relation
dcterms:isRequiredBy	dcterms:relation
dcterms:requires	dcterms:relation
dcterms:isPartOf	dcterms:relation
dcterms:hasPart	dcterms:relation
dcterms:isReferencedBy	dcterms:relation
dcterms:references	dcterms:relation
dcterms:isFormatOf	dcterms:relation
dcterms:hasFormat	dcterms:relation
dcterms:conformsTo	dcterms:relation
dcterms:accessRights	dcterms:rights

Continuation of the table 1	
Fields from the RGF Repository	**Fields from the eScience system**
dcterms:license	dcterms:rights
dcterms:temporal	dcterms:coverage

Table 2. Mapping the values of the field DCTERMS:TYPE in the FMG Repository to those of the DCTERMS:TYPE in OAI-PMH.[13]

Value of the DCTERMS:TYPE in the FMG	**Value of the DCTERMS:TYPE in OAI-PMH**
Докторска дисертација	doctoralThesis
Саопштење са скупа штампано у извод Рад у зборнику	conferenceObject
Дипломски рад	bachelorThesis
Магистарска теза Мастер рад	masterThesis
Рад у часопису	journalArticle
Поглавље у монографији	bookPart
Књига Монографија Практикум Скрипта	book

The mapping shown in Table 1 has been implemented using the mentioned OAI-PMH Repository module. In addition to what is presented, the default mapping of concepts and properties from the *bibo* ontology[14] (D'Arcus and Giasson 2016) to the *dcterms* ontology has also been applied.

14. BibliographicOntology – *bibo* – The Bibliographic Ontology, bibo, is a bibliographic ontology developed for the Semantic Web to describe bibliographic resources such as books, journals, and similar materials. It is based on the RDF (Resource Description Framework) data model. It includes concepts and properties that facilitate the description of bibliographic sources, bibliographic citations, document classifications, or the description of any document in RDF. Available

The concepts and properties of the *bibo* ontology are used in the metadata schema of the Repository to describe the following metadata: the number of pages (BIBO:PAGESTART, BIBO:PAGEEND), volume and issue numbers of journals (BIBO:VOLUME, BIBO:ISSUE), digital object identifier (BIBO:DOI), ISSN of the journal (BIBO:ISSN), and URI identifier (BIBO:URI). Figure 1 illustrates an example metadata record in the FMG Repository and the structure of the metadata schema. An example of the same record in the OAI-PMH access point is available at https://dr.rgf.bg.ac.rs/oai?verb=GetRecord&metadataPrefix=oai_dc&identifier=oai:dr.rgf.bg.ac.rs:5011. An alternative solution has been found because the OAI-PMH Repository module does not support document typology mapping. Another separate application has been deployed alongside the Repository on the server, acting as an adapter for the results sent by the original OAI-PMH access point. The solution consists of three steps (Figure 2):

1. The OAI-PMH Adapter application receives a query in the format expected by the OAI-PMH access point;
2. The OAI-PMH Adapter application forwards the unchanged query to the OAI-PMH access point of the FMG Repository (Appendix 3);
3. The OAI-PMH access point sends a response to the adapter application in the form of an XML string;
4. The adapter application further processes the received XML string, mapping document typology values according to the data shown in Table 2. Once the adapted response is ready, it is sent to the eScience portal to respond to the issued query.

The developed OAI-PMH Adapter application is open-source and available on GitHub[15]. It can be downloaded and customized for the needs of other repositories.

After creating a collection for downloading and processing data sent via the OAI-PMH protocol, the established linking works almost perfectly. When a work is verified in the Repository, it becomes part of the "Radovi istraživača" collection and is pulled into the eScience system at a specific time. An example displaying the record from the FMG Repository on the eScience portal is provided on Figure 3.

The only issue we have identified is the lack of information transfer regarding the number of pages for publications without Persistent Identifiers

at: https://www.dublincore.org/specifications/bibo/bibo/ (accessed January 22, 2024.

15. OAI-PMH Adapter. Accessed on October 25, 2023.

```
<dcterms:type> Рад у часопису</dcterms:type>
<rgf:typeVersion>објављена верзија</rgf:typeVersion>
<dcterms:language>енглески</dcterms:language>
<dcterms:creator  xml:lang="sr">Petar Popović, Mihailo Škorić, Biljana Rujević</dcterms
    :creator>
<dcterms:title xml:lang="en">The Use of the Omeka Semantic Platform for the Development of
    the University of Belgrade, Faculty of Mining and Geology Digital Repository</dcterms
    :title>
<dcterms:source xml:lang="en">Infotheca</dcterms:source>
<dcterms:publisher xml:lang="en">Faculty of Philology, University of Belgrade</dcterms
    :publisher>
<dcterms:issued>2021</dcterms:issued>
<dcterms:abstract xml:lang="en"> Under the regulations of the Ministry of Education,
    Science and technological Development, a digital repository based on the Omeka S data
    storage platform has been developed for the Faculty of Mining and Geology. The platform
    has been upgraded with the required modular extensions, Solr index and automatic OCR.
    Furthermore, document indexing and search have been fine-tuned with the aid of e
    -dictionaries of the Serbian language, which has brought about outstanding results in
    terms of usage facilitation and overall speed of document storage and search within the
    repository that is a part of the application. </dcterms:abstract>
<bibo:volume>20</bibo:volume>
<bibo:issue>1-2</bibo:issue>
<bibo:pagestart>136</bibo:pagestart>
<bibo:pageend>148</bibo:pageend>
<bibo:doi>10.18485/infotheca.2020.20.1_2.9</bibo:doi>
<bibo:issn>1450-9687</bibo:issn>
<dcterms:subject xml:lang="sr">Дигитални репозиторијум, Омека, претрега дигиталних
    библиотека</dcterms:subject>
<dcterms:subject xml:lang="en">Digital Repository, Omeka, Digital Library searching
    </dcterms:subject>
<bibo:uri href="http://dx.doi.org/10.18485/infotheca.2020.20.1_2.9">http://dx.doi.org/10
    .18485/infotheca.2020.20.1_2.9</bibo:uri>
<rgf:identifierCategory>M50</rgf:identifierCategory>
<rgf:identifierSubcategory>M53</rgf:identifierSubcategory>
<dcterms:format>.pdf</dcterms:format>
<dcterms:rights>Отворени приступ</dcterms:rights>
<dcterms:license>All rights reserved</dcterms:license>
```

Figure 1. The structure of metadata schema and values of an original entry in the FMG Repository

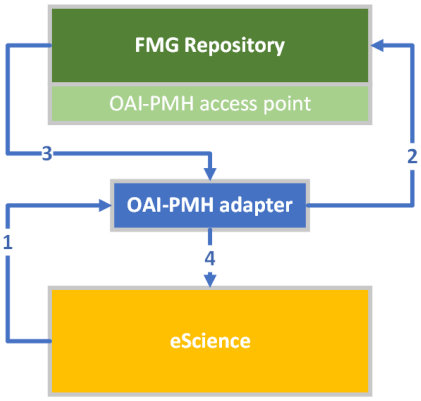

Figure 2. Structure of the OAI-PMH Adapter Application

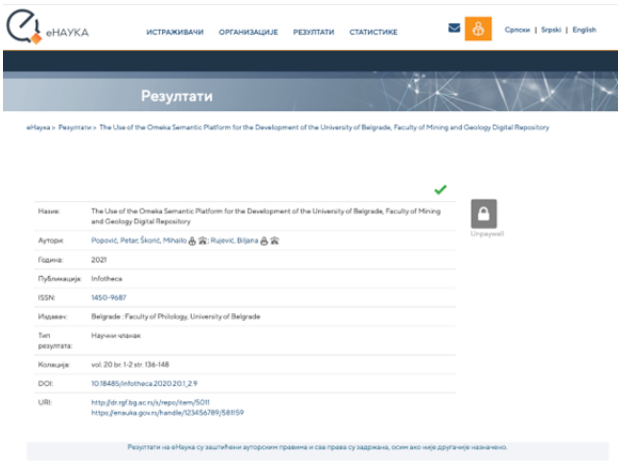

Figure 3. Example on Figure 1 in the eScience system

(PIDs). When a publication has a PID, the eScience system retrieves information about the number of pages from an appropriate external source.[16] In practice, this issue is most common with conference papers because they often lack PIDs, making it impossible to add page number information from other sources without editorial intervention.

3 Improvement of Metadata Structure

Over time, it was identified that metadata could be enhanced. Therefore, using the OAI-PMH Adapter application, additional processing of the following results was applied:

1. Individual data from the fields for listing authors (DC:CREATOR), keywords (DC:SUBJECT), and spatial coverage (DC:SPATIAL), which were originally entered in the Repository in the same field separated by

16. To enhance the system's interoperability, data related to Scientific Research Organizations (NIO), researchers, and results have been enriched with Persistent Identifiers (PIDs), such as ORCID, E-CRIS ID, APVNT, Researcher ID, COBISS, SR ID, DOI, Scopus ID, etc.

commas, were separated into distinct fields. For example, all authors initially added to the DC:CONTRIBUTOR field in the Repository as "PETAR POPOVIĆ, MIHAILO ŠKORIĆ, BILJANA RUJEVIĆ" (as shown in Figure 1). As a result of using the OAI-PMH Adapter application on the OAI-PMH access point were separated into distinct repeated fields DC:CREATOR with values "PETAR POPOVIĆ," "MIHAILO ŠKORIĆ," and "BILJANA RUJEVIĆ" (example on the OAI-PMH access pointhttps://dr.rgf.bg.ac.rs/oai?verb=GetRecord&metadataPrefix=oai_dc&identifier=oai:dr.rgf.bg.ac.rs:5011).

2. For authors added to entries as resources from the Omeka system, ORCID identifiers were imported if they exist. In the example provided in https://dr.rgf.bg.ac.rs/oai?verb=GetRecord&metadataPrefix=oai_dc&identifier=oai:dr.rgf.bg.ac.rs:5011, the DC:CREATOR field includes the HREF attribute with the value being the path to the author's resource in the Repository from where author's (researcher's) ORCID ID is retrieved if exists. As a result of the OAI-PMH Adapter application's work, in the DC:CREATOR field instead of HREF attribute is added ID attribute with the value being the ORCID ID of the given author (researcher) which can bee seen in example https://dr.rgf.bg.ac.rs/oai?verb=GetRecord&metadataPrefix=oai_dc&identifier=oai:dr.rgf.bg.ac.rs:5011. This way, the entry harvested from the Repository is automatically attributed to the profile of a specific researcher in the eScience system. In cases where authors are not added as separate resources, the DC:CREATOR field is split using commas to ensure that each author gets their own field, as illustrated in the example in the preceding paragraph (Figure 1 and example https://dr.rgf.bg.ac.rs/oai?verb=GetRecord&metadataPrefix=oai_dc&identifier=oai:dr.rgf.bg.ac.rs:5011).

4 Conclusion

Six months after the launch[17] of the eScience portal and the establishment of automatic metadata transfer from the FMG Repository, it is evident that this served as an additional encouragement for Faculty members to add their papers to the Repository. There has been an increase in the number of

17. Portal eScience was officially launched on July 3, 2023. Faculty members objectively had less time to use the eScience portal as its launch coincided with the period of collective annual leave in higher education institutions.

new entries, likely because employees realized that depositing papers in the Repository is beneficial. During 2021, 412 entries were deposited; in 2022, 437 entries; and in 2023, when the eScience system was active, the number increased to 655 entries. This number is anticipated to continue to grow, considering that eScience is currently the most systematic way of collecting and presenting information about scientific production in Serbia. It is believed that the system will become even more valuable and functional in the following stages of development.

In the future, efforts will be focused on refining metadata in the Repository to ensure that values of all metadata fields are transferred to the eScience system properly (e.g., page numbers). Simultaneously, communication with the eScience development team will continue, to ensure that all system improvements are implemented in a timely manner.

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DC. 2012. *Dublin Core™ Metadata Element Set, Version 1.1: Reference Description.* Preuzeto 23. 10. 2023, https://www.dublincore.org/specifications/dublin-core/dces/.

Lagoze, Carl, Herbert Van de Sompel, Michael Nelson, and Simeon Warner. 2015. *The Open Archives Initiative Protocol for Metadata Harvesting.* Preuzeto 24. 10. 2023, http://www.openarchives.org/OAI/2.0/openarchivesprotocol.htm.

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eNauka – CRIS in Serbia

UDC 655.411(0.034.2):004.65]:378.4(497.11)
DOI 10.18485/infotheca.2023.23.2.5

ABSTRACT: The paper presents the basic entities and functionalities of eNauka - a publicly visible information system and portal created to provide an overview of scientific research activities in Serbia. The legal basis for the existence of such a system is described in detail, as well as all the sources from which data are collected/harvested in eNauka. For each of the sources, the shortcomings that have become apparent due to a large traffic, especially enhanced visibility, are also listed. Additionally, the paper describes the process of introducing eNauka into full production (enabling all functionalities for all end-users' roles), as well as experiences during training and end-user support implementation. Finally, the paper discusses future plans for improvement and conditions for its sustainability.

KEYWORDS: CRIS, eNauka, PIDs

PAPER SUBMITTED: 31 October 2023
PAPER ACCEPTED: 8 December 2023

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1 Introduction

The basic aim of the digitization process of the scientific research sector is to gathering information of researchers, scientific research organizations, and their results. At the core of this process is the creation of an information technology basis for modernizing management and data-driven decision making, with the ultimate goal of ensuring a high quality and efficient scientific research system (e.g., rationalization of funding, reduction of administrative burden on all participants, etc.).

Systems aimed at achieving this goal are called CRIS (Wikipedia 2023), and teams dealing with the implementation of CRIS systems in Europe are united in the organization euroCRIS[1]. Commercial publishers/vendors have

1. euroCRIS - The International Organization for Research Information

also recognized that decision-makers need such systems and have offered (financially burdensome) solutions, such asClarivate[2] and Elsevier-PURE[3].

In Serbia, there have been several attempts in the last twenty years to establish a national CRIS, but none have succeeded in satisfying all needs, especially in terms of the completeness and quality of data, orend-user support. Some of the systems mentioned are: IRIS, cris-NS (Ivanović et al. 2017), KNR-Vojvodina[4], Dositej[5], E-CRIS.SR[6] (Albahari 2017), RIS[7], BeOpen (Smederevac et al. 2020). All aforementioned systems have been supported in some way by the ministries responsible for science (financially or organizationally), indicating clearly that CRIS is an essential tool for decision-making. The Strategy of Scientific and Technological Development of the Republic of Serbia for the period from 2021 to 2025, "The Power of Knowledge," also envisaged that "a necessary condition for the dynamic development of the scientific research and innovation system, especially concerns the process of digitization and establishment of the information basis in the form of a unified national information system of scientific research activities" (PC 2021b).

For these reasons, at the end of 2021, the Office for Information Technology and Electronic Administration issued a public call for the construction of a Registry of Researchers in Serbia, based on which subject of this paper, information portal eNauka(NITRA 2023) was developed.

