

Managing Science and Technology: the Mozambican Ecosystem

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Abstract The Current Research Information System (CRIS) emerges as an embracing paradigm for managing the multitude of Science and Technology (S&T) components and players. Instantiating its concepts and directives in the S&T ecosystems of developing countries allows to save years of progress, bringing these countries directly to the european level regarding S&T management.

In this context, this article aims at discussing the challenges and strategies for the implementation of technological platforms for managing S&T, taking Mozambique and its NREN as the primary goal. By identifying and understanding the components of the mozambican S&T ecosystem, we expect to foster science in developing countries and promote international cooperation.

1. Introduction

In today's society, the stage of Science and Technology (S&T) of a country evinces its developing level. In this sense, despite being rich in natural resources, which could be considered an advantage for economic and social progress, the development of most African countries is still immature, largely due to the lack of qualified human resources, the economic dependence, and the lack of a consistent system for managing science, technology and higher education.

National Research and Education Networks (NRENs) play an extremely important role being supported by non-profit organizations whose mission is to provide advanced services to the research community and higher education. In the absence of a single model that can be applied to all NRENs, as well as its constitution and funds, creating a model of NREN must meet the reality of each country in coordination and collaboration at regional and international level. Deploying NRENs infrastructures has been an important step for fostering S&T in these countries, however, to become fruitful, advanced services oriented to S&T management need to be provided to the academic and research community.

The amount of information related to scientific knowledge has grown exponentially on the Internet. The communications paradigm of next generation networks resulted in a new environment and a new challenge for science, facilitating not only the dissemination and sharing of knowledge, but also new models of doing science. The available technological tools enable broader cooperation, transparency and visibility of scientific production (Vu, 2011; Audretsch & Welfens, 2013). Currently, most of the scientific research is carried out using electronic format. The production of scientific documents, the collaboration between researchers, the publication of research results, are examples of the application of information and communications technology (ICT).

In this context appears the concept of Current Research Information System (CRIS), defined as an information system that stores and manages data related to the entire life-cycle of research. However, the implementation of technological platforms for managing S&T, cannot be decoupled from the research ecosystem of each country. Thus, by: (i) taking worldwide initiatives and the Portuguese experience; (ii) identifying and understanding the components of the Mozambican S&T ecosystem, this article is devoted to discuss the challenges and strategies for deploying technological platforms for managing S&T in developing countries, more particularly in Mozambique.

This paper is organized as follows: Section II presents and interrelates the issues for managing S&T, including the description of CRIS components; Section III discusses the challenges and trends of CRIS evolution; Section IV enters into the Mozambique research ecosystem, ending with a set of recommendations for fostering open science in the country; finally, in Section V, are presented the conclusions of this work.

2. Managing Science and Technology

Managing S&T involves understand the issues related to the national scientific system, considering its players, general framework and relationships (Lundvall, 2009). The absence or ineffectiveness of S&T management services, such as technological platforms for submission of research projects or scholarships, scientific open access repositories and data centers, force researchers to tasks that absorb their time and may compromise the research itself. A crucial step is the usage of information systems to support S&T management.

In Portugal, the electronic applications submission system provided by the *Foundation of Science and Technology (Fundação para a Ciência e a Tecnologia - FCT)*, the main funding agency for research in all scientific domains, working under responsibility of the Ministry for Education and Science, has advanced tools that allow the management of application processes, and the interactive and efficient monitoring of the entire projects life-cycle until their closure. In the case of the portuguese NREN, for example, represented by FCT, the evolution of the network infrastructure enable the creation of projects supporting research and education services, being the national repository RCAAP (*Repositório Científico de Acesso Aberto de Portugal*) one of the most important.

The concept Current Research Information System (CRIS) arises in this context, being defined as an information system that stores data on research carried out by organizations and researchers, usually related to projects under funding programs. CRIS can manage all relevant information directly related to research, starting with funding opportunities, through call and proposals, following the publication of winning proposals that will become active projects to be managed and monitored until completion. Such projects generate outcomes, resulting in scientific publications or other type of document or product (Clements, 2014; Simons, 2014). Managing S&T based on CRIS can bring the following benefit:

- (i) offer to administrators and science managers tools that facilitate the evaluation and report of scientific practice;
- (ii) offer to researchers and academic community tools for accessing and managing information about scientific activity;

- (iii) facilitate to media professionals, technology transfer companies, civil society organizations and individual citizens the discovery of innovative technologies and ideas, promoting links between science and society.

