Sharing science: The state of institutional repositories in Ghana

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Abstract
Scientists around the world benefit from sharing scientific data, lab notes, and preliminary papers, as well as traditional, formal scientific papers. Institutional repositories (IR) are open spaces for scientists to deposit their work. Doing so could potentially spark new collaborations, allowing scientists and scholars to build cross-institutional capacity. However, scientists must trust that the repository is secure, and they must understand copyright law and protections. Many African nations are at a crossroads: poised to solve major problems with well-trained scientists, yet stymied by expensive and unpredictable ICT. Many African scientists are also wary of the Internet due to rampant scams and fraud. This paper describes current African ICT development, reports on findings from a study about ICT, databases, and IRs in Ghana, and concludes with recommendations for expanding the use of IRs.

Keywords
institutional repositories, collaboration, research, developing nations, Ghana

Introduction
Librarians tend to see information as a public good. By definition, a public good increases in value when it is shared and used. However, some scholars and scientists might not want to share their information. They are recognized, evaluated and compensated based on their production and contributions to their field, so they have a vested interest in ensuring that they retain ownership of their scholarly products. Informational researchers have found that putting papers into Institutional Repositories (IRs) has helped scholars disseminate their work, which in turn should raise their (and their institution’s) profile. This is very promising, but the act of depositing works into an IR requires the scholar’s trust—trust in the system’s purpose and that it is stable and secure. They need assurance that their work will not be stolen, and they need to understand how to protect it with copyright. Certain aspects of developing countries present especially vexing challenges for implementing an IR. For instance, institutions often lack a strong and secure Information Communication and Technology (ICT) network. Scientists might lack knowledge about copyright laws to protect their work. There may be insufficient resources for managing the IR, there are often inconsistent power supplies, and above all, there is a lack of funding for major IT projects.

This paper relates findings from a survey of Ghanaian scientists and librarians at four governmental scientific institutions. It reports on scientists’ current sharing habits and their feelings about sharing papers and data online. It seeks to uncover obstacles to sharing in order to advance cross-disciplinary work and institutional capacity. The brief literature review provides background on sharing data and scientific papers, specifically as it pertains to perceptions of IRs in developing nations. It concludes with recommendations about IT infrastructure and management of IRs, as well as education for scholars in developing nations.

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nations about IRs and copyright in order to explain how IRs might advance internal and external research recognition and help build a foundation for research collaboration.

**Significance of the study**

This study aims to provide an initial assessment of scientists and librarians that will help create a blueprint for successful institutional repository development in Ghana. In order to make progress towards this goal, it is important to gauge participants’ feelings about some of the most important or pressing issues, such as copyright and ownership. It also points out some of the obstacles that Ghanaian scientific institutions face regarding IR implementation. Ghana’s IT problems are similar to those in many developing nations; therefore, while this research looks specifically at Ghanaian institutions, we believe that the findings are widely relevant.

**Literature review**

This research looks at Institutional Repositories (IRs) as a solution to communication roadblocks within institutions and between nations. The literature review concentrates on scholarly communication, management of IRs, and the concept of open scholarly communication, highlighting the needs and challenges of scientists working in developing nations.

**Defining institutional repositories**

The explosion of electronically produced scholarly work (and the resulting required storage and organization for access) has required librarians to extend their creative problem-solving skills. Electronic resources continue to grow in importance to researchers (Russell, 2009); contributing to the body of electronic scholarly knowledge is very important for globally recognized scholarship. The IR is one way to gain exposure and collaborate with other scholars.

What, exactly, is an IR? As with other emerging technologies, IRs may not have a single accepted definition, but their purpose is to help scholars store and share their work. Heery and Anderson (2005) define a repository as a collection of digital objects defined by the characteristics of the materials and the community that uses it, but not differentiating between repositories and other systems such as databases or catalogues. They state that different repositories may hold particular kinds of materials—for instance, e-prints and dissertations or discipline-specific materials. Crow (2002) sees the importance of IR digital collections in capturing and preserving the intellectual output of university communities. Russell (2009) says the aim of IRs is to aid the management and dissemination of the increasingly copious amount of scholarly electronic resources produced by academics.

