

Open Science-friendly national R&D knowledge and information e-infrastructure:

A case study from Korea

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Abstract

This paper outlines the functionality of the South Korea's National Science and Technology Information Service (NTIS), maintained by the Korea Institute of Science and Technology Information (KISTI). NTIS is a "one-stop shop" portal federating information on national R&D projects from multiple databases and metadata aggregators, including links to downloadable Open Access outputs and raw data. Among other functions, it provides a range of services based on R&D information analysis to facilitate open collaboration and knowledge co-development (e.g., providing network maps visualising collaboration among researchers and research institutes based on the field of research interest). In addition, some challenges associated with NTIS are outlined, including a lack of explicit Open Science mandates in national legislation and policies. We also suggest some opportunities for further development of the NTIS platform so that it can better support Open Science. These include, for example, alternative research impact metrics and a virtual laboratory service to be embedded into the NTIS functionality. Insights offered in this paper regarding the Korean experience of building an Open Science infrastructure could be useful to anyone planning to establish an R&D knowledge and information infrastructure, including various Open Science building blocks, in other contexts and countries.

Keywords

Open Science building blocks, R&D, knowledge and information infrastructure, South Korea, NTIS

Introduction

Open Science (OS) manifests itself in different forms, which are known as "OS building blocks", "OS practices", "open research practices", or "open scholarship practices" [1-5]. These terms, which are often used interchangeably, are typically associated with the elements of the research lifecycle and can be defined as ICT-enabled open and

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collaborative scholarly communication processes of production, distribution (sharing), or consumption of scientific knowledge and information with the expectation to make a scholarly domain more transparent, accessible, and inclusive. Examples of OS building blocks include Open Access (OA) to scientific publications, Open Research Data, and Open Collaboration within and beyond research communities.

However, establishing knowledge ecosystems that synthesise and interconnect individual OS building blocks remains a challenge, which might lead to fragmentation and weak coordination in OS uptake. This paper examines the National Science and Technology Information Service ([NTIS](#)), a crucial part of the South Korea's digital knowledge and information infrastructure with built-in functionality to integrate information on national Research & Development (R&D) projects and connect different OS building blocks, such as OA, Open Research Data, and Open Collaboration. We highlight the challenges that inhibit the full realisation of OS potential of the NTIS platform as well as propose certain measures for its future development.

Korea's National Science and Technology Information Service (NTIS) and its key functionality

Vast investments in the R&D sector, leadership in managing and sharing of public sector information, and advanced computing infrastructure to support data-driven innovation provided preconditions for promoting OS commitments in South Korea. A part of the country's commitments on realisation of OS is fulfilled through the NTIS platform targeted government-funded R&D information derived from "national R&D projects". In the Korean context, a "national R&D project" is defined as a project selected by the head of a responsible central administrative agency, such as a ministry, to promote a national R&D programme for which this central administrative agency provides funds [6].

NTIS is a pan-governmental information service platform supporting the whole national R&D lifecycle, from planning and managing a national R&D project to accessing R&D outputs and information that foster new project ideas and stimulate effective policy decisions. The NTIS platform is supported from the national R&D budget and coordinated by the Ministry of Science and ICT, with the main responsibility for its maintenance and development designated to the Korea Institute of Science and Technology Information ([KISTI](#))¹. The legal basis for operation of the NTIS platform is established in several laws underpinning the Korean system of management and distribution of national R&D project outputs. In particular, these include the Framework Act on Science and Technology (Art. 26) [7] and a related presidential enforcement decree (Art. 40) [8] as well as the National R&D Innovation Act (Art. 20) [9] and a related presidential enforcement decree (Art. 43) [10].

NTIS serves as a single point of access (portal) that connects, integrates, and provides in one place national R&D-related information distributed throughout multiple domestic databases and metadata aggregators, including databases of national R&D output management institutions and the national research data platform "[DataON](#)". The information accessible through the NTIS portal includes the following: R&D management

¹ KISTI is a national public research institute that supports various tasks of managing and distributing knowledge and information related to national R&D projects, with a particular focus on the Science and Technology (S&T) field.

information specified in a national standard [11] (e.g., project budget, ID numbers and information on participating researchers, Digital Object Identifiers/DOIs and other metadata of R&D outputs); URL links to actual R&D outputs and raw research data (in case they are made publicly available); and Artificial Intelligence (AI)-powered analytical information on current status of national R&D indicators, such as trends and statistics. Figure 1 summarises the main NTIS partners (i.e., connected information providers).

