2021 – 2028

NATIONAL
STRATEGY FOR
OPEN SCIENCE

National Strategy for Open Science
2021-2028

Contents

List of abbreviations

Abbreviation	Explanation	Source
APC	Article Processing Charge	https://openaccess.cvtisr.sk/slovnik-pojmov/
SRDA	Slovak Research and Development Agency	https://www.apvv.sk/
CC	Creative Commons	https://openaccess.cvtisr.sk/slovnik-pojmov/
CERN	Conseil Européen pour la Recherche Nucléaire	https://home.cern/about/who-we-are
SCSTI	Slovak Centre of Scientific and Technical Information	https://www.cvtisr.sk/
DCC	The Digital Curation Centre	https://www.dcc.ac.uk/, https://wikisofia.cz/wiki/Digit%C3%A1ln%C3%AD_kur%C3%A1torstv%C3%AD
DMP	Data Management Plan	https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-data-management/data-management_en.htm
DOAJ	Directory of Open Access Journals	https://openaccess.cvtisr.sk/slovnik-pojmov/, Sprievodca svetom vedeckého publikovania
EOSC	European Open Science Cloud	https://eraportal.sk/eraportal/otvoreny-pristup-eosc/europsky-cloud-pre-otvorenu-vedu-eosc/
ERA	European Research Area	https://eraportal.sk/
FAIR	Findable, accessible, interoperable, re-usable	https://www.go-fair.org/fair-principles/
ISSN	International Standard Serial Number	https://www.ulib.sk/sk/narodna-agentura-issn/system-issn/
KEGA	Cultural and Educational Grant Agency of the Ministry of Education, Science, Research and Sport of Slovakia	https://www.minedu.sk/kulturna-a-edukacna-grantova-agentura-msvvas-sr-kega/

Abbreviation	Explanation	Source
MESRS	Ministry of Education, Science, Research and Sport of the Slovak Republic	https://www.minedu.sk/
NOAD	National Open Access Desk– in Slovakia, it is the Contact Office for Open Access at the SCSTI	https://www.openaire.eu/noad-activities
NRP	National Reference Point – the NRP for the area of Open Access to scientific information and its storage/preservation	https://www.eqavet.eu/eu-quality-assurance/glossary/quality-assurance-national-reference-point-for-vet
OA	Open Access	https://openaccess.cvtisr.sk/
OAI-PMH	Open Archives Initiative Protocol for Metadata Harvesting	http://old.nacr.cz/Z-files/moznosti_06.pdf
OECD	Organisation for Economic Co-operation and Development	https://www.oecd.org/
OpenAIRE	Open Access Infrastructure for Research in Europe	https://www.cvtisr.sk/cvti-sr-vedecka-kniznica/projekty/medzinarodne-projekty/openaire-2020.html?page_id=15576
OPII	Operational Program Integrated Infrastructure	https://www.opii.gov.sk/
ORD Pilot	Open Research Data Pilot (Horizon 2020 program)	https://www.openaire.eu/what-is-the-open-research-data-pilot
ROAD	Directory of Open Access Scholarly Resources	https://road.issn.org/
ROARMAP	Registry of Open Access Repository Mandates and Policies – maps the Open Access strategies adopted by research institutes that publish peer-reviewed articles with research outputs in their repositories	https://eiz.cvtisr.sk/doi/nastroje-na-podporu-online-publikovania/
SAS	Slovak Academy of Sciences	https://www.sav.sk/

Abbreviation	Explanation	Source
SCOAP3	Sponsoring Consortium for Open Access Publishing in Particle Physics	https://openaccess.cvtisr.sk/slovnik-pojmov/ ; https://scoap3.org/what-is-scoap3/
SPARC	The Scholarly Publishing and Academic Resources Coalition	https://sparcopen.org/
VEGA	Scientific Grant Agency of the MESRS of the Slovak Republic and SAS	https://www.minedu.sk/vedecka-grantova-agentura-msvvas-sr-a-sav-vega/
WoS	Web of Science – a bibliometric database	https://clarivate.com/webofsciencegroup/solutions/web-of-science/

1 National Strategy for Open Science

The development of a knowledge society is one of the keys to increasing the competitiveness of Slovakia and the standard of living of its inhabitants. Moreover, knowledge is the foundation of a knowledge society and a source of public welfare if the society can foster knowledge creation and efficient dissemination.

The National Strategy for Open Science (hereinafter also as the National Strategy) aims to improve the availability of the Slovak science results and change the system of research and evaluation processes towards greater transparency, reproducibility, and integrity. Openness increases the visibility of the work of researchers and research institutions, the scientometric parameters of Slovak scientists, and the development of domestic and international cooperation. It also strengthens the connections with the private and public sectors, which ultimately increases the quality of research output. However, the merits of open science exceed an academic environment. The dissemination of open science practices contributes to the modernization of education and digital transformation of society and increases economic competitiveness.

The creation of the National Strategy is an integral part of the Action Plan of the Open Government Partnership Initiative 2020-2021.[1] It aims to harmonize the development of Slovak science and research with the Recommendation of the EU of 2012 on access to and preservation of scientific information and its 2018 update[2] and with the Horizon 2020 and Horizon Europe Guidelines on the rules of open access to scientific publications and research data.[3] It also reflects a significant development at the European Union level related to open science and open access: the 2016 European Council Conclusions on the transition to an Open Science system, the Plan S, the developments of the European Open Science Cloud (EOSC), taking into account the Slovak conditions for the science and research development. The National Strategy builds on the Research and Innovation Strategy for Smart Specialization,[4] and the 2021–2024 Manifesto of the Slovak Government.[5]

The National Strategy is also connected with other vital documents of Slovakia and the EU that take into account open government; support for open science and open-access publishing; open society; open data; participatory, open, and transparent public administration and governance; open Internet and open markets. The list of relevant domestic and foreign strategic materials is in Appendix 2 to this document.

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[1] Action Plan of the Office of the Plenipotentiary of the Government for the Development of Civil Society 2020–2021

[2] COMMISSION RECOMMENDATION (EU) 2018/790 of 25 April 2018 on access to and preservation of scientific information

[3] Annotated Grant Agreement (Horizon 2020)

[4] Ministry of Economy of Slovakia (2013): Research and Innovation Strategy for Smart Specialization. Currently, an updated version of this document is being prepared for 2021-2027.

[5] The Slovak Government (2021): The 2021–2024 Manifesto of the Government of the Slovak Republic

> **The National Strategy aims to create a sustainable paradigm of participation of all stakeholders in science and research in Slovakia in the implementation of open science global principles in disseminating, mutual sharing, reusing and making research outputs available in Slovakia. This shall foster the development of domestic and international scientific cooperation, public and private sectors cooperation, scientific structure improvement, education of new generations of researchers and higher education teachers, and creation of an environment of better-quality strategic research management and education.**

2 Open Science Definition

Open Science (OS) is a new approach to the scientific process based on cooperation and new ways of diffusing knowledge through the optimal use of digital technologies and on the application of the principles of openness in every aspect of the research lifecycle[6]. The principles of open science started to be promoted as a solution for the crisis in the accessibility of scientific literature and the related crisis in research reproducibility, replicability and generalization, and problems related to science evaluation. OS is a complex approach that emphasizes transparent information strategies, methods, practices, data, access to knowledge, the peer-review process, and knowledge evaluation.[7]

OS aims to make the output of publicly funded research—publications and data—more widely accessible in a digital format with no restrictions or as few restrictions as possible.[8] An important aspect is the use of public licenses that enable users to not only access research results, but also reuse them without any conflict with intellectual property rights (copyright).

'Open Science is a systemic change leading to more efficient science through an open and collaborative way of producing and sharing knowledge and data as early as possible in the research process and for communication and sharing of results. This new approach affects research institutions and science practices by creating new ways of funding, evaluating, and rewarding researchers. Open Science increases the quality and impact of science by fostering reproducibility and interdisciplinarity. It makes science more efficient by better sharing resources, more reliable through better verification, and more responsive to society's needs.'[9]

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[6] According to Foster Open Science

[7] Steinerová J. (2017): Otvorená veda a informačné správanie vedcov v SR (Open Science and information behavior of scientists in Slovakia)

[8] According to OECD

[9] European Commission (2019): Open Science

Open Science affects the whole ecosystem of research and scientific communication. It is based on open access to scholarly publications, which, however, represents only one aspect of OS. Other aspects are as follows:

- Open research data sharing: Data should be FAIR (findable, accessible, interoperable, reusable), i.e., linkable on interoperable platforms and reusable,

- Detailed sharing of scientific methods fostering verifiable and reproducible research,

- Introduction of transparent practices to open peer review,

- Use of open source software,

- Sharing open education resources (OERs) that constitute a bridge between formal and informal education,

- Citizen Science that involves citizens in research within research projects.

The main difference between open access publishing and traditional (non-open) publishing is that articles, which are open access on the Internet, are easier to access and, therefore, more cited[10]. On the other hand, articles published only in a traditional way are visible only to people who have a license/subscription for non-open access journals. However, articles from traditional journals can also be published in OA repositories. Still, publishers set the condition that authors may only do it after the embargo period expires (usually 6-12 months).

Open Science also enhances the cooperation between universities and the world of education and industry. Society needs free of charge, accessible, transparent, verifiable, and reusable research outputs publicly funded more than ever before. Educators, health care professionals, patients, professionals, lay public and public administration representatives are looking for quality information sources so that they could familiarize themselves with issues new to them, keep pace with the global development of their profession, or make evidence-based decisions. Openness creates conditions for improvement of public services; enables the faster introduction of innovations and efficient use; develops information society, and fights against disinformation. The private sector benefits from open science through publicly available information. It is still compatible with the existing structures of intellectual property rights protection; moreover, it gives authors of scholarly publications greater control over their publications through public licenses. Public bodies also do not lose out as information providers: on the contrary, transparency increases their visibility, credibility, and social importance.

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10 Schmitz J. (2017): What's the difference between publishing in open access journals and in non-open access journals?

3 Open Science in Europe

The development of Slovak science is difficult to imagine without any contact with European Research Areas. The European Commission has been promoting an open science and research model and recommending the member states formulate and introduce national strategies in this area since 2012.[11] Opening up of science at the European level gives Slovakia an opportunity for higher-quality participation in the area of resources or cooperation—provided that the standards of openness and research integrity, copyright, and intellectual rights protection are fulfilled.

In 2015, the European Commission (EC) set three goals for the Research and Innovation Policy for 2014-2020: open science, open innovation, and open to the world. These goals affected, in addition to other things, the funding conditions of the Horizon 2020 program. The EC demands from all beneficiaries of Horizon projects **mandatory** open access to peer-reviewed scholarly publications, i.e., accessible online, free of charge to anyone, through a repository (green open access[12]), on the publisher's website (mostly gold open access[13]) or the publication platform.

Under Horizon 2020, the member countries ran a pilot project, Open Research Data Pilot (ORD Pilot). In this project, the principles of openness were applied to research data representing a fundamental pillar of the published research output. The ORD Pilot was gradually extended to cover all thematic areas of Horizon 2020. The ORD Pilot was applied mainly to the data needed to validate the results in scientific publications, and other data (in the DMP) could be provided voluntarily. It was necessary to comply with the following conditions: developing a Data Management Plan (DMP), storing the data in a data repository, ensuring the access of third parties to the data, and providing information and tools needed to access the data.

In the following program period, the Horizon Europe Framework Program 2021-2027, the EC fully supports open science as the *modus operandi* for European science. In addition to mandatory open access to scientific publications, the outputs of grants, the Horizon Europe projects require mandatory DMP. In these projects, closed access to research data will be an exception, not an option. Furthermore, Horizon Europe continues to support building a federated technological infrastructure, the European Open Science Cloud (EOSC), enabling European scientists and researchers to share and process research data.

The EC requires that research data be as open as possible and as closed as necessary. Data sharing is not suitable in duly justified cases, for example, if the research output should be patent or if the data are personal or confidential. The EC aims to introduce best practices in data management into research as a standard in the data policy. Data do not always have to be available to the public. However, if they are organized and stored in repositories in

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[11] European Commission (2012): Open Access

[12] Green Open Access – Articles are published through repositories or on the authors' websites (self-archiving), either immediately or after the expiration of the embargo period (usually 6-24 months).

[13] Gold Open Access - This access is provided directly by the publisher of a journal, who then ensures that readers can access articles for free, but the publisher may ask for the APC, a charge for article publishing.

compliance with the FAIR principles, the entitled users may access them with the permission of the administrator, or they may be published later when the reasons for protection expire.

Apart from open access to research information and research data, the EC in the Horizon Europe program will focus on creating new-generation metrics and considering open science in science evaluation. It will also focus on observing common research integrity standards, education development, and Citizen Science. The purpose is to increase the efficiency of EU support for research and innovation by simplifying the circulation and reuse of excellent research and innovation funded by the Framework Program.

In the European Research Area (ERA), a third of 27 countries implemented an Open Science/Open-Access strategy; the other countries took steps and measures that will lead to strategy development and enforcement. In many countries, the institutions concerned discuss the processes how to ensure the most efficient access to scientific publications and data at the national level. According to the evaluation and analysis of the survey, carried out by the Digital Curation Centre (DCC) and The Scholarly Publishing and Academic Resources Coalition (SPARC),[14] there are only ten member countries in the ERA that have implemented a national strategy.[15] Although the remaining 17 member countries have not adopted a national strategy yet, they are active in its development, official adoption, and efficient implementation. The current situation in adopting the Open Science strategy is shown in the map of 27 European Union (Fig. 1).