Terms such as ‘digital library,’ ‘virtual library,’ ‘institutional repository,’ or ‘electronic library’ have been used interchangeably by various scholars. MacColl, Jones and Andrew (2006) create a mathematical bridge between these terminologies and resolve that IRs are simply a subset of libraries: libraries are repositories, modern libraries focus on digital materials, and IRs are a type of digital library. Kassim and Kochtanek (2003), in studying IR implementation, found that ‘IR’ is being used interchangeably with ‘virtual library,’ ‘electronic library,’ or ‘library without walls.’ Talja (2002) says that IRs encourage collaborative learning within academic institutions. Masinde and Rajan (2010) discuss IRs as a means of preservation and expansion of access. Likewise, Harnad et al. (2004) say that IRs increase the visibility of materials among research and academic communities. Dunning (2006) says, though, that merely having documents in a repository will not assure their visibility. Clearly, though, online data (including scholarly and research output) is growing daily, and organization of the material is vital. IRs offer one viable method for organizing institutional output, and the organization offered by an IR can help users make sense of scholarly data by providing institutional context. There are differences in terminology, but most scholars of IRs do agree that they increase the visibility of scholarship, thereby promoting sharing and use by academic communities inside and outside of an institution.

**The open nature of IRs**

The Registry of Open Access Repositories (ROAR) (2014) proclaims, “Open access to research maximizes research access and thereby making research more productive and effective.” Perhaps one of the most important (and as we found, problematic) aspects of IRs is their openness. This means that scholars freely deposit items into their own institution’s repository, including items that a scholar might submit to a journal. This requires the author to either maintain copyright or negotiate with the journal to maintain the right to deposit a version of their paper into the IR. Other items that they submit to the IR (such as notes, lab results, etc.) might be valuable to other researchers. Most of these items can be found through search engines on the open web. Borgman (2012) calls this a “conundrum” because it is urgent that researchers share data, it is being demanded by
publishers and finders, but there is little discussion of the “competing interests and differing incentives of the any stakeholders involved” (p. 1061).

There are two types of Open Access communication, as defined by the Budapest Open Access Initiative (BOAI): green OA (repositories) and gold OA (journals). This group asserts that scholars and their institutions have a duty to work with OA publishing in order to “to make knowledge available to everyone who can make use of it, apply it, or build on it.” The term OA was coined by BOAI as:

‘free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited’ (Budapest Open Access Initiative 2013).

Furthermore, the BOAI says that funders should cover reasonable publication costs, and institutions should require deposit into the repository for immediate dissemination. The BOAI model ensures quality scholarly output while providing the fastest dissemination of material and protecting the author.

Managing communication, ICT, and IRs
Meadows (1998) traces the history of research and communication from Aristotle through modern electronic publishing, explaining that communication technologies are at the heart of research. Modern research is innately embedded in new technologies through its entire lifetime—from inception through storage. Therefore, it can only thrive in a robustly supported Information Communication Technologies (ICT) environment. A strong infrastructure, in turn, enables more scholarly output (not to mention different kinds of output, including papers, books, multimedia, etc.). Technologies are always under development that might shape the possibilities for production, storing and sharing (and thus the IR).

The fluid environment of production and retrieval, of course, requires robust management at all stages, including the IR. Warwick et al. (2006) say that users of electronic resources do not necessarily differentiate between types of sources as they would with print sources. Electronic resources usually link to other sources, or several types of material might be combined in one document. Peer review may or may not be present or apparent. This also means that managers of digital resources should understand what their users’ needs are when building and maintaining the IR. Since IRs are based within the community, librarians or other IR managers must understand the needs of the users.

Developing countries and the information age
ICT is an enabler—it holds the power to bridge economic and development divides, but people must recognize what it can offer them, and embrace the aspects that will provide the means to grow. Roy (2005) explains that ICT has the potential to enable closer interaction and universal bonds between and within national borders and between individuals, groups and institutions. Theories on ICT cannot be separated from the realities of local, national, regional and international political economy that shape its adoption. There is still a large ‘digital divide’ between and within developed and developing nations that needs to be resolved and that is located in the context of inequalities between nations.