For these reasons, at the end of 2021, the Office for Information Technology and Electronic Administration issued a public call for the construction of a Registry of Researchers in Serbia, based on which subject of this paper, information portal eNauka[8] was developed.

2 Legal Basis

A mandatory condition for eNauka, based on databases maintained as Registers (researchers and research performing organizations- RPOs), is to

2. Converis – The essential tool for research information management, accessed 24. 10. 2023.
3. Pure – Leverage the world's leading Research Information Management System, accessed 24. 10. 2023
4. Research Register of Vojvodina (KNR), accessed 25. 10. 2023
5. Information Szstem DOSITEJ, accessed 25. 10. 2023
6. E-CRIS.SR, accessed 25. 10. 2023
7. Register of researchers in Serbia - RIS, accessed 25. 10. 2023.
8. eNauka, accessed 25. 10. 2023.

be fully compliant with the following aspects of theexisting legal framework in Serbia:

Law on Science and Research (PC 2019a):

- Article 6, paragraph 1 prescribes that in order to increase the quality and visibility of scientific work, research should be conducted in accordance with the principles of open science, with optimal use of research infrastructure. This includes e-infrastructures as well as databases and other systems necessary to achieve excellence in science and research;
- Article 21 prescribes the procedure for accreditation for conducting scientific research activities, i.e., obtaining the status of RPO;
- Articles 45, 47, and 50 prescribe that all types of institutes, i.e., scientific institutes, research and development institutes, and institutes of national importance for the Republic of Serbia, have scientific-information documentation and a library-information center in accordance with the law governing library-information activities;
- Article 68, paragraph 1 prescribes that the Ministry maintains a record of FROs that meet the conditions for conducting scientific research activities of general interest (FRO Register) and a record of researchers (Researcher Register); paragraph 2 prescribes that the purpose of maintaining these registers is planning and monitoring funding and the work of RPOs and researchers, monitoring the quality of research and research results, monitoring the advancement of researchers, improving the quality, efficiency, and effectiveness of the science and research system for better utilization of research results;
- Article 72 prescribes that data from the RPO Register and the Researcher Register are open data and publicly available on the Ministry's website in a processable format for use and further publication.

Law on Higher Education (Official Gazette of the Republic of Serbia, No. 88/2017) (PC 2023):

- Article 43 determines the types of higher education institutions and states that within the activities of higher education, a higher education institution, among other things, conducts scientific research and artistic activities;
- Article 72 prescribes that the teaching staff of a higher education institution consists of individuals engaged in educational, scientific, artistic, research, and innovation activities.

Law on Library and Information Activities (PC 2021a) :

– Article 14 prescribes that an educational and scientific institution is obliged to organize a school, higher education, university library, or library of a scientific research institute and institution and to provide all necessary conditions for its operation;
– Article 51 states that higher education and university libraries and libraries of scientific research institutes and institutions are organized to support and improve the educational, research, and scientific work of students, teachers, professors, and researchers.

Law on Electronic Administration (PC 2018):

– Article 9 regulates the exchange of data and documents in electronic form from registers maintained by the authority within its jurisdiction, through the Hub of the authority;
– Articles 10 - 11 prescribe the manner of establishing and maintaining registers and records in electronic form and the manner of using data from them;
– Article 13 prescribes the establishment and maintenance of the Meta-Register containing basic data on registers and records in electronic form, the basis for their establishment, the type of data collected with an indication of the origin of the data.

Personal Data Protection Law (PC, 2018a):

– Article 4 prescribes that the data controller is a natural or legal person or authority that independently or jointly with others determines the purpose and manner of processing, while the data processor is a natural or legal person or authority that processes personal data on behalf of the controller;
– Article 42 prescribes organizational and technical measures to protect data from misuse, destruction, loss, unauthorized changes, or access. The data controller and processor are obliged to take technical, personnel, and organizational measures to protect data, in accordance with established standards and procedures, necessary to protect the data from loss, destruction, unauthorized access, change, disclosure, and any other misuse, as well as to determine the obligation of employees involved in processing to maintain the confidentiality of data.

Regulation on Internal Organization and Job Classification (PC 2019b):

– Article 39, paragraph 4 envisages the establishment of a unified national system as a digitized unified system in the field of scientific research and innovation activities in the Republic of Serbia, including electronic databases maintained as registers.

3 System Description

eNauka is a publicly accessible portal for monitoring the scientific performance of researchers and institutions in the Republic of Serbia, which is aligned with international standards and practices to establish interoperability for data transfer. Behind eNauka is a flexible data model that enables the collection and management of research data and information typical for CRIS systems, defining entities and attributes through their reciprocal relationships. The system allows for the management of research profiles (e.g., name variants, ORCID, identifiers from other systems in Serbia, Scopus ID, etc.), the use of standard and various persistent identifiers (e.g., DOI, COBISS-Id, ScopusId), linking researchers to institutions, and so on. Such data models are called CERIF (Common European Research Information Format (euroCRIS 2023), and the data model applied in eNauka is developed according to this standard.

eNauka is comprised of two closely interconnected parts (Figure **??**):

– An administrative part that ensures the registration of accredited RPOs in the RPO Register and the registration of researchers in the Researcher Register, and
– A publicly visible registry of results, which includes basic data about researchers and RPOs.

The administrative part encompasses the input and maintenance of general business and legal data about each RPO (Research Performing Organisation). The responsibility for the accuracy of administrative data about RPOs, or administrative-personal data of researchers, is entrusted to designated individuals within the institutions (RPOadministrator). This part of the system is linked to existing registries in the Republic of Serbia, such as the Unified Information System of Education (JISP), the Business Registers Agency (APR), and the Central Register of Social Insurance (CROSO).

If an institute, higher education institution, or institution of national significance meets all the conditions stipulated by the Law, the Accreditation Board makes a decision on the accreditation of that institution. The Ministry issues a decision on satisfying the conditions for conducting scientific research

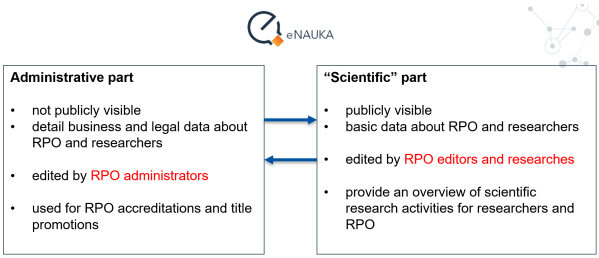


Figure 1. Facts and relationships between administrative and publicly visible registry of results

activities of general interest. Based on this decision, the Ministry registers the institution in the Register of Scientific Research Organizations.

RPOadministrators are responsible for entering, verifying, and updating basic personal data of researchers. They are responsible for all employed researchers, as well as for those researchers who are currently not employed but have obtained their research title within that RPO. The Register of Researchers includes individuals who have permanent residence or residence in the Republic of Serbia and have obtained the title of researcher in accordance with the Law on Science and Research, as well as individuals who have obtained titles in accordance with the law governing higher education.

Researchers and RPOs receive profiles on the publicly visible eNauka portal automatically (the next day) upon registration in the Register of Researchers or the Register of RPOs. Most titles and accreditations have expiration dates. Upon the expiration of the title/accreditation period, the "Active" status transitions to "Passive."

Data about results on the public eNauka portal are maintained by researchers and RPO editors. All data on eNauka are publicly available, which undoubtedly contributes to their accuracy and usability.

4 Data in eNauka - PIDs

In order to increase the interoperability of the system and utilize positive flows in the exchange of scientific information, data about RPOs, researchers, and results have been enriched with persistent identifiers, or PIDs. This enables connections with existing information systems in the country (such as E-CRIS.SR, KNR), as well as verification of the accuracy of result data

(such as DOI, PubMed, etc.). A list of all PIDs, along with explanations, is available in Table 1.

5 Data in eNauka - Results

The system initially loaded all results (publications) that existed in the previous RIS (Research Information System). The conversion was performed in May 2022, regardless of the fact that the data were not deduplicated at that time (a significant number of papers appeared multiple times), and the majority were unverified. Up to that point, the RIS was only partially publicly visible at the address http://istrazivaci.mpn.gov.rs/ (containing only published articles from journals up to 2017), which is likely the reason for the insufficient data quality. Retrieving data from the RIS was necessary because another request to researchers to enter data for all their outputs would have immediately led to an unfavorable status for eNauka in the scientific community. Although automatic deduplication was performed, we acknowledge that some unduplicated and low-quality data may still remain.

New data, as well as data for researchers who were not part of the RIS, are retrieved from other sources. The process is schematically shown in Figure 2.

Immediately following the data conversion from the RIS, data from all repositories in the RPOs were collected, provided they met the necessary condition of having an OAI/PMH server. This protocol for exchange was chosen as it is most commonly used for exchanging scientific information. In June 2022, 45 RPOsmaintain a repository/information system that met this condition. By October 2023, this number had increased to 110. About half of the institutions in this increase were not newly established repositories but had already had a repository or information system where OAI/PMH was implemented. Since data entry, verification, and supplementation in repositories are mostly done by librarians, the data collected in this manner are not additionally verified for accuracy in eNauka. It has also been observed that not all the advantages of PIDs have been applied in many systems, and it is expected that this practice will lead to improvement. Furthermore, a serious lack of IT support for maintaining infrastructure at institutions has been noted. Harvesting from these 110 sources is done regularly on a weekly basis.

The NaRDuS (National Repository of Doctoral Dissertations,[9] is also regularly harvested as a consolidated source of all doctoral dissertations de-

9. NaRDuS, accessed 27. 10. 2023

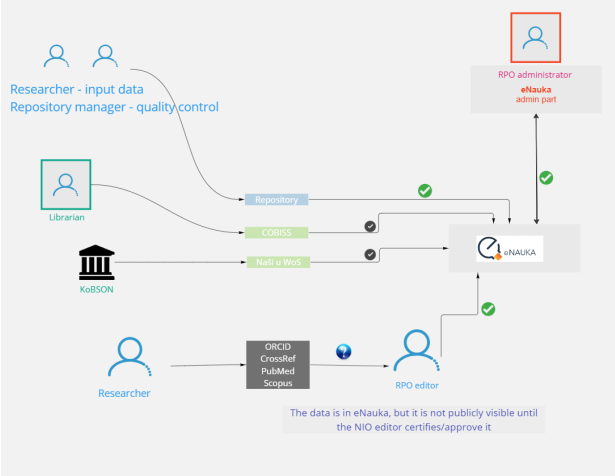


Figure 2. Work-flow of harvest and modification of data about publications/results

fended in Serbia. These obligations, prescribed by the Law on Higher Education, are adhered to by all universities, although with some delays in deposition. Namely, the mentioned law has prescribed a deadline of 3 months after defense, which is not always respected, especially by universities with a larger number of defended dissertations.

In May 2023, following twelve months of negotiations, data from COBISS began to be regularly harvested (weekly). This source is valuable because COBISS covers the entire publishing production of the Republic of Serbia according to the Law on Mandatory Copy. Unfortunately, the analytical processing of articles from scientific journals and conference proceedings is neither timely nor comprehensive. Data from COBISS-NET member libraries indicated that there are librarians with cataloging licenses in the COBISS system in 93 RPOs (COBISS.SR 2023).

Given that the entire publishing activity in Serbia is cataloged in COBISS, it was necessary to extract only records relevant to scientific production. Therefore, a request was made to create such a set according to the following rules:

– in field 001 - completed subfield t (document typology)

– in field 7XX - filled in subfield 7, i.e. in the corresponding normative record in field 200 filled in subfield r (author/researcher's code).

With representatives from the University Library "Svetozar Marković" data exchange about the unique researcher identifier (eCRIS-Id, i.e., researcher code in the e-CRIS.SR system) was initiated, ensuring that all records harvested from COBISS and meeting the specified criteria are automatically linked to researcher profiles. Given that only licensedlibrarians input data into COBISS, these records also do not require verification. The implementation of this solution required cooperation with IZUM (the provider of the COBISS system) and was executed very efficiently, considering that the COBISS system already supports the OAI/PMH protocol for exchange. Through detailed data analysis, problems were identified with some data obtained from COBISS, the most common being:

– lack of document typologydata, which is now being supplemented,
– a large number of duplicates at the COBISS level,
– lack of and insufficiently precise PIDs (primarily DOI).

The broad visibility of eNauka will undoubtedly contribute to improving the quality of data in the COBISS.SR system and expedite coordinated actions at the COBISS.net level for better data quality.

In September 2023, data transfer from the Research Register of Vojvodina (KNR) was enabled, as this system has established the good practice of researchers in Vojvodina entering data about their results into KNR since 2012. Data from this system is not harvested; instead, the transfer is initiated by the researcher whose profile is associated with their APVNTid (a unique researcher identifier in KNR). The transfer component was developed in collaboration with the Computer Center of the Faculty of Technical Sciences at the University of Novi Sad.

In October 2023, the harvesting of data from Naši u WoS[10] (Timotijević, Kosanović, and Vasiljević 2013) service by the National Library of Serbia, Belgrade is expected to begin. This service is maintained by the Center for Scientific Information of the National Library of Serbia within KoBSON (Kosanovic 2004). It is envisaged that data from this source will not undergo verification by RPO-editors, as this service is maintained by librarians. The launch of eNauka has been postponed several times due to lengthy

10. Податак је преузет са званичне веб стране Naši u WOS, accessed 24. 10. 2023.

negotiations and defining contractual obligations. However, after realizing the continuous delays, the decision was made to launch eNauka regardless of omitting records from this service. There are no consequences for researchers, but the time of RPO-editors spent verifying records that definitely exist in this source and were downloaded from other systems has been irretrievably wasted. At the time of writing this paper, a positive administrative step has been achieved, so it is expected that data from this system will soon be available in eNauka.

The collection of additional result data is initiated by the researcher, and the correctness of the metadata is verified by RPO-editors. This way, the responsibility for the completeness of the data lies with the researchers, while the quality of the metadata lies with the RPO-editors.

Researchers registered on eNaukacould log in exclusively using their ORCIDiDs, using the same credentials for authentication as for editing their ORCID profiles. This was made possible due to NITRA[11] becoming a regular member of the ORCID organization. The ORCID solution was implemented because the ORCIDiD has become an internationally accepted researcher identifier, becoming a mandatory requirement for submitting papers for publication in a large number of international (and increasingly local/national) journals, and for applying for project funding with most international funders (e.g., the European Commission).

