Current Status of the Research Information Management in Peru

Abstract

Nowadays, there is full consensus that the promotion of Science, Technology and Innovation (STI) has a positive impact on the economic growth of a country. In Peru, the National System of STI doesn't have enough information for decision-making, because it doesn't have an information system to manage (collect, systematize, store and communicate) the data generated during execution of each activity carried out. In this context, CONCYTEC (public body in charge of the development of policies, regulations and promotion of activities related to the STI) is planning to build a tool to cover this need, project that has financial support from the World Bank. To fulfill this task in order to cover the needs of all the actors involved in STI in the country, a study was carried out at a national level to know the current state of the processes and the computer supports of the research centers, research institutes and universities of the country to know their needs, and be able to pursue a common goal. We visited 20 public universities, 23 private universities and 10 research institutes. Through these visits, it was possible to know their needs, institutional objectives, type of decisions they make, the level of implementation of their current management systems of research activities and what kind of systems are being used (open-source products, commercial products or in-house systems) and how these systems interoperate with other ones, the type of content they store, and the type of indicators they need to generate as part of their management activities, as well as their degree of satisfaction with respect to the they have for decision making. The information collected was compared with the benefits of different CRIS alternatives existing in the market in order to establish the path we will follow as a country. The decision taken is aligned with the needs of the institutions visited, with the needs that we have as a State, and with the project "Improvement and Expansion of the Services of the National System of Science, Technology and Innovation" financed by the World Bank.

Introduction

Investment in Science and Technological Innovation (STI) has a positive impact on competitiveness, economic growth, and social indicators of countries (Aghion and Howitt, 1992; National Council of Science, Technology and Technological Innovation, 2013; Czarnitzki and Thorwarth, 2012; Grossman and Helpman, 1991; Lichtenberg and Siegal, 1991; Mansfield, 1980; McMillan and Hamilton, 2003; Nin-Pratt, 2011; Prettner and Werner, 2016; Salter and Martin, 2017; Rivera-Batiz and Romer, 1991; Romer, 1990; Zachariadis, 2004). Likewise, investment in Research and Development (R & D) by the government strengthens the scientific human capital, and allows the industrial sector to have local professionals for their transformation and innovation initiatives (Murray, 2017).

On the other hand, Murray (2017) states that the Government is in the capacity to encourage collaboration between researchers and industry, improving national economic results. In this connection, article 14 of the Political Constitution of Peru establishes that it is the duty of the State to promote the scientific and technological development of the country; and in article 2 of the Consolidated Text of the Framework Law of Science, Technology and Technological Innovation, the development, promotion, consolidation, transfer and diffusion of Science, Technology and Technological Innovation, are of public necessity and of preferential national interest, as fundamental factors for productivity and national development at different levels of government (Presidency of the Council of Ministers of Peru, 2016).

In Peru, institutions and individuals, dedicated to Research, Development and Technological Innovation (R+D+i) in science, technology and its promotion, conform the National System of Science, Technology and Technological Innovation, known in Spanish as the SINACYT (Consolidated Text of the Framework Law on Science, Technology and Technological Innovation, 2007). The initiatives by the government regarding the promotion of the STI should

be directed towards this SINACYT. However, this SINACYT, shows a weak and inefficient system, due to the insufficient information about the conditions in which are executed the activities carried out by the different stakeholders of the SINACYT, the deficit of mechanisms and services of technological surveillance, inadequate information systems and inadequate communications infrastructure (National Council of Science, Technology and Technological Innovation, 2016b).

The list below, show the detail of these points, according to the diagnosis presented in the National Policy for the Development of Science, Technology and Technological Innovation (National Council of Science, Technology and Technological Innovation, 2016b):

- The national system of technological innovation doesn't have mechanisms or services of technological surveillance that allow to identify and access new technologies with feasibility of application and the solution of the priority problems of the country. This situation limits the possibilities of reducing the technological and innovation gaps faced by the country and reduces the possibilities for development.
- The SINACYT doesn't have an information system that allows it to manage (collect, systematize, store and communicate) the data generated in the execution of its activities. Each stakeholder that integrates the SINACYT may have its own management mechanisms, which makes it difficult to share and homogenize the information between institutions. This situation does not allow to properly manage the STI, evaluate the progress levels of the activities and evaluate their results.
- Peru is a country with a deficit in communications infrastructure. The levels of access of the population to Internet broadband services are still low and the same occurs in the institutions that operate in SINACYT. This situation is even more precarious at a regional level, with regions where this type of connectivity is very limited. This situation hinders the exchange of information, coordination and decision making.

