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## FINAL E-INFRASTRUCTURE SUCCESS AND UPTAKE MONITORING REPORT WITH RECOMMENDATIONS

April 2017



# Sci-GaIA

Energising Scientific Endeavour through Science Gateways  
and e-Infrastructures in Africa

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## **Executive summary**

Work-Package 1 (WP1) “Promote the uptake of Science Gateways and e-Infrastructures in Africa and Beyond”, as described in the Sci-GaIA Description of Work (DoW), aims to:

The objectives of this work package are to:

1. Create Science Gateway and e-Infrastructure development guidelines and materials for African NRENs and CoPs;
2. Create Science Gateway and e-Infrastructure development guidelines and materials for African educational programmes;
3. Monitor the successful implementation and uptake of e-Infrastructures in Africa;
4. Ensure the interoperability and interoperation between the African, the EU and the global e-Infrastructures.

This deliverable is related to Objective 3 and presents a report of the assessment of the success of Science Gateways and e-Infrastructures and makes recommendations for sustaining their implementation and uptake.

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## **1 – INTRODUCTION**

### **1.1 – OBJECTIVES OF THE STUDY**

Results from the eI4Africa Survey in 2013 revealed some very interesting findings and highlighted some important avenues for further exploration, including 20 potential e-Infrastructure applications and opportunities for understanding the current and potential future use of a global e-Infrastructure by African researchers and scientists.

This deliverable contributes to the promotion of e-Infrastructures services and Science Gateways in WP1 by assessing their implementation and uptake.

### **1.2 – STRUCTURE OF THE DOCUMENT**

The deliverable is organised in 3 main sections with a final conclusion section at the end. The first section provides information about the methodology followed to collect and analyse the data, while the second looks at the main findings resulting from this survey. The third section presents an overview of the results of a related, more focused survey of a community of African pharmacological scientists to identify priority areas of needs that might be fulfilled by access to information and tools through e-infrastructures. A discussion and recommendations section concludes this report.

## **2 – METHODOLOGY**

### **2.1 – STUDY DESIGN**

An online survey was chosen as the preferred data collection procedure for its economy of design and ease of use, and for the advantage of identifying attributes of a large population from a small group of individuals.

The survey which was launched in July 2015 using the open source LimeSurvey®<sup>1</sup> system, consists of a self-administered questionnaire containing 23 open-ended questions designed for the purpose of this study, to collect information in 4 main areas on the basis of the study's objectives: (1) the participant's background information, (2) the participant's current or planned e-Infrastructure application and users, (3) technical requirements and technologies of current or planned e-Infrastructure applications, and (4) future contact arrangements with the participant.

An introductory page is also presented to the participant briefing him/her about the scope of the study and introducing the concept of e-Infrastructures and science gateways.

The survey is currently open and on going, and it is available online<sup>2</sup>

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<sup>1</sup> <http://www.limesurvey.org>

<sup>2</sup> <http://surveys.sci-gaia.eu/index.php/531683>

## 2.2 – OVERVIEW OF DATA COLLECTION PROTOCOL

Participants were identified for the survey was based on the mailing lists and networks of contacts of the Sci-GaIA partners particularly those of the African regional research and education networks. Some of the partners being beneficiaries of previous FP7 projects including ERINA4Africa and eI4Africa were able to extract key African contacts involved in e-science projects.

Potential survey participants were also identified from Sci-GaIA workshops and training events. To strengthen participant recruitment from the academic and research domain in Africa, the Association of African Universities (AAU)<sup>3</sup> was approached. They assisted in the recruitment by promoting the survey and workshops to their network of contacts.

The identified potential contacts were approached and asked to participate in the survey by email invitations that had a direct link to the survey. Participants were also asked to distribute the survey widely to others participating in e-Infrastructure-related activities. To ensure that the best possible response rate was achieved, the LimeSurvey® system was configured to send two follow-up reminders to those who were been invited, but had not yet responded, and to those who had responded, but had not yet completed the survey.