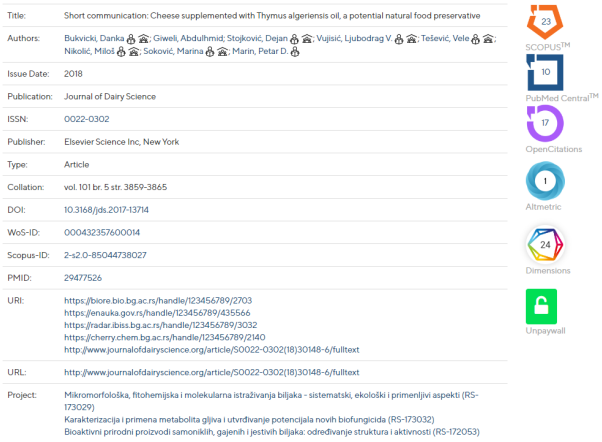
It has been noticed that many researchers have opened "empty" ORCID profiles, i.e., profiles with only their surname and name, without any information about their affiliations and results. This is a lost opportunity because it represents them in international information exchange. It may not be as important for experienced researchers, but young researchers should certainly be educated on the importance of maintaining their profiles. The "Little ORCID Video School"[12] is certainly not sufficient for this, and steps should be taken to improve education for this activity.

6 Data about publications in eNauka

Each publication in eNauka is equipped and visible with all its PIDs, sources where it is available, and its citation in relevant sources (Figure 3)). Citations can only be tracked for publications that have recorded PIDs.

Among all PIDs, the DOI stands out because:

11. Ministry of Science, technological development and innovation
12. Доступно на: Little ORCID Video School



Title:	Short communication: Cheese supplemented with Thymus algeriensis oil, a potential natural food preservative
Authors:	Bukvicki, Danka; Giweli, Abdulhmid; Stojković, Dejan; Vujisić, Ljubodrag V.; Tešević, Vele; Nikolić, Miloš; Soković, Marina; Marin, Petar D.
Issue Date:	2018
Publication:	Journal of Dairy Science
ISSN:	0022-0302
Publisher:	Elsevier Science Inc, New York
Type:	Article
Collation:	vol. 101 br. 5 str. 3859-3865
DOI:	10.3168/jds.2017-13714
WoS-ID:	000432357600014
Scopus-ID:	2-s2.0-85044738027
PMID:	29477526
URI:	https://biore.bio.bg.ac.rs/handle/123456789/2703 https://enauka.gov.rs/handle/123456789/435566 https://radar.ibiss.bg.ac.rs/handle/123456789/3032 https://cherry.chem.bg.ac.rs/handle/123456789/2140 http://www.journalofdairyscience.org/article/S0022-0302(18)30148-6/fulltext
URL:	http://www.journalofdairyscience.org/article/S0022-0302(18)30148-6/fulltext
Project:	Mikromorfološka, fitohemijska i molekularna istraživanja biljaka - sistematski, ekološki i primenljivi aspekti (RS-173029) Karakterizacija i primena metabolita gljiva i utvrđivanje potencijala novih biofungicida (RS-173032) Bioaktivni prirodni proizvodi samoniklih, gajenih i jestivih biljaka: određivanje struktura i aktivnosti (RS-172053)

Figure 3. Detail preview for results/publications

- Other PIDs (ScopusID, PMID, etc.) are automatically assigned based on it. A special application has been developed to add other PIDs without the need for manual input;
- It alerts to the correctness of the data in terms of the number of authors in the publication in eNauka and the number of authors assigned by the publisher when assigning the DOI and depositing metadata in CrossRef;
- It indicates the existence of duplicate records;
- It establishes a direct link to the landing page at the publisher's or aggregator's website, i.e., the one that assigned the DOI;
- It alerts to incorrect DOI assignment;
- It collects citations from open sources (OpenCitations);
- It checks the openness of publications for full-text access (UnPay Wall);
- It determines the mention of publications on social media (AltMetrics).

DOI has been applied in scientific publishing in Serbia since 2005, but only now have conditions been met for a comprehensive overview and the identification of problems that require resolution:

- A large number of publishers/providers (47) from Serbia deposit DOI and associated metadata in CrossRef. Each of them pays the same annual membership fee, which amounts to 275 USD;

- Even 26 of them deposit DOI only for one journal or proceedings, significantly increasing the cost of individual DOIs;
- The deposited metadata in CrossRef is poor, i.e., it does not include all significant metadata (e.g., ORCID for authors, project, licenses, cited literature, etc.);
- Inconsistent deposition, i.e., a DOI is assigned to the publication, but the metadata is not deposited in CrossRef.

Assigning DOI and its full-capacity application requires the engagement of experts who know and regularly monitor changes in metadata standards (CrossRef innovates them at least twice a year), as well as IT experts who can implement these requirements. In Serbia, there are few of the former, and the latter are expensive. This is recognized as the main reason for the mentioned problems.

Direct links have been established for each entered PID to the service where the PID was assigned, except in the case of ISSN, where the link is established to the KoBSON service EleČas as the reference source for researchers in Serbia, where the availability and category of journals are checked.

For publications available in RPO repositories, links to each individual repository are provided, enabling access to the full texts of papers. Of course, access is only provided if the papers are deposited in the repository and access is granted. The positive practice of establishing repositories in RPOs in Serbia began ten years ago, but conditions for broader implementation were only met in the middle of the past decade (Kosanović et al. 2019). Credit for this primarily goes to motivated librarians in RPOs, as well as decision-makers in institutions who recognized that repositories significantly contribute to the visibility of published results and expressed readiness to allocate financial (establishment and maintenance of infrastructure) and human (population of repositories, rule changes) resources for it. In 2021, 32 repositories (Đoković 2021) were registered in Serbia, but a more detailed timeline graph is available at https://time.graphics/line/314977, which is regularly maintained by Milica Ševkušić, a librarian at the Institute of Technical Sciences SASA.

Upon NITRA's announcement of establishing eNauka, many RPOs began (belatedly) establishing their repositories, and by mid-October 2023, data from 111 RPOs were imported into eNauka, of which 107 have their own repositories. The quality of data in these repositories is not the subject of this paper, but it is up to the management of RPOs to decide what is a

sustainable solution and what is more cost-effective: paying for more modern IT solutions that require less manual work or a free solution with a lot of time invested in data entry. It is a positive fact that in Serbia, there is now a larger group of highly educated and dedicated librarians who have mastered all the intricacies of well-maintained repositories and are very involved in international initiatives/projects of the same purpose. The acquired knowledge will surely contribute to easier tackling of challenges expected in scholarly communications (e.g., preserving primary data, data management workflows, etc.).

Citation data are periodically retrieved in regular cycles from available sources using PIDs for each individual publication. This further means that if a publication does not have a PID in a service where citation tracking is conducted, then there is no data on citation. Additionally, citation tracking is only conducted in sources that have clearly (and transparently) displayed procedures for deduplication, sources from which they gather data, selection of sources for referencing, etc.

7 Training and end-user support

Quality of metadata about publications in eNauka is the responsibility of RPO editors, and special attention has been given to their education. Portal functionalities were gradually released to RPO editors starting from December 2022, and by April 2023, eNauka was fully operational for the University of Kragujevac, which had the most developed infrastructure. The experiences of RPO editors and researchers from Kragujevac were significant for the IT improvement of the process. In July 2023, eNauka was launched for all active researchers in Serbia.

Online (Zoom) training sessions for RPO editors were held in 5 sessions, and the entire recorded material is available to everyone at https://enauka.gov.rs/regres. Additionally, detailed instructions for work were provided. The following problems were identified:

– In several RPOs, researchers were appointed as editors who do not have sufficient knowledge about metadata and their exchange. In some cases, they perceived this as a degradation. According to the Law on Science and Research, RPO is obliged to have a "scientific-information documentation and library-information center," and it is expected that a librarian will work there. The fact is that in Serbia, there are more than 10 RPOs that do not have these. Neither a center nor a librarian. Only in one institution did we notice a change, i.e., they hired a librarian;

– Frequent changes of RPO editors, especially at the beginning, as decision-makers in science in their institutions (deputy directors or vice-deans) were appointed for this role by RPOs. Change is always good, but only if the newly appointed independently review the entire recorded material.

Researcher training was conducted exclusively through (1) recorded video tutorials and (2) instructions. In both cases, tutorials of different lengths were prepared (e.g., "Shorter is not possible" or "eNauka on one page"), but there are (rare) instances where even that was not viewed or read. By mid-October 2023, over 5500 researchers had logged into the system at least once.

User support was immediately established, but the number of people engaged in this activity changed. This is a necessary and binding service that must function because experiences from previously established systems indicate that this was a crucial drawback. Portals have good quality to operate 24/7, and users are inclined to utilize that quality. This means that a large number of eNauka users, especially researchers, log in during nights and weekends. Perhaps they do not expect a response during those periods, but if they receive one, they are certainly pleasantly surprised.

8 Conclusion and further plans

Establishing a national CRIS (Current Research Information System) is not a simple task, as if it were, it would have already been established. Time will tell whether NITRA's decision to finance the development of a national CRIS instead of subscribing to existing foreign commercial solutions was good or not. The result will only be measurable after a minimum of three years, but what is already visible is:

– Human capacity in RPO has been improved in terms of understanding the flows of scientific information;
– The number of repositories has significantly increased;
– Researchers' trust that they will not have to constantly enter their data from scratch has increased;
– Citations are collected from various sources, creating conditions for creating different indicators of success;
– Broad public accessibility contributes to data accuracy;
– Easier and faster rectification of identified deficiencies, and adaptation to domestic regulatory acts;

– Data collection from all domestic sources has been enabled...

For the next phase, expansion of eNauka to other entities important for the scientific research sector, such as projects and equipment, is planned.

Certainly, researchers and RPO editors play a key role in eNauka. If they accept the system without major resistance, the chance of success increases. However, the decision on the survival of eNauka is ultimately made by NITRA, in several ways: (1) providing institutional user support, (2) providing IT support and development in the same manner, (3) adapting regulations and rules, and (4) planning annual funds for eNauka.

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Table 1. An overview of various PIDs in eNauka. A share is calculated as a proportion of a total number for each entity.

Entity	Acronym	Description	Proportion
 **Istraživači**	ORCID	Open Researcher and Contributor ID	83.28
	E-CRIS ID	Researcher ID in eCRIS, or COBISS.SR	98.03
	APVNT	Researcher ID in Research Register of Vojvodina (KNR)	25.26
	IBI	Researcher ID - a connector to eNauka admin	100
	Researcher ID	Researcher ID in Web of Science	754
	Scopus ID	Researcher ID in Scopus	17.43
 **Organizacije**	ROR	Research Organization Registry	12
	EC PIC	European Comission Participant Identification Code	164
	E-CRIS ID	Organization's ID in E-CRIS	100
	eNauka ID	Organization's ID - a connector to eNauka admin	100
 **Rezultati**	DOI	Digital Object Identifier	21.64
	Scopus ID	Publication's ID in Scopus	15.13
	WoS_UT	Publication's ID PubMed	2.68
	PubMed ID	Publication's ID PubMed Central	0.96
	COBISS.SR-ID	Publication's ID in COBISS.SR	31.21

Digital Repository of the University of Belgrade PHAIDRA and the eScience Portal

UDC 655.411(0.034.2):004.65]:378.4(497.11)
DOI 10.18485/infotheca.2023.23.2.6

ABSTRACT: The digital repository PHAIDRA, based on the Fedora system and created at the University of Vienna, has been serving as the technical foundation for depositing doctoral dissertations and other works produced at the University of Belgrade for over a decade. With the establishment of the eScience portal, the possibility of using the PHAIDRA infrastructure for the dissemination and presentation of contributions from scientific research organizations and researchers was opened. Consequently, another system (Phaidra Research) was initially launched for all institutions outside the University of Belgrade. A series of training sessions were organized for interested organizations looking to input their works into the PHAIDRA system for transmission to eScience. Finally, the opportunity was provided to process library materials through all available systems, including the repository, as one of the library services.

KEYWORDS: repositories, depositing works, researcher profiles, education, library services

PAPER SUBMITTED: 30 October 2023
PAPER ACCEPTED: 17 December 2023

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1 Introduction

The digital repository of the University of Belgrade, PHAIDRA, was established in 2011 as a technical support for the concept of open science, which was explicitly endorsed by the University of Belgrade at that time (*Берлинска декларација о отвореном приступу научном знању* 2011). In November of the same year, the University joined the signatory

countries of the Berlin Declaration on Open Access to Scientific Knowledge, becoming part of a group of over 300 universities worldwide.[1]

The foundation of this first university repository was based on a system developed since 2006 at the University of Vienna as a modified version of the Fedora system. This modification was created to meet criteria for reliability, adaptability, and accessibility developed by the user community. (Хокнер and Будрони 2011) From the beginning of its use, the uniqueness and simplicity of the PHAIDRA system were emphasized, along with a structure that actively promotes open access policy. It provides the opportunity for self-archiving for all members of the university community, with clear copyright protection through the implementation of Creative Commons standards.

The PHAIDRA system allows the input of various types of objects (text, video, audio materials, images), grouping objects into collections, and obtaining a permanent link with a simple structure suitable for citation. The operation of the PHAIDRA system at the University of Belgrade, specifically at the University Library "Svetozar Marković," where the repository is maintained, involved not only providing a service but also implementing a series of educational and organizational activities.

The PHAIDRA system has been implemented at universities in Niš and Kragujevac, as well as in Podgorica, Sarajevo, and Tuzla. This led to a consortium, with universities in Austria and Italy (Graz, Linz, Padua),[2] designed to foster collaboration and exchange of experiences. All partners can independently develop the system and offer solutions to other consortium members based on their experiences (Stolić, Mazić, and Mazić 2012).

PHAIDRA has been and remains a project in development, creating a community in the Western Balkans and neighboring European countries, facilitating direct and regular communication and learning.

2 PHAIDRA - The First Decade at the University of Belgrade

Although part of the consortium (Phaidra.org), each university using the system was entirely independent regarding the usage of the repository and the formulation of local policies. From the beginning, the University

1. Open Science at the University of Belgrade, 2023. Today, the number of universities signatories to the Declaration is around 500. Accessed on October 24, 2023

2. PHAIDRA community. Accessed on October 25, 2023

of Belgrade allowed faculty and collaborators to be authorized PHAIDRA users, enabling them to self-archive their works in the system. Towards the end of 2011, several training sessions were held, involving librarians and, to a lesser extent, faculty members.

Repositories, as the foundation of the green open access model, are filled with content following satisfactory and controlled dynamics only if there is a mandatory deposit requirement (Harnad 2005). Since 2012, following the decisions of the University of Belgrade, all dissertations undergoing review and evaluation must have both a printed and an electronic version. The electronic versions are deposited in the PHAIDRA repository through the eTheses subsystem at the University Library.[3] Electronic versions of defended dissertations at the University of Belgrade, along with a smaller number of retrospectively digitized dissertations, as obligatory copies, represent a continuous and stable inflow of publications in electronic form into the repository.

As a system equipped with a stable identifier, PHAIDRA is recognized as a useful tool for presenting other collections, such as those dedicated to the Europeana project (collection of oriental manuscripts and publications about Alexander the Great), thus maintaining a connection with the higher education purpose in the broadest sense. This purpose has been fulfilled on some faculties using PHAIDRA for depositing master's theses, thus solving the problem of publication storage.