Block (2013) says that developing countries must overcome any obstacles if they want be a part of the information age. The information flow in developing nations is different from that in developed nations. Additionally, there is little scholarship on the information seeking behavior of scholars and scientists in developing countries. Inadequate ICT is a hindrance to scholars’ communication in developing countries, and it also renders them less globally competitive.

Yadamsuren (2013) found that the research infrastructure in Mongolia (a developing country) fails to meet the needs of researchers for sharing and collaborating; therefore, researchers are often dependent on western scholarly communication products. Salager-Meyer (2008) says that open access policies in countries with well-funded research (such as the United States and members of the European Research Council) may help scientists in developing nations publish their research, and also increase collaboration between developed and developing (which she calls central and peripheral) nations, in terms of scientific output.

Despite the obvious public (indeed global) good that open access policies fulfill, there are still roadblocks; for instance, the tenure process in academia does not favor OA journal publication (Park and Qin, 2007). Van Noorden (2013) explains that commercial journals “tend to be more selective.” They often cost more to produce, as well—“the more effort a publisher
invests in each paper, and the more articles a journal rejects after peer review, the more costly is each accepted article to publish” (Van Noorden, 2013). Many commercial vendors do offer discounted or free access to their journals in developing nations through programs such as Research4Life (http://www.research4life.org/) and INASP (http://www.inasp.info/en/), but there is still much that is unavailable, even in print. Willinsky (2006) explains: “In Africa, there is no less of a struggle underway to support the development of research capacities amid scarce access to the scholarly literature” (p. 99)—for instance, one librarian at the Development Policy Centre in Ibadan, Nigeria, was unable to get “more than 60 percent of the issues published each year of the print journals to which the library subscribes” (pp. 99–100). Free online access certainly helps, but slow network problems continue to pose barriers to access. Yet another problem is that many African scholarly journals face continuous economic struggles and are not indexed (p. 103).

ICT networks will have to be developed for scholars in developing countries to gain recognition and collaborate with people in developed nations. Globalization implies that human problems extend beyond national borders; therefore, strong ICT infrastructures in developing nations should be an international priority (Chan and Costa, 2005).

The role of ICT in Africa’s scholarly development is not in doubt as leaders in developing nations have always expressed a strong awareness of ICT for communicating research. At the 10th meeting of the Africa Partnership Forum in Tokyo (2008), delegates agreed on the following resolutions about ICT that demonstrate African leadership’s acceptance and interest in using ICT for economic and scientific growth:

- ICT is a powerful tool to boost economic growth and reduce poverty.
- African nations will respect the World Summit on the Information Society (WSIS) resolutions regarding the key role of ICT for inclusive, globally competitive and knowledge based societies.
- Infrastructural bottlenecks will be removed in order to address the New Partnership for Africa’s Development (NEPAD) broadband initiative.
- Africa will prioritize ICT access and effective use at all levels.
- African governments must create an ICT specific regulatory framework within an overall policy that promotes economic and political governance.

ICT in Ghana

Both a ‘big picture’ of ICT and Internet penetration in Ghana as well as a focused presentation of ICT among scientists are required to understand the promise and problems with research institutions’ IRs. How many of Ghana’s 25 million people (United Nations Data, 2014) are using the Internet? What are they using it for? A historical approach will frame the current situation.

The Internet came to Ghana in 1995, though it is still not widely used. Quarshie (2012) said that there was very slow growth of Internet use between 1999 and 2005 (0.1 percent), but use rose incrementally until 2009. Between 2009 and 2011, there was more drastic (3 percent) annual growth. Currently 8.4 percent of Ghana’s population uses the Internet regularly, but there is every indication that it is poised to grow in
importance. At the time of this writing, they found that education accounted for 23.75 percent of Ghana’s Internet use, and only 6.35 percent of the traffic was for commercial purposes.

Martey (2004) discusses ICT’s usefulness for distance education, but also the potential improvements ICTs could make across other spheres of life. In a study about rural development and ICT use, Alemna and Sam (2006) agree: agriculture, education, small industries, and other related areas would benefit from ICT developments. Hinson (2005) described how the Internet is used in Ghana, finding that it is used across many spheres—for instance, research, consulting, administration, teaching and policy making. Akkermans (2010) describes practical ICT use and development in Ghana, such as mobile applications for banking, emphasizing that applications for rural development, such as those that allow farms to receive market information and negotiate prices, are of special interest. Before that will work, though, applications must be developed that use local languages and dialects—as FM radio, which is currently and successfully used, has proven.