[14] SPARC Europe, Digital Curation Centre: An Analysis of Open Science Policies in Europe (2020)
[15] Belgium, Cyprus, the Czech Republic, Finland, Lithuania, France, Malta, the Netherlands, Slovenia, Spain.
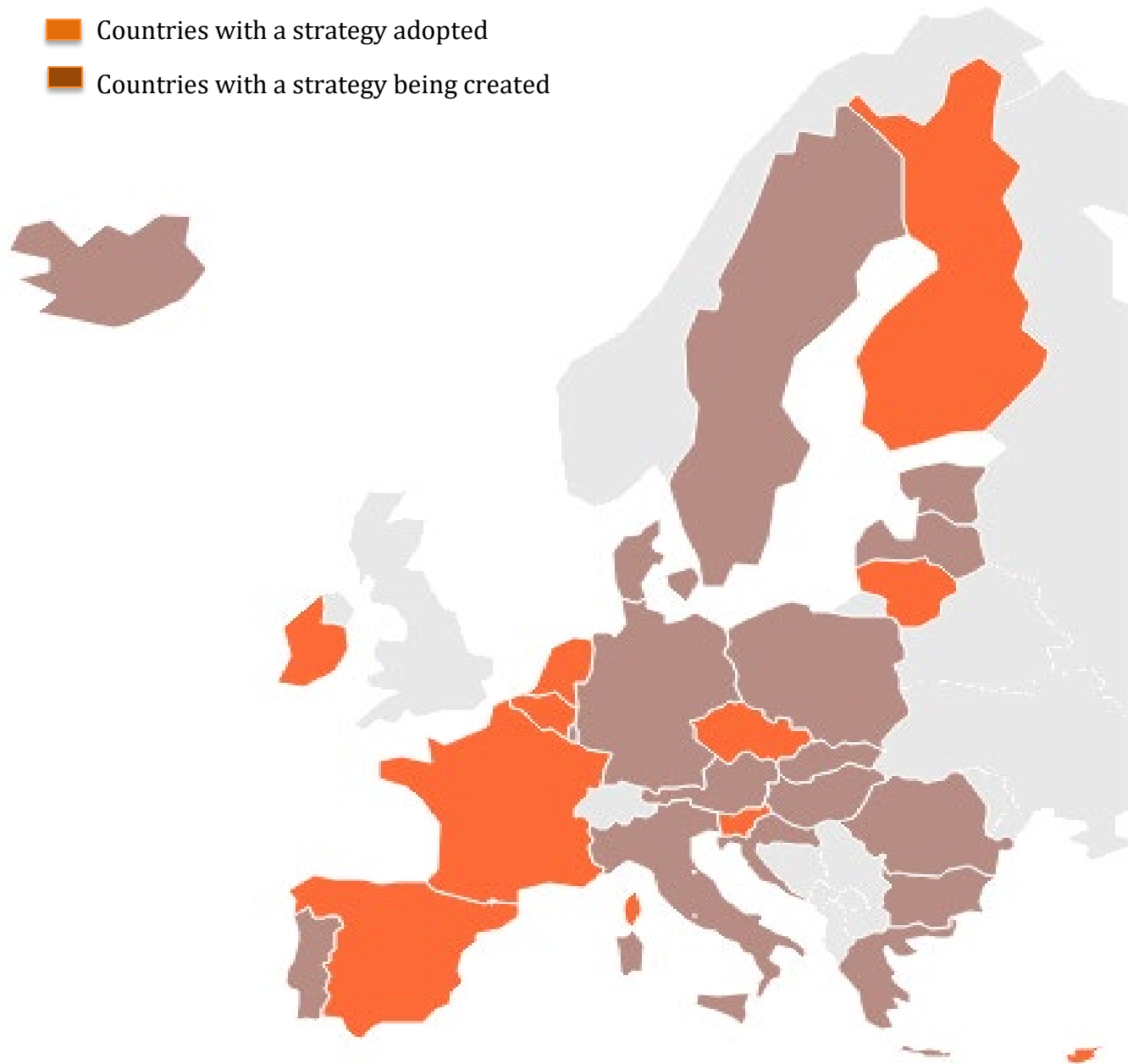
Fig. 1. Strategic models of open science in the EU

Regarding neighboring countries, it is only the Czech Republic that has a national strategy in force (Tab. 1). Austria does not have a national strategy, but a commitment has been made to promote Plan S at all research institutions and universities. Poland is developing many activities for the adoption of national strategies under the auspices of the Ministry of Science and Higher Education. Hungary has adopted an official commitment to join the Open Science movement. Ukraine has adopted legislation on open access.

Table 1. National strategies in the neighboring countries

Country	Open Science/Open-Access National Strategy or other document
CZ	(2017) The Czech Republic National Strategy for Open Access to Scientific Information for 2017-2020 (Národní strategie otevřeného přístupu ČR k vědeckým informacím na léta 2017–2020), (2020) Action Plan for Implementation of the Czech Republic National Strategy for Open Access to Scientific Information for 2017-2020 (Akční plán pro implementaci Národní strategie otevřeného přístupu České republiky k vědeckým informacím na léta 2017-2020), (2021) The Czech Republic National Policy for Research, Development and Innovation for 2021+ (Národní politika výzkumu, vývoje a inovací České republiky 2021+)
HU	(2019) The National Research, Development and Innovation Office (NRDIO), a funding agency, requires OA to publications and DMP
PL	(2015) Directions of the Development of Open Access to Research Publications and Research Results in Poland (Kierunki rozwoju otwartego dostępu do publikacji i wyników badań naukowych w Polsce) (2020) OA Policy of Publications of the National Science Centre (Polityka narodowego centrum nauki dotyczaca otwartego dostepu do publikacji)
AT	(2015) Austrian Science Fund (Fonds zur Förderung der wissenschaftlichen Forschung) has its own OS Policy, (2016) OS mentioned also in the Open Innovation Strategy for Austria (Open Innovation Strategie für Österreich) (2020) Plan S implementation at all research institutions and universities
UA	(2007) Legislation: On the Basic Principles for the Development of an Information-Oriented Society in Ukraine for 2007–2015 (Про Основні засади розвитку інформаційного суспільства в Україні на 2007 – 2015 роки)

4 Open Science Basis and Frameworks in Slovakia

4.1 Institutional System of Open Science in Slovakia

Open Science in Slovakia is institutionally under the umbrella of the Office of the Plenipotentiary for the Development of the Civil Society and the MESRS (SCSTI).

The Slovak Government authorized the Office of the Plenipotentiary for the Development of the Civil Society to address open government issues (the Open Government Partnership). The main goals for this area are defined by the Action Plan of the Open Government Partnership in Slovakia for 2017-2019[16] and 2020-2021.[17] The Action Plan for 2017-2019 in the Area of Open Access set three goals: using Creative Common licenses in documents, methodologies, handbooks, and procedures so that they can be disseminated and used by authors and other right holders in scholarly outputs (accomplished); setting up and running a repository for storing of, long-term archiving of and providing access to Slovak scholarly and expert publications, research data and grey literature (in progress); setting up Contact Office for Open Access (accomplished). The National Strategy is one of the goals of the Action Plan for 2020-2021.

The Contact Office for Open Access was established at the SCSTI in 2016. Its tasks include increasing awareness of open access and open science and systematic fulfillment of the tasks resulting from international projects in which the SCSTI participates. Furthermore, it actively addresses the tasks arising from the Action Plan of the Open Government Partnership in Slovakia and develops cooperation among individual stakeholders in the process of open science and open publishing in Slovakia. Having established the Contact Office for Open Access, the SCSTI took over the role of a national coordinator and methodologist for open science in Slovakia.

The Contact Office for Open Access organizes specialized events to foster open science annually; it carries out webinars; provides consultations, and organizes accredited training on these issues.[18]

Since 2013, the SCSTI has been a National Point of Reference on Scientific Information in the EU. The NRP cooperates with the EC and coordinates the implementation of the measures stated in the EC Recommendation on access to and preservation of scientific information. This role requires active participation in developing common principles, standards, and measures of open science in the ERA and informing about their implementation.

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[16] The Slovak Office of the Plenipotentiary for the Development of the Civil Society (2017): The Action Plan of the Slovak Open Government Partnership for 2017-2019, adopted by the Slovak Government Decree N. 104/2017, dated 1 March 03.2017

[17] The Slovak Office of the Plenipotentiary for the Development of the Civil Society (2019): The Action Plan of the Slovak Open Government Partnership for 2020-2021, adopted by the Slovak Government Decree N. 553/2019, dated 13 November 2019

[18] Open Access courses (2020)

Another project for which the SCSTI is responsible is SCOAP3. Its goal is to unify the publishing of publications related to particle physics and ensure open access to them and other publication services provided by contracted publishers to all interested parties – research institutions, libraries, and experts who are involved in the cooperation in the area of particle physics not only within CERN.

In 2015, the SCSTI accepted another role in the OpenAIRE project, as a National Open Access Desk for Slovakia.[19] OpenAIRE promotes Open Access/Open Data mandates in Europe. The OpenAIRE project provides financial and technical support that Slovakia uses to ensure personnel capacity, access to know-how, and technical infrastructure, enabling the introduction and implementation of OS in the academic and scientific environment of Slovakia. In 2021, OpenAIRE was transformed into a non-profit organization, of which the SCSTI is a member.

In October 2020, the SCSTI entered the EOSC association on behalf of Slovakia. The goal of the EOSC is to build and later run the European federated e-infrastructure, the European Open Science Cloud (EOSC) (more on this in Technical Infrastructure).

4.2 Research and Development Structure in Slovakia as Basis for Open Science Implementation

For statistical purposes in Slovakia, the legal and physical entities carrying out research are divided into the following research and development sectors:[20]

a) a state sector comprised of the Slovak Academy of Sciences[21] and legal entities conducting research and development and established by the central state administration authorities[22] (hereinafter as 'central authority'),

b) a public research institution sector comprised of public research institutions,[23]

c) a higher education institution sector comprised of public higher education institutions, state higher education institutions (HEIs), private higher education institutions, and research and development legal entities established by HEIs,

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[19] OpenAIRE (2020): National Open Access Desk

[20] The basic information on the current research and development structure in Slovakia presents Act No. 172/2005 on the Organization of State Aid for Research and Development in Section 7. Sections 7a and 7b characterize two specific structure elements, i.e., the Centre of Research Excellence (a legal entity) and the Specialized Organization of Science and Technology (a business company).

[21] LP/2021/104 Act that amends the Act No. 133/2002 Coll. on the Slovak Academy of Sciences as amended by later legislation

[22] Act No. 575/2001 Coll. on the Organization of Activities of the Government and Organization of the Central State Administration

[23] Act No. 243/2017 Coll. on a Public Research Institution

d) a non-profit sector comprised of civic societies, non-profit organizations, and associations of legal entities doing research and development,

e) a business sector comprised of entrepreneurs[24] conducting research and development within their business activities.

An important measure, affecting the whole research process in the context of its organization and financial aid, is the certification of research and development entities in Slovakia and the acquisition of a certificate of qualification and competence to conduct research. The current list of organizations contains the organizations that obtained the certificates of qualification and competence to do research according to Section 26a of Act No. 172/2005 Coll. On the Organization of State Aid for Research and Development and amendments to the Act No. 575/2001 Coll. On the Organization of Activities of the Government and Organization of the Central State Administration as amended by later legislation. There are 796 entities with the following number of certificates (Table 2):

Table 2. Number of certificates of qualification and competence to conduct research as from 15 December 2020[25]

Entity	Number	Note
The SAS organization in total	50	
Subsidized (contributory) organizations of the SAS	*22*	
Budgetary organization of the SAV	*28*	
Public higher education institutions	20	
State higher education institutions	3	
Private higher education institutions	9	
Legal and physical entities	714	*Including public research institutions*

The current research and development environment in Slovakia is represented by three sectors:

- a state sector (the SAS and organizations/institutions under the direct authority of some ministries),

- a sector of HEIs (all-type HEIs, science parks, centers of excellence, technology transfer centers),

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[24] Section 2 of the Commercial Code
[25] Source: https://www.vedatechnika.sk/SK/VedaATechnikaVSR/Certifikacia/Stranky/default.aspx

- a business sector (physical and legal entities, including incubators, industrial parks, and industry/business clusters).

The Research and development structure in Slovakia is significantly diversified, and this diversity affects legislation and funding mechanisms.

4.3 Open Science in Slovak Legislation

The implementation of OS principles into the Slovak research and development (R&D) environment is connected with a complex of legal instruments that constitute a legislative framework for the regulation and management of the existence and scope of individual parts of the R&D sector structure and other specific measures such as copyright.

The Slovak Organization for Research and Development (SOVVA) stated: 'In 2015-2020, no systemic and conceptual changes were carried out in Slovakia. Neither the state research and development policy nor the innovation policy were developed for ten years compared to good international practice in many EU member states. No necessary legislative steps were taken: legislatively, the research and development and innovation (R&D&I) follows the Act No. 172/2005 on the Organization of State Aid for Research and Development, which has not been changed systemically for some time and does not meet the current needs of modern R&D&I management at the state level'.[26]

Implementing OS principles at the national level affects **at least** ten laws that constitute a legislative framework for R&D regulation in Slovakia.[27] Considering the fragmentation of this issue in the legal system, the selection of laws affected by the National Strategy, and preparation of changes that will create the necessary conditions to implement OS principles, require a thorough professional analysis. Without such analysis, the specific measures in the OS Action Plans cannot be carried out as prepared.