During the first decade of using the PHAIDRA system, repository capacities were predominantly utilized for the secure deposition of documents. Other functionalities, such as data transfer to other systems, only included doctoral dissertations visible on the national, European, or global portal.[4]

3 The eScience Project

According to media reports, although the eScience portal officially became operational in May 2023 ("Pokrenut portal eNauka" 2023), organizational, technical, and other preparations had started considerably earlier. The University Library "Svetozar Marković" started its initial activities directly tied to this project intensively in the spring of 2022. The eScience initiative by the Office for IT and e-Government of the Government of the

3. eTheses. Accessed on October 26, 2023

4. Portals: Nardus, Dart Europe и Open Access Theses and Dissertations. Accessed on October 26, 2023

Republic of Serbia aimed to provide a more efficient, transparent, and comprehensive insight into the scientific contributions of research institutions and researchers. It strived to integrate some of the existing systems and enrich them with bibliometric data.

Unlike previous projects with similar goals, the eScience concept involved a unique form of decentralization, relying on other systems, primarily repositories at that time. Data would be extracted from these repositories using the OAI PMH protocol. Apart from this precondition, a key requirement for eScience was that records should be in the appropriate format (Dublin Core).

Starting from these assumptions, the University Library recognized the sustainability of the concept: if records are created at the places where they naturally originate, such as libraries and research organizations, often by specialized personnel like librarians, it ensures the long-term, comprehensive, and successful presentation of research results. This approach is not left solely to researchers nor focused on a single system, as was the case with the Register of Researchers of Serbia (RIS). However, the requirement for results to be presented, as a crucial precondition for evaluation and professional advancement, meant also encouraging researchers and research institutions to reevaluate the extent of their visibility and analyze where and how their results are seen.

What researchers identified as a requirement to fulfill, the University Library understood as a call to reassess, adapt, and mobilize its capacities. Systems identified immediately as resources or pillars capable of meeting the new needs of researchers were COBISS, eCRISS, and PHAIDRA. However, when it comes to the PHAIDRA repository, several shortcomings were noted in the new context,which needed to be overcome.

Approaching the PHAIDRA repository as a resource in service to eScience, at the same included the analysis of all aspects, identifying potential shortcomings, and formulating appropriate responses to each of them.

1. *Policy of depositing / concept of the repository.* The existing repository was intended for professors and associates of the University of Belgrade. In this sense, the question arose of how to meet the needs of other research institutions outside this university without disrupting the existing concept. The solution was found by establishing another repository, identical to the first, specifically designed for a diverse network of research institutions outside the University of Belgrade, named Phaidra ReSearch. In subsequent steps, with inquiries coming from state universities, the policy of the original repository was somewhat modified. In the "old"

PHAIDRA, in the end, besides the works of professors and associates of the UB faculties, works from other state universities, such as the faculties of the University of Arts in Belgrade or the State University in Novi Pazar, were also deposited.

2. *Education.* Potential users were offered the opportunity to use the PHAIDRA system for document deposition. The users had to attend a short, half-day training session, during which they became fully equipped for independent work in the system, with available expert technical support. Deposited documents would be grouped into corresponding collections that could be registered and harvested by the eScience platform. The entire process involved the collaboration of multiple library departments to ensure the seamless flow of the registration, record-keeping, and implementation of education processes, along with the necessary technical support.
3. *Library service.* For users who did not wish to use the system independently, a package of services was developed, involving the processing of delivered materials within the mentioned available library systems (COBISS, eCriss, and PHAIDRA). This aspect also required additional reorganization and engagement within the Library to ensure that objects were deposited into PHAIDRA in an appropriate manner.
4. *Technical adjustments.* Although the PHAIDRA system implements the Dublin Core metadata scheme and follows the specified requirements of the eScience system, possessing mandatory fields for describing digital objects, additional, specific requirements were needed for the records to be treated as valid in the context of eScience. Among them, the most prominent were various identifiers or document typologies, which practically had to be considered mandatory fields in this context. PHAIDRA repositories are adapted to the eScience system based on the OpenAIRE typology.[5] Through the OAI-PMH protocol and following DOAJ recommendations,[6] the implementation includes the transmission of researcher identifiers such as ORCID and CONOR, as well as corresponding DOI, ISSN, and COBISS identifiers related to the object itself.

The response to the eScience requirements involved multidimensional, team collaboration and simultaneous engagement of multiple departments within the Library, integrating organizational, technical, and educational components of work.

5. Open Aire Guidelines. Publication Type (M). Accessed on October 27, 2023
6. DOAJ. Accessed on October 27, 2023

4 Education for using PHAIDRA

From April 2022 to September 2023, 25 collections were created, with 13 collections located in the newly established Phaidra ReSearch repository and 12 collections in the original PHAIDRA repository. The number of collections reported on the eScience portal, from which objects are downloaded for eScience, is slightly lower (around 20[7]), as some collections are not being filled with new objects.

A total of 22 collections were created as a result of training for representatives of research institutions, while 3 were established as part of the Library's services and material processing in library systems.

Although time-constrained, the training successfully covered:

- familiarization with the repository structure, types of objects, and recommended formats;
- walkthrough of the deposition process and understanding the mandatory description fields, both those required by the PHAIDRA system and those set as eScience requirements;
- formation of collections and explanation of the procedure for adding new objects to collections;
- object and collection editing procedures;
- copyright and licensing, "locking" objects.

Thanks to the simplicity of the PHAIDRA system and its focus on essential functionalities, representatives of research institutions, even those who are not librarians, could easily understand the archiving procedure and collection preparation. Additional assistance from the Library after the training included material (presentation), illustrating the depositing process, assistance in registering the repository on the eScience portal, and availability for consultations on practical questions.

7. Колекције у оквиру *Phaidra ReSearch*: Collections within Phaidra ReSearch: Institute of meat hygiene and technology, Institute for water resources "Jaroslav Černi," Institute of soil, Mining Institute, Institute of forestry, Faculty of law for business and judiciary, Faculty of economics and engineering management, Institute of artificial intelligence, Institute for medicinal plant research "Dr. Josif Pančić," Institute of mining and metallurgy Bor, Institute for Serbian culture Pristina – Leposavić, Institute for cardiovascular diseases Dedinje. Collections within PHAIDRA: INEP, Teacher education faculty, Faculty of economics, Institute "Mihajlo Pupin", State University of Novi Pazar, Faculty of fine arts, Faculty of dramatic arts.

5 Usage of the repository - status overview

Created collections in both repositories contain a different number of objects, depending on the needs and production of research institutions. The fact that in some collections new objects are not added, meaning that only objects entered during training remain, is more noticeable in collections belonging to the original PHAIDRA repository. In contrast, almost all collections of the Phaidra ReSearch repository are continuously supplemented. This circumstance indicates different initial states in institutions and different motivations for using the repositories. Faculties that are members of the University of Belgrade, as well as members of other state universities, generally have access to other systems for processing and presenting library material, such as COBISS, so they use the PHAIDRA system as additional infrastructure for open access deposition. In addition, some faculties already have their own repositories, so the training involved only familiarizing or reminding them of the operation of this system, which is continuously available to members of the University of Belgrade.

The most intensive use of the system in this way has come from those research institutions that are not part of the COBISS system and do not have the capacity to create their own repository. This group includes all users of the Phaidra ReSearch system and one user from PHAIDRA at the University of Belgrade.

Similarly, there is a difference between the two PHAIDRA systems regarding the individuals who attended the training and are depositing their work into the system: users of the Phaidra ReSearch system are mostly not librarians but other professionals, while in the use of PHAIDRA, almost all collections are formed by librarians. All this confirms the high level of development of library systems within the University of Belgrade and other state universities (work in the COBISS system, employed librarians), in contrast to other accredited research institutions that often do not have such capacities.

In several cases, familiarizing with the repository through training, not only as a specific system but also in its function of representing and promoting the results of research institutions, prompted institutions to consider initiating their own systems, engaging special human resources, or hiring librarians. In this way, PHAIDRA education has made a step beyond its purpose in a narrower sense, aiming to help institutions recognize and understand their needs and possibilities, and identify the best ways to improve

their work, through familiarization with the functions of repositories and the benefits they provide.

6 Conclusion

The development, reorganization, and utilization of the PHAIDRA repository for displaying results on the eScience portal involved the integration of multiple functions – technical development, educational aspects, and organizational components – along with the establishment of support systems. Together, these elements have brought a new and distinct perception and role for the repository. In its initial stages, the repository was focused on the permanent deposition of works by faculty and associates of the University of Belgrade, ensuring the reliable preservation of mandatory copies of doctoral dissertations and enhancing visibility in open access. However, the current role of PHAIDRA has evolved to become an integral part of library services, addressing specific requests from library users.

PHAIDRA is now recognized as a user-friendly, straightforward, and optimal tool for presenting research outcomes on the eScience portal, requiring minimal investment from research institutions. This evolution hasn't diminished its original purpose, which includes archiving and long-term preservation of electronic materials while respecting copyright and offering the possibility to transfer content to other systems.The expansion of PHAIDRA's role and perception has been concurrent with the broadening of its user base, extending beyond the University of Belgrade to encompass all interested research institutions. With two identical systems in place, the initial editorial concept has remained consistent. The ongoing experience with PHAIDRA's involvement in eScience demonstrates an adaptive approach, responsiveness to changes, and a commitment to meeting the evolving needs and interests of users.

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University Library Support to the eScience: Integration and Optimization of Information Resources for Scientific Progress

UDC 655.411(0.034.2):004.65]:378.4(497.11)
DOI 10.18485/infotheca.2023.23.2.7

ABSTRACT: The information system eScience is a publicly available system for monitoring the scientific work of researchers and institutions in the Republic of Serbia. The University Library "Svetozar Marković" helped in the process of unification of data for the eScience from different information systems and offered help to scientific research organizations in the Republic of Serbia (NIO) in achieving the highest and more representative metadata quality of researchers' scientific results.This paper will presenta package of services that the University Library created for NIOs that didn't have the personnel and technical capabilities to use the eScience system independently.

KEYWORDS: eScience, University Library "Svetozar Marković", COBISS.SR, PHAIDRA, processing library materials, metadata

PAPER SUBMITTED: 28 December 2023
PAPER ACCEPTED: 21 January 2024

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1 Introduction

The information system eScience[1] is a publicly available system for monitoring the scientific work of researchers and institutions in the Republic of Serbia. It shows current information and data about scientific research organizations in the Republic of Serbia (NIO), affiliated researchers, and their research results. The system was implemented with the idea of being "an aggregator which will draw on all existing information resources and

1. eScience

obtain information from existing systems and platforms" (Милновић 2023) and "aligned with international standards and practices to establish interoperability for data transfer" (Косановић 2023). Since libraries in Serbia have developed and maintained resources that store the results of scientific research activities, it was determined that libraries are key organizations in the eScience system realization and data unification. Thus, the two most important steps in the entire process were realized in cooperation with the two biggest libraries in the country, the National Library of Serbia[2] and the University Library "Svetozar Marković"[3]. The systems immediately identified as the most important resources or pillars that can respond to the eScience project needs were COBISS.SR[4], E-CRIS[5], and PHAIDRA[6], developed and maintained in the previously mentioned libraries.

Although the eScience portal officially started in May 2023, organizational, technical, and other preparations began much earlier, and University Library "Svetozar Marković" started to participate in those activities in the spring of 2022.Librarians from several departments in the University Library were involved in the work process and they received additional tasks besides their regular work. This required reorganization of their daily work activities and additional engagement, in order to prepare adequate data and objects for harvesting into the eScience system. Scientific research organizations had a choice either to prepare necessary data by themselves or to turn to the University Library for help (Столић, Милошевић, and Жикић 2023). For NIOs that did not have the personnel and technical capabilities to use the eScience system by themselves, the University Library created a package of services that included the processing of scientific research material submitted via the already mentioned available library systems (COBISS.SR, E-CRIS.SR and PHAIDRA). The paper by (Тртовац and Стијеповић 2023) presents the importance of the COBISS.SR and E-CRIS.SR systems for eScience, while the paper (Столић, Милошевић, and Жикић 2023) outlines the importance of the PHAIDRA repository for eScience. This paper will present the processing of submitted scientific research material in the system COBISS.SR and digital objects storage in the digital repository PHAIDRA, as well as their metadata structure.

2. National Library of Serbia
3. University Library "Svetozar Marković"
4. COBISS.SR
5. E-CRIS.SR
6. PHAIDRA

2 Processing of scientific research material in the COBISS system

In the digital repository PHAIDRA, NIOs created 25 digital collections out of which three were created within the University Library services package. The University Library was asked for help by three NIOs: Mining and Metallurgy Institute, Institute for Serbian Culture Priština – Leposavić and Institute for Cardiovascular Diseases "Dedinje". The three Institutes, in cooperation with their researchers, prepared bibliographies and full texts of research materials, which they submitted to the University Library. The first step of processing of research materials involved librarians from the Cataloguing Department,who performed bibliography cataloging and classification of delivered material in the COBISS system, while librarians who maintain the digital repository PHAIDRA stored the digital objects in this repository. Bibliography cataloging and classification involved, on the one hand, a redaction of existing bibliography records in the COBISS.SR system, and,on the other hand, the creation of new ones when necessary. In addition to regular metadata such as title, author name(s), collation, year of publication, subject i.e. keywords, UDC classification, as well as metadata describing an integral part of a publication (article in journal and proceedings, monograph chapter, etc.) such as volume and number of the journal, link to the journal, proceeding/monograph, encyclopedia/lexicon/dictionary, etc. it was extremely important to enter material typology, and then link the bibliographic record with an appropriate record in the authority database CONOR, as well as to enter the code of research institution where the researcher is employed.

In the COBISS system metadata "material typology" is inserted in the field **001** subfield **t** (Example 1) from the offered code list,according to the COMARC/B format (IZUM 2023a, 001/1–001/8)(Figure 1). The code list enables different material typology: article in journal (original scientific paper, review scientific paper, other scientific paper, professional paper, popular paper), preface, afterword, introductory article, article review, paper in proceeding, chapter in monograph, bibliography, register, encyclopedia/lexicon/dictionary, encyclopedia/lexicon/dictionary units, proceedings (from a conference), monograph (scientific and professional), catalog, patent, etc. A code defining material typology was assigned to submitted scientific material in the COBISS records according to the proposed categorization. There were no major problems in the process of assigning typology during the bibliographic processing of scientific material from the Institute for Ser-

bian Culture Pristina – Leposavic. However, while processing the material from the Mining and Metallurgy Institute and the Institute for Cardiovascular Diseases "Dedinje" some specific issues appeared, and categorization that was originally assigned to some papers could hardly be fitted into the existing COBISS typology code list. More precisely, librarians from the Cataloguing Department had to find a compromise when entering typology codes to ensure that the submitted material had appropriate typology assigned in the COBISS records, as mandatory metadata. In the next sections, specific material categorization and typology solutions in COBISS.SR records will be explained in detail.