To solve these difficulties, the National Council of Science, Technology and Technological Innovation of Peru, know in Spanish as CONCYTEC, public body in charge of the development of policies, regulations and promotion of activities related to the STI, and governing body of the SINACYT (Law of the National Council of Science, Technology and Technological Innovation, 2005; Consolidated Text of the Framework Law on Science, Technology and Technological Innovation, 2007) is obliged to generate quality information on the performance of the actors that conform SINACYT, as well as follow up on the public policies that are implemented. Regarding this, the National Policy for the Development of Science, Technology and Technological Innovation (National Council of Science, Technology and Technological Innovation, 2017) states that countries with more developed innovation systems have information systems that allow their stakeholders to carry out their activities with a lower degree of uncertainty. In addition, information systems at STI avoid duplication of the actions undertaken to strengthen STI activities in their countries and show citizens the progress and accountability of STI policies.

In order to fulfill this goal, the following guidelines have been established:

- Develop and improve the quality of STI information systems, considering the generation, collection, management, dissemination and use of knowledge.
- Generate mechanisms and services for planning and technological surveillance, in coordination with the competent sectors.
- Improve the quality and availability (coverage and accessibility) of the communications infrastructure (broadband networks and others) for a better flow of information in STI, in coordination with the competent sectors.

In this paper, we present the alternatives that have been evaluated in order to comply with the guidelines outlined in the previous paragraphs, as well as a diagnosis of the needs of the different stakeholders of the SINACYT, as a result of a national study carried out in order to align the functionalities of the computer systems to be implemented, with the needs of the target audience for which it is intended.

Exploring Research Information Management needs at the SINACYT

Current Status of Support Platforms for the National Scientific, Technological and Technological Innovation Registry

Currently, in Peru we have national directories that store information about researchers, institutions, open access publications, research projects and innovation projects, as part of a national registry, which serves as an identification tool for institutions and people related to science, technology and technological innovation (Regulation of the National Scientific, Technological and Technological Innovation Registry, 2016). These directories have been implemented independently, covering specific needs for which they were built. However, the absence of a comprehensive platform hinders SINACYT's current consolidation and growth needs and requirements.

These national systems have some degree of integration with external sources. The ORCID (Open Researcher and Contributor ID) interfaces are used for consulting scientific articles and, previously, we had access to the Scopus platform (the integration was done using the Elsevier interfaces). Likewise, the interface of the National Superintendence of University Higher Education (known in Spanish as SUNEDU) is used for the querying of academic degrees and professional titles and the interface of the National Registry of Identification and Civil Status (known in Perú as RENIEC) for the validation of personal data of users.

However, the provision of information to the directories is a complex task that consumes a lot of time of the user, as a consequence of which only basic information is provided, preventing the generation of indicators that reflect the reality of our country and therefore harming the foundations for the formulation of policies and plans. For example, in all cases of interaction with other systems mentioned above, the user must select the respective options to activate the functionality and import the researcher's information even though much of this information could be automatically linked to his or her datasheet. There are many organizations that have STI management systems where they integrate information related to the scientific production of their institution. The researchers of these institutions, in many cases, must supply the information both in the systems of the institutions to which they belong and in the national directories.

It would be valuable if it becomes possible to manage the data contained in these directories to generate useful information and knowledge that will serve all SINACYT stakeholders.