## 2.3 – OVERVIEW OF DATA ANALYSIS APPROACH

The data from the online survey was exported into a spreadsheet organized according to the 23 survey questions (1 question per column), allowing for better analysis of the presented data.

This phase mainly consisted of analysing the data on a per question basis, which involved reviewing the data that have been collected for each question separately and then graphically summarizing them for an easiest interpretation of the findings. Additionally, data findings from each question have been combined and cross-referenced, where applicable, for more in-depth insights, all of which are presented in section 3 of this deliverable.

## 3 – KEY RESULTS AND FINDINGS

### 3.1 – OVERVIEW

This section presents the results of the analysis of the survey responses. The 124 responses (28 complete; 96 incomplete; 22.6 % response rate) received during the course of the project went through a data-cleansing phase to remove duplicates and unusable responses. Responses from which one could not identify a current or future implementation of e-Infrastructure were deemed unusable.

26 full responses were found usable and considered in the analysis. The results are presented in 3 subsections formed in accordance with the 3 main parts of the survey, supported by graphical summaries. A terminal subsection highlights the influence of Sci-GaIA training and hack fests on response to the survey.

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<sup>3</sup> <http://www.aau.org>

### 3.2 – DEMOGRAPHICS

The survey yielded responses from a number of African countries (n=6) from the different sub-regions and from Europe (n=1).

Figure 1 below present the lists of these countries and the number of the respective responses that have been received from each.

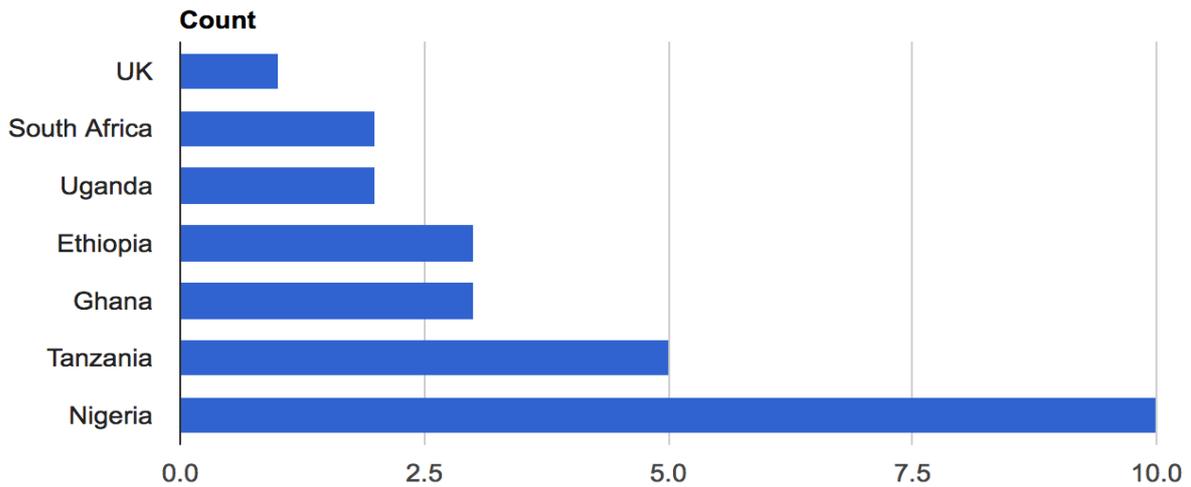


Figure 1. Number of full responses per country

The affiliations of the respondents were varied, with the majority being projects from single researchers and research groups in universities (76.9 %). Others included researchers from R&D organisations (7.7%), NRENs (7.7%), a living lab (3.8%) and a regional NGO (3.8%).