4.4 Open Science in Existing Strategic Documents

Some of the relevant domestic and foreign strategic documents in Appendix 2 relate to open science. The most current of domestic documents are:

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[26] Havlíčková, Katarína, Straka, Daniel (2020): V teórii a praxi. Analýza výskumných a inovačných politík v SR 2004 – 2020 (In theory and practice. An analysis of research and innovation policies in Slovakia 2004-2020)

[27] Act No. 147/1997 Z. z. on Non-Investment Funds and on the amendment to the Act of the Slovak National council No. 207/1996 Coll.; the Act No. 575/2001 Coll. on the Organization of Activities of the Government and Organization of the Central State Administration; the LP/2021/104 Act that amends the Act No. 133/2002 Coll. on the Slovak Academy of Sciences as amended by later legislation; the Act No. 131/2002 Coll. on Higher Education; the Act No. 172/2005 Coll. on the Organization of State Aid for Research and Development; the Act No. 185/2009 Z. z. on Incentives for Research and Development; the Act No. 185/2015 Coll. on Copyright and Related Rights (Copyright Act); the Act No. 243/2017 Coll. on a Public Research Institution; the Act No. 18/2018 Coll. on Personal Data Protection.

1. **The Research and Innovation Strategy for Smart Specialization of Slovakia** (RIS 3 SK) emphasizes the need for a change of the Slovak economy toward a knowledge-oriented economy, the alignment of Slovak policies with European policies, the inevitability of digital transformation, and a transparent approach to scientific data. The cooperation between scientific and technological stakeholders and business stakeholders must be supported to stimulate innovation. The aim is to gradually create a new cooperation culture, remove deep-rooted stereotypes on both sides, and increase the willingness to share ideas, foster trust, networking, and cooperative behavior.

2. **The Recovery Plan** aims to restart the process of bringing Slovakia closer to developed European countries by improving human capital and creating an innovative environment that will stimulate the competitiveness of Slovakia in activities with higher added value. The Component 9 (More efficient governance and strengthening funding of research and development and innovation) presents the plan for the reform of R&D&I management, evaluation and support; improvement of cross-sectoral cooperation; unification of the system of institutional evaluation and institutional funding of science, research and innovation. It also fosters Slovakia's participation in the Horizon Europe programs, cooperation between academic and business sectors, and digital transformation.

3. **The Roadmap for Research Infrastructures (SK VI Roadmap 2020-2030)** highlights the potential of the existing research infrastructure and its role as a driver of the transition from Slovakia's development and innovation tendencies to a knowledge society. Furthermore, it fosters the application of FAIR principles and solutions that support open science within research infrastructures; a research infrastructure should have, for example, a policy for data management that supports the open science concept in which the research methods, data, and results are thoroughly documented and publicly accessible.

Common denominators of several strategic documents aiming to make the Slovak research environment better and improve its conditions are transparency and the need for wider access to scientific data; digital transformation; following global trends; increasing research management efficiency; improving coordination and mutual communication among higher education institutions, research institutions, and companies. Open Science aims to help fulfill these goals through better access to research results, higher efficiency and productivity of the research system, and multiple opportunities for domestic and global research cooperation.

4.5 Technical Infrastructure for Open Science

The technical infrastructure for open science to preserve data in Slovakia lags behind other European countries. For example, the EC Open Science Monitor, while mapping, among other

things, the area of institutional research data repositories[28] (Fig. 2), points out their lower number in Slovakia (Fig. 3). The situation is better with institutional digital storage systems[29] that are mainly used to store and provide internal access to publication outputs from the institution or the institution's section (Tab. 3).
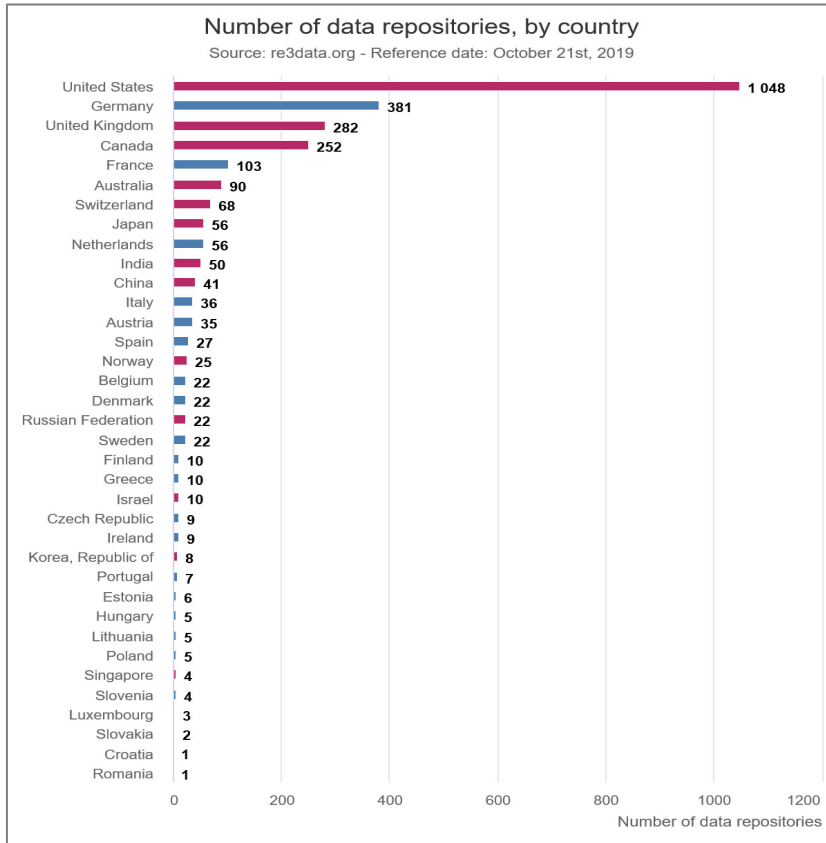
Fig. 2. Number of research data repositories by countries[30]

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[28] *An institutional repository* is a repository containing digital documents produced by research, scientific, development, and other creative activity of a specific institution/consortium of institutions. *A repository* is a network-accessible storage system in which digital objects may be stored for possible subsequent access or retrieval. It has mechanisms for adding new digital objects to its collection (depositing) and for making them available (accessing), using, at a minimum, the repository access protocol. The repository **may contain other related information, services, and management systems**. (Kahn, R., Wilensky, R. A framework for distributed digital object services (2006).

[29] *Digital storage* is an information system providing storage, protection, integrity, authenticity, and availability of digital documents and data in the long term.

[30] European Commission (2019): Study on Open Science: Monitoring Trends and Drivers
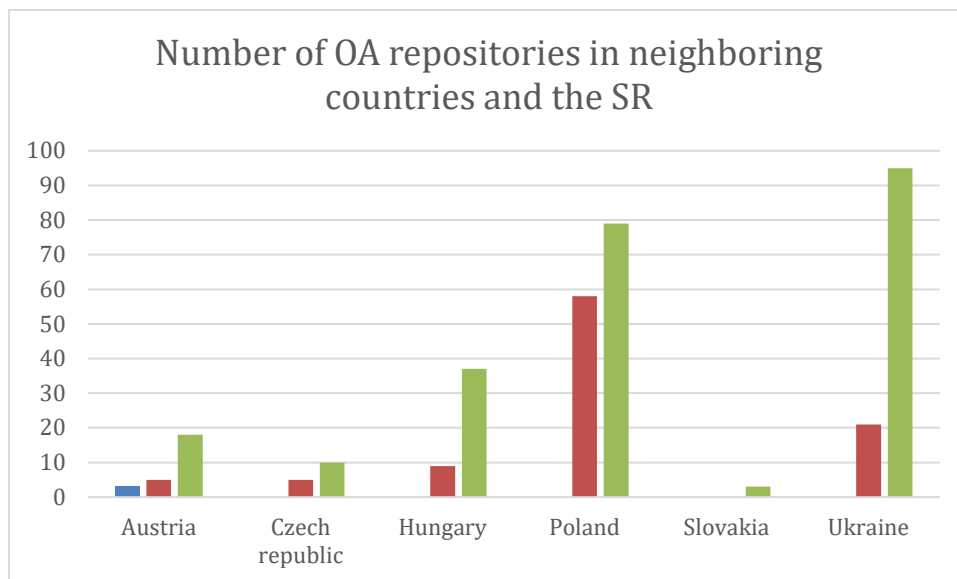
Fig. 3. Number of repositories in neighboring countries and Slovakia in ROAR[31]

Table 3. Existing data storage systems and repositories in Slovakia

Institution (year)	Software	Type	Purpose	Policy
Faculty of Chemical and Food Technology, Slovak University of Technology, 2007	Fedora	Institutional digital storage	Storage of and access to the SUT FCFT publication output	An exclusive license for the institution
Department of Mediamatics and Cultural Heritage, University of Žilina, 2017	DSpace 6.3	Institutional repository	Storage of and access to the DMCH publication output and data and thematic and external content	DMCH publisher: OA theses: solely for the institution external content: OA

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[31] Registry of Open Access Repositories (2020)

Institution (year)	Software	Type	Purpose	Policy
Slovak Academy of Science, 2019	Extension of the registry of publication output ARL	Institutional digital storage	Storage of and access to the SAS employee's publication output	As open as possible, as closed as necessary, the publications of employees – OA for the institution's employees, external content – according to the web/license conditions of the publisher
Slovak University of Agriculture, 1998	Apache, OpenSSH	Institutional digital storage	Storage of and access to the SUA publication output	Solely for the institution
Ministry of Education, Science, Research and Sport, 2020		National digital storage of educational content	Storage of, access to, and creation of open educational resources (OERs)	open access

Higher education institutions usually ensure storing and preserving publication output through academic libraries; the SAS through the SAS Central library. However, the internal rules of research institutions are not set to ensure the publication of the employee's output primarily under a public license. Consequently, the access conditions differ from institution to institution, depending on the type of research publication or data.

In September 2020, the Slovak Ministry of Education, Science, Research and Sport launched the central storage of educational content for OERs, called Viki,[32] whose objective is to introduce public licenses for available and emerging educational resources procured from public funds. These resources should be available to the public with no limitations.

Slovak employees who conduct research and development can use foreign or international repositories of research data and information. The list of such repositories can be found in

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[32] http://viki.iedu.sk

the Registry of Open Access Repositories, ROAR,[33] (e.g., the ZENODO repository[34]), or they can use the OSF platform.[35]

In 2016, the European Commission launched the EOSC initiative, whose aim is to run a federated technological and data infrastructure, following the principles of OS. The EOSC integrates existing data and IT infrastructures that are currently scattered between disciplines and EU member states. The EOSC will offer all European scientists and professionals in natural sciences, technology, humanities, and social sciences a single pan-European virtual environment with open services to preserve, manage, analyze, and reuse research data. It will also offer high-speed connectivity, high-capacity cloud solutions, and supercomputers to them.

The EOSC is a supportive environment whose aim is to accelerate the transition to open science, open innovation, and a single digital market.[36] It is part of the infrastructure that addresses the needs of European researchers in digital services, such as networking, computational technology, and data management. The e-infrastructures support OS development, i.e., new working methods based on sharing digital tools and resources in different disciplines and technological areas and sharing results and on an open method of cooperation. The EOSC, as part of the European Cloud Initiative[37], shall fully develop the value of big data and boost scientific and technological innovation.

4.6 Trends in Open Access Publishing in Slovakia

The Central Registry of Publication Activity (the CREPČ, abbreviated from the Slovak name "Centrálny register evidencie publikačnej činnosti") registers the publication output of the Slovak Higher Education Institutions. According to this registry, higher education institutions produce annually approximately 3,400 scientific articles in journals registered in the Web of Science or Scopus databases, approximately 2,900 scientific articles in other journals, and approximately 1000 monographs and many other types of publications.[38] The CREPČ system registers detailed information on publications, but not the information, whether published in an open-access model. Adding the open-access indicator to the CREPČ system would simplify the process of fact-finding related to open-access publishing of Slovak authors and include openness in evaluating research. Open access itself also makes it easier to verify records in the system.

The CREPČ system does not include information on the SAS publication activity, but this information can be found in the SAS annual reports.[39] The SAS authors publish annually over

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[33] Registry of Open Access Repositories (2020)

[34] CERN (2020): Zenodo

[35] Open Science Framework

[36] Ferrari T., Scardaci D. (2018): The Open Science Commons for the European Research Area

[37] The European Cloud initiative https://ec.europa.eu/digital-single-market/en/european-cloud-initiative

[38] CREPČ https://cms.crepc.sk/statistiky.aspx

[39] SAS https://www.sav.sk/?lang=sk&doc=docs-ann

1,300 articles in journals indexed in the Current Contents database, several hundred articles in other journals, about 100 monographs, and many other types of publications. According to the SAS Central Library analysis (A. Doktorova, personal communication), the SAS authors published 633 open-access articles in Elsevier, Springer-Nature, and Wiley in 2015-2019, which represents less than 22% of the total number of articles published by these publishers for the SAS authors. This ratio varied from publisher to publisher. Some publishers allow OA publishing less than others do or under such unfavorable conditions that authors do not choose that option. While open-access publishing was up to almost 40% in Springer-Nature and 33% in Wiley, Elsevier published only 7% of articles by the SAS authors in an open-access model. However, the existence of the SAS repository creates conditions for open access to all publications of the SAS authors.

The international databases the Web of Science (WoS) and Scopus have been registering the open access to publications for some years, so it is possible to determine the percentage of OA from the resources indexed in these databases. The limitation of these databases is that they do not index quality journals equally in all scientific disciplines (they index almost all quality journals in some disciplines, in other disciplines only some journals). Around 70% of the publications of Slovak authors in these databases represent articles in scientific journals; the remaining articles are contributions to conference proceedings or book chapters.