Proposed Redesign of the Support Platforms for the National Scientific, Technological and Technological Innovation Registry

Given the situation described, we present the following recommendations for the redesign of support platforms for the National Scientific, Technological and Technological Innovation Registry, among which:

- It is necessary to make an integral redesign of the software platforms that support the National Scientific Registry, so that through a single digital platform, information is managed both by institutions and by persons related to CTI.
- An adequate software architecture is necessary to allow horizontal scaling, reuse of services and integration with external data sources.
- It is necessary to have a data and information model based on international standards.
- It is necessary to avoid that SINACYT members provide information on their production in STI on more than one platform. To avoid this, it is necessary to design a module that allows interoperating with diverse sources of information including and expanding interfaces with editors of scientific publications (for example Scopus, Web of Science, Springer Nature, Medline, ACM DL, IEEE, among others), operating with information systems of universities and public research institutes, incorporating information from funding sources of projects.
- It is necessary to transform the National Scientific Registry into a virtual space of cooperation and technological integration among universities, researchers, innovators, technological developers and companies. In this space, the various SINACYT stakeholders could register their offers and demand for services linked to the STI.
- It is necessary to include a module that allows the generation of indicators based on the information of all the mentioned national directories. These indicators must also be updated and their generation must be done automatically without the intervention of the human being. The construction of these indicators must be carried out taking into account international standards such as the Oslo manual, the Frascati manual and the Canberra manual. In addition, within this module it should be possible to visualize the evolution of each indicator over time in such a way that it serves for the formulation of policies and plans in STI.
- Finally, we propose the construction of a module that allows the monitoring of national transversal programs. In this module it should be possible to quantify the goals and indicators defined for each program. Some of these indicators may be fed through the national directories, in other cases it will be necessary to integrate information from other sources. This module should be built as a generic system that allows the definition of goals and indicators in a dynamic manner. In this way, it will not be necessary to modify this module when new programs are approved.

Project "Improvement and Expansion of the Services of the National System of Science, Technology and Technological Innovation" (Funded by the World Bank)

In order to carry out this redesign, we obtained a credit of 45 million dollars from the World Bank, as part of the project “Improvement and Expansion of Services of the SINACYT”, which will be complemented with a national counterpart of 55 million dollars in the next four years (Supreme Decree N° 397-2016-EF, 2016).

The exposed needs are of great importance for the successful development of what is indicated in Component 1, Sub-component 2: Strengthening CONCYTEC's management capabilities.

One of the expected results of this component is: the implementation of an integrated Knowledge Management System, which includes the following points:

- Development of an integrated information system that allows strengthening the generation of information on the innovation system for decision making, as well as the tasks of monitoring and control of system actions.
- Development of an application for monitoring and evaluation. The system should systematically collect existing information from other sectors.
- Development of an application that includes technological surveillance.
- Operation and management of the public expenditure tracking system in STI. Budgetary application of public expenditure tracking that allows the monitoring of the expenditure of the various public entities of the country in STI and training of users in the management of the application.

All these points require, as explained in the previous section, to have a unique digital platform that can integrate the information of different people, institutions, projects, funding sources, equipment and other capabilities and products that are part of the System National Science, Technology and Technological Innovation.

Offering support for Information Management on R+D+i in universities and public research institutes of the SINACYT

This proposal must also allow the different stakeholders of the SINACYT to manage their R+D+i information. This platform must consider the needs that we have as a Country, as well as the management needs of the Universities and Research Institutes.

By promoting RIM (Research Information Management) practices, the stakeholders of the SINACYT will be able to have reliable, up-to-date and quality data that allows planning, monitoring and evaluating the levels of progress and results of research activities, and thus support strategic decision-making at the institutional, local, sectoral or national

The collection and analysis of Research Information depends on the creation of capacities at institutional level (at Universities and Public Research Institutes) for the adequate registration, storage and exchange of data about research activities and their results.

An adequate Management of Research Information fosters the making of informed strategic decisions and promote prompt and reliable answers to questions such as: How many scientific publications have been published in the institution by academic unit, by year, by projects, by research lines, by OECD areas, or by source of funding, what infrastructure is available for the execution of new projects, how many research projects are being developed in agreements with companies, how many patents have been granted to the institution per year and to which projects are associated, etc., questions that the SINACYT stakeholders usually have to answer by doing a lot of manual work.

Study on the state of the Research Information Management in the Universities and Public Research Institutes of the SINACYT

The implementation of an Integrated Research Information System at a national level requires that institutions that carry out research have standardized information. This is necessary in order to generate national indicators.

The establishment of standards requires a technical and organizational effort and coordination to ensure that the motivation, needs and situation of the Universities and Public Research Institutes of SINACYT are being considered, so that a proposal can be generated aligned with

the national requirements at all levels and facilitate the adoption of the guidelines proposed by its governing body, CONCYTEC.