In this sense, CRIS will provide information on publications resulting from research produced in an institution, and corresponding authors. More information can be obtained, as the activities, projects, departments, funds and portals that can provide information to researchers in order to increase the visibility of research results produced in the involved institutions. In more detail, CRIS components are described hereinafter and represented in Figure 1:

- Academic expertise: platform for collection, delivery and analysis of intellectual production, scientific and other curriculum information from national researchers, which should be promoted by the government entity that manages science. As examples can be cited the Lattes Platform in Brazil and DeGóis in Portugal.
- Organizations database: database of research and development projects approved through competitions annually open to all scientific areas or through calls targeting research in certain areas or specific topics.
- Scientific equipment: database of research infrastructures and equipment, especially research infrastructures of strategic interest for supporting scientific and technological advances and for enhancing the development and innovation capacity of the research community.
 - Statistics: science indicators.
- Project database: database of R&D projects; the portal allows to see the list of approved projects through competitions.
- Grant management: portal for submission of applications for individual grants, after registration in the Information System.
 - Projects call: portal for submission of applications for R&D projects, after registration in the Information System.
 - Evaluation: evaluation of research quality.
- Outcomes/Outputs: corresponds to the creation of technological platforms, specifically open access (OA) repositories that allow the deposit, access and sharing of knowledge of national scientific production results, publicly funded by policies and governmental/institutional mandates.
 - Scientific journals: another way of publication of scientific production in OA is carried out through OA scientific journals, i.e., Gold OA¹.
 - Research Data: the data used in research must be deposited in a data repository².
- Research news: management system of news related to investigation.

¹ In the OA field, the Budapest Open Access Initiative (BOAI) defined two pathways to OA described as: (i) Green OA - where the authors through self-archiving must deposit their publications in a thematic or institutional repository; (ii) Gold OA - which refers to publications in OA scientific journals with peer review.

² The new guidelines of OA launched under Horizon 2020 (EC, 2013), reinforce that *data* resulting from research, including the associated metadata necessary to confirm the results, must be deposited in a scientific data repository, and the free access to bibliographic *metadata* related to the deposited publication (the terms of the funder, the action's name, the initials and number of the agreement, the publication date, the embargo period and a persistent identifier).

- Research ethics: database with information on ethics in science.
- Research portal: integrated search system.

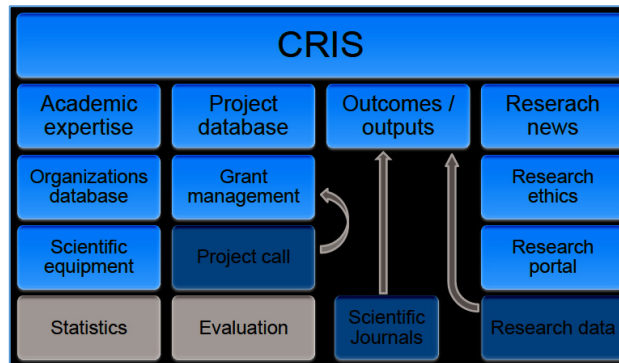


Figure 1: CRIS Ecosystem

3. New Trends for CRIS

The evolution of information systems for the management of scientific activity has evolved, mostly in developing countries with a vast human resource capacity in ICT. Currently, the European Union (EU) has been a major engine of the debate on the development, integration and interoperability of services and platforms for managing science.

3.1 OpenAire

One of the european initiatives related to OA is the OpenAIRE project, which is an integral infrastructure that allows to manage scientific publications, and the information associated with them, through a network of repositories. This project presents several advantages because it links the aggregated publications in the repositories with financing information and scientific data sets (Príncipe, 2014). To be more effective, the project also provides a service helpdesk and technical guidance to all partners involved.