What does ICT mean for global scholarly participation? Atiso (2002) described the impact that ICT has on both national development and academic work. Early Internet users in Ghana were mostly students who used it for email, chatrooms, and for personal affairs. He concludes that a strong ICT infrastructure must be available in order to make the Internet a useful tool for scholarly pursuits. Ynalvez et al. (2005) asked if the Internet would indeed be a panacea for global scholarly participation, and found that “The digital divide that has direct bearing on scientific output is the divide that pertains to practice and experience, not access and use.” Adika (2003) found that faculty members at the University of Ghana did not use the Internet often, and recommended that librarians and information professionals help faculty understand changes in scholarly communication.

Asunka (2013) describes the lagging ICT networks and poor state of digitization in developing nations, which affect scholars’ visibility and ability to compete globally and be a part of the Information Age. He recommends upgrades to the infrastructure and leadership from librarians and ICT experts. Adeyoyin (2005) thinks that in view of technological changes, libraries’ services must undergo a fundamental shift (which many developed nations have already embraced). ICT is both the cause and the solution for librarians’ involvement and central position in scholarly activity.

Rogers’ (2010) Diffusion of Innovation Model can help us understand Internet use for scholarly sharing via ICT, which generally starts with early adopters and eventually the practice becomes more commonplace. As Ynalvez et al. (2005) found, people who have obtained a graduate degree in Europe or the United States were more likely to use ICT regularly; eventually, its use spreads throughout the institutional culture as people recognize its applicability to their own work. There is no overnight fix, but training and education can help reduce resistance to change. There are still significant barriers in taking full advantage of the Internet’s practical and scholarly uses for citizens and scholars of Ghana, as well as other developing nations.

Statement of the problem

Institutional repositories should ultimately provide a manageable digital system that is useful for providing access to scholars at the point of their need. The problem is that users must both trust the IR and then proceed to use it (Ynalvez et al., 2005). IRs are a new innovation in developing nations, but they have the potential to help scholars in those nations become more active participants in the global knowledge economy. This study addresses scholars’ and librarians’ attitudes about IRs and barriers to their use in research libraries in Ghana. In Ghana, there is no national or institutional policy requiring scientists to deposit their works in the IR. There is, however, a legal requirement that binds all scientists to give a paper copy to the national library. At this time little research has been conducted on research libraries in Ghana. This paper therefore will help to explain how Ghanaian research libraries can continue to grow and meet patrons’ needs as the Internet and a culture of sharing data changes the face of scholarly communication worldwide.

Objectives

The aim of this research is to define barriers to use of IRs in research institutions in Ghana. The study looks specifically at:

1. the role of IRs in research institutes in Ghana
2. scientists’ knowledge about IRs, and how IRs might fit into scholarly communication in Ghana
3. legal and cultural issues and beliefs associated with open access and IRs.

Research questions

1. Are scientific researchers aware of IRs?
2. Do scientific researchers want to use IRs—do they trust them? Do they have the knowledge to use them?
3. What are the barriers for effective IR implementation in research institutions?

Methodology
This research was conducted via online (Qualtrics) survey. One survey was developed for researchers and one for librarians (see Appendices 2 and 3). The surveys were sent directly to the listservs of all four institutions. Participants responded online. The second-named author is a former employee of one of the Institutes, and thus had insight into some of the problems and issues with IRs in Ghanaian scientific institutes. Thus, some of the questions were formulated based on experience, and others were more general in nature.

Scope and limitations
This study is about the use of IRs in scientific research institutes in Ghana. Four research institutes, the Animal Research Institute, Water Research Institute, Ghana Atomic Energy Commission and the Food Research Institute, were selected because they are the main research organizations in the country (see Appendix 1). The Water Research Institute, the Food Research Institute, the Animal Research Institute are under the umbrella of the Council for Scientific and Industrial Research (CSIR), and the Ghana Atomic Energy Commission is the other main research organization. There are two factors in Ghana that we anticipated as barriers to data collection in this study: unpredictable ICT connectivity and researchers’ general reluctance to participate in survey research. Despite these known barriers, we opted to use an online survey because of its low expense and expediency. We acknowledge the low rate of participation; therefore, we will not claim that the findings are statistically significant, but we do believe that they provide insight into the problem and gauge scientists’ attitudes on IRs at this point in time. There was a higher participation rate in some institutes because of the personal connection the author had to its librarians, who reminded scientists to fill out the surveys.