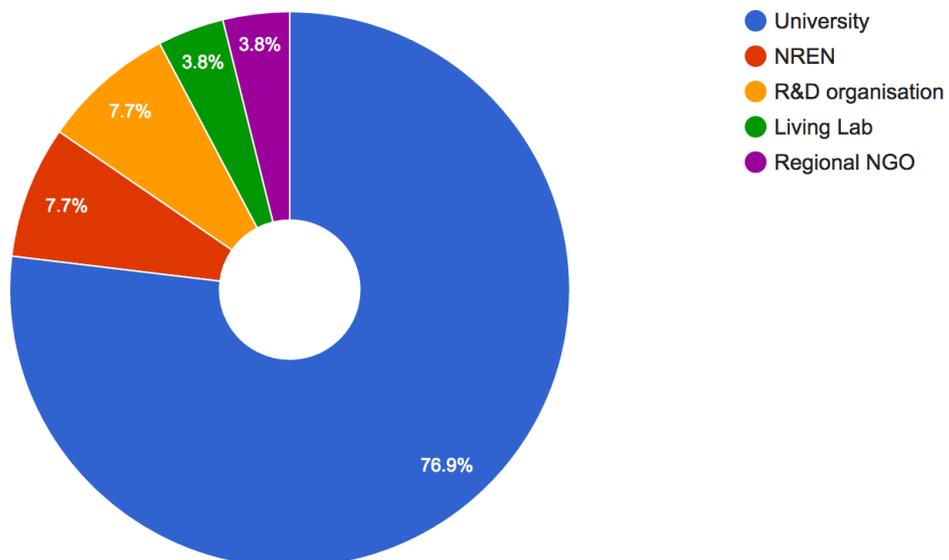


Figure 2. Respondents' affiliations and respective number of responses

### 3.3 – CURRENT OR PLANNED E-INFRASTRUCTURE APPLICATION

With the main focus of the survey being to monitor uptake of e-Infrastructure and Science Gateways, respondents were asked to outline their use cases in terms which were examined for answer to three questions: *“what is your application? What is its purpose? Is there a set of problems that it is attempting to address?”*

Table 1 below presents the distribution of the answers to the first question and identified applications. Answers with the development of a repository as main activity (60.9%) are presented as “Open Access Repository”

Affiliation	Country	Outline of e-Infrastructure use case
Atmospheric Physics Group (APRG), Obafemi Awolowo University, Ile-Ife, Nigeria	Nigeria	Science Gateway for collaborative measurements of atmospheric for identified research groups across Africa and outside regions. The datasets will provide basis to run atmospheric models and comparison of cases.
Elimu Living Lab	Tanzania	A digital library for students and teachers in Tanzania's secondary and open schools to easily access educational materials on their mobile devices.
CSIR	South Africa	Open Access Repository
Department of Economics/Kwame Nkrumah university of Science & Technology, Ghana	Ghana	Open Access Repository
Federal University Lafia, Nigeria	Nigeria	Open Access Repository
Gulu University	Uganda	Open Access Repository
College of Medicine, University of Ibadan	Nigeria	Open Access Repository
Sokoine University of Agriculture	Tanzania	Open Access Repository
The University of Dodoma	Tanzania	Open Access Repository
University of Ghana	Ghana	Open Access Repository
Kyambogo University	Uganda	Open Access Repository
Association of African Universities	Ghana	Open Access Repository
University of Dar es Salaam	Tanzania	Open Access Repository