The main objective that was achieved with this study was to know the current state of the Research Information Management in the Universities and Public Research Institutes of SINACYT.

In order to fulfill this objective, the following specific objectives were proposed:

- Identify the roles and areas responsible of Research Information Management.
- Know what kind of information is needed for decision making and how this information is collected.
- Identify the current state of implementation of research information management systems for and the type of system being used (free software products, commercial products or systems made in-house).
- Identify what type of content is being stored in the Research Information Management Systems.
- Identify how these systems currently interact with other internal and external systems.
- Identify the degree of satisfaction of the institutions with their Information Management systems and the degree of satisfaction with the quality of the information they currently have.
- Identify some other needs related to the Research Information Management.

Scope and Method. According to the I National Census of Research and Development (National Council for Science, Technology and Technological Innovation 2016a), the target population is a total of 296 research institutions, distributed as follows:

- 17 public research institutes
- 7 health institutes
- 42 public universities
- 35 private non-profit universities
- 46 private universities for profit
- 141 private non-profit institutions
- 8 others

We proposed to carry out two types of analysis: a quantitative and a qualitative one.

For the quantitative analysis, a virtual survey was carried out on the total number of institutions surveyed. As an instrument, a standardized international survey was used that encompassed all the specific objectives of the study, which has been developed as part of the joint effort of euroCRIS and OCLC (Ribeiro, 2016; Bryant, 2017).

For the qualitative analysis, a sample of universities and other research institutions was visited in 12 regions, in which a semi-structured interview was applied to deepen the objectives of the study and incorporate additional observations. A total of 53 institutions were visited.

For the visit plan, we clustered the types of regions by indicators such as the number of researchers, the number of publications and the expenditure on R&D. The Directory of institutions found at the I National Census of Research and Development was taken into account to consider contact points and different types of institutions.

The visits were made by teams of maximum 2 interviewers, and included at least 3 institutions per visited region, with the exception of the Ayacucho region, where only 2 institutions were visited, and Lima, capital of Peru, in which it was possible to visit 13 institutions due to its proximity to the CONCYTEC.

Results. Below are some of the main results that were found through this study:

- Level of implementation of RIM systems is almost nil, but all have a DSpace repository. That said, they would already have the infrastructure ready to configure a DSpaceCRIS.
- There has been no national dissemination about data representation standards and CRIS tools. Those who started to build a software to manage their information, carried out independent developments, covering very specific needs of their institution.
- The SINACYT do not have robust software tools that help their stakeholders in the management of research activities, they must carry out many processes at hand. When they have the urge to prepare a very extensive report, which contains cross-information from different entities related to the research activities, they should ask for help from other areas and offices of their institution, which will stop doing their tasks in order to fulfill this request.
- They need to monitor the progress of their institutional projects, and projects financed with external funds (currently only the researchers assigned to these projects have access to the projects information, but the managers in charge of the institutional research information cannot monitor their progress).
- In some institutions, physical records are used to monitor the progress of their projects and research activities.
- Limited staff dedicated to the Research Information Management. There are no full-time professionals dedicated to the management of research activities.
- Some institutions are operating with a low budget. Sometimes, they do not even have a budget allocated for the management of research activities.
- The main quality indicator used for management is the number of articles accepted in indexed journals. For the case of publications that are not sent to this type of journals, no other quality indicator is used.
- Other needs related to the strengthening of its scientific production capacity:
    - ➢ Need to strengthen research capabilities in students and teachers.
    - ➢ They need more information about how to participate in competitive funds and how to fill out the application forms.
    - ➢ There are no competing funds designed based on the characteristics of some regions of the country. Universities with different capacities and needs must compete for the same funds. This causes some institutions to miss the opportunity to participate.
    - ➢ Some institutions that do have a budget for research, would like CONCYTEC to totally manage this fund to conduct research competitions.

- ➢ They need to know how the other universities (Peruvian or foreign) are working, what projects they are carrying out and what subjects and topics they are working on.
- ➢ They need to contact external evaluators to avoid conflicts of interest in the process of evaluating institutional projects, as well as to comply with the guidelines of those journals that have established peer review as a measure of quality.

Towards the adoption of a national CRIS

Global context of the GII

In order to choose the best path we would take as a country, it was important to also review initiatives around the world to include in our development the best practices regarding RIM.