Findings
Two surveys were created because there were a few questions that were different as between the researchers and the librarians, due to the nature of their work regarding the IR. Twenty-six scientists and 12 librarians completed the study, though they were not required to answer every question. The following tables illustrate all of the data that was collected in the surveys. Respondents were not required to respond to all questions; when possible, the responses are combined into a single table, with R indicating researcher and L indicating librarian.

Demographic data included work affiliation (see Appendix 1), educational background, and age.

Affiliated institute. Almost half (n = 17) of the respondents were from one institution, the Animal Research Institute, where the second named author in this study formerly worked (Table 1).

Table 1. Institution.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSIR – Animal Research Institute</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>CSIR – Water Research Institute</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>CSIR – Food Research Institute</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Ghana Atomic Energy Commission</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>12</strong></td>
</tr>
</tbody>
</table>

Educational background of respondents. Most (n = 25) of the respondents held a master’s degree or equivalent as their highest level of educational qualification (Table 2).

Table 2. Education.

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Master’s Degree or equivalent</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>Bachelor’s degree or equivalent</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>High School diploma or other</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>

Age. The majority (n = 21) of the respondents were aged between 31 and 40 (Table 3).

Table 3. Age.

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>21–30</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>31–40</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>41–50</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>51–60</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>60+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>
**Self-reported comfort level with Information and Communication Technologies (ICT).** Most \( n = 21 \) of the respondents consider themselves to be early adopters of technology (Table 4).

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am an early adopter – I use new technologies, read blogs, and enjoy innovation.</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>I tend to wait and see if new technologies work well before I will use them.</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>I avoid new technologies. I prefer tried-and-true methods to communicate or deal with information.</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>20</td>
<td>11</td>
</tr>
</tbody>
</table>

**Internet connection.** Respondents’ answers varied widely, but the majority of the librarians \( n = 7 \) have a cable connection, while the majority of researchers \( n = 14 \) have a modem. Some have more than one type of connection (Table 5).

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial-up</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>DSL</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Cable</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Modem</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Other (all filled in &quot;wireless&quot;)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>31</td>
<td>10</td>
</tr>
</tbody>
</table>

**Speed of Internet service.** Most of the respondents \( n = 23 \) said that they have a “fast” or “somewhat fast” Internet connection. Four said that it was somewhat slow, and one did not know.

**Use of Internet and Communication Technologies.** Multiple answers were allowed. The most common reason for researchers to use ICT is to share their research, followed closely by research activities (Table 6.1). The most common use of ICT by librarians is for cataloging and classification, also followed closely by research activities (Table 6.2).

**Funding ICT projects.** Most respondents \( n = 22 \) reported that their institute funds its ICT projects; however, they felt that the central government should be more active in funding ICT projects in order to strengthen their communication capabilities (Table 7).

**Main problems with ICT.** Most \( n = 24 \) respondents said that funding was the main problem that they faced with ICT, though low bandwidth was almost as problematic (reported by 18) (Table 8).

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>The library system/finding local resources in my library</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Databases</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Sharing my research</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Other (answers included research and emailing)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>38</td>
<td>38</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated library system</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cataloging and classification</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Serials control</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Database management</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Acquisitions</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Research work</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>26</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>The institute</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>The government</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Internally generated funds</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Foreign funding</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other (write-ins: researchers and projects)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>26</td>
<td>11</td>
</tr>
</tbody>
</table>

Solving ICT problems. Qualitative data was sought; Table 9 represents a summary of the answers, followed by illustrative answers from respondents.
Some of the illustrative statements made by respondents are:

“Though there are limited funds in the institute, more funds need to be allocated to solve ICT problems. Also, proposals could be sent to foreign donors for assistance in the form of free subscription and access to relevant materials, to have some form of concessions where it may not be possible to acquire services for free and many others.”