Affiliation	Country	Outline of e-Infrastructure use case
Lagos State University	Nigeria	MIPAR is a Science Gateway for Collaboration in Medical Image Analysis. It addresses the problem of lack of specialized medical data in Africa, and will be used to share and process medical images and compensate for the shortage of medical image analysts. MIPAR will be useful for medical experts and researchers interested in processing medical images, e.g. MRI data
Federal University of Agriculture, Abeokuta	Nigeria	e-Service Communication Model for Rural Agricultural Extension. Involves a mobile web application leveraging e-infrastructure applications to support an ecosystem of various agents in agricultural extension services. Aims at improving the kind and manner of information disseminated to farmers, extension agencies, researchers, institutes, ministries and other stakeholders.
University of Ibadan	Nigeria	Addressing the problem of inaccessible research data through open access and federated log-in with NADA using Nesstar linked to REST APIs for metadata archiving and documentation.
African Centre of Excellence in Phytomedicine Research and Development (ACEPRD) University of Jos	Nigeria	Science Gateway for Phytomedicine starting with a repository that contains medicinal plants located in Nigeria. Further development will provide tools for data processing and analysis. The service is targeted at researchers, students and traditional medical practitioners wanting to acquire information on medicinal plants located in Nigeria.
Obafemi Awolowo University, Ile-Ife.	Nigeria	Collection of reliable atmospheric data (in near real-time) from an array of low-cost automatic (and autonomous) weather stations. This online database will be useful for the study of the atmospheric phenomena (regional climate modelling, aerosol loading and pollution, etc.).

Affiliation	Country	Outline of e-Infrastructure use case
Brunel University, London.	UK	WEKA (J48) Algorithm - A science gateway that could analyse the output of simulation results. This output will be obtained from the Repast Science Gateway that was earlier developed.
Jimma University	Ethiopia	Science Gateway providing access to QUANTUM ESPRESSO packages or VASP on High performance computers to solve problems with respect to Density functional theory.
North-West University	South Africa	Science gateway for a Speech Technology research community. Enable the community to use grid resources at their disposal by joining a federated ID.
Tanzania Education And Research Network	Tanzania	Developing web interface for WEKA. The main purpose of porting WEKA is to break accessibility and performance barrier. Currently focused on doing this with use case of analysis breast cancer data to predict the number of cancer tumor out of all diagnosed with tumors
Nnamdi Azikiwe University, Awka	Nigeria	Science Gateway for Drug Design, Discovery, Development Platform and Repository (D4PR). D4PR will contain an integrated set of tools, applications, data repositories etc. for finding new drug candidates from natural products, existing drugs or chemical databases. The Science Gateway addresses the problems associated with collaboration, limited computational resources and capacity building.

**Table 1. Respondents' current or planned e-Infrastructure use case**

From a geographic point of view, answers to the question “Where would the application be used? Single country, several countries, continent, the world?” are summarized in Figure 3 with the majority of the applications targeting users in Africa and beyond.

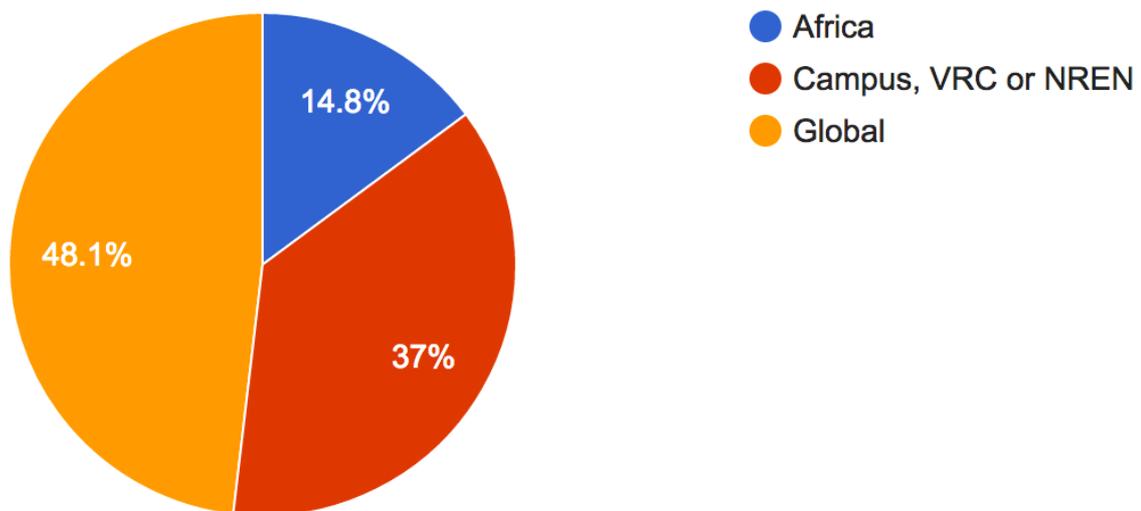


Figure 3. Geographical locations of users of respondents' e-Infrastructure applications