In a regional panorama, projects such as OpenAIRE can benefit:

- researchers in the deposit and sharing of research results;
- national OA initiatives to establish, implement and align scientific data policies;
- repository managers to increase the visibility of content;
- policy makers and funders to monitor the results of funded research;
- managers of projects and science administrators to support the realization of reports, statistics and dissemination of research results;
- potential data providers wishing to explore the interconnection of their research.

3.2 EuroCris, CERIF

In the European context, the euroCRIS is a non-profit association that brings together professionals of research information and of CRIS area for “*development and curation of the international standard data model for research information called CERIF: the Common European Research Information Format. The promotion of cooperation and*

exchange of expertise between stakeholders in the research information domain...)." (euroCRIS, 2015).

In this perspective, the euroCRIS has developed CERIF, which is the standard model of storage and interoperability of research information, e.g., the research metadata. CERIF has the advantage of including all components of research information of CRIS and the ability to represent the relationships between entities that are semantically defined (Simons, 2014; Seo, 2014). The CERIF-XML is a language that allows the exchange of information between systems. The CERIF/CERIF-XML are recommendations to EU member states.

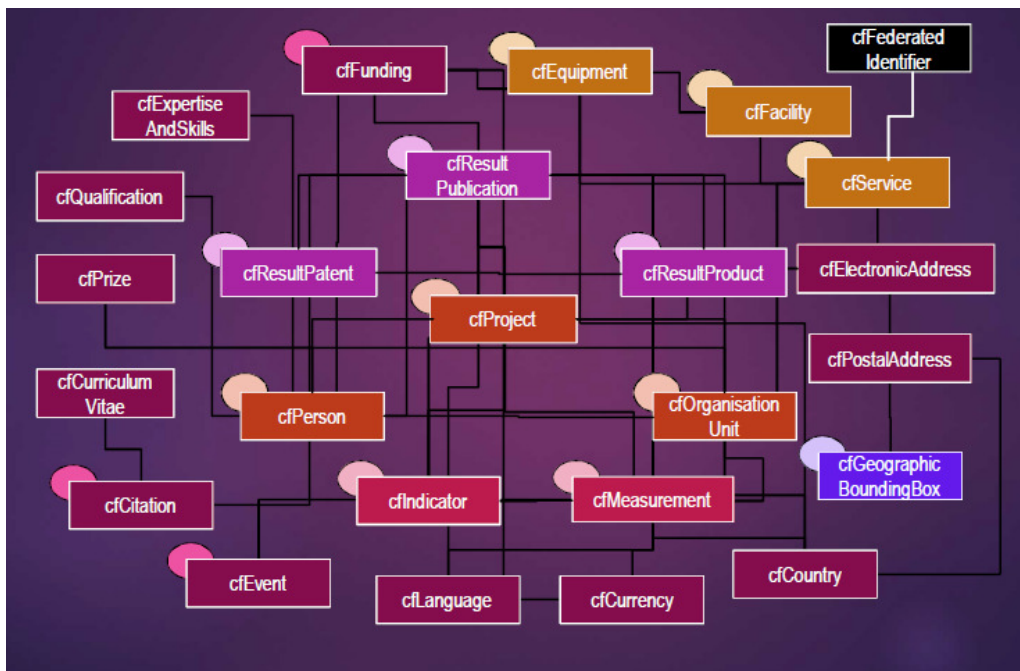


Figure 2: The CERIF model (euroCRIS, 2015)

The CERIF model, illustrated in Figure 2, provides great flexibility and robustness because complex roles and date-limited relationships between the three major entities (in orange) can be expressed, and other entities can be linked by role/date relationships to any or all of these three major entities. As example, it is possible to convey information such as:

- researcher x works for organizational unit y which is a sub-unit of organizational unit z ;
- publication Z came from project X which is a sub-project of project K ;
- person a is a reviewer of a result publication b .

In this context, CRIS allows to answer several questions, such as: How many PhD students took part in national research projects? In which countries did they obtained their masters degree? How many scientific papers have been published by author a in 2014 as a first author?