“ICT could be funded by the government with some input from a foreign donor e.g. project funds. However, in Ghana in general, I have the opinion that the cost of the Internet is too high and the bandwidth is low. Furthermore, reliability is low. It will help a lot of the government can put in place policy to regulate ICT providers in Ghana, especially ISPs and communication companies. In regards to regulation, I mean the quality of service, the price of service and the reach of communication services.”

“Getting broadband from better Internet service providers probably at a higher cost which researchers cannot afford.”

“The solution to my institute’s ICT problem can be solved through increased and sustainable measure. The ICT problem is also an issue lack priority. Administrators of my Institute must see ICT as the driving force in advancing its developmental agenda. [The] head of the institute must therefore set it as a priority.”

Use of databases and relevancy to work. Most of the respondents were from the Animal Research Institute. Therefore, the data is illustrative of the nature of the respondents and is not generalizable to Ghanaian scientific institutes. The most relevant foreign database for respondents is AGORA, and the most relevant local database was AGRIS; both are agricultural databases.

Paying for databases. Most (n = 15) respondents said that the Institute pays for access to databases. Five researchers said that the government pays for access, five said that internal organizations pay for them, and four said that international organizations pay for access.

Communication and social networks. Most (n = 29) of the respondents use email for work. A smaller number use Facebook (n = 12) and LinkedIn (12).

Table 9. How can ICT problems be solved?

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding (generally)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Local funding</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Foreign funding or donors</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Central/government funding</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Levy on users</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Some of the illustrative statements made by respondents are:

“The service provider was maintained but the service was switched from DSL to cable (fiber optics). There was a slight interruption in the switch, which did not affect work that much. However, the quality of the service was supposed to improve, but it as rather worsened—[there are] lots of interruptions and slow Internet speed.”

“Yes, we have changed Internet Service Providers twice and it did disturb my work for about a month.”

Changing Internet Service Providers and work disruptions. The survey asked respondents if their institute had changed ISPs, and if so, if it had disrupted their work. The question was open-ended. Most respondents who answered this question (n = 11) said that they had not experienced problems due to ISP changes, but eight said that they had changed ISPs more than three times. Six respondents said that it did affect their work; the illustrative quotes below expound on the nature of this problem.

Table 10. Number of times institute has changed Internet Service Providers.

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>No/do not know</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>1 – 2 times</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3 or more times</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 11. Work disruptions caused by changing Internet Service Providers.

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>No</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 12. Communication and social networks for work purposes.

<table>
<thead>
<tr>
<th></th>
<th>Researchers</th>
<th>Librarians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>Twitter</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Facebook</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>LinkedIn</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Other (s): (write-ins: Blogs, Pinterest, YouTube)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Total responders:</td>
<td>18</td>
<td>17</td>
</tr>
</tbody>
</table>
Use and relevancy of ICT and library services. Both researchers and librarians said that ICT and library services were most important for gaining access to resources, though “promoting data sharing”, “promoting new types of resources” and “preserving digital resources” were also said to be highly relevant by the majority of respondents. Respondents were less enthusiastic about the library’s role in new forms of peer review and information management.

Beliefs about the purposes of IRs. Most respondents agree that repositories should contain a wide variety of electronic resources, including peer reviewed articles, books, and other articles, images, datasets, and software. Librarians strongly agreed (n = 11 out of 12), and researchers agreed (n = 10 out of 18), that someone should be in charge of quality control and navigability of the IR.

Problems with IRs. Most respondents (combined, librarians and researchers) believe that funding (n = 20 out of 28) and copyright (n = 14 out of 28) are very problematic issues in the IR. Less problematic is scholars’ trust in the IR, theft, and preservation, though those issues were still cited as being “somewhat likely” to be a problem by both researchers and librarians.

Management of the IR. The majority of the respondents (n = 24 out of 34) said a librarian should be in charge of the IR. Nine said that a committee should be manage the IR.

Training to use the IR. Researchers were asked what types of training would be helpful in learning to use the IR. Responses included: seminars and workshops, training in using databases, training to effectively manage and access e-resources online as well as to share information, training in information management and web applications, training in scientific writing and presentation skills.