We find that the greatest advances in the Research Information Management worldwide have been made thanks to the creation in 2002 of euroCRIS with the mission of promoting cooperation and exchange of knowledge and interoperability through CERIF, the common format European to represent research information (Simons and Zendulková, 2013). EuroCRIS has gained notable international recognition for its experience and management capacity at an institutional, national and international level.

In the field of research, the growing level of inter-institutional relationships as well as advances in communications infrastructure have meant a greater capacity to collect and exchange information in a reliable manner. The opportunity to be proactive in the generation of interoperability and information reuse capabilities has been well exploited with increasing adoption in many countries.

Recently, euroCRIS is working in conjunction with OCLC Online Computer Library Center (creators of WorldCAT and OPAC) in order to be able to extend its reach globally beyond the borders of Europe.

CRIS commercial products

Given the widespread need for CRIS systems at an international level, it is not surprising that various commercial products have arisen that, to a greater or lesser extent, seek to meet this demand. Some of these commercial products have almost 10 years of presence in the market.

Studies and reports on the need and implementation of standards for the interoperability of CRIS studies are abundant and growing in recent years (Hornbostel, 2006; Joint, 2008; Jeffery, 2009; Houssos et al., 2014; Dragan, Lidija y Bojana, 2014; Clements and McCutcheon, 2014; Galimberti and Mornati, 2016; Moreira et al., 2016; Piščanc et al., 2017; Burland and Grout, 2017; Quix and Riechert ,2017; Schöpfel, 2017).

The international community is progressing more and more towards the integration of CRIS systems not only with repositories of open access to documents but also with research data (Schöpfel, 2017).

Countries like Italy are also having a breakthrough in the adoption of CRIS open source systems, specifically DSpace-CRIS. This offers a viable alternative for institutions and countries with fewer resources, which previously could not afford the purchase of commercial CRIS products (Galimberti and Mornati, 2016).

It is also known that countries such as South Africa and Brazil are carrying out implementation plans for these CRIS technologies at the national level (National Research Foundation, 2017; Almeida, 2016).

Based on this, it was considered convenient to contact some key institutions and establish international links to take advantage of the extensive global experience accumulated over the past 20 years for the management of knowledge on research and innovation in science and technology. Specifically, we sought to establish links for international interoperability standards coordination, with those responsible for the development of open source software DSpace-CRIS and CRIS system implementers in Italy, and with CRIS implementation projects at a national or regional level in Spanish language.

Pilot of Implementation of a DSpace-CRIS system in the National Council of Science, Technology and Technological Innovation - CONCYTEC.

With the aim of developing technical capacities within CONCYTEC for the implementation of a DSpace-CRIS, and to be able to see what would be the main difficulties of this type of initiatives in our country, we decided to carry out a DSpace-CRIS implementation pilot that includes information about researchers, publications, patents and research projects.

To accomplish this task, we worked with existing information in national information systems, mentioned in the previous blocks, as well as external sources such as: Scopus, in the case of scientific production; the National Institute for the Defense of Competition and the Protection of Intellectual Property (known in Perú as INDECOPI), in the case of patents; the National Superintendence of University Higher Education (known in Perú as SUNEDU), in the case of degrees; and lists of projects provided by three funding entities (the National Health Institute, the National Fund for Scientific, Technological and Technological Innovation and the National Innovation Program for Competitiveness and Productivity).

With this pilot, it was possible to know the requirements and needs prior to this type of implementation, as well as to know what would be the main causes to stop this type of initiatives. The main difficulties are related to the unification of different sources of data corresponding to the same entity. Here are some examples:

- Absence of persistent indicators. Some records have the name and surname of the person associated with a publication or patent, but do not have the national identification number of that person. Some registries have names and surnames entered manually, allowing human error, which makes comparison with information from other systems difficult.
- Much manual work to disambiguate data that may belong to more than one entity.
- Not all the researchers registered in the national systems have entered their ORCID or their ScopusID, so it is not possible to gather information associated with them.

through this pilot we could see what data would be used in Peru, because this allows us to explore what data is available and what data is necessary for each of the entities included, with the objective of adopting and extending information representation standards, and allowing the evaluation of the feasibility of the final system, the ability to aggregate and relate large volumes of information from various sources and domains.

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