3.3 Unique Researcher Identifiers and Bibliometrics

To facilitate disambiguation in the use of authors' names and automate links to research, the ORCID (Open Researcher and Contributor ID) organization, an international non-profit organization governed by the research community, has as main activity to provide the registration of unique identifiers for the researchers and academic community (ORCID, 2015).

The unique identifier ORCID iD allows identifying unequivocally each researcher and facilitates the recovery of its scientific production that is linked to other existing systems of authors identification, such as ResearcherID, Scopus Author Identifier, My Citations Google Scholar, etc.

In this way, ORCID iDs avoid ambiguity and disorder related to the names of the authors and avoid the dispersion of scientific literature by the same author (Thomas, 2015). The use of ORCID iD identifiers are already being adopted in the science management systems from various countries, editorials groups (e.g., Nature Publishing Group) and funding agencies (e.g., National Institutes of Health - NIH, FCT in Portugal), who seek to follow with recent directives on CRIS and OA.

In the case of EU countries, the use of ORCID iDs will allow:

- to implement a national repository, solving problems in communication and interoperability of national and institutional information systems;
- to integrate efficiently in national reporting systems researchers from foreign institutions who come to develop their activity, and allow national researchers to export easily their scientific production to the information systems out of the country;
- to obtain ORCID iD is free and simplifies bureaucratic processes, allowing only one record to be used to identify a researcher into multiple entities.

Regarding CRIS evolution, the study conducted by (Ilva, 2014) reports that one of the biggest challenges encountered is related to the coexistence of CRIS and repositories, since they have distinct concepts, however, the trend is the integration of these two systems, for their coexistence in future. Another important aspect to be considered is that, while the platforms for building repositories are open source platforms such as DSpace and ePrint, the main existing CRIS platforms are all based on proprietary systems. Nevertheless, there are CRIS open source development projects, still premature to say whether they will have acceptance by the community.

Taking into account the perspective presented on the new CRIS paradigm, at present, it appears that this trend of change appears to be more at European level, although it corresponds to more advanced systems for managing science (Ilva, 2014).

In this sense, it is important that developing countries or institutions with limited financial resources rethink on existing open source alternatives to create repositories and forms of integration and interoperability with existing CRIS systems. At interoperability level, the main CRIS data collectors are Academic expertise, Research portal, Outputs and Project database. The main data providers are Organizations database and Outputs.

4. Mozambique Higher Education and Scientific Research

Scientific research in Mozambique is still in its infancy. After independence in 1975 the number of trained teachers was insufficient to cover the needs of education and higher education in the country, and not kept pace with population growth. Currently, Mozambique has near 50 higher education institutions (18 public and 31 private). In the world ranking, Eduardo Mondlane University (*Universidade Eduardo Mondlane - UEM*) is the oldest institution of higher education in Mozambique and considered the best higher education institution in the country.

The ICT policy adopted in 2000 defines main objectives to combat poverty and improve Mozambicans life. Ensure the production and access to knowledge are some of the fundamental aspects of the ICT policy for Mozambique to become a relevant and competitive partner in the global information society. Only in 2000 emerged the ministry specifically dedicated to science and technology, now called the Ministry of Scientific and Technology, Higher Education and Professional Training (MSTHEPT), and a strategic plan was approved for scientific research in the country to support the development of the National Research System (NRS).

In addition, to support the development of research in Mozambique, in 2005 was created the National Research Fund (NRF), the main government agency responsible for funding research in Mozambique. The promotion of programs, projects and actions in the field of scientific research in accordance with the strategic priorities of the country are the main objectives of the NRF. From the NRF budget to support research projects, mainly resulting from external support, a large part of the investment is dedicated to the training of human resources.

To develop its activity one of the biggest initial challenges that the NRF faced was in terms of the quality of the proposals of the submitted projects that were too weak when it was launched the first call. This led the NRF moving forward with training in research methodologies and on preparing of project proposals aimed at teachers, researchers, technicians and innovators, who have given positive results in terms of quality and quantity of proposals. In this context, research has presented some progress in Mozambique and the evaluation carried out since its inception in 2006 until 2014 shows that NRF has funded 250 projects, demonstrating the interest in scientific research.