Librarians were asked if they currently provide education for researchers on the IR. Four out of nine said that they are not interested or able to provide training; three said that they provide regular training sessions, and two said that they have annual or irregular training sessions.

Sharing information about IRs. Librarians were asked if they discuss or work with other librarians who are interested in institutional repositories. Most said that they do, through formal collaborations and at conferences.

<table>
<thead>
<tr>
<th>Table 13. Librarians’ information sharing about IRs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, informally.</td>
</tr>
<tr>
<td>Yes, and conferences or through formal collaborations.</td>
</tr>
<tr>
<td>No.</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

User education. Librarians were asked, “What kind of education do you think you or the other scientists and researchers at your institution need to be able to most effectively share their data, findings, and papers?” They mentioned a variety of areas for instruction, including information literacy instruction, communication strategies and advanced modern technologies, copyright, citations, and metadata. Funding was also mentioned.

Monitoring the IR. Google Analytics (n = 8 of 21) garnered the most votes as a tool to monitor the IR.

<table>
<thead>
<tr>
<th>Table 14. How should the IR be monitored?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server transactions</td>
</tr>
<tr>
<td>Google analytics</td>
</tr>
<tr>
<td>User surveys</td>
</tr>
<tr>
<td>Download history</td>
</tr>
<tr>
<td>Other “They can be easily assessed”</td>
</tr>
</tbody>
</table>

Additional Commentary. Respondents were asked if they had anything to add. The majority of respondents who chose to answer this question concurred that staff and researchers need to have additional training to use ICT effectively for collaboration; however, Internet services and funding are a prerequisite, and good management of resources was also mentioned. One researcher said, “for effective use of ICT, there should be an Internet service with high band width which should make accessing information fast and effective. This is not so in the Institute and hence all efforts to improve ICT usage will be ineffective.” A librarian added, “The IR and ICT are the key for now and the future development in research and information delivery.”

Recommendations
ICT enables scholars and scientists to share their work at an unprecedented rate. There are different methods involving ICT that scholars might use to share their work. Institutions that provide scholars with a repository are giving them a valuable tool for sharing their data to increase production and prestige while protecting their work. However, the users must be comfortable with the system, and the system must
work well. A slow connection is frustrating to use, and the librarians in this study might have had a different perspective on Internet connectivity. Generally, the library has a stronger wireless connection than scientists throughout the building. Scientists might rely on a different connection (such as a modem) to connect, which could influence how they approach their work, including using the IR. This problem should be addressed in order to meet the scientists’ needs.

Respondents in this study demonstrated a strong awareness of the IR and its role in scholarly communication and sharing. The scientists understood the importance of sharing their work. They did express genuine but not insurmountable concerns in fully utilizing the IR. The librarians, likewise, are aware of the advantages offered by IRs. The librarians’ concerns are similar to those of the scientists; major concerns are funding of the IR and ICT in general, copyright, and management issues.

Users of the IR must understand copyright. Copyright is confusing even to librarians, but education will help the researchers understand new rules and models so that they are confident about what they can put in the IR for sharing and cooperation. Previously, the second named author of this paper found that researchers rarely wanted to share their data or technical papers out of fear of theft. Surprisingly, this study found that most scientists thought the librarians should be responsible for managing the repository, which indicates that the scientists trust the librarians’ ability to manage their documents.

A steering committee, composed of scientists and scholars, though, is needed to help evaluate the IR’s effectiveness and to encourage peers to use the IR. The steering committee can bridge the gap between librarians and scholars.

A bigger problem (and one that is universally recognized in this study) involves connectivity and bandwidth. As many other researchers have pointed out, developing nations must address problems with ICT in order for the scientists to be part of global scientific networks. The scientists who participated in this study are all working for governmental agencies that deal with critical problems in the nation: food, agriculture, energy, and water. ICT is no longer a luxury; it is a necessity for successful scientific partnerships that solve real-world problems. There is no level ‘playing field’ at this point - a true digital divide exists which can only be addressed through sustained investment in a robust ICT infrastructure by the government. Only after governments realize the importance of stable and sustained ICT projects will solutions to the other problems follow – solutions that will allow scientists in developing nations to share their work, create collaborative relationships, and create solutions for the most pressing issues in those countries.