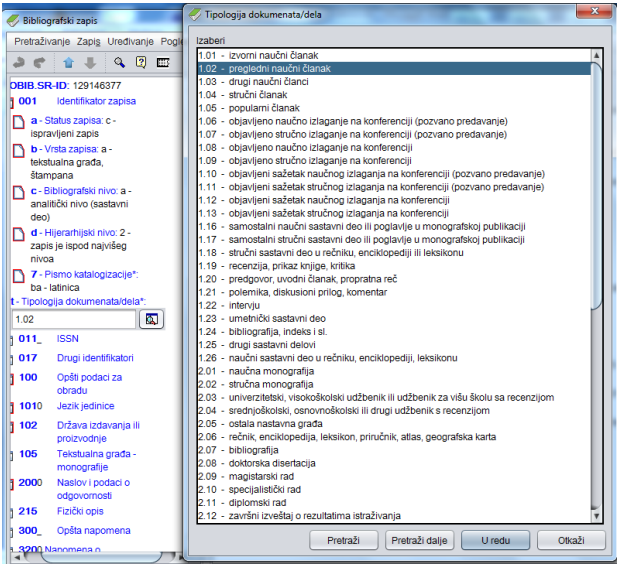

Figure 1. Typology code list in COBISS.SR system

Another specificity in material processing was intellectual responsibility. According to the cataloging rules, all authors and co-authors who signed a paper need to be entered in a bibliographic record and linked with the appropriate authority record in the CONOR database (Savic 2017; Trtovac and Dakić 2020). Before the bibliographic processing of researchers' scientific material, librarians had an obligation to check if there was a CONOR record

for each specific researcher. If a record for a specific researcher didn't exist, a new one had to be created with accurate and precise metadata. On the other hand, if a record for a specific researcher existed, librarians had to check the correctness and completeness of the metadata, and then, if necessary, enter additional metadata. The most common case when metadata were supplemented was related to a researcher's name on the submitted material that has to be in the proper form for the mandatory metadata in the authority record, which is also important for the harvesting process in the eScience system.

In the delivered material some specific forms of a researcher's name needed to be entered in the appropriate CONOR record. The first was the Serbian author's name without diacritics.[7] Such cases appeared most frequently in the material from the Institute for Cardiovascular Diseases "Dedinje" because researchers from this NIO publish a lot in foreign journals (mostly in English). The second example was a researcher's name in Russian, which appeared in materials from the Institute for Serbian Culture Priština – Leposavić because they were published in Russian publications. Also, a frequent name form was with a middle letter,which is a mandatory form of the author's name in some journals, both domestic and foreign. All mentioned forms of a researcher's name, if they didn't exist, were added in the authority record as mandatory metadata in field **400**, while the bibliographic unit in which the researcher was signed with a specific name form was added in field **810** (Example 2) (IZUM 2023b, 400–480). Completed CONOR records were linked with the bibliographic record using subfield **3** in the fields **700**, **701**, and **702**(Example 1).

The next very important metadata for eScience is the researcher's ORCID[8] identification.This is the internationally accepted researcher's identification,which became necessary for paper submission in international journals (lately more often also in Serbian journals), but also for applying to project calls(e.g. European Commission calls). This metadata is also essential because researchers use ORCID ID to log into the eScience system.Thus, librarians entered this metadata within the CONOR record in the field **017**, subfields **a** (ORCID ID) and **2** (ID definition) (Example 2). During the work the problem of two or more ORCID profiles of the same researcher appeared. In this situation librarians used the E-CRIS database and the eScience sys-

7. Authors usually sign without diacritical marks when publishing in foreign journals.

8. Open Researcher and Contributor ID Orcid: Connecting research and researchers

tem to check the validity of the researcher's ORCID profiles. If ORCID IDs in these two systems were also different, the ORCID ID assigned in eScience system was taken as relevant.

The third important metadata about a researcher was the research organization code. It is entered within the bibliographic record in the fields **700**, **701** and **702**, subfield **8** (Example 1). Institutional code is chosen from the offered code list, in the same way as typology (Figure 2), and these codes for the three aforementioned NIOs are: the Mining and Metallurgy Institute – *SR11-059*, the Institute for Serbian Culture Pristina – Leposavic – *SR31-001*, and the Institute for Cardiovascular Diseases "Dedinje"– *SR13-01.08.36.20*. There were also some specific issues when adding the organization code, which will be explained in the following sections.

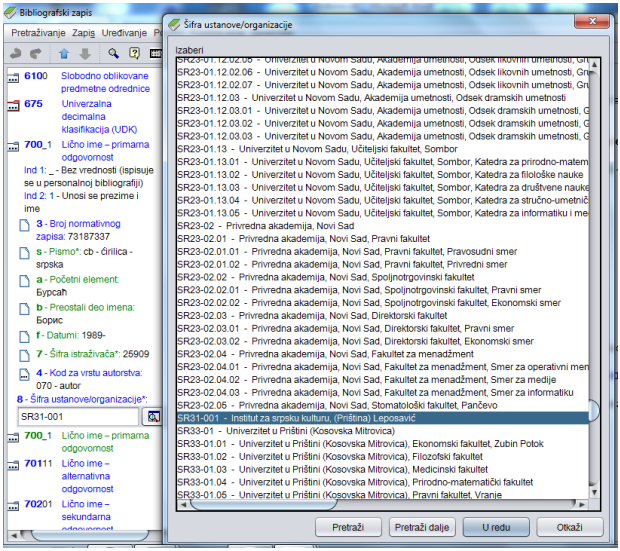

Figure 2. Scientific research organization code list in the COBISS.SR system

3 The Mining and Metallurgy Institute

The Mining and Metallurgy Institute (IRM)[9] is a scientific and research organization with prevailing activity including applied and developmental research aimed at meeting the needs of direct beneficiaries, and fundamental research as a basis for applied and developmental research (IRM 2023). Currently, the Mining and Metallurgy Institute Bor has 28 employees with a PhD, 7 with an MSc degree, 37 with a Master's degree,as well as 49 employees with a university degree.[10] Researchers in the Institute perform a wide range of activities in the field of geology, mining, metallurgy, and technology, and carry out expertise, produce studies, pre-investment and investment studies and projects, investment programs, and investment-technical documentation. IRM also creates scientific research projects and interdisciplinary programs, to support technological and scientific research development. Moreover, the Institute performs research in the fields of mining, mineral processing, new materials, technologies, environmental protection, and recycling.

The Mining and Metallurgy Institute was the first NIO to submit the bibliographies of its researchers to the University Library, in May and June of 2022. Seven librarians from the Cataloguing Department of the University Library with the highest professional title were included in the bibliographic processing of the material. They processed 244 papers from 51 researchers in the COBISS.SR system. The scientific research materials were in Serbian and English. During the processing of these materials, librarians encountered numerous specific issues, because it was necessary to create bibliographic records for patents, technical documentation, technical solutions, projects, video conferences, etc., which they had not previously encountered in their daily work. However, there were no major problems when assigning the typology because the available code list (Figure 1) offered adequate typology items for this type of scientific material. On the other hand, for many papers adding the block of intellectual responsibility (block 7) was demanding.

Example 1 illustrates a bibliographic record for laboratory tests, where the first highlighted author is a collective body, the Mining and Metallurgy Institute (entered in the fields **200f** and **710** of COBISS.SR record), while all other authors were entered in the field **200g** and subsequently in the field **702** with authorship code **070**. Although field **702** refers to secondary

9. The Mining and Metallurgy Institute

10. The data are from the Institute's official website on 27. 12. 2023., https://irmbor.co.rs/o-nama/zaposleni/

authorship (translator, editor, arranger, etc.), in this example, authors are listed here because they are not explicitly highlighted on the paper itself, i.e., on the front page. The same case is for project documentation in example 3.1. In the case of multiple authorships (more than three listed authors), the first author and the standardized formulation "... et al." (example 2.1) are entered in field **200f**, and all remaining authors are listed in field 701. Example 2.2 illustrates a study with a collective body, the Mining and Metallurgy Institute, as the first highlighted author (entered in the fields **200f** and **710** of the COBISS.SR record), followed by highlighted authors entered in the fields **200g** and **701**, while other contributors were entered in the field **702** with authorship code **070**. The investor was entered in field **338**. In example 3.2 the chief designer was entered as the first author in the field **701**, while research contributors were entered in the field **702** with authorship code **927**. The bibliographic record for this specific scientific material will be presented in the text that follows.

3.1 Examples

Example 1. Laboratory tests[11]

001 ac - ispravljeni zapis bl - elektronski izvori cm - monografska publikacija d0 - nema hijerarhijskog odnosa t2.12 - završni izveštaj o rezultatima istraživanja 7ba - latinica
100 c2021 hsrp - srpski lba - latinica
101**0** aeng - engleski
102 asrb - Srbija
135 ad - tekst bz - drugo
200**0** aLaboratory tests for waste materials treatment bElektronski izvor hPt. 3 iLaboratory tests for secondary slag treatment fInstitut za rudarstvo i metalurgiju Bor gSrđana Magdalinović, Sanja Petrović
210 aBor cInstitut za rudarstvo i metalurgiju d2021
215 a1 datoteka PDF
230 aTekstualni podaci
300 aNasl. sa naslovnog ekrana
337 aSistemski zahtevi: nisu navedeni.
338 **1** bKPME Ltd. Ukraine
610**0** zsrp - srpski aotpadni materijali alaboratorijska ispitivanja
675 a622.7 bRUDARSTVO. RUDARSKA TEHNIKA. RUDARSKI

11. Record available at: https://plus.cobiss.net/cobiss/sr/sr/bib/70910217, downloaded on 28. 12. 2023.

RADOVI I ISTRAŽIVANJA c622.7 - Prerada mineralnih sirovina sRUDARSTVO
702**01** 35481063 sba - latinica aMagdalinović bSrđana f1967- 712305 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 35481063 scb - ćirilica - srpska aМагдалиновић bСрђана f1967- 712305 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 360041481 sba - latinica aPetrović bSanja f1981- 712312 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 360041481 scb - ćirilica - srpska aПетровић bСања f1981- 712312 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
710**02** aInstitut za rudarstvo i metalurgiju cBor
830 a12312-21
830 a12305-21
856**41** uhttps://unilib.phaidrabg.rs/o:936
902**01** 35481063 sba - latinica 9srp - srpski aMagdalinović bSrđana R. f1967-
902**01** 360041481 sba - latinica 9srp - srpski aPetrović bSanja J. f1981-
902**01** 360041481 5k - devojačko prezime sba - latinica 9srp - srpski aBugarinović bSanja f1981-

Example 2. Study
Example 2.1[12]
001 ac - ispravljeni zapis bb - tekstualna građa, rukopis cm - monografska publikacija d0 - nema hijerarhijskog odnosa t2.13 - elaborat, predstudija, studija 7ba - latinica
100 bd - publikacija, zaključena prilikom izlaska ili u okviru kalendarske god. c2021 ek - odrasli, ozbiljna (nije lepa knjiž.) hsrp - srpski lba - latinica
101**0** asrp - srpski
102 asrb - Srbija bcs - Centralna Srbija
105 aa - ilustracije
200**1** aTehnološka ispitivanja prerade nestandardnog jarosit PbAg taloga na uvećanom laboratorijskom nivou eizveštaj f[istraživački tim Vesna Conić ... et al.]
210 aBor c[Institut za rudarstvo i metalurgiju] d2021
215 a39 str. cilustr. d30 cm
300 aNaručilac: Metal Recovery D.O.O.
300 aIzvršilac: Institut za rudarstvo i metalurgiju Bor, Centar za razvojne

12. Record available at: https://plus.cobiss.net/cobiss/sr/sr/bib/65960969, downloaded on 28. 12. 2023.

tehnologije u metalurgiji
6100 zsrp - srpski ajarosit PbAg talog aprerada atehnološka ispitivanja
675 c669 - Metalurgija a669 b669 - METALURGIJA
70111 355525641 sba - latinica aConić bVesna f1971- 712300 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 355525641 scb - ćirilica - srpska aЦонић bВесна f1971- 712300 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 352519945 sba - latinica aBožić bDragana f1980- 712299 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 352519945 scb - ćirilica - srpska aБожић bДрагана f1980- 712299 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 323392871 sba - latinica aAvramović bLjiljana 707823 f1964- 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 323392871 scb - ćirilica - srpska aАврамовић bЉиљана 707823 f1964- 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 377776905 sba - latinica aDragulović bSuzana f1960- 712301 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 377776905 scb - ćirilica - srpska aДрагуловић bСузана f1960- 712301 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 323394663 sba - latinica aJonović bRadojka 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
70111 323394663 scb - ćirilica - srpska aЈоновић bРадојка 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
830 a12300-21
830 a12299-21
830 a07823-21
830 a12301-21
85641 uhttps://unilib.phaidrabg.rs/o:469
90111 355525641 5k - devojačko prezime scb - ćirilica - srpska 9srp - srpski aСоколов bВесна f1971-
90111 355525641 scb - ćirilica - srpska 9srp - srpski aЦонић bВесна T. f1971-
90111 352519945 scb - ćirilica - srpska 9srp - srpski aБожић bДрагана C. f1980-
90111 323392871 scb - ćirilica - srpska aАврамовић bЉиљана P. f1964-
90111 377776905 scb - ćirilica - srpska 9srp - srpski aДрагуловић bСузана C. f1960-

901**11** 323394663 sba - latinica 9eng - engleski aJonovic bRadojka

Example 2.2[13]

001 ac - ispravljeni zapis bl - elektronski izvori cm - monografska publikacija d0 - nema hijerarhijskog odnosa t2.13 - elaborat, predstudija, studija 7ba - latinica
100 c2021 hsrp - srpski lba - latinica
101**0** asrp - srpski
102 asrb - Srbija
135 ad - tekst bz - drugo
200**0** aElaborat o rezervama i resursima bakra i zlata u porfirskoj mineralizaciji ležišta Čukaru Peki, do nivoa -1.152 m.n.v bElektronski izvor estanje: 01.09.2021. godine fInstitut za rudarstvo i metalurgiju Bor gautori elaborata Mile Bugarin, Vladan Marinković
210 aBor cInstitut za rudarstvo i metalurgiju d2021
215 a1 datoteka PDF
230 aTekstualni podaci
300 aNasl. sa naslovnog ekrana
337 aSistemski zahtevi: nisu navedeni.
338 **1** bMinistarstvo građevinarstva, saobraćaja i infrastrukture eRepublika Srbija
610**0** zsrp - srpski abakar azlato aležišta aČukaru Peki
675 a622.7 bRUDARSTVO. RUDARSKA TEHNIKA. RUDARSKI RADOVI I ISTRAŽIVANJA c622.7 - Prerada mineralnih sirovina sRUDARSTVO
701**11** 31664103 sba - latinica aBugarin bMile f1962- 712247 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
701**11** 31664103 scb - ćirilica - srpska aБугарин bМиле f1962- 712247 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
701**11** 384862729 sba - latinica aMarinković bVladan f1975- 712271 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
701**11** 384862729 scb - ćirilica - srpska aМаринковић bВладан f1975- 712271 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 360041481 sba - latinica aPetrović bSanja f1981- 712312 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 360041481 scb - ćirilica - srpska aПетровић bСања f1981- 712312