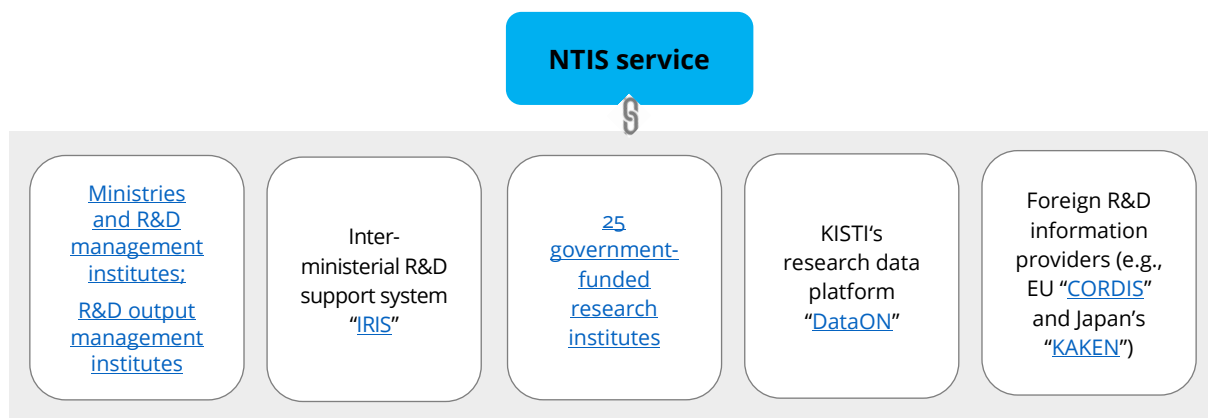


Figure 1. Main information providers of the NTIS platform. © Hanna Shmagun, licensed under [CC BY 4.0](#).

One of the key strategic goals of the NTIS Basic Plan for 2022-2024 [12] is promoting a new, collaborative R&D paradigm based on OS. In addition to the OA and Open Research Data built-in capabilities (i.e., connecting via Open Application Programming Interface/API to external domestic databases and metadata aggregators of open R&D outputs/data and making them accessible through the NTIS portal), NTIS also provides some Open Collaboration services. The latter are intended to provide a virtual space and R&D information-based resources and tools for collaboration between researchers as well as between researchers and government R&D managers. For example, Open Collaboration services include the provision of automated knowledge maps (based on keyword search related to particular research interests), which visualise collaborative networks among researchers and research institutes having been involved in national R&D projects, and thus help find potential R&D partners.

Open Science-related challenges and opportunities for the future

Many OS-related challenges associated with the NTIS have their roots in the Korean system of management and distribution of national R&D project outputs supported by a number of laws and regulations (for detail see [6]). In this light, the relevant legal and regulatory instruments (e.g., [9, 10]) put the requirements on public availability of standardised R&D management information (i.e., metadata prescribed by [11]), but they do not contain explicit mandates for OS practices, such as OA. The only explicit mandate is the requirement for researchers to submit a full-text final R&D report to be made publicly available, after an embargo period, in the national databases of R&D output management institutions, which shall be linked to the integrated NTIS platform. Thus, the system of management and distribution of national R&D outputs does not require full-text outputs (except final reports), and this explains why some outputs have not been accessible through NTIS in OA format.

Another problem, which is related to the NTIS's Open Research Data capability, is the fact that research data are not considered as a type of output from national R&D projects, according to the above-mentioned R&D laws and regulations. In particular, Art. 3 of the presidential enforcement decree of the National R&D Innovation Act [10] provides a close-ended list of possible R&D outputs, which does not include research data. It means that research data (including both metadata and raw data) are out of the scope of the system of management and distribution of national R&D outputs. Despite this fact, researchers may still deposit their data arising from R&D projects in specialised data centres and institutional repositories to be publicly available through the national research data platform "DataON", which is linked to NTIS. The latter uses the OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting) based API to make the DataON's research data searchable and accessible through the NTIS portal. However, due to the above-mentioned law-related reasons research data have not been linked yet to NTIS's R&D information and outputs that share a common identifier, i.e., the R&D project number, and the number of available datasets is still relatively modest.

Finally, even though Korea has invested in NTIS and related digital resources, scholarly communication culture and incentive and reward structures across the country do not sufficiently encourage researchers' OS practices. At present, there are no dedicated policy efforts observed that consider and reward OS practices within evaluation procedures of R&D projects and researchers. The evaluation procedures tend to consider traditional performance indicators, such as the number of scientific articles in SCI-level journals and their citations, the number of registered patents and their grades (e.g., [K-PEG](#) and [SMART grades](#)) [13].