In the Web of Science (Table 4), the percentage of OA publications by Slovak authors has increased slightly (from 30.8% in 2016 to 43% in 2019). The Scopus database (Table 5) shows a similar trend (from 26% of the OA articles of Slovak authors in 2026 to 39% in 2019). However, when compared internationally, Slovakia lags behind most neighboring countries, except for the Czech Republic (but in absolute numbers, the Slovak scientists publish about half as many OA publications in the WoS and Scopus databases as the scientists in the CR, which is caused by the overall lower publication output of Slovak science). The Netherlands, a European pioneer in open access, publishes 48% of scientific publications in the Scopus database and 55% of scientific publications in the WoS database in an OA model.

Table 4. Percentage of OA publications in the Web of Science

Percentage of OA publications in WoS

	2016	2017	2018	2019
Austria	39,56	40,57	44,03	48,55
Czech republic	30,87	32,74	35,44	37,99
Hungary	46,92	45,73	49,08	54,05
Poland	40,31	42,09	43,25	49,55
Slovakia	30,82	34,88	36,54	43,16
The Netherlands	44,52	48,28	52,45	55,4
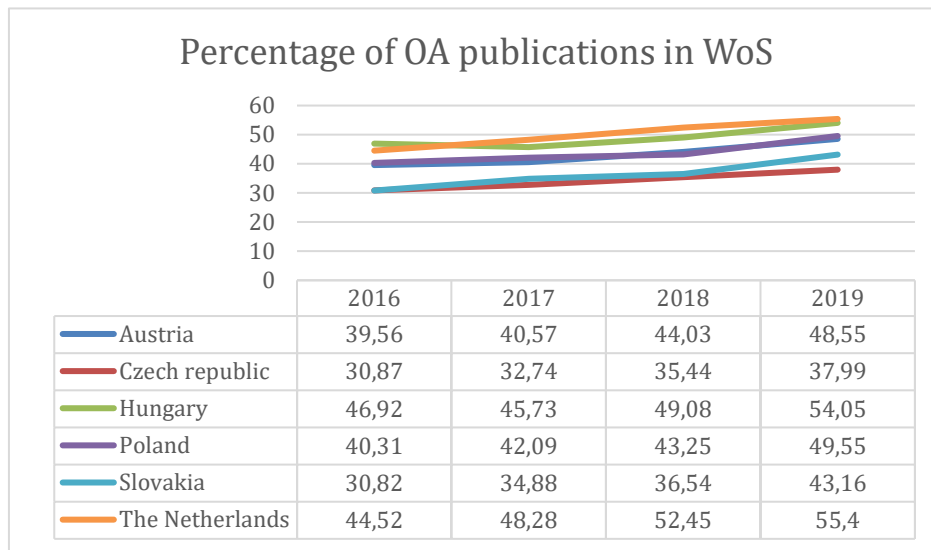
Table 2. Percentage of OA publications in the Scopus database

Percento OA publikácií

	2015	2016	2017	2018	2019
Slovenská republika	26,32	31,05	34,64	35,46	39,00
Česká republika	26,61	29,26	30,37	31,92	34,46
Rakúsko	29,48	34,19	35,06	39,78	43,30
Maďarsko	27,15	30,20	30,84	34,90	43,65
Poľsko	33,31	36,65	37,79	39,00	44,46
Holandsko	31,41	37,04	40,42	44,11	47,97
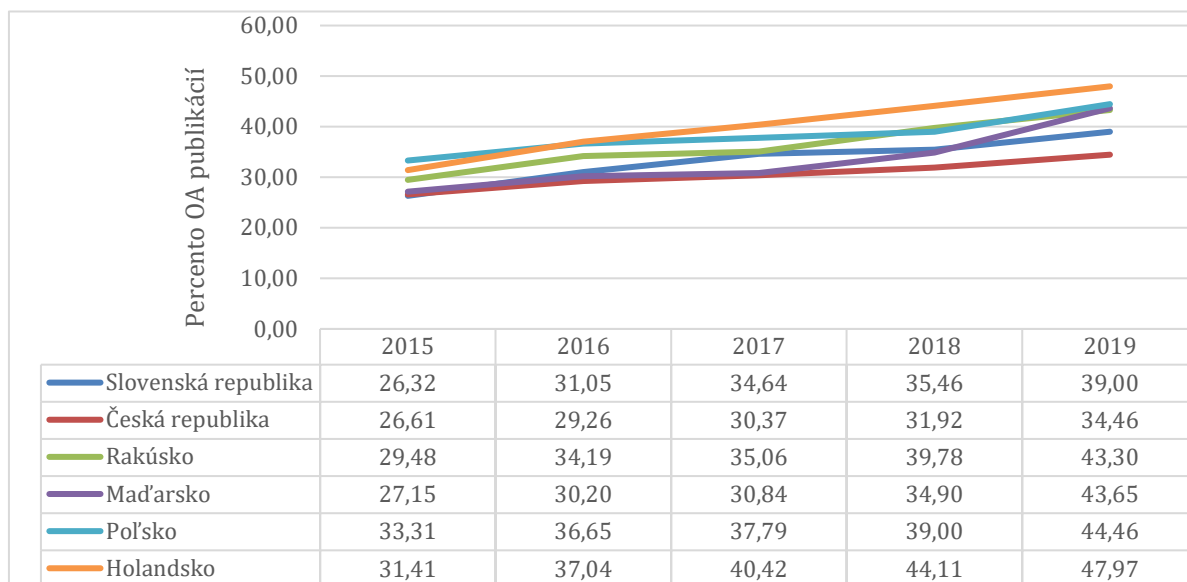
The journal lists of the Web of Science and Scopus databases, which publish the majority of articles of Slovak authors (Appendix 1), indicate that Slovak scientists often cannot publish in the most prestigious journals. Discussion about publication output cannot be separated from funding. The higher prestige of a journal is usually associated with the higher APCs (article processing charges). Slovak scientists from underfunded Slovak institutions can afford such APCs only if they participate in large international projects. However, obtaining research grants is often conditioned by previous publication in recognized scientific journals.

First-class scientific OA journals that do not require APCs exist, but they are not easy to find in every scientific discipline.

4.7 Open Access Publishing Funding

Evaluation of the Slovak research ecosystem has long pointed out that science and research in Slovakia are underfunded (European Semester 2019). The expenditure on science and research is much less than 1% of GDP, compared to the average in the EU is 2.19% of GDP (2019).[40] Researchers identify the lack of funding as the main factor limiting OA publishing. In Slovakia, the costs of publishing the publication output of the project/research data in an OA model are funded solely in the form of eligible costs of the implemented research project.[41]

4.7.1 State Budget of Slovakia

a. Slovak Research and Development Agency

The Slovak Research and Development Agency (the SRDA) is the only national grant agency established to support research and development by granting funds from the state budget. The SRDA has considered the costs of publication in OA journals (Gold OA – APCs) within the realized project as eligible costs of the implemented project since 2012 (up to the amount of 5000 EUR):

'The SRDA considers the expenditure on publication in OA journals as eligible costs of the project and encourages principal investigators and co-investigators of the projects to prioritize the publication of the results of the SRDA projects for a reasonable and justified price in OA journals.'.[42]

'A cost related to open access is an eligible cost if the expenditure on open access is provably and directly related to the realization of the activities of the project and the dissemination of its publication output. Regarding scientific information, the support for open access is earmarked only for professional research articles published in professional peer-reviewed journals; a professional research journal is a provider of an open-access service, i.e., it can mean subscription-based journals that offer authors the possibility to pay for open access ((hybrid open-access journals) or journals completely open (open-access journals). Eligible costs related to open access **may not exceed the amount of 5000 EUR.** *The published professional research article has to be subsequently deposited in a repository".*[43]

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[40] Source: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20201127-1

[41] Act No. 172/2005 Coll. on the Organization of State Aid for Research and Development, Section 17

[42] SRDA (2018). About SRDA

[43] SRDA (2018). About SRDA

The Scientific Grant Agency (the VEGA, abbreviated from the Slovak name "Vedecká grantová agentúra") was established as an advisory body of the minister and an auxiliary body of the SAS Presidium. It ensures mutual coordination in selecting and evaluating basic research projects carried out at the higher education institutions and scientific institutes of the SAS.[44]

Given the number of researchers, projects and the number of first-class research outputs, the overall budget of the VEGA is low: 'it represents only 2.3% of the total financial means in the category of current expenditure on science and research in Slovakia (EUR 16,267mil/697,029 mil), or 5.4% of the total national expenditure on basic research (EUR 16,267mil/301,22 mil). In 2019, one project funded through the education sector received on average 8,868 euros in the category of current expenditure; one project in the SAS received on average 7,169 euros in the category of current expenditure.'[45]

It is possible to reimburse the charges for open-access publications, but in view of the amount of current APCs[46] and the number of project grants, it is rarely done.

Cultural and Educational Grant Agency of the Ministry of Education, Science, Research and Sport of Slovakia (the KEGA, abbreviated from the Slovak name "Kultúrno-edukačná grantová agentúra") is an internal grant organization for higher education institutions. The agency provides financial support for applied research projects in education, pedagogy, creative, and interpretative arts. Since 2018, the system has also been available to private higher education institutions. In 2020, 4.4 million euros were redistributed to the KEGA projects.[47]

Slovak grant schemes currently do not use mandate policies regarding publishing publication outputs/research data in an open-access model, and such obligation do not results from existing legislation.

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[44] Slovak MESRS (2018). Scientific Grant Agency of the MESRS and SAS (VEGA), the VEGA statutes
[45] The VEGA Annual Report for 2019
[46] Markin, P. (2017): How Much Do Top Publishers Charge for Open Access?
[47] The KEGA Annual Report for 2020

4.7.2 EU funds

The EC vision and policy[48] on open science are reflected in financial aid for OA publishing of scientific publications and data produced in the approved project. Furthermore, the new programming period of the EU Cohesion Policy for 2021-2027[49] puts the emphasis is on entering the most updated data into the open data platform.

a. Horizon 2020 and Horizon Europe Framework Programs

Horizon 2020 and Horizon Europe framework programs accept as eligible the costs of publishing in OA journal during the time of the duration of the project and the expenses that are necessary within the open Research Data Pilot. There is no limitation on the amount of APC. The funding of OA for scientific publications and scientific data is provided only in the time of the project's duration. Detailed specifications and conditions for OA funding in research projects under Horizon 2020 are stipulated in the General Grant Model Agreement (29.2 Open access to scientific publications, 29.3 Open access to research data).[50]

The conditions for OA funding in a new programming period Horizon Europe) were not known at the time of preparation of the National Strategy.

b. Operational Program Integrated Infrastructure (OPII)

The OPII has accepted the costs of OA publishing of publications from the OPII projects as eligible since 2018. The manual of eligible costs for OPII R&D of the Ministry of Education, Science, Research and Sport[51,52] defines costs as eligible if they are associated with peer-reviewed publication and APC **do not exceed 5000 EUR.**

*'A cost related to open access is an eligible cost if the expenditure on open access is provably and directly related to the realization of the activities of the project and the dissemination of its publication output. Regarding scientific information, the aid for open access is earmarked only for professional research articles published in professional peer-reviewed journals; a professional research journal is a provider of an open-access service, i.e., it can mean subscription-based journals that offer authors the possibility to pay for open access ((hybrid open-access journals) or journals completely open (open-access journals). Eligible costs related to open access **may not exceed the amount of 5000 EUR**. The published professional research article has to be subsequently deposited in in a repository'.*[53]

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[48] Towards better access to scientific information: supporting benefits of public investment in research (2012)

[49] https://ec.europa.eu/regional_policy/sk/2021_2027/

[50] European Commission (2012): AGA –Annotated Model Grant Agreement (Horizont 2020)

[51] SR MESRS (2018): Manual of Cost Eligibility of the Operational Program Research and Innovation

[52] The OPRaI (Operational Program Research and Innovation) program was focused on the creation of a stable environment, favorable to innovation. Since 13 December 2019, it has been merged with the Operational Program Integrated Infrastructure (OPII) on the basis of the decision of the Commission C (2019) 9078 .

[53] SR MESRS (2018): Manual of Cost Eligibility of the Operational Program Research and Innovation

4.8 Education about Open Science in Slovakia

The Contact Office for Open Access at the SCSTI is the only institution providing systematic education about open science since 2018. This education is carried out through module courses called 'Open Access Basics.'

This course follows the UNESCO curricula[54] and consists of 4 thematic modules, all of which the MESRS accredits:

- Introduction to Open Access,

- Infrastructure for Open Access,

- Resource Optimization,

- Interoperability and Retrieval.

The course is intended for librarians, researchers, and university teachers who want to improve their open access and science knowledge. From 2018 to 2020, 77 participants from all regions of Slovakia were trained.[55,56] The philosophy of the course is the 'train the trainer' model, and the goal is for its graduates to spread information about OA and organize education about open science at their workplaces.

In addition to continuing education, academics and researchers in Slovakia have webinars at their disposal, in the Slovak language or a foreign one, in which case they have to understand it. Furthermore, libraries and research institutions[57] occasionally organize lectures on open science.

The attention associated with open access to scientific content is focused more on the so-called predatory publishers [58] of open-access scientific content. Deceitful practices of predatory publishers are used when charging APCs in exchange for fast publication of scientific publications with no or fake peer review. Such practices present a risk for Slovak science, and the academic community has to be warned about it because various myths are spread in association with this negative communication (for example, identifying OA journals

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[54] UNESCO (2015): UNESCO launches Open Access Curricula for Researchers and Librarians

[55] Open Access courses (2020)

[56] Note: the SCSTI does not provide only continuing/lifelong education; therefore, the capacity to organize courses to a greater7 extent is limited.