13. Record available at: https://plus.cobiss.net/cobiss/sr/sr/bib/68219145, downloaded on 28. 12. 2023.

4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 35481063 sba - latinica aMagdalinović bSrđana f1967- 712305 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 35481063 scb - ćirilica - srpska aМагдалиновић bСрђана f1967- 712305 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 323392871 sba - latinica aAvramović bLjiljana 707823 f1964- 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 323392871 scb - ćirilica - srpska aАврамовић bЉиљана 707823 f1964- 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 385244425 sba - latinica aMilutinović bSandra f1987- 712306 4927 - saradnik na istraživanju 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 385244425 scb - ćirilica - srpska aМилутиновић bСандра f1987- 712306 4927 - saradnik na istraživanju 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
710**02** aInstitut za rudarstvo i metalurgiju cBor
830 a12247-21
830 a12271-21
830 a12312-21
830 a12305-21
830 a07823-21
830 a12306-21
856**41** uhttps://unilib.phaidrabg.rs/o:551
901**11** 31664103 sba - latinica 9srp - srpski aBugarin bMile M. f1962-
901**11** 384862729 sba - latinica 9eng - engleski aMarinkovic bVladan f1975-
902**01** 360041481 sba - latinica 9srp - srpski aPetrović bSanja J. f1981-
902**01** 360041481 5k - devojačko prezime sba - latinica 9srp - srpski aBugarinović bSanja f1981-
902**01** 35481063 sba - latinica 9srp - srpski aMagdalinović bSrđana R. f1967-
902**01** 323392871 scb - ćirilica - srpska aАврамовић bЉиљана P. f1964-
902**01** 385244425 sba - latinica 9srp - srpski aTrpković bSandra f1987-

Example 3. Project documentation
Example 3.1[14]

14. Record available at: https://plus.cobiss.net/cobiss/sr/sr/bib/66725385, downloaded on 28. 12. 2023.

001 ac - ispravljeni zapis bl - elektronski izvori cm - monografska publikacija d0 - nema hijerarhijskog odnosa t2.14 - projektna dokumentacija (idejni projekat, izvođački projekat) 7ba - latinica
100 c2021 hsrp - srpski lba - latinica
101**0** asrp - srpski
102 asrb - Srbija
135 ad - tekst bz - drugo
200**0** aIzgradnja zelenog terminala u luci Prahovo bElektronski izvor iProjekat za građevinsku dozvolu za izgradnju novih lučkih kapaciteta Luke Prahovo (PGD) h7.2 iTehnološki projekat za građevinsku dozvolu zelenog terminala fizrada Institut za rudarstvo i metalurgiju Bor g[odgovorni projektant Vojka Gardić]
210 aBor cInstitut za rudarstvo i metalurgiju d2021
215 a1 datoteka PDF (46 str.)
230 aTekstualni podaci
300 aNasl. sa naslovnog ekrana
337 aSistemski zahtevi: nisu navedeni.
338 **1** bMinistarstvo građevinarstva, saobraćaja i infrastrukture eRepublika Srbija
540**0** aProjekat građevinske dozvole za izgradnju zelenog terminala u luci „Prahovo“ u okviru rekonstrukcije, dogradnje lučkih kapaciteta na novoj teritoriji Luke Prahovo
610**0** zsrp - srpski aluka Prahovo aizgradnja azeleni terminal
675 a624 bGRAĐEVINSKO INŽENJERSTVO. c624 - Građevinarstvo i konstrukcije uopšte (Građevinski zanati vidi: 69, Građevinski materijali vidi: 691, Građevinski delovi vidi: 692)
702**01** 32789735 sba - latinica aGardić bVojka f1971- 712302 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 32789735 scb - ćirilica - srpska aГардић bВојка f1971- 712302 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
710**02** aInstitut za rudarstvo i metalurgiju cBor
830 a12302-21
856**41** uhttps://unilib.phaidrabg.rs/o:853
902**01** 32789735 sba - latinica 9srp - srpski aGardić bVojka R. f1971-
902**01** 32789735 sba - latinica 9eng - engleski aGardic bVojka f1971-
902**01** 32789735 sba - latinica 9srp - srpski aAndrejević bVojka f1971-

Example 3.2[15]

001 ac - ispravljeni zapis bl - elektronski izvori cm - monografska publikacija d0 - nema hijerarhijskog odnosa t2.14 - projektna dokumentacija (idejni projekat, izvođački projekat) 7ba - latinica
100 c2021 hsrp - srpski lcb - ćirilica - srpska
101**0** asrp - srpski
102 asrb - Srbija
135 ad - tekst bz - drugo
200**0** aДопунски рударски пројекат изведеног стања постројења за припрему минералних сировина и одлагалишта рударског отпада и концентрата пирита из лежишта Чукару Пеки - Горња зона bЕлектронски извор fизрада Институт за рударство и металургију Бор gглавни пројектант Ивана Јовановић g[сарадници на пројектовању ПМС (припрема минералних сировина) постројења Сандра Милутиновић и Весна Цонић]
210 aBor cInstitut za rudarstvo i metalurgiju d2021
215 a1 datoteka PDF
230 aTekstualni podaci
300 aNasl. sa naslovnog ekrana
337 aSistemski zahtevi: nisu navedeni.
610**0** zsrp - srpski apostrojenje amineralne sirovine arudarski otpad aprerada
675 a622 bRUDARSTVO. RUDARSKA TEHNIKA. RUDARSKI RADOVI I ISTRAŽIVANJA c622 - Rudarstvo. Rudarska tehnika. Rudarski radovi i istraživanja sRUDARSTVO
701**11** 379412745 scb - ćirilica - srpska aЈовановић bИвана синжењер рударства f1977- 708364 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
701**11** 379412745 sba - latinica aJovanović bIvana cinženjer rudarstva f1977- 708364 4070 - autor 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 385244425 scb - ćirilica - srpska aМилутиновић bСандра f1987- 712306 4927 - saradnik na istraživanju 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 385244425 sba - latinica aMilutinović bSandra f1987- 712306 4927 - saradnik na istraživanju 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 355525641 scb - ćirilica - srpska aЦонић bВесна f1971- 712300 4927

15. Record available at: https://plus.cobiss.net/cobiss/sr/sr/bib/66992137, downloaded on 28. 12. 2023.

- saradnik na istraživanju 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
702**01** 355525641 sba - latinica aConić bVesna f1971- 712300 4927 - saradnik na istraživanju 8SR11-059 - Institut za rudarstvo i metalurgiju (IRM), Bor
710**02** aInstitut za rudarstvo i metalurgiju cBor
830 a08364-21
830 a12306-21
830 a12300-21
856**41** uhttps://unilib.phaidrabg.rs/o:627
901**11** 379412745 sba - latinica 9srp - srpski aJovanović bIvana M. f1977-
902**01** 385244425 sba - latinica 9srp - srpski aTrpković bSandra f1987-
902**01** 355525641 5k - devojačko prezime scb - ćirilica - srpska 9srp - srpski aСоколов bВесна f1971-
902**01** 355525641 scb - ćirilica - srpska 9srp - srpski aЦонић bВесна T. f1971-

3.2 Institute for Serbian Culture Pristina – Leposavić

Institute for Serbian Culture Priština – Leposavić (ISK)[16] is a multidisciplinary scientific institution with departments for Serbian language and literature, history, archeology, art history and ethnography. It has 51 employees out of which 44 work in the scientific sector and 7 in the administration. The scientific sector consists of associates, including 28 with a PhD (2 scientific advisors, 3 full professors (2 expert advisors), 10 senior scientific associates, 15 scientific associates); 6 doctoral students as research associates, 6 doctoral students as research trainees and 5 doctoral students as expert associates.[17] In 2023, the Institute delivered the scientific researchers' material to the University Library for processing. As of December 2023,scientific material from 37 researchers from the Institute was processed in the COBISS.SR system, a total of 334 papers: articles in domestic and foreign journals, articles in proceedings from domestic and foreign conference and chapters in domestic and foreign monographic publications. Material was in Serbian, English and Russian. During the processing of the material, the librarians did not encounter any major difficulties. Example 4 shows one bibliographic record, while Example 5 shows a record in the authority database CONOR for Dr. Borivoj Baltezarević, one of the researchers in the Institute.

16. Institute for Serbian Culture Pristina – Leposavić
17. The data is from the Institute's official website on 25. 01. 2024., https://iskp.co.rs/o-institutu/

The examples contain all mandatory metadata previously mentioned in this paper.

Example 4. Bibliographic record in Russian published in conference proceedings[18]

001 an - novi zapis ba - tekstualna građa, štampana ca - analitički nivo (sastavni deo) d2 - zapis je ispod najvišeg nivoa t1.08 - objavljeno naučno izlaganje na konferenciji 7ba - latinica
100 c2021 hsrp - srpski lca - ćirilica - nije specifikovana
1010 arus - ruski deng - engleski drus - ruski
102 arus - Rusija
2000 aСила и мощь – международно-правовые аспекты fМарина Д. Миятович
215 aСтр. 35-40
320 aБиблиографија: стр. 40.
464 1 1109922313 (TI=Политическое пространство и социальное время: : глобальные вызовы и цивилизационные ответы : в двух томах. Т. 2 AU=Сенюшкина, Татьяна Александровна)
5170 aForce and power – international and legal aspects
6100 zrus - ruski aсила aмощь aгосударство aполитика aмеждународно-правовые аспекты
6100 zeng - engleski aforce astate apolitics ainternational legal aspects
675 a32 c32 - Politika
700 1 321569127 scb - ćirilica - srpska aМијатовић bМарина Д. f1989-712209 4070 - autor 8SR31-001 - Institut za srpsku kulturu, (Priština) Leposavić
700 1 321569127 sba - latinica aMijatović bMarina D. f1989- 712209 4070 - autor 8SR31-001 - Institut za srpsku kulturu, (Priština) Leposavić
830 a12209
85641 uhttps://unilib.phaidrabg.rs/o:1312
900 1 321569127 scb - ćirilica - srpska 9srp - srpski aМијатовић bМарина f1989-
900 1 321569127 sca - ćirilica - nije specifikovana 9rus - ruski aМиятович bМарина Д. f1989-

18. Record available at: https://iskp.co.rs/o-institutu/, downloaded on 28. 12. 2023.

Example 5. Record in authority database CONOR[19]

001 ac - ispravljeni zapis bx - normativni zapis ca - lično ime
017**7** a0000-0002-6798-6981 2orcid - ORCID
100 ba - usvojena csrp - srpski gcb - ćirilica - srpska
101 asrp - srpski aeng - engleski
102 asrb - Srbija
106 a0 - može da se koristi i kao predmetna oznaka
120 ab - muški ba - lično ime se razlikuje
152 aPPIAK - Pravilnik i priručnik za izradbu abecednih kataloga
190**11** a1976 b04 c25
200 **1** 7cb - ćirilica - srpska aБалтезаревић bБоривоје f1976- r12193
200 **1** 7ba - latinica aBaltezarević bBorivoje f1976- r12193
340 aДоктор културолошких наука. Области научног истраживања: филозофија науке, (културни) идентитет, култура сећања и питања слободе појединца у контексту глобализације и живота посредованог технологијом.
400 **1** 7cb - ćirilica - srpska 9srp - srpski aБалтезаревић bБоривоје B. f1976-
400 **1** 7ca - ćirilica - nije specifikovana 9rus - ruski aБалтезаревич bБоривое B. f1976-
400 **1** 7ba - latinica 9eng - engleski aBaltezarevic bBorivoje f1976-
810 aOtimanje materijalnog blaga Kosova i Metohije od strane međunarodnih i domaćih faktora / Marko M. Milović, Borivoje Baltezarević. - U: Megatrend revija : međunarodni časopis za primenjenu ekonomiju. - ISSN 1820-3159. God. 18, br. 4 (2021), str. 293-302
810 aУтицај технолошких иновација на тржиште рада и креирање потребе за новим стручним профилима / Оливера В. Милутиновић, Боривоје В. Балтезаревић. - У: Баштина : гласник. - ISSN 0353-9008. Св. 49 (2019), стр. 203-210

3.3 Institute for Cardiovascular Diseases "Dedinje"

Institute for Cardiovascular Diseases "Dedinje" (IKVBD)[20] is a scientific institution within the Faculty of Medicine of University of Belgrade, Clinical Center of Serbia. It has 65 employees of which three senior research associates, 15 research associates, six research assistants, and 38 junior research

19. Record available at: https://plus.cobiss.net/cobiss/sr/sr/conor/15177063, downloaded on 28. 12. 2023.
20. Institute for Cardiovascular Diseases "Dedinje"

assistants.[21] Librarians processed scientific material delivered by this NIO in the COBISS.SR system in September and October 2023, a total of 126 papers by 14 researchers. During the work, librarians encountered some specific issues while entering typology in the COBISS.SR records. As part of scientific research, researchers from IKVBD publish various types of articles in journals, for example, case studies, case reports, scientific reports, clinical investigations, clinical research, and others. The existing typology code list (Figure 1) in the COBISS.SR system does not have such detailed codes for scientific articles, so the librarians made compromise solutions during processing and entered typologies from the list that most closely define the existing material categorization. For example, for „case report", the typology „other scientific articles" or „review scientific paper" was entered, for „clinical investigation", the typology „original scientific paper" was entered, etc.

Another challenge for librarians was multiple authorship. Researchers from IKVBD collaborate with foreign experts from related scientific fields and they jointly present their research results in papers. Thus, in many papers processed on this occasion, in addition to researchers from IKVBD dozens of foreign researchers were also signed. According to the bibliographic processing rules, all signed authors are listed in the field **200f** in the COBISS.SR system as follows: up to three authors, all authors are listed, if there are more than three authors signed, then the first one is listed and the formulation „... [и др.]" for papers in Cyrillic script or formulation „... [et al.]" for papers in Latin script or foreign language. In the intellectual responsibility block (block 7 in the COBISS.SR system) all authors are listed as follows: up to three authors, the first one is entered in field **700** and the remaining two in field **701**. If there are more than three authors all of them are entered in field **701**. As a large number of submitted papers were signed by dozens of authors and co-authors, of which the largest number were foreign researchers, the librarians decided not to include all of them in the processing. If three to ten authors were signed on the paper the first one and the formulation „*...[et al.]*" were enteredin field **200f**. For example „*Zachi I. Attia... [et al.]*" (Example 6). The remaining authors, both domestic and foreign, were entered in field **300a**, and then their respective field **701**, using subfield **3**, was linked to the CONOR record of the first author (a new record was created in the CONOR database if necessary), and the authors with affiliation „Institute for Cardiovascular Diseases "Dedinje"". If

21. The data are from the Institute's official website on 13. 10. 2023, https://www.ikvbd.org/en/scientific-activity/list-of-researchers/

the first signed author in the paper was an author with affiliation „Institute for Cardiovascular Diseases "Dedinje"", only one field **701** was assigned.