### 3.4 – E-INFRASTRUCTURE APPLICATION REQUIREMENTS

This section focuses on the technical requirements of the applications, as reported by the survey respondents. The specific requirements examined cover a range of basic e-Infrastructure features, and include computing, communication, data, specialized instrumentation, sensors, access, and scientific literature requirements.

Participants asked to indicate the computing requirements of their current or planned application. Not surprisingly, many of the respondents planning open access repositories had generic requirements in the form of typical server hardware, adequate storage and high-speed Internet as main needs.

The responses of the remainder are tabulated in Table 2 and are mainly centered on the use of particular software, its requirements (e.g. storage size, operating system (OS), language, graphical processing capabilities (GPU), etc.), the application's speed requirements, as well as the need for access to specialized High Performance Computing (HPC) facilities.

Application	Computing Requirement	Instrumentation Requirements	Sensor requirements	Communication Requirements
Science Gateway for collaborative measurements of atmospheric for identified research groups across Africa and outside regions.	FutureGateway API Server, Regional Climate Models, High Performance Computing, High Speed Internet	Requires 5 GHz Routers (wireless), Yagi antennae and GSM Modems+E14	Meteorological sensors, cup anemometers, wind vane, radiation sensors, psychrometers, ultrasonic anemometers, infrared hygrometers, rain gauges, etc.	GSM modems (3G) that can be used to acquire the data in the field in real time, and further, high-speed internet connectivity for remotely transfers
MIPAR - Science Gateway for Collaboration in Medical Image Analysis.	Image processing software, Linux operating system. 1TB of hard drive is fine. A server with about 52 GB of RAM should be fine to run the software	N/A	N/A	High-speed Internet
e-Service Communication Model for Rural Agricultural Extension.	High performance servers, end-user test smartphones, workstations for network testing facilities and high-end laptops. LAN infrastructure for base testing and aggregation.	Video capturing devices and monitoring; remote monitoring devices. In the process of highlighting types and detailed model with specifications.	N/A	High-speed Internet

Application	Computing Requirement	Instrumentation Requirements	Sensor requirements	Communication Requirements
Open access and federated log-in with NADA using Nesstar linked to REST APIs for metadata archiving and documentation.	Need to incorporate back-end analytical software like the R software package.	N/A	N/A	High-speed Internet
Science gateway for a Speech Technology research community.	HTK, Kaldi Software, GPUs if available to make it run faster.	N/A	Speech and camera sensors	High-speed Internet
Science Gateway for Drug Design, Discovery, Development Platform and Repository	VINA, GROMACS, HPC, Broadband Internet	N/A	N/A	High-speed Internet

**Table 2. List of e-Infrastructure with non-generic application requirements**

#### 4 – REPORTED NEEDS OF AFRICAN PHARMACOLOGICAL SCIENTISTS

As separate activity in the Sci-GaIA project, and building on a community of practice identified in the preceding FP7 ei4Africa<sup>4</sup> project, a study was undertaken by the Medicines Utilization Research in Africa (MURIA) Group<sup>5</sup> to identify available resources and priority areas of needs of African pharmacological scientists that might be fulfilled by access to information and tools through e- infrastructures; and if these could be satisfied by the Africa Pharmacological Science Gateway<sup>6</sup> developed in ei4Africa as demonstration of an e-Infrastructure community.