[57] Research institutions – institutions qualified to conduct R&D

[58] Predatory publishers - unscrupulous, fraudulent publishers focused on the quantity of published content. To make a profit from publication fees, they try to attract as many paying authors as possible (often by unsolicited emails and false statements about the prestige of their journal). They pretend to conduct a peer-review process, but it is not carried out; they publish any texts without any review, thereby contaminating scientific records with poor quality and damaging trust in the process of scholarly communication (more about this issue: https://openaccess.cvtisr.sk/homepage/predatorske-publikovanie/).

with predatory journals[59]). These myths have a negative impact on the perception of OA and OS, not only in Slovakia.

Low or deformed awareness of this problem can be solved by ensuring complex education about OS directly in organizations and institutions that are part of the Slovak scientific ecosystem.

4.9 Copyright Protection and OA Publishing

Public licenses in the Slovak legal system are governed by Section 76 of the Copyright Act No. 185/2015. Public licenses are always free of charge, non-exclusive, and irrevocable. The most widespread licenses in the world are Common Creative licenses that work on a simple principle:

'By using CC licenses, authors give some of their rights to potential users and reserve other rights. Creative Commons licenses do not negate the classic understanding of copyright; they are its extension.'[60]

There are seven CC licenses; each of them has specifically defined licensing conditions. In the Slovak legal environment, it is problematic to apply the CC0 license/tool, public domain dedication, as this license marks the work as public domain work, but according to the Slovak legislation, authors cannot relinquish their rights.

CC licenses represent a standard for publishing OA journals. The situation with the Slovak scientific journals is not clear. Slovak OA journals can be searched for in online directories of OA journals such as DOAJ[61] and ROAD. [62] The list of Slovak OA journals is also maintained by the ISSN National Agency ISSN [63] and SCSTI. The website https://openaccess.cvtisr.sk/ contains the list of Slovak OA journals, the type of CC licenses used, and the databases in which the journals are registered. [64] In 2020 (July 2020), CC licenses, according to this list, were used by 76 journals of 182 registered Slovak OA journals.

4.10 Open Educational Resources in Slovakia

The Action Plan of the Open Government Partnership Initiative 2020-2021, in its part Open Education, addresses the development of Open Educational Resources (OERs) in Slovakia. According to Adamova et al. (2020):

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[59] Predatory journals – journals of publishers whose editorial practice violates publishing ethics and the content does not meet quality standards of international scientific publishing.

[60] Creative Commons Slovakia (2015): Creative Commons

[61] Directory of Open Access Journals

[62] Directory of Open Access Scholarly Resources

[63] University Library in Bratislava (2020): OA journals

[64] Open Access journals

'To implement OERs, it is necessary for Slovakia to participate actively in the international movement in this area. Participation of Slovak experts in important international events and creating partnerships can help achieve that.'[65]

OERs in Slovakia can be divided into several categories: informatics, open software, and various subjects for schools for which the Office of the Plenipotentiary for the Development of the Civil Society collected the links.[66] The Alliance for Open Education promotes open education in Slovakia.[67]

The current epidemic situation has led to a stronger need and demand for OERs. The current effective Act No. 245/2008 [68] stipulates that 'the holder of copyright to the approved textbook, approved teaching material, approved workbook or recommended textbook, for purchase of which the ministry of education provided funds, shall, for the period of the emergency situation and state of emergency, agree to provide access to an electronic version of a textbook, teaching material or a workbook, including those published in the minority language, on the website designated by the ministry of education for pupil/students and their legal guardians, pedagogical employees, and professional employees.'

The Viki digital storage (originally called the Central storage of digital content, CSDC) has been offering educational resources for primary and secondary schools since 2020, and these resources are partly accessible in an open-access model under a public license. OERs for higher education can be found individually on the websites of universities or various educational platforms. However, they are still waiting for a systemic solution or a common platform.

4.11 Science Evaluation

Evaluation of research results is a complicated process aiming to monitor science quality, find out how well it fulfills its mission in society, compare the performance of institutions, teams, or scientists and help distribute financial means to foster good practice and enable the development of excellence.

Research quality evaluation has many difficulties. One of them is the very nature of research, overcoming the boundaries of known and unknown, which often makes it impossible to reach a clear conclusion about the future impact of research. Another problem is personnel: Quality evaluation by peer-review requires groups of independent experts educated and experienced in specific disciplines. On the other hand, it is technically possible to measure quantitative outputs such as the number of publications and references, and it seems more

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[65] Bednárik and Adamová (2015): Otvorené vzdelávanie (Open Education)

[66] The Office of the Plenipotentiary for the Development of the Civil Society (2020): Open Educational Resources as a tool to support pupils and students during school closure / a list of interesting links.

[67] Adamová et al (2020): Otvorené vzdelávanie (Open Education)

[68] Section 13b of Act No. 245/2008 as of 1 January 2021

objective than peer review. Therefore, bibliometric indicators are used as a basis in science evaluation in many countries, including Slovakia.

The legal framework for science evaluation in Slovakia is given by Act No. 172/2005 Coll. On the Organization of State Aid for Research and Development and Amendments to the Act No. 575/2001 Coll. On the Organization of Activities of the Government and Organization of the Central State Administration as amended by later legislation. Publication activity is the first criterion in evaluating the ability to conduct research and development (according to Section26a Subsec.7). Other criteria are patents, utility models, and licenses, the amount of financial means acquired in the calls for tenders for targeted R&D support, active participation in projects whose results were applied in economic or social practice, participation in international projects and projects in international R&D centers, ensuring conditions for education of employees in R&D, and a management quality certificate in a respective R&D area. These criteria form the basis of a support system stipulated in Section 16 of Act No. 172/2005 Coll., including the references to other laws and implementing regulations. The Slovak Academy of Sciences and public research institutions within its founding scope of authority and HEIs within the founding scope of authority of central state administration bodies have a different level of formalization of evaluation systems, but, in the end, the evaluation relies on quantitative performance indicators in considering the weight of publication outputs.

Publication activity has a special position in science evaluation and its own registry: The Central Registry of Publication Activity (the CREPČ). In addition to Ordinance No. 397/2020 on the Central Registry of Publication Activity and the Central Registry of Artistic Activity, Act on Higher Education and Directive No. 13/2008-R on Bibliographic Registration and Classification of Publication Activity, Artistic Activity, and References of the Slovak MESRS are also used in the evaluation.

The SAS system or the VEGA and KEGA project databases work independently of the CREPČ. In Slovakia, there is no single system for science evaluation in all segments working at a national level (as it is, for example, in the Czech Republic, the Netherlands, or the UK).

Science evaluation based on publication uses mainly metrics of the Web of Science and Scopus databases: the journal impact factor (IF), Scimago journal ranking (SJR), quartile (Q showing in which quartile the given journal is based on citations in a particular subject category). However, bibliometric systems face criticism that they do not sufficiently consider the limitations of quantitative evaluation, the need for professional interpretation of metrics, the context of the citation, and the differences between disciplines in the publication and citation habits.

Bibliometric systems do not take into account the accessibility of results, efficiency, transparency, and increased reproducibility that open science offers, although these characteristics undoubtedly contribute to the good practice in research, and many scientists are aware of it. Collegiality toward scientists from developing countries or the significant citation advantage of the OA publication can encourage openness among scientists. However, the science evaluation system in Slovakia does not take into account the merits of open science and does not motivate scientists to openness yet.

The fact that the evaluation system poses one of the main obstacles, obstructing faster OA and OS growth, also resonates at the European level, together with an argument that if scientists should change their behavior and culture of scholarly communication, institutions and grant agencies should also change the view of science evaluation. In 2017, the EC Working Group, The Open Science Working Group on Rewards/Recognition, prepared a recommendation on the evaluation of R&D researchers in Europe[69] with the OS-CAM criteria (Open Science Career Assessment Matrix), enabling complex assessment of the contribution of a researcher or university teacher.

This material could serve as a valuable contribution to the professional discussion of the modification of the Slovak science evaluation system.

4.12 Citizen Science

Citizen science (CS) involves the wider public in scientific projects and often uses advanced forms of scholarly communication. Citizen science complies with traditional science standards regarding the expertise and quality of outputs (tackles current scientific questions and yields new original results, including scientific publications) and involves the public in traditional science. It creates conditions for the cooperation of scientists and various partners from civil society, thereby increasing the social impact of research. Citizens' engagement can take different forms: most often, they help collect or analyze big data files. The citizen science projects are carried out under the guidance of researchers. In addition to primary research goals, they can also fulfill other goals, such as community development, education, popularization of science, increasing public trust in science, skill development, awareness-raising about various issues relevant to the community, and solutions to local problems. Citizen science has a great potential to reduce the communication barrier between the research environment and the public; therefore, it is becoming more and more popular worldwide.[70,71]

There are many established international CS platforms working abroad (e.g., https://www.zooniverse.org/, https://eu-citizen.science/). An effort to reach as wide a public as possible is a specific feature of citizen science; including the groups of the public who might not have a good command of English might and some projects are carried out only in a specific region. Therefore, it is important to create local platforms in national languages (e.g., in the Czech Republic: https://www.citizenscience.cz/, in Austria: https://www.citizen science.at/en/, https://zentrumfuercitizenscience.at/, or in Germany: https://www.buergerschaffenwissen.de/projekte.

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[69] European Commission (2017): Evaluation of Research Careers Fully Acknowledging Open Science Practices: Rewards, incentives and/or recognition for researchers practicing open science
[70] Socientize (2014): White Paper on Citizen Science for Europe
[71] European Citizen Science Association defines 10 principles of citizen science (translated by M. Gogola): https://ecsa.citizen-science.net/wp-content/uploads/2020/02/ecsa_ten_principles_of_citizen_science_slovak_0.pdf

Several projects with citizen science features are carried out in Slovakia (e.g., Visitor: http://visitor.sav.sk/#/ or Enviróza (Enviroza): https://www.enviroza.sk/). However, systematic support, greater recognition of citizen science, or a Slovak platform for citizen science are still absent.

5 Analysis of Initial State in the Context of Open Science in Slovakia

This analysis is not an analysis of the current situation in Slovak research and development. Open science logically reflects all the merits and deficiencies of Slovak science as they have been identified many times, currently, for example, in the SOVVA report: 'What from and how science lives in Slovakia II. – Evaluation of Research and Innovation in Slovakia.'[72] This analysis aims to determine and define the basis for the direction of development of open science in Slovakia. The tool used is a SWOT analysis, that is, the analysis of external factors (opportunities and threats) and internal factors (strengths and weaknesses).

5.1 Strengths
- Increase in the participation of the Slovak scientific and academic community in international R&D activities and project calls,

- Representation of Slovakia in international structures focused on education, science, research and innovation,

- Increase in the number of scientific outputs published in an OA model,

- Increase in the interest of researchers, university teachers, students, and librarians in open science,

- Strong institutional background at the national and international level (National Point of Reference in the group for Open Science in the EC, the Governance Board member of the EOSC, the EC infrastructure, and the National Coordinator of the activities in the area of Open Science (Contact Office for Open Access),

- Long-term systematic education in the area of open access (accredited curriculum),

- Support of the Plenipotentiary for the Development of the Civil Society, development of the National Strategy as a part of the Action Plan of the Open Government Partnership,

- Support of the Slovak Rectors' Conference in developing and implementing the National Strategy,

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[72] Halásová, B., Straka, D. (2020): What from and how science lives in Slovakia II. – Evaluation of Research and Innovation in Slovakia. https://www.sovva.sk/publication/z-coho-a-ako-zije-veda-na-slovensku-ii-hodnotenie-stavu-vyskumu-a-inovacii-na-slovensku/

- Participation of Slovakia in international projects for open science (e.g., OpenAIRE, EOSC). [73,74]

5.2 Weaknesses

- Low awareness of open science in the academic and scientific community, persistent disinformation about open science,

- Weak technical infrastructure: absence of institutional and data repositories,

- Lack of open science policies at the institutional level (open access, research data management),

- Traditional system of evaluation of scholarly publishing and pressure for quantitative indicators of R&D performance,

- Fragmentation of R&D funding,

- Complicated legislation,

- Long-term insufficient funding of science and research in Slovakia,

- Insufficient use of open education possibilities,

- Insufficient awareness of citizen science,

- Low level of inter-institutional cooperation,

- Insufficient access to foreign research results,

- Absence of tools to share knowledge and research results,

- Brain drain.

5.3 Opportunities

- Reducing duplicity of scientific projects and more efficient use of investment in research investments,

- Increasing transparency in R&D evaluation and funding,

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[73] EOSC (2020): EOSC

[74] For example, Science Europe, The European University Association, EOSC Governing Board, Commission National Points of Reference on Scientific Information.

- Establishing new partnerships for researchers and increasing interactivity between researchers (internationalization),

- Fostering research interdisciplinarity,

- Increasing the citation of scientific publications and reuse of research outputs and publications,

- Increasing the visibility of Slovak R&D internationally,

- Accelerating the process of discovering, innovation, and knowledge transfer,

- Improving digital skills of researchers and university teachers,

- Fostering continuing/lifelong education of researchers and university teachers,

- Participating in building and implanting European vision of open science,

- Participating in existing and emerging European projects associated with open science (EOSC, OpenAIRE, etc.),

- Using a federated technological infrastructure [75] EOSC (preservation and access to scientific data from the entire European scientific community),

- Opportunity to use a qualitative aspect of R&D evaluation,

- Developing institutional and technical infrastructure.