In this paper, we do not discuss further how to address the three challenges outlined above in terms of changing the Korean legal and regulatory environment on the management and distribution of national R&D project outputs (previous studies [6, 14] provide important insights into it). Nevertheless, we still suggest certain measures related to NTIS platform-specific capabilities that can be complementary to the required policy interventions for OS progression.

One of the measures is to embed alternative research impact metrics (known as "altmetrics") into the NTIS platform functionality to foster OS. Altmetrics are considered as complementary to traditional indicators, which are mainly based on citation counts and journal Impact Factors. In contrast to the latter, altmetrics have the potential to reflect the impact faster relying on online attention (e.g., number of tweets, comments, Wikipedia references, mentions in blogs and news media) that research outputs receive from a wider audience [15, 16]. Although there are some concerns arising with altmetrics use, there are many arguments that altmetrics can be both outcomes and drivers of OS practices; i.e., advancements in the OS movement would benefit altmetrics in terms of greater online attention/visibility of research outputs, and vice versa, altmetrics may help motivate researchers to adopt OS practices more widely.

In this regard, we recommend that NTIS implements "[Altmetric Badges](#)", a tool provided by altmetrics data aggregator Altmetric.com. As part of our feasibility study, we assessed the amount of online attention of a sample of articles resulting from national R&D projects²,

² We retrieved all COVID-19-related scientific articles published during the period of 2020-2022, with the expectation that there should be a higher public demand for this research topic.

having extracted relevant metadata from NTIS and mapped them with Altmetric.com data based on articles' DOIs. According to the results, 50% of the final sample that fully matched the Altmetric.com database had received online attention (whilst 50% of articles had not). The most frequently appeared sources of online attention were the following: Twitter, news outlets, blogs, patents, Facebook, and Wikipedia (sources are listed here in descending order based on the number of mentions). Our results indicate that OA articles, compared to closed articles, are more likely to gain attention and have higher Altmetric Attention Score (AAS) [17]. In particular, 87 % of the articles that received online attention were OA articles; the average AAS value for OA articles were more than twice as high as for non-OA ones (12.8 and 5.7, respectively). Our results are consistent with a few prior studies showing evidence that OA status tends to lead to higher AAS [18–20].

At the piloting stage, the most feasible solution is to embed Altmetric Badges in NTIS only for scientific articles, since each article is typically assigned a DOI that is required for tracking online attention in various sources. In addition, articles arising from national R&D projects tend to be published in overseas SCI-level journals in English³, which is definitely the most effective for attention tracking purposes. However, it is worth noting that Altmetric Badges alone will not be sufficient and should be accompanied by the development of mechanisms on the interpretation of altmetrics data and their gradual integration in evaluation procedures to be considered along with traditional performance indicators.

The second measure we suggest, in addition to altmetrics, is to enhance the Open Collaboration capability of the NTIS platform by developing and providing a real-time interactive service “virtual laboratory”, which would offer new opportunities for reproducible research and scientific experiments undertaken in a collaborative manner based on exploitation of shared R&D knowledge and information. Virtual laboratories, which have a potential to be used for collaborative research [21] and S&T education and training [22] purposes, can provide an environment for co-developing study protocols, freely accessing input data, models and software tools needed for experiments, and sharing and discussing of outcomes with a prospect of future paper co-authorship.

Concluding remarks

Our paper shows that the Korean R&D knowledge and information platform “NTIS”, equipped with advanced technologies, has a great potential to include different OS blocks, such as OA, Open Research Data and Open Collaboration, and eventually become a crucial component of the whole national digital infrastructure supporting OS. However, a fuller realisation of NTIS's OS potential can be attained if the existing legal and regulatory framework of management and distribution of national R&D project outputs is changed in a way being able to explicitly mandate and incentivise diverse OS practices and consider research data along with other in-scope outputs. In the context of Korea's government-funded R&D, such a “top-down” approach requiring policy interventions is a necessary step for further OS promotion.

Insights offered in this paper regarding the Korean experience of building an Open Science-friendly infrastructure could be useful to anyone planning to establish an R&D knowledge

³ According to NTIS data, 77% of all articles published in 2021 as a result of national R&D projects were articles published in overseas SCI-level journals.

and information infrastructure, including various Open Science building blocks, in other contexts and countries. In addition, this paper encourages further studies that propose linkage of open R&D information resources of Korean and foreign OS infrastructures.

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