4.1 MoRENet

Under the Mozambique Science, Technology and Innovation Strategy (MOSTIS), launched in 2006 to strengthen the National System of Science, Technology and Innovation, began the project for the development of the country NREN, called Mozambique Research and Education Network (MoRENet).

The challenges for the effective implementation of MoRENet are enormous taking into account economic, social, technical, technological, and infrastructural aspects. In this context, there is still much to do and a great commitment and pressure to put MoRENet fully operational.

The MoRENet project infrastructure is based on optical fiber and SDH-STM technology. In more detail, it has 5 PoPs and operates at 155 Mbps for backbone and 34 Mbps for institutions, with a 155 Mbps shared Internet connection. This project will connect more than 80 institutions across the country.

Until January 2015, the network has been installed, but only in Maputo city and only in 13 institutions, being Internet the only service provided. Actually, with a new contract with a new communications service provider (CSP), the links to other institutions in Maputo, including the wireless network, are being completed, and then will be contemplated gradually the provinces.

Given this perspective, it has been made an enormous effort on the part of stakeholders to ensure that the project becomes a reality, although they were detected the following difficulties in the agreements reached with the first operator responsible for MoRENet implementation:

- the lack of terminal equipment in the market, which must be imported, leading to delays in the project implementation;
- lacks of metropolitan optical fiber, which creates difficulties to carry the optical fiber to institutions;
- another aspect which undermines the proper functioning of MoRENet is related to the power outages, common in the country, which implies the creation of contingency plans for infrastructures and natural disasters.

4.2 Scientific Contents and SABER

The lack of budget in research and education institutions to provide international scientific contents in different fields supplied by publishers is a big challenge. The effort of UEM in this context, enabled through the INASP program with whom UEM has worked since 2001, regards the negotiation with international publishers for the access to journals and books without charge or at low cost price for Mozambican institutions. With INASP support, Mozambique can access 90% of the publications paying 10% of their real value.

The acquisition model of scientific literature through commercial publishers in Mozambique is not associated with the academy of sciences of the country. In this sense UEM is the national coordinator of the consortium of universities supported by the INASP project, being responsible for channeling the budget available for paying the access to publications for the institutions of higher education in the country. Currently all Mozambican institutions of high education, public and private, access about 23 000 titles. There are other organizations with programs supporting access to scientific literature from specific areas that Mozambique and other developing countries use, namely HINARI, for biomedical, OARE, in the environmental field and AGORA for agriculture.

The OA movement in Mozambique is recent, mostly driven by UEM initiatives that try to give visibility and preserve the academic and scientific production of national institutions. In order to collect, preserve, aggregate and index academic and scientific production of higher education and research institutions in Mozambique, was released in November 2009 the multi-institutional repository SABER. SABER repository is a common platform that integrates six member institutions, including the Judicial Training Center (JTC), the Higher Institute of Science and Technology of Mozambique (HISTM), the Eduardo Mondlane University (UEM), the Pedagogical University, Polytechnic University and the University of St.Thomas of Mozambique (UST). Although the institutions mentioned above are officially integrated, SABER repository maintains scientific and academic documents produced or related with Mozambique from other institutions in the country (SABER, 2009).

Key aspects to the successful implementation of SABER repository are: the contribution in terms of resources from the then Ministry of Education, under the background of quality improvement and innovation; Sida/SAREC funding (Greenberg & Muchanga, 2006), the Swedish agency for international development; and the technical collaboration with University of Minho in Portugal, for setting up the repository in the chosen platform DSpace. Although being a multi-institutional repository, SABER is hosted in UEM, which is responsible for the technical support, and the administrative tasks related to the workflow of the deposit of documents. After near six years, SABER stores about three thousand documents, including teaching materials, monographs and dissertations. In more detail, UEM with near 97.77% of documents deposited, is the institution that contributes with the largest number of documents, and the remaining documents, 2.23% are related to JTC, Polytechnic University and Pedagogical University. The rest of institutions, although integrating the repository, have no contribution in terms of contents. Another conclusion observed when analyzing the increasing number of documents in repository SABER, is that much of the contents, 2341 documents, are related to the period before the creation of the repository, as shown in Figure 3. This has involved a great job of the SABER repository team in the digitization of existing documents in physical format from previous years, even without existing national and institutional policies and mandates to promote OA in the country.