5.4 Threats

- Obstacles in obtaining scientific project grants,

- Pressure from big publishers of scientific content: lack of funding to pay for costs associated with OA publishing,

- Insufficient circulation of ideas, researchers, and university teachers between the Slovak and global scientific community (insufficient visibility of Slovak science),

- Systems of traditional R&D evaluation emphasizing quantitative metrics such as the impact factor,

- Standardization of scientific policy by the EU down to the level of member states, building open science down to the level of member states, and open science development in given structures and legislation.

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[75] The federated infrastructure EOSC aims to connect existing (or planned) data technical infrastructures (such as repositories or data storages) and create a common European scientific data network in the EU.

5.5. Evaluation of SWOT Analysis

To determine the influence of individual SWOT factors, the weight and importance of these factors must be determined, that is, their weight and significance within the given area, while taking into account their depth and scope together with conditions of the Slovak academic and scientific environment.

A three-score scale was used for weighting: minor weight, moderate weight, and major weight. A five-score scale was used to rate significance: very significant, significant, moderately significant, slightly significant, and insignificant.

Weight					
Major positive influence	Moderate positive influence	Minor positive influence	Major negative influence	Moderate negative influence	Minor negative influence
+0.10	+0.05	<0.05	-0.10	-0.05	<-0.05

Significance				
Very significant	Significant	Neither significant nor insignificant	Slightly significant	insignificant
5	4	3	2	1

When we evaluate external threats and opportunities, internal strengths and weaknesses of the Slovak R&D environment from the viewpoint of open science, we will get the following score:

Strengths	Weight	Significance	Value
Increase in the participation of the Slovak scientific and academic community in international R&D activities and project calls,	0.15	5	0.75
Increase in the interest of researchers, university teachers, students, and librarians in open science	0.06	4	0.24
Representation of Slovakia in international structures focused on education, science, research and innovation	0.16	5	0.8
Increase in the number of scientific outputs published in an OA model	0.1	4	0.4
Strong institutional background at the national and international level	0.15	4	0.6
Long-term systematic education in the area of open access (accredited curriculum)	0.1	4	0.4
Support of the Plenipotentiary for the Development of the Civil Society, development of the National Strategy as	0.06	2	0.12

a part of the Action Plan of the Open Government Partnership,			
Support of the Slovak Rectors' Conference in developing and implementing the National Strategy,	0.06	3	0.18
Participation of Slovakia in international projects for open science (e.g., OpenAIRE, EOSC).	0.16	5	0.8
	1		**4.29**
Weaknesses	**Weight**	**Significance**	**Value**
Low awareness of open science in the academic and scientific community, persistent disinformation about open science,	0.12	-5	-0.6
Weak technical infrastructure: absence of institutional and data repositories,	0.12	-5	-0.6
Lack of open science policies at the institutional level (open access, research data management),	0.08	-4	-0.32
Traditional system of evaluation of scholarly publishing and pressure for quantitative indicators of R&D performance,	0.12	-5	-0.6
Fragmentation of R&D funding,	0.12	-5	-0.6
Long-term insufficient funding of science and research in Slovakia,	0.12	-5	-0.6
Complicated legislation,	0.12	-5	-0.6
Insufficient use of open education possibilities,	0.04	-4	-0.16
Insufficient awareness of citizen science,	0.08	-2	-0.16
Low level of inter-institutional cooperation,	0.08	-5	-0.4
	1		**-4.64**
Opportunities	**Weight**	**Significance**	**Value**
Reducing duplicity of scientific projects and more efficient use in research investments,	0.078	5	0.39
Increasing transparency in R&D evaluation and funding,	0.078	5	0.39
Establishing new partnerships for researchers and increasing interactivity between researchers (internationalization),	0.078	4	0.31
Fostering research interdisciplinarity,	0.078	3	0.23
Increasing the citation of scientific publications and reuse of research outputs and publications,	0.078	5	0.39
Increasing the visibility of Slovak R&D internationally,	0.078	5	0.39

Accelerating the process of discovering, innovation, and knowledge transfer,	0.078	5	0.39
Improving digital skills of researchers and university teachers,	0.078	4	0.31
Fostering continuing/lifelong education of researchers and university teachers,	0.06	4	0.24
Participating in building and implanting European vision of open science,	0.06	4	0.24
Participating in existing and emerging European projects associated with open science (EOSC, OpenAIRE, etc.),	0.078	5	0.39
Using a federated technological infrastructure EOSC (preservation of and access to scientific data from the entire European scientific community),	0.078	5	0.39
Opportunity to use a qualitative aspect of R&D evaluation,	0.078	5	0.39
Automation of institutional and national infrastructure.	0.078	3	0.23
	1		**4.68**
Threats	**Weight**	**Significance**	**Value**
Obstacles in obtaining scientific project grants,	0.21	-3	-0.63
Pressure from big publishers of scientific content: lack of funding to pay for costs associated with OA publishing,	0.21	-5	-1.05
Insufficient circulation of ideas, researchers, and university teachers between the Slovak and global scientific community (insufficient visibility of Slovak science),	0.21	-5	-1.05
Systems of traditional R&D evaluation emphasizing quantitative metrics such as the impact factor,	0.21	-4	-0.84
Standardization of scientific policy by the EU down to the level of member states, building open science down to the level of member states, and open science development in given structures and legislation.	0.16	-2	-0.32
	1		**-3.89**
Internal factors	-0.35		
External factors	0.79		
Total score	**0.44**		

The analysis highlights the factor of opportunities that open sciences offers. The weaknesses outweigh the strengths in the internal factor analysis (negative score). The strategic goals of the National Strategy for Open Science must take into account and use strengths in the form of **a strong representation of Slovakia in international structures of open science and**

solid institutional background. On the other hand, **weaknesses must be reduced** to use all possibilities of open science fully.

6 Target Groups of the National Strategy for Open Science

This strategy aims to address not only individual researchers and university teachers, who have been used to publishing in 'closed' resources for many years and for whom the Internet and open access opened new possibilities; other target groups of the Nationals Strategy are:

6.1 Researchers

Open science represents a benefit for researchers, university teachers, and students in the form of increased visibility and prestige of their work. However, they are also consumers of open science because they benefit from free-of-charge access to global knowledge and the output of the scientific world.

6.2 Research Institutions

The SAS organizations, higher education institutions (public, state, private), legal and physical entities qualified to conduct research and development (including public research institutions and legal entities doing R&D that are established by central authorities) want the results of their R&D activities to be more visible, more cited, and to have a greater impact, and thus increase the prestige and influence of their institution. Open access to scientific publications and scientific data enables a more transparent evaluation of research institutions, and thus a more efficient use of financial means.

6.3 Research and Development Funders

Open access makes it easier for funders to map R&D possibilities. Openness also facilitates transparency of R&D funding and more efficient use of financial means.

6.4 Business Sector

Companies can benefit thanks to the availability of the basic research results, publicly funded, and develop them in applied research into innovations beneficial for society. A transparent environment and increased visibility of researchers' work will also make it easier for companies to find partners for cooperation in research institutions. Furthermore, open access for commercial economic entities represents a transfer into the innovation of products and services. Thus, open access fosters the competitiveness of the economy and economic growth.

6.5 Government and Executive Power

The Slovak Government through its executive bodies (the Ministry of Education, Science, Research, and Sport of Slovakia, the Slovak Ministry of Finance, and other relevant stakeholders) aims to support the development of excellent scientific disciplines, develop

innovation, and make Slovak research and development visible at the European and global level. Openness increases transparency and more detailed evaluation of R&D activity and enables strategic and targeted R&D management with respect to more efficient use of funding and investment in Slovak research teams and institutions.

6.6 Primary and Secondary Schools

Open educational resources are an integral part of open science. Open science gives schools from the primary level of education and research institutions the possibility of fast distribution of teaching aids; online open access is available anytime from anywhere. Furthermore, it enables sharing examples of good practice, cooperation, rapid production of up-to-date materials, diversity and creativity in the teaching process, and education in the area of copyright and intellectual property protection. The financial means saved in the production and distribution of teaching materials allow the funds to be transferred to investments in innovative education methods.

6.7 Libraries, Archives, Museums, and Galleries

Open science brings free access to the latest expert knowledge from all over the world to libraries, archives, museums, and galleries, their users, and visitors. It ensures new forms of R&D information support (e.g., scientific publication and data repositories and storages, scholarly publishing on open source platforms, virtual collections of museums, etc.) and significantly increases awareness of institutional memory funds.

6.8 Publishers of Open Scientific Publications

Open access for publishers of open scientific publications means a benefit in the form of increased use and citation of their products. Currently, publishers take into account trends in open science by offering alternative business publishing models (golden access[76], hybrid journals[77], diamond access[78], etc.)

6.9 Administrators of Repositories and Information Systems for Research, Experimental Development and Innovation

Administrators of repositories and information systems for research, experimental development and innovation are important actors in open science because they ensure functioning and long-term sustainability of systems essential for making open content accessible to all actors participating in scholarly communication. Open science brings to them increased content, its visibility and use, and increased demands on services provided.

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[76] Gold open access/gold route: open access to scholarly publications is ensured by a publisher that requires processing fees (APCs, article processing charges) to be paid to cover the cost.

[77] A hybrid journal is a scientific peer-reviewed journal that publishes some papers in an open-access model and some articles in a traditional model: for a fee.

[78] Diamond open access/diamond route: scientific journals make their articles accessible in an open-access model with no APCs.

6.10 Public

As a contributor or collaborator, the general public can participate in various R&D projects within citizen science. Open access provided on equal terms to all citizens can increase interest in science itself and, through citizen involvement, improve the quality and overall impact of science on society.

7 Strategic Areas

The National Strategy for Open Science contains nine priority strategic areas that define the main direction of open science development in Slovakia in 2021–2028.

The priority strategic areas of the implementation of open science principles in Slovakia are the following areas:

1. Open access to publications funded from public resources and/or in the public interest,

2. Open access to scientific data and supplementary materials,

3. Technical infrastructure for open science,

4. Open science funding,

5. Protection of intellectual property rights in the context of open science,

6. Fostering the use of open IT tools and existing open data,

7. Education in the area of open science,

8. R&D evaluation in line with open science principles,

9. Fostering citizen science.

It is important to emphasize that the individual strategic areas are connected with the currently effective Action Plan for Open Science that continuously monitors the implementation of a strategic vision into Slovak scientific and academic practice through specifically defined tasks.

Strategic area 1 – Fostering Open Access to Publications Funded from Public Resources and/or in the Public Interest

Vision: Strategic support for free online access to scientific publications publicly funded.

- Task 1.1: Recommend developing institutional policies[79] requiring publication and preservation of research outputs[80] in an open-access model, preferring diamond

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[79] Institutional policies help the employees of the institution understand how to proceed with the research outputs in an open-access model. The policies can be found in the register ROARMAP.

[80] research output

access (publishing in scientific journals with open access with no APCs for authors) and green access (archiving preprints, scientific articles, and supplementing materials in repositories).

- Task 1.2: Specify and unify the conditions for public access, in the form of open access under public licenses, to final (bachelor's thesis, master's thesis and dissertation) and qualification (rigorous and habilitation) theses, monographs, university textbooks, and teaching materials that are published mandatorily and funded from public resources.

- Task 1.3: Popularize the publication of Slovak scientific publications in an open-access model through online publishing platforms.

- Task 1.4: Recommend grant agencies that they develop policies requiring the publication of research results in an open-access model.

Strategic area 2 – Open Access to Scientific Data and Supplementary Materials

Vision: Research data and research materials that form the basis of scientific publications and research projects are as open as possible and as closed as necessary. Fostering data management policies in line with FAIR principles.

- Task 2.1: Develop institutional policies that require research data management, research material management, and mandatory data management plans in accordance with the FAIR principles.

- Task 2.2: Require mandatory research data management plans for publicly funded projects.

Strategic area 3 – Technical Infrastructure for Open Science

Vision: Building a new infrastructure and connecting the existing technical infrastructure that enables storing and preserving, analyzing, and providing access to scientific publication and data and is compatible with FAIR principles.

- Task 3.1: Develop a methodology for building institutional repositories in Slovak research institutions; create a list of repositories funded from public resources and publish it on the institution's website.

- Task 3.2: Connect the Slovak technical infrastructure for open science with the European EOSC infrastructure.

Strategic area 4 – Open Science Funding System

Vision: Stable and transparent mechanisms that enable to cover the costs associated with open access publishing.

- Task 4.1: Increase grant schemes for projects funded by public resources by APCs.

- Task 4.2: Systematize and institutionalize the open-access publishing funding mechanism and the transparent APC funding mechanism.

- Task 4.3: Conclude temporary transformative agreements ('read and publish' agreement[81]) with publishers of scientific content. These agreements allow the publication of a certain amount of publications in an open-access model without paying APCs, and they will make the transition to full OA possible.

- Task 4.4: Raise awareness of Horizon Europe projects and their mandatory open science policy for the 2021–2027 programming period[82] and raise awareness of and support for the development of a data management plan.

Strategic area 5 – Protection of Intellectual Property Rights in the Context of Open Science

Vision: Using a copyright in line with the principles of publishing in an open-access model.

- Task 5.1: Define the terms and conditions in institutional policies for granting public licenses to scientific publications and research data in research institutions to the maximum extent possible, while considering the protection of intellectual property rights.