The cross sectional questionnaire study also used the open source survey tool; LimeSurvey® and was conducted among 472 identified members of pharmacological societies in Africa to obtain information on their research interests, available research skills and resources and expressed needs and knowledge gaps. A total of 118 responses from 13 countries were received, mostly from Nigeria (48.3%) and South Africa (21.3%) giving a response rate of 25%. Results were explored using descriptive analysis and respondents had wide range of research interests predominantly in drug utilization research.

<sup>4</sup> <https://web-beta.archive.org/web/20151018103800/ei4africa.eu>

<sup>5</sup> <http://muria.nmmu.ac.za/>

<sup>6</sup> <https://sgw.africa-grid.org/pharmacology-science-gateway>

The most frequently mentioned pharmacological science based needs were online training programs in drug utilization research techniques, pharmacokinetics modeling and pharmacometrics training, access to drug utilisation calculation tools (90%), access to pharmacokinetics and pharmacometrics software, access to drug-drug interactions software and international medicines pricing. Other desired resources include laboratory equipment and trainings in specific laboratory techniques, access to journals and funding for research related activities among others as summarized in Table 3.

Categories of Resources	Specific Resources
<b>Pharmacological Science Related Needs</b>	
	Training in drug utilization research methods
	Access to DU 90% calculation tools
	Training in pharmacokinetics modelling and pharmacometrics
	Access to pharmacokinetics and pharmacodynamics software
	On line access to pharmacometrics software: NONMEM, Monolix, PopEd etc.
	On line access to drug-drug interaction software e.g. Micromedex
	Access to database of international medicine pricing
<b>Research and Statistical Training Needs</b>	
	Training in Qualitative Research
	Advance On-Line Training in Statistical Analysis Techniques: STATA, R, SAS
<b>Laboratory Technique Training Needs</b>	
	Advanced Tissue Culture Technique Training
	DNA Sample Analysis
<b>Access to Laboratory Equipments</b>	
	Molecular Biology equipment
	HPLC
	TDM laboratory
	GC/Atomic Mass Spectrophotometer
	High Capacity Vacuum Pump and Rotatory Evaporator
	Water Cooling Circulatory System
	Heating Mantle
	Cell Culture Facilities
	Genomics and Informatics Equipment
	Beta Scintillation Counter
<b>Other Needs</b>	
	Access to Journals
	Funding for Research and Collaboration
	Sponsorship of Attendance at International Conferences
	Payment of Publication Fees

**Table 3: Desired resources and knowledge gaps expressed by respondents**

The report concluded that African Pharmacological Scientists will benefit greatly from e-Infrastructure platforms providing drug utilization research tools and trainings, a database of international medicine prices and costing tools, pharmacokinetic, pharmacodynamics and pharmacometric tools and trainings, on line resources on statistical analysis, drug-drug interactions software, access to journals and enhanced opportunities for networking with the global research communities in relevant areas.

Priority areas of needs not currently provided in the African Pharmacological Science Gateway were identified. These will guide further development of the e-infrastructure and potentially enhance research capacity in this community within the African continent.

## 5 – DISCUSSION AND RECOMMENDATIONS

Despite attempts to exploit the consortium partners and circulate widely, full appreciation of e-Infrastructure and science gateways beyond broad definitions did not seem pervasive enough for respondents to successfully complete the survey. This is in part due to the general unavailability of resources but with the implementation of the AfricaConnect2 network rollout and cloud and shared services<sup>7</sup> pilots by the regional RENs, it is expected that some of these issues will be tackled benefiting from the growth of Internet and data services in the whole continent.

The analysis of the survey responses revealed that researchers and communities that had the opportunity to interact directly with the project training events and Open Science platform i.e. Sci-GaIA Champions<sup>8</sup> were those who largely responded to the survey. The workshops, training and especially the hack fests were the onboarding required for these respondents to articulate their ideas and requirements for e-Infrastructure for their use-cases and communities. It is important therefore that hack fests are adopted as a mainstream component of further training on development of e-Infrastructure.