If more than 10 authors were signed in the paper the content of the field **200f** was the same as in the previous example, but only authors with affiliation „Institute for Cardiovascular Diseases "Dedinje"" were listed in the field **300a**. The field **701** was filled in the same way as in the previous example. In this case the field **970**, subfield **b**, was also assigned with data about the number of signed authors in the paper, written in Arabic numerals. Example 6 illustrates a bibliographic record in the COBISS.SR system for a paper with 48 signed authors, i.e. coauthors. In the example it can be observed that three **701** fields were filled, of which the first one refers to the first signed author in the paper (it was necessary to create a new record in CONOR database), while the other two **701** fields were linked with the CONOR records for authors with affiliation „Institute for Cardiovascular Diseases "Dedinje"".

Example 6. Bibliographic record for the paper with 48 signed authors[22]

001 ac – ispravljeni zapis bl – elektronski izvori ca – analitički nivo (sastavni deo) d2 – zapis je ispod najvišeg nivoa t1.01 – izvorni naučni članak 7ba – latinica
011 a1942-5546 (TI=Mayo Clinic Proceedings [Elektronski izvor])
017 adoi.org/10.1016/j.mayocp.2021.05.027 2doi – digitalni identifikator objekta
100 c2021 hsrp – srpski lba – latinica
1010 aeng – engleski deng – engleski
102 agbr – Velika Britanija
105 aa – ilustracije
2001 aRapid exclusion of COVID infection with the artificial intelligence electrocardiogram fZachi I. Attia... [et al.]
215 astr. 2081-2094 cilustr. IVol. 96 hno. k2021
300 aOstali autori iz Srbije: Goran Lončar, Vladan Vukomanović.
320 aBibliografija: str. 2093-2094
320 aAbstract.
6100 zsrp – srpski aCOVID akorona virus aveštačka inteligencija amašinsko učenje arespiratorne infekcije aelektrokardiogram
675 c616.1 – Bolesti srca i krvotoka. Hematologija a616.12-073.7:004.85

22. Record available at: https://plus.cobiss.net/cobiss/sr/sr/bib/125801225, downloaded on 28. 12. 2023.

b616.1 – KARDIOVASKULARNE BOLESTI
675 c616-07 – Semiologija. Simptomatologija. Dijagnostika
675 c004.8 – Veštačka inteligencija. Veštački razum

701**11** 3105100553 sba – latinica aAttia bZachi 4070 – autor
701**11** 3105100553 scb – ćirilica – srpska aАтиа bЗаки 4070 – autor
701**01** 329116519 sba – latinica aLončar bGoran f1976- 713295 4070 – autor 8SR13-01.08.41 – Univerzitet u Beogradu, Medicinski fakultet, Institut za kardiovaskularne bolesti 'Dedinje'
701**01** 329116519 scb – ćirilica – srpska aЛончар bГоран f1976- 713295 4070 – autor 8SR13-01.08.41 – Univerzitet u Beogradu, Medicinski fakultet, Institut za kardiovaskularne bolesti 'Dedinje'
701**01** 361903369 sba – latinica aVukomanović bVladan f1969- 4070 – autor 8SR13-01.08.46 – Univerzitet u Beogradu, Medicinski fakultet, KBC 'Dr Dragiša Mišović'
701**01** 361903369 scb – ćirilica – srpska aВукомановић bВладан f1969- 4070 – autor 8SR13-01.08.46 – Univerzitet u Beogradu, Medicinski fakultet, KBC 'Dr Dragiša Mišović'

856**41** uhttps://unilib.phaidrabg.rs/o:2966
901**11** 3105100553 sba – latinica 9eng – engleski aAttia bZachi I.
901**11** 3105100553 sba – latinica 9eng – engleski aAttia bZachi Itzhak
901**01** 329116519 sba – latinica aLončar bGoran M. f1976-
901**01** 329116519 sba – latinica 9eng – engleski aLoncar bGoran f1976-
901**01** 361903369 sba – latinica 9srp – srpski aVukomanović bVladan D. f1969-
901**01** 361903369 sba – latinica 9eng – engleski aVukomanovic bVladan f1969-
970 b48

The scientific material collection of researcher Milan Milojević, as the most extensive from the IKVBD at that moment, was separately delivered. An other specificity, in addition to those already explained in this section, was that authors were not always signed with affiliation "Institute for Cardiovascular Diseases "Dedinje"" and so in a large number of bibliographic records, subfield **8** in block **7** was not filled.

4 Collection structure in the digital repository PHAIDRA

After bibliographic description of scientific research material from these three NIOs librarians who maintain the digital repository PHAIDRA in the University Library stored the submitted digital objects. Three separate digital collections were formed: "Mining and Metallurgy Institute" (PHAIDRA ID o:179),[23] „Papers of professors and associates at the Institute for Serbian Culture Priština – Leposavić" (PHAIDRA ID o:1311)[24] and „Papers of associates at the Institute for Cardiovascular Diseases "Dedinje"" (PHAIDRA ID o:2793).[25] Each collection is described by the following metadata: title (srp) (srb. наслов), contributor (srb. сарадник), description (srp) (srb. опис), object language (srb. језик објекта), date (srb. датум креирања колекције), number of objects in the collection (srb. број објеката у колекцији) (Figure3). Metadata can be exported into the Dublin Core[26] and LOM Schema. Collections were created manually and the digital objects also stored in them manually.

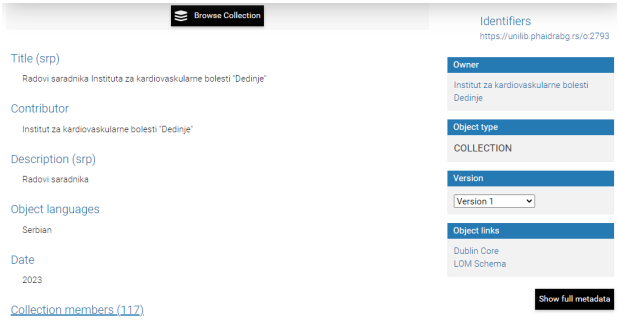

Figure 3. Метаподаци за колекцију „Радови сарадника Института за кардиоваскуларне болести Дедиње"

23. Mining and Metallurgy Institute
24. Papers of professors and associates of the Institute for Serbian Culture Priština - Leposavić
25. Papers of associates of the Institute for Cardiovascular Diseases, Dedinje
26. Dublin Core

Similarly to collections, during the storage, each digital object got its own PHAIDRA ID number,which is entered in the field **856** subfield **u**, of the COBISS.SR record. In addition to the ID number the material is described with following metadata: title (srp) (srb. наслов), author (srb. аутор), publisher (srb. издавач), description (srp) (srb. опис), object language (srb. језикобјекта), date (srb. датум креирања колекције), access rights (srb. право приступа), member of the collection(s) (srb. део колекције(а)) (Example 7). Created digital objects can be accessed in two ways: by means of metadata „collection members" within one collection, when all digital objects are listed, and by searching metadata in a browser. Users are enabled to download the full text of the object, reviews of the object in the PHAIDRA browser, as well as export metadata in the Dublin Core and LOM Schema (Figure 4).

Example 7. Metadata in the digital repository PHAIDRA for digital object in the collection "Mining and Metallurgy Institute"[27]

Title (srp)
Glavni rudarski projekat pripreme mineralnih sirovina i odlagališta rudarskog otpada i koncentrata pirita iz ležišta Čukaru Peki – Gornja zona : rešenje o imenovanju radnog tima
Author
Jovanović, Ivana
Publisher
Institut za rudarstvo i metalurgiju, Bor
Description (srp)
Projektna dokumentacija Rešenje br. 2687/20 od 17.11.2020.
Object languages
Serbian
Date
2020
Rights
© All rights reserved
Member of the Collection(s) (1)
o:179 Institut za rudarstvo i metalurgiju Bor

Metadata structure in the PHAIDRA repository differs from those in the COBISS.SR system. Already explained problems with material typology and

27. Example available at:https://enauka.gov.rs/handle/123456789/605134. The same example in the eScience system, https://enauka.gov.rs/handle/123456789/605134, downloaded on 19. 12. 2023.

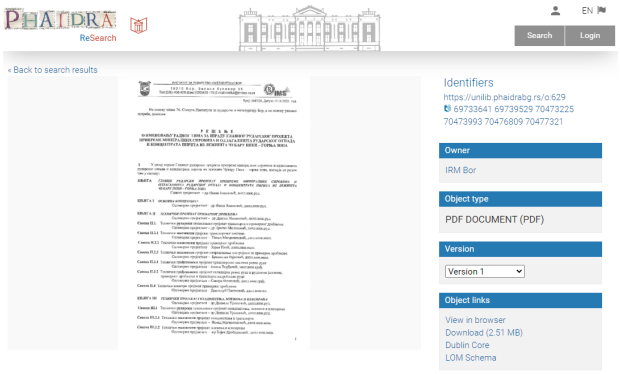

Figure 4. Дигитални објекат из колекције „Института за рударство и металургију Бор“ у репозиторијуму PHAIDRA

multiple authorship are solved in a different way in the PHAIDRA repository. The typology system of digital objects in PHAIDRA is adapted to the eScience system according to the OpenAIRE typology[28], where the solutions for some examples are not the best, and such examples were encountered when depositing material from the aforementioned NIOs. For example, for different reviews, the assigned typology can be „article“ or „original scientific article“, while „conference paper pertains to all papers from a conference, including abstracts. It remains to consider in the future whether it is possible to change the typology list and solve this type of problems. Table 1 shows how typology mapping was done in the system, while Figure 5 shows the list of available typology in the metadata editor in the PHAIDRA, visible to users.

Multiple authorship, another specific issue explained in this paper, was resolved in PHAIDRA in a different way than in the COBISS.SR system. As it is explained in previous section, if there are more than 10 signed authors in one paper not all are entered in the COBISS.SR record, while in PHAIDRA, all signed authors were entered in the metadata field “Author”. This is because the eScience system displays an error if the entered number of authors in the system doesn’t match the number of authors signed in the paper. In the most cases all metadata,together with appropriate digital object (mostly paper in PDF) are harvested from the PHAIDRA into

28. OpenAIRE Guidelines for Literature Repositories v3: Publication Type (M)

Table 1. Metadata mapping in PHAIDRA according to OpenAIRE typology

Типологија у репозиторијуму PHAIDRA	**Типологија у OpenAIRE**
Article	article
Doctoral dissertation	doctoralThesis
Other	other
Original research paper	article
Research dataset	dataset
Report	report
Book	book
Patent	patent
Book chapter	bookPart
Review article	review
Preprint	preprint
Review	review
Peer review	review
Conference proceeding	conferenceProceedings
Habilitation	other
Professional paper	article
Final paper	other

the eScience system, so the number of entered authors in the PHAIDRA metadata structure had to be the same as the number of authors signed in the paper that is stored. As we can see Example 6 in field **970b** we can see that 48 authors are signed in the paper. If we look at Figure 6 we can see the same example in PHAIDRA and all 48 authors from the paper in the metadata field „Author".[29]

5 Conclusion

In this paper we explained and illustrated the processing of scientific research results from three scientific research organizations in Serbia that

29. Paper available at: https://unilib.phaidrabg.rs/o:2966, downloaded on 14. 12. 2023.

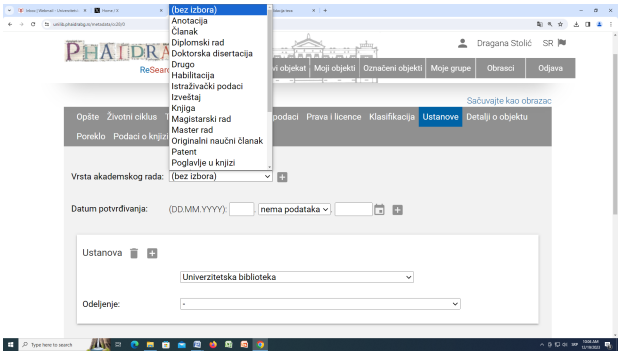

Figure 5. Typology in the metadata editor in PHAIDRA visible to users

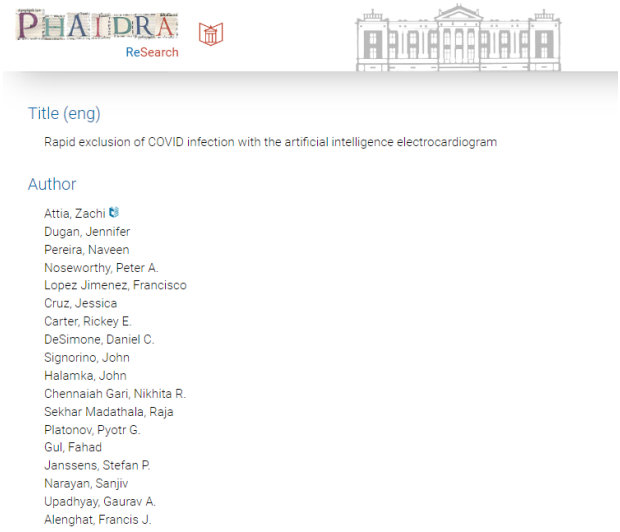

Figure 6. Metadata in the repository PHAIDRA for the paper signed by 48 authors

turned to the University Library „Svetozar Marković“ for help for scientific harvesting research data to the eScience system. The Mining and Metallurgy Institute, the Institute for Serbian Culture Priština – Leposavić and the Institute for Cardiovascular Diseases “Dedinje” delivered scientific research material of their researchers to be processed and stored in the library-information systems maintained in the University Library, important for data harvesting in the eScience system. The processing included bibliographic processing in the COBISS.SR system and depositing digital objects in the digital repository PHAIDRA. To that end, a huge number of different papers were bibliographically processed and stored in the digital repository, whereby three separate digital collections were created. During the work librarians encountered different challenges from library and information science, which they successfully solved. The scientific research result processed in this way was successfully harvested to the eScience system, and the librarians of the University Library will continue to provide services and help to all NIOs that need it.

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IZUM. 2023b. *CONOR/A. Format za normativne podatke: priručnik za korisnike.* Preuzeto 28. 12. 2023, https://home.izum.si/izum/e-prirucnici/2_COMARC_A/Ceo_2_COMARC_A.pdf.

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52 nd LIBER Annual Conference: Open and Trusted – Reassessing Research Library Values (July 5-7, 2023, Budapest, Hungary)

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PAPER SUBMITTED: 20 October 2023
PAPER ACCEPTED: 6 November 2023

The European association of academic libraries LIBER (fr. *Ligue des bibliothèques européennes de recherche*) was founded in 1971. It organizes its work through the annual Conference, the work of the General Assembly, the executive board, and various expert sections. Participants of the Annual Conference are experts from the field of librarianship and publishers of scientific information whose users are libraries. The National Library of Serbia has been a member of this association since 2003.