Strategic area 6 – Fostering the Use of Open IT Tools and Existing Open Data

Vision: Open science is more accessible to anyone if open IT tools (open software, open hardware, open standard transfer protocols, and open standard data formats) are used to process data and for other activities. Using open IT tools reduces costs and helps avoid a lock-in commercial solution. Open science can work with existing open data from public or private spheres.[83]

- Task 6.1: Popularize using open IT solutions in research institutions and open science.

- Task 6.2: Foster the requirement to use open IT solutions in project and grant calls.

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[81] Technopolis Group (2020): Read & Publish contracts in the context of a dynamic scholarly publishing system
[82] European Commission (2019): Horizon Europe
[83] Open data file is a file of machine-readable data in an open standard format with a public license.

- Task 6.3: Popularize and promote the use of existing open data in research institutions and open science.

Strategic area 7 – Education in the Area of Open Science

Vision: Open science as an integral part of study programs at higher education institutions (level 1-3) and in the SAS (level 3); open science as part of lifelong education of librarians and information specialists.

- Task 7.1: Recommend incorporating the topic of open science in introductory subjects of HE study programs of 1st, 2nd, and 3rd level.

- Task 7.2: Develop and operate online platforms for open science-related OERs for an academic and scientific community.

- Task 7.3: Incorporate the topic of open science into the study programs of future generations of information specialists and librarians in Slovakia.

Strategic area 8 - Evaluation of R&D according to Open Science Principles

Vision: To expand the evaluation criteria for science, research, and academic activity in accordance with open science principles in all scientific areas and disciplines. The gradual transition and introduction of these criteria are in line with the priority of ERA[84] that defines open sciences as one of the key aspects of scientific activity.

- Task 8.1: Recommend changing the R&D evaluation system with considering the open science elements.

- Task 8.2: Include open science in policies of development, support, and recognition of researchers and university teachers.

- Task 8.3: Establish a methodological and coordination body that will provide guidelines and national coordination in the implementation of open science principles in all research processes.

Strategic area 9 – Fostering Citizen Science

Vision: Citizen science projects actively involve citizens in a scientific endeavor that brings new knowledge or understanding. They achieve genuine scientific results, and thus are beneficial not only for scientists but also for citizens.[85]

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[84] European Commission (2020): What is ERA
[85] ECSA (2018): 10 Principles of Citizen Science

- Task 9.1: Ensure visibility and recognition of the results of scientific and technical projects of citizen science in society.

- Task 9.2: Promote the concept of citizen science by developing educational materials.

- Task 9.3: Engage students in citizen science projects.

- Task 9.4: Build a network of cooperation and support for Slovak citizen science projects.

8 Implementation of National Strategy for Open Science

The National Strategy defines the main steps and measures necessary to introduce and fulfill the open science principles in Slovakia.

Particular tasks and measures resulting from the National Strategy and their schedule are included in the Action Plan for Open Science, whose development is connected with the National Strategy and will be updated regularly every two years, starting with the Action Plan for Open Science 2021-2022.

8.1. Institutions Responsible for Implementation

The Ministry of Education, Science, Research and Sport is responsible for the implementation of the strategy.

The Slovak Center of Scientific and Technical Information is designated as a supervisor of the implementation of the NS. Its task is to supervise the process of implementing the strategy, monitor risks, and, depending on the situation, develop Action Plans for Open Science. The SCSTI and the Working Group for Open Science shall continually assess and publish the fulfillment of the tasks and prepare the final Evaluation report that will be submitted to the Slovak Government Council for Science, Technology and Innovation.

8.2. Plan for the Implementation of Activities

PHASE 1   INITIATION AND ENSURING OF CONDITIONS FOR IMPLEMENTATION

The initial phase includes the activities necessary for a proper setup of implementation conditions. They mainly involve analyzing, mapping the environment, and gathering information to ensure a smooth transition to the next phase of implementation. At the end of Phase 1, all activities are evaluated and, based on the evaluation outcomes, the parameters and schedule for Phase 2 are defined.

PHASE 2   REALIZATION

Phase 2 includes realizing the tasks and measures defined Action Plans, including inter-ministerial activities and legislative changes. Phase 2 is the main stage of the National Strategy implementation.

PHASE 3   EVALUATION

Phase 3 represents a final detailed evaluation of the defined tasks and measures, aiming to create a long-term follow-up strategic document.

8.3. Timetable

Table 3. Timetable

	2021	2022	2023	2024	2025	2026	2027	2028
PHASE 1								
Action Plan 1	██	██						
PHASE 2								
Action Plan 2, Action Plan 3			██	██	██	██		
PHASE 3								
Action Plan 4							██	██

8.4. Funding Sources

The implementation of the NS is funded by a combination of EU financial resources and the state budget of Slovakia. The allocation of financial resources for specific tasks in 2-year intervals is part of regular Action Plans for Open Science.

8.5. System of Monitoring and Evaluation of Strategy Implementation

The fulfillment of the vision of the National Strategy will be continually evaluated continually in the course of implementation (*in medias res*) through Action Plans. An evaluation report will be published after each implementation phase. If the execution of tasks is not sufficient and does not lead to the fulfillment of NS visions, it will be necessary to alter the funding, time schedule, the capacity of human resources, and other aspects that determine the implementation of NS. The supervisor and Working Group for Open Science at the MESRS will propose the specific form of measures. Monitoring the implementation of the Action Plan measures and fulfilling the visions of the National Strategy for Open Science is the responsibility of the supervisor, the Slovak Center of Scientific and Technical Information. In the final implementation phase, Phase 3, the supervisor shall prepare the Final Evaluation Report and submit it to the MESRS and the Slovak Government Council for Science,

Technology and Innovation. The Final Report will analyze and map the current state of research and development in Slovakia in view of the openness of individual aspects of the research cycle and the application of qualitative tools in the evaluation of R&D evaluation in Slovakia. The entire implementation of the National Strategy for Open Science will be evaluated in accordance with the EU Science and Innovation Policy, in which open science represents one of three pillars.

8.6. System of Risk Management and Conditions for Implementation

In addition to the goal of a successful implementation of the National Strategy, it is necessary to define the prerequisites for success and identify the associated risks. In view of the long-term character of this strategic document, the main risk is maintaining the continuity of the implementation along with preserving the philosophy of the content.

The following risks and success prerequisites for successful fulfilment of the visions of the National Strategy were identified:

Table 4. Risks to the Implementation of the National Strategy

Risk	Significance of Impact[86]	Prerequisite of Success
Insufficient allocation of funds from the European funding mechanisms	high	Ensuring necessary allocation of EU funding to implement strategic projects via financial resources from the EU funds and the EU Recovery Plan funds.
Insufficient allocation of funds from the state budget	high	Ensuring necessary allocation of funding from the Slovak state budget via the budget chapter of the MESRS.
Economic crisis	critical	Identifying priority areas and a system of crisis management of the implementation.
Political instability	critical	Identifying priority areas and a system of crisis management of the implementation.
Aggravated epidemiological situation	critical	Identifying priority areas and a system of crisis management of the implementation.
Insufficient involvement of the relevant stakeholders	relevant	A strong mandate and discipline of the stakeholders necessary to implement the National Strategy.
Academic community – conservative and closed	relevant	Continual realization of educational activities and raising awareness of open science principles in a scientific and academic community.

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[86] Negligible, relevant, high, critical

Insufficient inter-ministerial cooperation	relevant	Active communication and cooperation of individual stakeholders in order to ensure connection of the legislative process with the sector of education, finances and other relevant actors.
Not complying with the timetable of Action Plans	relevant	Strong project management and system of increased crisis management of the areas that pose a risk to the timetable of the NS implementation.

The SCSTI, the NS supervisor, will continually assess risks during the implementation of individual Action Plans for Open Science.

The following activities will be carried out in the risk assessment:

1. Assessment of identified risks, changes in impact significance, or changes in the prerequisites for success,

2. Possible adjustments in measures to minimize impacts of identified risks,

3. Initiation of remedial measures in individual tasks of strategy implementation,

4. Monitoring the implementation of the remedial measures,

5. Identification of new risks, their assessment in view of their impact significance and probability of occurrence.

9 Conclusion

The National Strategy for Open Science 2021–2028 is the first long-term strategic document that introduces the implementation of open science principles in the Slovak scientific environment. Its primary goal is to direct the development in this area and give the implementation of open science in Slovakia strong foundations that can be used for further development.

The National Strategy for Open Science 2021–2028 will be evaluated in 2028.

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Annexes

Annexe 1. The APC amount for journals in which the Slovak scientists publish most

The Bibliometric Database Web of Science

OA Journal Title[87]	Publisher	Country of Origin	APC Amount	Number of Publications (WoS)
Sustainability	MDPI	CH	1900 CHF	99
Bratislava Medical Journal (Bratislavské lekárske listy)	AEPress, s.r.o.	SK	0 €	84
Journal of Microbiology, Microtechnology and Food Sciences	Faculty of Biotechnology and Food Sciences, SPU Nitra	SK	0 €	82
Journal of High Energy Physics	Springer	IT	0 €	70
MM Science Journal	MM publishing Ltd	CZ	9 000 CZK	68
European Physical Journal C	EDP Sciences, Società Italiana di Fisica, Springer Berlin Heidelberg	FR, IT	covered by SCOAP	65
Physics Letter B	Elsevier	NL	0 €	65
TEM Journal – Technology Education and Management Informatics	UIKTEN	SRB	400 €	64
Molecules	MDPI	CH	2000 CHF	61
Advances in Science and Technology Research Journal	Lublin University of Technology	PL	250 €	58
Acta Chimica Slovaca	STUBA	SK	0 €	53
International Journal of Environment Research and Public Health	MDPI	CH	2300 CHF	50
Physiological research	Institute of Physiology, CAS	CZ	400 – 1000 €	50
Nuclear Physics A	Elsevier	NL	1680 €	48
Physical Review D	American Physical Society	US	2500 $	48
Acta Montanistica Slovaca	FBERG TUKE	SK	0 €	47
Bioresources	NC State University	US	1452 $	47
Journal of Electrical Engineering (Elektrotechnický časopis)	FEI STU	SK	0 €	41
Scientific Reports	Nature Research	US	1690 €	37
Clinical Social Work and Health Intervention	I-GAP	AT	0 €	36
Management Systems in Product Engineering	De Gruyter	PL	200 €	36
Metals	MDPI	CH	1600 CHF	34
Polish Journals of Management Studies	PCZ	PL	650 €	33
Materials	MDPI	CH	2000 CHF	30
Scientific Journal of Silesian University of Technology – Series Transport	Silesian University of Technology	PL	0 €	30

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[87] TOP 25 most frequented OA journals in which Slovak authors published in 2018 and 2019 (arranged by a number of articles, source: Web of Science)

The Bibliometric Database Scopus

OA Journal Title [88]	Publisher	Country of Origin	APC Amount	Number of Publications (Scopus)
Matec Web of Conferences	EDP Sciences	FR	0 €	245
IOP Conference Series Material Science and Engineering	IOP Publishing	UK	0 €	241
Transportation Research Procedia	Elsevier	NL	0 €	198
Slovak Journal of Food Sciences (Potravinárstvo)	Association HACCP Consulting	SK	250 €	110
Sustainability	MDPI	CH	1900 CHF	101
Bratislava Medical Journal (Bratislavské lekárske listy)	AEPress, s.r.o.	SK	0 €	100
Molecules	MDPI	CH	2000 CHF	87
Manufacturing Technology	J. E. Purkyne University	CZ	150 €	85
Journal of High Energy Physics	Springer	IT	0 €	73
Journal of Microbiology, Microtechnology and Food Sciences	SPU Nitra	SK	0 €	73
European Physical Journal C	EDP Sciences, Società Italiana di Fisica, Springer Berlin Heidelberg	FR, IT	Covered by SCOAP	72
MM Science Journal	MM publishing Ltd	CZ	9 000 CZK	72
Physics Letter B	Elsevier	NL	0 €	70
Scientific Reports	Nature Research	US	1690 €	64
E3S Web of Conferences	EDP Sciences - Web of Conferences	FR	0 €	62
Physiological Research	Institute of Physiology, CAS	CZ	400 – 1000 €	61
International Journal of Environmental Research and Public Health	MDPI	CH	2300 CHF	56
International Journal of Molecular Sciences	MDPI	CH	2000 CHF	51
Journal of Physics Conference Series	IOP Publishing	UK	2315 €	51
IFAC PapersOnLine	Elsevier	AT	0 €	50
Physical Review D	American Physical Society	US	2500 $	49
Xlinguae	Slovenská Vzdelávacia a Obstarávacia s.r.o., Nitra	SK	290 – 310 €	47
IOP Conference series Earth and Environmental Science	IOP Publishing	UK	0 €	46
Journal of Electrical Engineering (Elektrotechnický časopis)	FEI STU	SK	0 €	43
Filozofia	Filozofický ústav SAV	SK	0 €	42

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[88] TOP 25 most frequented OA journals in which Slovak authors published in 2018 and 2019 (arranged by a number of articles, source: Scopus)