The study has proven useful not only in monitoring the uptake of e-Infrastructures, it also highlighted a key area that has not received enough attention that could significantly impact on the successful adoption of these digital infrastructures and resources. The practice of research and education has seen the evolution and incorporation of so-called “Open” movements such as Open Source, Open Access, Open Data, Open Innovation, Open Science and Open Development<sup>9</sup>. The main philosophy underpinning these movements is free, unfettered access to, and use of, information resources for the betterment of beneficiary communities. Both TANDEM<sup>10</sup> and the Sci-GaIA projects have sought to support emerging scientific communities of practice enabled by infrastructural development under national research and education networks (NRENs). A key end-user community of practice that has been identified as a result of this work, is the African universities’ librarian community.

It is widely recognised that librarians play a critical role in providing access to information and in fact, the role of libraries is seen as explicitly key to the success of Open Science initiatives. FOSTER<sup>11</sup> recognizes this role as comprising 4 important objectives: (1) advocating and raising awareness; (2) giving support to the infrastructures; (3) research data management; and (4) training and supporting researchers.

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<sup>7</sup> <http://wacren.net/en/news/wacren-cloud-pilot-open-call>

<sup>8</sup> <http://www.sci-gaia.eu/champions>

<sup>9</sup> [http://pasteur4oa.eu/sites/pasteur4oa/files/resource/Discussion%20Paper\\_Researchers%20and%20Open%20Science.pdf](http://pasteur4oa.eu/sites/pasteur4oa/files/resource/Discussion%20Paper_Researchers%20and%20Open%20Science.pdf)

<sup>10</sup> <http://www.tandem-wacren.eu>

<sup>11</sup> <https://www.fosteropenscience.eu/content/libraries-roles-and-opportunities-open-science>

Librarians can therefore be positioned as key institutional actors in the appropriation, provision and dissemination of information resources through the services offered by RENs. The issue, however, is that they lack institutional visibility, legitimacy and capability to undertake this role. This needs to be addressed to reap the benefits of Open Science and e-Infrastructure.

Development of libraries corresponds with the use cases for open access repositories observed in the significant percentage (60.9%) of the respondents surveyed. A program with the following objectives could address these needs and embed the appropriate culture and structures for sustainable uptake of e-Infrastructures:

- identify and address the institutional enablers and barriers to librarians taking on new roles as higher education environments adapt to external pressures, digitalisation, open source/data/access, new forms of information management etc.
- develop expertise and build capacity for Open Science, Open Innovation and Open Data in African education through a network and community of practice, offering local support and advice to the research community as well as providing sustainable infrastructure and services such as repositories and local open access journals
- federate these communities and infrastructures in national, regional and global collaborations for pervasive adoption of policies, services and infrastructures.

## 6 – CONCLUSION

The results received over the 22 months that the survey has been running has demonstrated uptake of e-Infrastructure across the region, mostly by universities but also from regional aggregators of African academic output and large research organisations.

The evident need for e-Infrastructure to curate and share data for education and research mirrors results from the TANDEM Survey<sup>12</sup> for education-related networked services that were rated as both highly desirable and useful. Access to content and ability to share data were ranked by more than two-thirds of the respondents. NRENs can work towards making the identity federations, repositories and other computing, data and networking infrastructures that support these needs available for African researchers.

Beyond the technology, the NRENs will need to broaden the conversation with these communities as the e-Infrastructures are deployed. The Sci-GaIA hack fests have proven to be a useful way to engage the researcher community to adopt new methods, at the same time providing use cases that help to clarify the e-Infrastructure requirements.

The survey continues and it is expected that as the recommendations are implemented, there will be increased uptake of Science Gateways with more use cases exploiting federated data and document repositories as they become available.

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<sup>12</sup> <http://www.tandem-wacren.eu/wp-content/uploads/2017/01/D3.2-Analytical-Results-of-the-Questionnaires-on-End-User%E2%80%99s-Requirements.pdf>