Every year, a part of the fund is set aside for the LIBER's Annual Conference Fund award, enabling representatives of libraries from different countries to attend. LIBER's Executive Board agrees on which countries meet the requirements every October, while the final decision is made by the Conference's Program Board. This year, 12 funds were awarded, and the countries whose representatives could apply were Croatia, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Portugal, Slovakia, Slovenia, Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Georgia, Moldova, Montenegro, North Macedonia, Romania, Serbia, Turkey and Ukraine. When applying, it is necessary to attach a letter of motivation and a short biography. Two of us from Serbia received a fund.

The topics of this Conference throughout the years are diverse, from "The Future of Old Libraries" to "The Electronic Library at Work", to open-access topics that have been popular for years (e.g. s "Towards Open Science", held in London in 2015).

This year's conference, entitled "Open and trusted", was held in Budapest and hosted by the Hungarian Academy of Sciences (Magyar Tudományos Akadémia, MTA), the most important and prestigious learned society in Hungary. The building of the Central European University (CEU) was used for the purposes of the Conference. This year's theme is not a coincidence, and the reason for that is that the most important milestone on

the way to open science is precisely the Budapest initiative for open access from 2002, whose catchphrase is - "to make research free and available to everyone who has access to the Internet and promote progress in science, medicine and healthcare"[1]. Although accompanied and supported by many other declarations, this Initiative is still alive - in 2022 it celebrated its 20th anniversary with new recommendations for the next ten years regarding infrastructures, research assessment, transporters and reading and publishing contracts.

The lectures were about open access, open data, science, and knowledge, which is closely related to the work that my colleagues and I do in the Department of Scientific Information. The connection is reflected through constant communication and training of users for the purpose of publishing works in OA (Open Access) scientific journals, through communication with the editors of domestic scientific journals, establishment and maintenance of the DoiSerbia system. Maintaining the DoiSerbia system also implies its constant improvement in accordance with modern trends, which is intensively worked on and strived for.

The first day of the Conference was dedicated to workshops in the pre-conference part. Due to the large number of workshops, they were divided into different halls, since as many as 12 workshops were held at the same time.

The workshop of great importance to me was "Diamond Open Access in Europe and beyond"[2] organized by the DIAMAS Project.[3] The European Union funds this project with the aim to support Diamond Open Access[4] and institutional publishing by setting new standards, increasing visibility and promoting the sustainability of various publishing industries. As part of the project, a survey was launched[5] as a starting point for understanding institutional publishing in Europe. The National Library of Serbia and the Department of Scientific Information participated in filling out the above-mentioned survey, namely the National Library of Serbia as a journal publisher (The Herald of the National Library of Serbia and Archeographical papers), and the Department of Scientific Information as a service provider through the DoiSerbia system (66 scientific journals are on the platform,

1. Budapest Open Access Initiative, retrieved 25 August 2023
2. Workshop details
3. DIAMAS Project
4. Diamond Open Access refers to a scientific publishing model in which journals and platforms do not charge fees to either authors or readers"
5. Name of the survey: DIAMAS Institutional Publishing Landscape Survey

57 are active). The survey aimed to collect data on institutional publishing in open access. The questionnaire was filled out by more than 700 institutions from over 50 countries, and Serbia is in the top ten in terms of the number of institutions that responded to the invitation (along with Spain, Croatia, Poland, France, Italy, Germany, the United Kingdom, Finland and Switzerland).

Seven lecturers spoke at the workshop, including our colleague Milica Ševkušić from the Institute of Technical Sciences of the Serbian Academy of Sciences and Arts. Colleague Ševkušić is the coordinator of Serbia for Open Access at the EIFL Consortium of libraries. The topic of her presentation was "Why does the network matter?" through which she presented the good practices of the National Library of Serbia and the Serbian Library Consortium for Coordinated Acquisition (KoBSON). She also presented projects implemented in previous years with the help of EIFL to promote OA in Serbia. The news about the workshop and journals from Serbia included in the DoiSerbia system was shared on Twitter by Pierre Mounier, coordinator of the DIAMAS project.

Another tradition of the Conference after the pre-conference part is the reception of new participants (eng. Newcomer Session), i.e. participants who are at LIBER for the first time. As I attended LIBER for the first time, both as a delegate of the National Library of Serbia and as a LIBER's Annual Conference Fund award winner, the lecture was very useful and interesting because it aimed to present the practice of such a large gathering (on average, each year there are about 500 participants at LIBER).

The second day of the Conference, in addition to various lectures, was also marked by sponsor presentations and poster presentations. More than 20 publishers of scientific publications attended and it was a great honor to meet their representatives (EBSCO, Emerald, Elsevier, Springer Clarivate Analytics, Royal Society of Chemistry etc.) with which the National Library of Serbia cooperates through KoBSON.

The authors of the posters presentated, in a very concise way the work conducted in their countries on the promotion of open science and the solutions they applied not only to journals and books, but also to other non book materials, especially old and rare ones. Traditionally, the vote for the best poster was cast, and this year the winning poster was by colleagues from the University of Tartu, Estonia, entitled "EODOPEN: User Dialogue, Audience Development, and Copyright Issues & On-Demand Access to Hidden Collections".

On the third and last day of the Conference, the session entitled "A new paradigm: Open Access and the Diamond Model" was very well attended. It consisted of three lectures, which presented the state of this topic in America, Canada and France.

Mark Huskisson (OPERAS and Public Knowledge Project, United Kingdom) and Saurabh Khanna (Stanford University, United States) presented their research, which referred to over 30,000 journals in the Diamond OA model that use online journal publishing through the Open Journal Systems (OJS) open source platform. One of the parameters for the research was the coverage of these journals within the world index databases Web of Science and Scopus. Although the journals are completely open and free to use/publish, the research has shown that their coverage in the mentioned index bases is still small (slightly above 1%) (Khanna et al. 2022).

The closing ceremony of the LIBER Conference included the act of handing over the flag to the host of next year's Conference, which will be the State University of Limassol in Cyprus.

The National Library of Serbia has been a member of LIBER for 20 years. The Library has been recognized as important national institution through the interlibrary loan of European libraries, primarily national and university libraries, and supported in the networking of libraries. The purpose of participating in such a Conference is the care for the protection of European cultural heritage and improving access to the collections of European research libraries.

The topic of openness at the 52nd Conference was a prominent topic, and it has been discussed in Serbia for more than two decades. On this path, the education of librarians is very important so that they are able to help researchers, those who are just starting their research career and established researchers alike. Learning from the experiences of the colleagues from the countries in the region was a valuable and all the knowledge gained during this Conference will be passed on.

Also, at the end of the three-day conference, I can conclude that, although we all came from different institutions and do different types of work, we face similar problems and strive for the same goals, which is to help he promotion and development of the scientific research community, in the best possible way.

The Virtual Library of Serbia: The First Twenty Years

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PAPER SUBMITTED: 19 December 2023
PAPER ACCEPTED: 21 December 2023

On November 30, 2023, the National Library of Serbia celebrated the anniversary of twenty years since the establishment of the Center for Shared Cataloging of the Republic of Serbia. In collaboration with the Institute of Information Science (IZUM) in Maribor, where the COBISS bibliographic system (*Co-operative Online Bibliographic System & Services*) is developed, for the first time, the National Library of Serbia organized the "COBISS Day" and the conference "Virtual Library of Serbia: The First Twenty Years".

This was an opportunity for colleagues from member libraries of the COBISS.SR[1] system at the National Library of Serbia, where the Center for Shared Cataloging is located, to come together for the first time. Presentations on current topics were based on invitations from the organizers.. The introductory part of the conference featured speeches by Dr. Vladimir Pištalo, the director of the National Library of Serbia, Radovan Jokić, the assistant minister of culture of the Republic of Serbia, and Dr. Aleš Bošnjak, the director of the IZUM who then presented the acknowledgments. The first acknowledgment was presented to the director of the National Library of Serbia on the occasion of the 20th anniversary of the National COBISS Center, in recognition of their longstanding successful collaboration within the COBISS system. The second acknowledgment was awarded to Milorad Vučković, the former head of the Center for Shared Cataloging of the Republic of Serbia, for his dedicated efforts, long-standing commitment, and devotion during the establishment of the National COBISS Center in the Republic of Serbia. In her presentation, the deputy director and the head of the Virtual Library of Serbia sector, Tamara Butigan Vučaj, spoke about the inception of the Virtual Library of Serbia project, which was supported and endorsed by the Ministry of Culture of the Republic of Serbia. She discussed its developmental phases and the perspective of the COBISS system

1. COBISS.SR, accessed on December 19, 2023

in the context of digital transformation and disruptive technology challenges. The Chief of the Center for Shared Cataloging, Angelina Grujić, in her presentation, reminded the audience of the project System of Scientific and Technological Information of Yugoslavia, the precursor to the VBS project. She also outlined the development of the COBISS.SR system along with its accompanying services, addressing the question of "where we are today and what awaits us tomorrow."

The conference program was divided into two working sessions moderated by Emina Čano Tomić and Ljubica Ljubišić, library instructors at the Center for Shared Cataloging. The first session focused on presenting the new generation of COBISS4 software as a technological shift towards a unified web application. The conceptual solution for cataloging in COBISS4 was developed in 2020. The following year, the interface with basic functionalities was designed, and by the end of 2022, a trial version of the program was tested by selected catalogers from Slovenian libraries. Their feedback contributed to the creation of the first version of the production program called COBISS Cat,[2] which was launched in February 2023. The catalogers from the COBISS.Net network are now also able to use this program in its latest iteration. Some specific functionalities available in the COBISS3 version are still in development, allowing catalogers in the transitional period to simultaneously use both COBISS3/Cataloging and COBISS Cat. Branko Kurnjek, employed in the Bibliographic Control sector at IZUM, presented the features of the new interface. He highlighted advantages such as streamlining cataloging procedures, where certain processes were expedited or modified to be more user-friendly. During the panel discussion, Nebojša Kovačević, a librarian advisor from the Department of Serial Publications – Article Analytics at the National Library of Serbia, shared his observations and impressions from working with the COBISS Cat application as a selected cataloger for testing the internet application in the COBISS.SR system.

The new generation of COBISS Lib software was also introduced, and installed in the production environment in September 2023. This web application supports library business processes with all functionalities of existing segments (Holdings, Acquisitions, Serials, Electronic Resources, Interlibrary Loan, and Reports modules). MSc. Zdenka Kamenšek, from IZUM software development sector, participated in the development of the COBISS Lib application, striving to implement solutions from COBISS3 in the best possible way. During her presentation, she emphasized that the functionalities familiar to users remained unchanged, while the redesigned interface was

2. COBISS Cat, accessed on December 19, 2023

modern and transparent for use. The use of peripheral devices such as printers, RFID plates, cash registers, etc., requires the installation of the new COBISS DGW service. The logic behind performing procedures in COBISS Lib has remained the same as in COBISS3.

The theme of the second session was the ongoing projects within the COBISS.SR system. Mile Stijepović, a librarian advisor employed at the "University Library Svetozar Marković" in Belgrade, discussed the establishment and management of the "E-CRIS.SR information system on research activities in Serbia." He has actively participated in this project since 2005. IZUM's web application, E-CRIS[3] was used to establish a registry of researchers and institutions in the Republic of Serbia, enabling the management of bibliographies for scientific workers and institutions within the national library-information system. The E-CRIS.SR system was recognized in 2012 by the authorities of the Ministry of Education, Science, and Technological Development of the Republic of Serbia as a valid source of information for maintaining the Register of Scientific Research Organizations and the Register of Researchers in Serbia. After the renewed collaboration with the Ministry of Education of the Republic of Serbia in 2022, the E-CRIS researcher code became one of the author identifiers on the eNauka portal.[4]

Dr. Aleksandra Trtovac, a librarian advisor at the University Library "Svetozar Marković" in Belgrade and an active member of the working group supporting the implementation of the eNauka system, discussed the eScience project and the role of the "COBISS system in the context of the eScience project." The portal was launched in 2022 and implemented in May 2023 on the initiative of the Ministry of Science, Technological Development, and Innovation with the aim of supporting and advancing the scientific research sector. It seeks to unify the presentation of the entire scientific production and enable the evaluation of scientific results in institutions in the Republic of Serbia. Dr. Trtovac highlighted the challenges and difficulties faced by librarians, who are also NIO editors, in the process of collecting and verifying data on researchers' scientific results in the Republic of Serbia. The data generated on the publicly available eNauka portal were initially derived from the Research Information System (RIS). In addition to manually retrieving results initiated by researchers, data are supplemented by automatically retrieving results from existing institutional repositories, the COBISS library system, repositories of defended doctoral dissertations in NaRDUS, and the "Our in WoS' service."

3. E-CRIS, accessed on December 19, 2023
4. eNauka, accessed on December 19, 2023

Anđela Ognjanović, the director of the National Library "Vuk Karadžić" in Kragujevac, presented the project that can be characterized as a pioneering initiative and a step towards expanding the spectrum of services offered by public libraries in Serbia. This project, titled "Development of Web and Mobile Applications for Borrowing and Reading E-books" in the NBKG database, was accepted in April 2021 and financially supported by the Ministry of Culture of the Republic of Serbia. In the following year, a connection was established with the e-book lending system, coordinated by the Center for Shared Cataloging. This enabled transparency in data on purchased licenses and e-book loans within COBISS.SR system. This library is currently the first and only one in Serbia to offer such a service to its users. Nikola Stanković, a librarian and a member of the project team at the National Library "Vuk Karadžić" in Kragujevac, responsible for planning, coordination, and project implementation, introduced the attendees to the functionalities of the "Vuk eBook"[5] application. As the service did not gain anticipated traction and negotiations with publishers of e-books in Serbia did not yield the desired results, it was concluded that publishers are not yet ready for this type of collaboration with libraries.

During that occasion, an invitation was directed to anyone who could contribute to solving the current problem in communication between libraries and publishers, allowing the "Vuk eBook" application to be used to its full capacity. After a lively discussion and exchange of experiences with colleagues from Slovenia regarding e-books, the program concluded with a final part – a quiz prepared by Sandra Deljanin, a library instructor at the Center for Shared Cataloging. Participants had the opportunity to answer questions about the COBISS system using their mobile phones using the AhaSlides[6] platform and compete for one of three symbolic awards for the quickest correct responses. Based on the reactions of those present, gamification was a pleasant surprise for the conclusion of COBISS Day.

In addition to providing an opportunity for everyone involved in the COBISS.SR system to meet and stay informed about the latest developments from the COBISS platform, the conference was a chance to exchange opinions and ideas, share experiences, and establish contacts for future collaboration. The Virtual Library of Serbia project was initially designed to unify all libraries in Serbia into a comprehensive system of shared cataloging with a central electronic catalog. Although this was planned and prescribed by the Library and Information Activity Law in 2011, it is not the sole system,

5. Vuk eBook, accessed on December 19, 2023
6. AhaSlides, accessed on December 19, 2023

considering the parallel existence and development of the BISIS system. Still, the cataloging future of both systems is expected to be common and the representatives of the BISIS system attended the conference at the invitation of the organizers.

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