Annexe 2. The list of relevant domestic and foreign strategic materials

Year	Title	Origin	The main goal of the document	Connection to Open Science
2006	Study on the economic and technical evolution of the scientific publication markets in Europe	European Commission	To investigate the state of scholarly publishing industry; point out overpriced scientific journals (prices do not reflect costs but rather prestige indicators), specific features, and imbalance of the scientific publishing market in the context of economy and policies.	It recommends introducing open access to research results as soon as they are published; leveling up the 'playing field' in scientific publishing; ensuring permanent access to publications through reliable archiving; ensuring interoperability of visibility tools, accessibility, and dissemination of scientific information; and fostering a more balanced business environment.
2006	ERC Scientific Council Statement on Open Access	European Research Council	It emphasizes the importance of scientific journals and peer review, but expresses concerns that high prices of some journals limit the availability of research results and thus risk slowing down scientific progress. European funders of science should consider working together and taking a common approach.	The European Research Council intends to introduce in 2007 a policy to store research results, funded from the 7th Framework Program, mandatorily in open repositories.
2007	Long-term Purpose of State Policy for Science and Technology until 2015	Slovak MESRS	To involve science more intensively in dealing with the economic and social problems of Slovakia. The document describes R&D infrastructure in Slovakia; defines systemic priorities and priorities for action in science and technology, research and development; proposes a system supporting science and technology; defines priorities in international scientific and technical cooperation, and proposes a system for evaluation of science,	Technical R&D infrastructure, built via state infrastructure development programs funded solely from a state budget, must be publicly accessible to R&D organizations from the HEI sector and public sector. Popularization of science and technology - increasing the public's understanding of the world of science and technology world; improving the access to explanation of research goals and results; supporting public participation in the world of science and technology.

			popularization of science and technology.	
2007	Strategy for Popularization of Science and Technology in Society	Slovak MESRS	To raise public awareness of science tasks and implementation of research results in practice. To increase the interest of young people in science and the scientific profession. To improve the communication skills of scientists. To increase the prestige and societal recognition of scientific and research professions. To support public's participation in the world of science and technology via an intensive dialog. To raise awareness of the relationship and dependency between the amounts of funds allocated from the state budget for science/technology/R&D institutions and the public's opinion. To involve the public in the popularization of R&D processes.	The National Center for Science and Technology Popularization will run the Central information channel for science, technology and innovation that will provide a wide range of information on science, technology, and innovation and will be a key source of information on science, technology, and innovation in Slovakia. The central information portal will be formed as a web portal that will enable easy access via the Internet browser. It will ensure acquiring, processing, and providing information related to research and development.
2008	Strategy for Fulfilment of Long-term Purpose of State Policy for Science and Technology until 2015, for the period to 2010	Slovak MESRS	Strategy for fulfilling the main goals of state policy for science and technology until 2010, in the area such as R&D infrastructure, material R&D priorities, international cooperation in science and technology, R&D evaluation, popularization of science and technology, ethics in research and support for science and technology.	Fostering research, science, and technology; introducing research results in practice; evaluation of science; ethics in R&D, popularization of science.
2008	Modernization Program Slovakia	Slovak MESRS	To provide an initial stimulus for modernization efforts and outline specific measures in priority areas: R&D&I, education,	Fostering science, research and innovation, education, and employment; improving the business environment; achieving better regulation and greater transparency;

			employment, and the business environment improvement, better regulation, and higher transparency.	technology transfer and popularization of science.
2012	For better access to scientific information: fostering benefits of public investments in research	European Commission	Improving access to scientific information and fostering benefits of public investments in research; clarification of the ways of execution of open access policy in Horizon 2020.	It defines a measure that the SC intends to adopt to improve access to scientific information and foster the benefits of public investments in research. It clarifies the methods of execution of open access policy in Horizon 2020, the EU framework program for research and innovation (2014–2020). It calls on member states to develop better policies and procedures associated with data access and data preservation.
2013	Knowledge for Achieving Prosperity – Strategy for Research and Innovation for Smart Specialization of the Slovak Republic	Slovak MESRS	To demonstrate that Slovakia is capable of strategic management and concentration of permanently limited resources with an aim of sustainable development, and to develop the republic harmoniously on the principles of smart, sustainable, and inclusive growth in order to enhance the competitiveness of Slovakia and the EU as a whole.	Research promotion and funding; analysis of the current state of the Slovak research environment and creation of a dynamic, open, inclusive, and innovative society as a prerequisite for improvement of life quality and the public's attitude toward science, technology and innovation; popularization of science and technology.
2013	RIS3 Strategy for Research and Innovation for Smart Specialization	Slovak Ministry of Economy and Slovak MESRS	See 'Knowledge for achieving prosperity: a strategy for research and innovation for smart specialization of Slovakia.'	See 'Knowledge for achieving prosperity: a strategy for research and innovation for smart specialization of Slovakia.'
2016	National Plan of Research Infrastructure Use and Development (SK Roadmap 2016)	Slovak MESRS	To stimulate structural changes in the Slovak economy towards growth based on increasing innovation capacity and excellence in science and innovation. The	The role of the SCSTI as a National reference point for the area of open access to scientific information and its storage/preservation, rules of funding, and use of research infrastructures – it is an essential condition for

			document complements the RIS3 and OP Science and Innovation (OP S&I) and describes the area of research infrastructures so that their support could contribute to the fulfillment of the main goal of the RIS3 SK.	public funding of infrastructure, governed by the rules of state aid, to provide more users with open access to such infrastructure. Research infrastructure will be used to distribute R&D results on a large scale.
2016	National Concept of Public Administration Informatization	Office of the Deputy Prime Minister of Slovakia for Investments and Informatization	To define strategic goals and principles for public administration informatization and propose priorities for public administration informatization with an emphasis on the openness of processes, actual competitiveness, and increase in IT value in key functions of public administration.	Ensuring that public administration uses data fully: improving public administration data availability in the form of open data – all public administration data not subject to confidentiality or not containing sensitive or personal data will be published as open data via publicly accessible interfaces that will enable machine data processing and their free reuse. Proportion of systems using open source software – 40%; Public administration services must be easily accessible to any EU citizen. When using electronic services, users shall have access to all relevant information – openness of data, APIs and standards in the category of data, application and technological principles and the e-government platform.
2016	Smart Industry Concept (with Action Plan)	Slovak Ministry of Economy	Smart industry is an expected reaction to the fourth industrial revolution in which industrial production enters a turning period: After the era of steam, electricity, and computers, the era of digitalization is coming.	Smart technologies and their potential (Open Data as part of Big Data will give more power to citizens and bridge the information gap between industrial sectors) and improve the access of actors of smart industry implementation to science and technology infrastructure.
2017	Implementation Plan of Strategy for Research and Innovation for Smart Specialization of Slovakia	Slovak Ministry of Economy Slovak MESRS, Office of the Deputy Prime Minister of Slovakia for	To foster research, technological development, and innovation and realization of relevant investment priorities funded in the 2014–2020	An open and excellent research system and support for developing an open and inclusive innovative society are evaluated in the area of innovation excellence in the RIS3 evaluation system.

		Investments and Informatization and Government Office of Slovakia	program period, as well as the measures to which the Slovak Republic committed in the Science and Innovation Operations Program (OP S&I).	
2018	State R&D programs for 2019–2023 with prospect of 2028	Slovak MESRS	State R&D programs for 2019–2023 with the prospect of 2028.	The proportion of all OA scientific publications (data included) will be 80% at least; final work (theses/dissertations) will be in an open access model (data included). The number of datasets (open data) registered on data.gov.sk, the number of open professional materials (educational resources, research work, etc.), increasing the amount of open data. Authors will provide open access to OERs, theses/dissertations, and scientific publications under public licenses (e.g., CC-BY 4.0, CCBY-SA 4.0).
2018	RECOMMENDATIONS COMMISSION RECOMMENDATION (EU) 2018/790 of 25 April 2018 on access to and preservation of scientific information	European Commission	Recommendations on open access to scientific publications, research data management including open access, preservation, and reuse of research data, infrastructure for open science, skills and competencies, incentives, and rewards, a dialog of stakeholders about open science at national, European and international levels; structured coordination of the EU member states and subsequent steps based on this recommendation.	Objectives of open access policies; the way of using open access to share scientific output with view to research funding resources; System of preservation of science and research results; the European Cloud for Open Science; Specific recommendations for member states to introduce policies and action plans for open access to scientific publications; Recommendation on research data management, including open access, on preservation and reuse of scientific information, infrastructure for open science; Recommendations to participate in a dialog about open science at national, European, and international levels.
2019	Horizon 2020 – Grant Agreement	European Commission	H2020 Program description and a manual for grant applicants in the H2020 Program.	Expenditure associated with open access to peer-reviewed scientific publication and research data are eligible if

2019				the conditions for eligibility are met, namely mandatory publication of research outcomes (publications and research data) in an open access model; interim reports have to contain information if and how the outputs were published in an OA model.
2019	A European Green Deal	European Commission	Climate-neutral Europe and environmental protection and conservation.	Digital technologies are a key factor to achieve sustainability goals. Digitization also brings new possibilities in remote monitoring of air and water pollution or in monitoring and optimizing the use of energy and natural resources.
2019	Digital Transformation Strategy for Slovakia	Ministry of Investments, Regional Development and Informatization of Slovakia	To define the policy and specific priorities of Slovakia in the context of the digital transformation of the economy and society affected by innovative technologies and global trends in a digital era.	Keeping pace with current global trends and bringing new quality scientific knowledge thanks to open access publishing, open data, and open application interfaces.
2019	Vision and Strategy of Slovakia until 2030	Ministry of Investments, Regional Development and Informatization of Slovakia	To ensure sustainable development in Slovakia; national strategy for regional and territorial development of Slovakia under the Slovak Government Resolution and Act No. 539/2008 Coll.	Fostering research, excellence, and publication of public data to make them accessible also to disabled people.
2019	DIRECTIVE (EU) 2019/1024 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 on open data and the re-use of public sector information	European Parliament	Public sector information is a remarkable data source that can help to improve the functioning of the internal market and development of new applications for consumers and legal entities. Smart use of data, including their processing through artificial intelligence applications, can have a transformative effect on all sectors of the economy.	The open data concept is generally understood as data in an open format that anyone can freely use, reuse, and share for any purpose. Open data policies foster wide availability of public sector information and the possibility to reuse them for private or business purposes with minimum or no legal, technical, or financial limitations. Open data policies promote information dissemination in the interest of economic entities and the public; they can play an important role in promoting

				social engagement and start and foster the development of new services based on new ways of combining and using such information.
2020	Modern and Successful Slovakia	Slovak Ministry of Finance	Get the country out of the middle-income trap to the 92% of the EU-27 average in GDP per capita until 2030.	Improving access to data and international research infrastructure – it is necessary to create conditions for open science in Slovakia systematically at national level, and until 2021 ensure for Slovak scientists a free of charge possibility to publish in OA journals.
2020	Digital Europe Programme	European Commission	Building strategic digital capacities in the EU and facilitating widespread introduction of digital technologies to be used by European citizens, business, and public administration authorities. The goal of the program is to increase the competitiveness of Europe and the green transition to climate neutrality and to ensure technological sovereignty until 2050.	Ensuring access to information – increasing availability and use of supercomputers in the areas of public interest such as health, environment, security, and industry, including small and medium-size enterprises.
2020	Digital Future Europe	European Commission	Defines 3 areas of measures: technology working for the benefit of people; fair and competitive digital economy; open, democratic, and sustainable society.	Improving access to high-quality data and ensuring personal and sensitive data protection; fighting against disinformation on the Internet, and promoting diverse and reliable media content.
2020	White Paper on Artificial Intelligence: A European approach to excellence and trust	European Commission	To start a discussion of the wide public, professionals, and members of industrial and academic sectors on specific proposals of European approach to artificial intelligence.	Improving access to data and their management is essential. Supporting responsible data management procedures and compliance of data with FAIR principles will help build trust and ensure data reuse.
2020	European Data Strategy	European Commission	To ensure a leadership position of the EU among societies benefiting from data. Creating a single data market will enable free movement of data across the EU and	The aim: creating a single European data space; using public information by business; ensuring accessibility to large volumes of quality public data for their reuse. The EU provides

Year				
			between sectors for the benefit of businesses, employees, and public administration.	access to data through the open data portal according to the principle 'as open as possible, as closed as necessary' and shares data via the EOSC.
2020	Declaration on Fostering Culture of Scientific Integrity in Slovakia	SK4ERA	The declaration aims to call on all organizations that conduct and finance research and education in Slovakia to make a public commitment to observe the highest ethical standards of scientific integrity to foster an ethical aspect of scientific activity, the essence of science, and to increase the trust of the public and international research community in Slovak research institutions.	The content of the term scientific integrity is not sufficiently integrated in our environment, and this ignorance may lead to breach of scientific integrity. Therefore, it is necessary to include education in this area at all levels of HE, including the lifelong education of researchers and university teachers. This education must be guaranteed by people with unquestionable self-integrity and practice in communication of values of ethics of academic and research work so that it is not only formal and superficial.
2021	Restoration Plan	Slovak Ministry of Finance	The Slovak Republic restoration and resilience plan is a complex response to the consequences of the crisis related to the COVID-19 pandemic and a reaction to the main identified challenges and systemic shortcomings of the Slovak economy.	Research of higher quality, cooperation with the private sector and connecting with excellent researchers abroad, but also between quality research teams themselves, this will promote sectoral development with high added value, start innovation and lead to higher competitiveness of Slovak businesses.
2021	National Strategy for Cybernetic Security for 2021-2025 (+ Action Plan)	National Security Authority	Basic strategic document on cybernetic security.	Basic strategic document on cybernetic security that defines strategic goals and priorities for this area for 2021-2025.
2021	SK Research Infrastructure Roadmap	Slovak MESRS	A key document of Slovakia for research infrastructure. It monitors existing development and current state of important research infrastructure in Slovakia, its connection to economy, domains of smart specialization, international cooperation in the ESFRI	Research infrastructure should have a data management policy that supports the open science concept in which research methods, data, and results are properly documented and made accessible to the public. Therefore, research infrastructure must have a data management plan that contains information on data acquisition and processing,

			context, and the EU framework program for research and innovation for 201-2027 Horizon Europe.	data on storing, and data ownership.