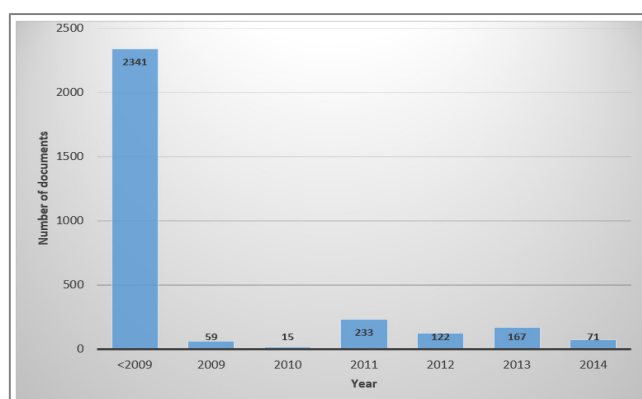


Figure 3: Evolution of SABER repository

4.3 OA Journals: the case of RC-UEM

Scientific journals play a crucial role in the generation and sharing of knowledge, and peer reviewing contributes to improve the quality of the publication system. With this frame, UEM created in 2010 the Scientific Journal of UEM (RC-UEM), a biannual OA journal aiming at presenting the results of Mozambique scientific production undertaken in national institutions of higher education and research. The journal covers eight specific areas: (i) biomedical sciences and public health; (ii) engineering, architecture, urbanism and technology; (iii) letters and social sciences; (iv) natural sciences and environment; (v) agricultural, forestry and veterinary sciences; (vi) science of education; (vii) legal sciences; and (viii) economics, management and development. The first series of RC-UEM were launched in 2012. Whilst its importance is recognised, RC-UEM project faces numerous difficulties due to the research landscape and quality of scientific production in the country. For example, the 2013 call for papers resulted in 70 submissions, and 14% of approvals after peer reviewing process (involving national and international reviewers).

The main challenges faced by the RC-UEM and other endogenous magazines are mainly related to the following aspects: (i) the lack of a national scientific community and the geographic boundaries of existing research lead to a shortage of submissions. Most of Mozambican researchers work in cooperation with international institutions (for instance, involved in their MSc and PhD studies). Even when the students return to Mozambique, it is common to maintain the external link and publish their work abroad. This is one of the biggest barriers to the creation of a scientific community turned inward; (ii) facing the lack of contents, the few endogenous magazines “die” prematurely, after two or three series; (iii) the reviewing process takes too long to be completed, impairing the process of launching a magazine edition. Moreover, as previously stated, most of the submitted works are not accepted.

Facing this scenario and the absence of national and institutional policies for scientific journals in the country, UEM is committed to build its institutional policy of publication and to register RC-UEM in the african directory of scientific journals.

5. Proposed Model for Open Science in Mozambique

Considering the challenges that mozambican institutions face in implementing national and institutional policies and mandates of OA, this section presents the proposal of an initial model for open science in Mozambique. This model, presented in Figure 4, inspired in the model of the portuguese national initiative RCAAP (Mulhanga, 2014), takes advantage of the benefits of a supporting NREN to propose the creation of the following services:

- the Hosting Repository Service for all institutions, so that they do not have to worry with the technical aspects related to the implementation of repositories, such as servers, connectivity, maintenance, backups, upgrades, monitoring, alarms. The national repository of Mozambique SABER should provide centrally the tasks related to the management and operation of repositories, and the member institutions only have to worry about the management of their documents (workflow and deposit).
- the Common Repository, oriented to institutions that do not have their own repositories, for various reasons, such as the low number of publications. Excluding UEM, the five other institutions integrated into SABER repository could benefit from this service. This alternative will allow researchers and the academic community of these institutions to have a shared repository for depositing in OA the results of their work. An institution taking part of a common repository may in future evolve to its own hosted repository, when an increase of documents resulting from the academic and scientific production occurs.
- a Hosting Service of Scientific Journals should be considered, such as the RC-UEM, which institutions may use to create a journal and make the whole life-cycle, namely the launch of calls for submission of articles, the support of peer reviewing, the editing and processing of scientific data.
- facing the issue of curation and preservation of scientific data, aligned with the recent guidelines on OA, it is important to include one Scientific Data Hosting Service, so that data that led to the publication of articles can be consulted and re-used.

Another aspect to consider, taking the example of the portuguese national repository

initiative to strengthen the visibility of OA scientific contents of portuguese language, is the signing of a memorandum of understanding between the governments of Portugal and Brazil, which resulted in the aggregation of theses and Brazilian scientific production and dissertations available in brazilian institutional repositories. Subsequently, it was also created the Luso-Brazilian Conference on OA (CONFOA) held annually and open to all interested in sharing knowledge and experiences.

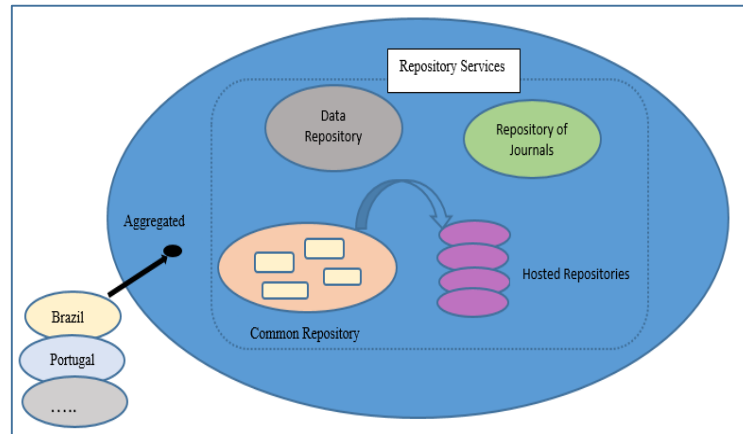


Figure 4: Model for OA in Mozambique

Considering that there is much work to do for the proposed model to be successful, the following challenges and recommendations should be considered:

- the guidelines of the ministry of science and technology are not specific in terms of repositories and OA, just pointing out the need for dissemination of scientific knowledge. In this sense, it is important that higher education institutions, through the Rectors Council of the country, the Academy of Sciences, the Ministry of Science and Technology entities and MoRENet, to engage in the debate about OA to involve a larger number of institutions into SABER repository;
- most of university libraries do not have a librarian. The country must invest in training librarians and specially trained staff to support the academic community and to manage contents;
- it should be created a national team for dissemination and training on OA, operating in the institutions in collaboration with other regional and international institutions, including the UbuntuNet Alliance which ensures effective implementation of OA in Mozambique;
- the collaboration at CPLP (the Community of Portuguese Language Countries) level on the issue of OA should also be considered. The team of UEM documentation services has participated in CONFOA, and has made efforts to become a membership. This has proved to be complicated by the need to establish memorandums of understanding between the governments. Currently, the FCT in Portugal showed interest in starting the initial collaboration through the organization of a workshop in Mozambique in 2016 aimed at training and debating the various issues related to OA and managing science;
- the NRF needs to create a database of researchers with unique identifiers, since this entity is responsible for financing research in Mozambique. It should also be rethought the most appropriate way to implement a management system of the curricula of researchers who may undergo an effective collaboration with

- institutions linked to similar projects, such as Lattes of Brazil and DeGóis in Portugal, for sharing experiences;
- for MoRENet, which is at the stage of implementing the network infrastructure and expanding the links to other institutions in the country, there is still the challenge of making an analysis of the network service quality levels, ensuring that institutions already connected may discard existing contracts with commercial operators, to ensure the reduction of investment costs previously held by them;
 - in the context of UbuntuNet Alliance and African Union, it is important to rethink effectively and comprehensively about creating a regional platform that can support researchers and research results funded by their supported programs and projects, hosting not only documents in full text format but also the research data set. The South Africa, being the country with the highest number of OA repositories, is also the only country that has implemented a data repository, the South African Data Archive (SADA) (Van Schalkwyk, 2014). These aspects underscore the need for sharing experiences among african countries that are at the forefront on the issue of OA, as South Africa and Kenya.

6. Conclusions

This paper has discussed the new trends and paradigms related to managing S&T components and players. The national system of higher education and research, in-line with strategies that contribute to develop science in a country, turn out to be significant in the current panorama, and NRENs play a crucial role in the provision of advanced services to the scientific and academic community. In Mozambique, as in any developing country, the issues related to OA and CRIS prove to be relevant and should be analyzed carefully. Therefore, this work has discussed not only the new directives for managing science but also has stressed the importance of NRENs and OA, making specific recommendations aiming at fostering the sharing and disseminating of the results of research conducted in Mozambique.

References

- Ilva, J. (2014). Integrating CRIS and repository - an overview of the situation in Finland and other Nordic countries in three. *National Library of Finland*.
- AJOL. (2014). *African Journals Online*. Retrieved October 22, 2014, from African Journals Online: <http://www.ajol.info/>
- Audretsch, D. B., & Welfens, P. J. (2013). The new economy and economic growth in Europe and the US.
- BOAI. (2001). *Budapest open access initiative*. <http://www.budapestopenaccessinitiative.org>
- Clements, A. &. (2014). Research data meets research information management: Two case studies using (a) Pure CERIF-CRIS and (b) EPrints repository platform with CERIF extensions. *Procedia Computer Science*.
- EC. (2007). Retrieved from European Commission: <http://ec.europa.eu/research/fp7/> EC.(2013). http://ec.europa.eu/research/participants/data/ref/h2020/mga/gga/h2020-mga-gga-multi_en.pdf
- euroCRIS. (2015). *euroCRIS*. Retrieved from <http://www.eurocris.org/>
- Greenberg, A., & Muchanga, A. (2006). *Evaluation of Sida Information and Communications Technologies*. Sida. Retrieved October, from <http://www.oecd.org/derec/sweden/37310728.pdf>

- Lundvall, B. A. (2009). Innovation as an interactive process: user-producer interaction to the national system of innovation: research paper. *African journal of science, technology, innovation and development*.
- Mulhanga, M. M. (2014). Expanding Scientific Knowledge Frontiers: Open Repositories in Developing Countries Supported by NRENs. In *New Perspectives in Information Systems and Technologies*. Springer International Publishing.
- OECD. (2004). Retrieved from The Organisation for Economic Co-operation and Development (OECD): <http://www.oecd.org>
- OpenDOAR. (2014). *The Directory of Open Access Repositories*. Retrieved October 2014, from Directory of Open Access Repositories: <http://www.opendoar.org>
- ORCID. (2015). Retrieved from <http://orcid.org/>
- OST. (2013). Retrieved from USA - Office of Science and Technology Policy: <http://www.whitehouse.gov/blog/2013/02/22/expanding-public-access-results-federally-funded-research>
- Príncipe, P. a. (2014). OpenAIRE Guidelines: supporting interoperability for Literature Repositories, Data Archives and CRIS.
- SABER. (2009). Retrieved October 21, 2014, from SABER Repository: www.saber.ac.mz
- Seo, D. H. (2014). The Past, Present and Future of the Blood Pre-Deposit System in Korea. *Korean Journal of Blood Transfusion*.
- Simons, E. (2014). EuroCRIS and CERIF. The Importance of an International Standard Metadata Model for Research Information.
- Thomas, W. J. (2015). ORCID Identifiers: Planned and Potential Uses by Associations, Publishers, and Librarians. *The Serials Librarian*.
- Van Schalkwyk, F. W. (2014). Open data in the governance of South African higher education.
- Vu, K. M. (2011). ICT as a source of economic growth in the information age: Empirical evidence from the 1996–2005 period. *Telecommunications Policy*.
- Willinsky, J. (2005). *The Access Principle: The Case for Open Access to Research and Scholarship*. Cambridge, Mass.: MIT Press.
- Xia, J., Gilchrist, S. B., Smith, N. X., Kingery, J. A., Radecki, J. R., Wilhelm, M. L., . . . Mahn, A. J. (2012). A review of open access self-archiving mandate policies. (P. L. Academy, Ed.) *vol. 12(1)*, pp. pp. 85-102.