Another challenge that most developing countries face is a poor or inconsistent energy supply. IR management demands a consistent and uninterrupted power supply. IR managers will therefore have to find alternative ways to supplement the existing supply to have a smoothly running IR in the research libraries in Ghana.

Even though the responses show a willingness to share, the second-named author of this study had previously seen an unwillingness to deposit materials into the IR. The investigator worked in one of the Institutes from 2004-2013 and found much resistance to using the IR. There are a number of reasons for this reluctance. First, there is a general distrust of ICT due to problems with cyber-fraud in the region. Organizations, businesses, and individuals were afraid of losing data, their bank accounts, and their identity to a low level of security in online environments. Therefore, they tended to be very reticent in sharing their data.

The librarian’s role in the research library has changed substantially. They can no longer be content with ensuring access to the scholarly work from other countries - they should be leaders in their institutions for copyright and data management, as well as taking an active role in ICT development. This is a Sisyphean task in developing nations where the ICT infrastructure lacks stability. However, without leadership and a stable ICT network, scientists in developing nations will lack the tools to become global scholars. As we stated earlier, globalization means that the problems in the developing world are everyone’s problems. Scientists from Ghana and other developing nations produce valuable work, but isolation reduces its worth and impact. This paper advocates that IRs are an important tool in breaking down barriers, and that every effort should be made to identify and remove barriers to their use.

**Appendix 1: Background of Research Libraries**

**Animal Research Institute**

The Animal Research Institute (ARI) is one of 13 institutes under the Council for Scientific and Industrial Research (CSIR) Ghana. The aim of the ARI is to conduct animal science research, develop technologies related to the animal industry, and to advise the government and other stakeholders in the industry. Okantah (1990) states that 70 percent of protein consumption of Ghana’s population is from animal
sources; hence its strategic role within the government. The institute has a library whose mandate is to store, manage and disseminate information related to the animal industry in the country.

**Water Research Institute**

The Water Research Institute’s mandate is to research water and related areas and to support socio-economic development, agriculture, health, the environment, and industry. Gyau-Boakye and Dapaah-Siakwan (2004) say almost 69 percent of Ghana’s population lives in the rural areas whose main source of water is raw surface water from streams and rivers. The Water Research Institute library collects, manages, and disseminates information for the researchers in the institute.

**Food Research Institute**

The Food Research Institute (FRI) was established in October 1963. Its mandate is to conduct market-oriented applied research, provide technical services and products to the food industry as well as assist in poverty alleviation through creation of opportunities for income generation, thus contributing to food security and foreign exchange earnings.

**Ghana Atomic Energy Commission**

The Ghana Atomic Energy Commission is a leading research organization into sustainable and effective utilization of nuclear science and technology. The library serves as a resource base for information in nuclear science and technology.

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**Appendix 2: Survey for Librarians about Institutional Repositories**

**Part 1. Demographic Information**

1. What is the name of the Institution at which you work?
   a. ARI
   b. WRI
   c. GAEC
   d. Food Research Institute (FRI)

2. What is your educational background?
   a. PhD
   b. A/Sc/Phil
   c. BA/Bsc
   d. Diploma/Other

3. What is your age?
   a. 21-30
   b. 31-40
   c. 41-50
   d. 51-60
   e. 60 +

**Part 2. Use of ICT**

1. Please indicate your level of comfort with Information and Communication Technologies (ICT).
   a. I am an early adopter - I use new technologies, read blogs, and enjoy innovation.
   b. I tend to wait and see if new technologies work well before I will use them.
   c. I avoid new technologies. I prefer using tried-and-true methods to communicate or deal with information.

2. What kind of Internet connection do you have?
   a. Dial-up
   b. DSL
   c. Cable
   d. Modem
   e. Other

3. How fast is your Internet service?
   a. Very slow
   b. Slow
   c. Don’t know
   d. Fast
   e. Very fast

4. What do you use the Internet and Communication Technologies (ICT) for?
   a. Integrated library system
   b. Cataloging and classification
   c. Serial control
   d. Database management
   e. Acquisitions
   f. Research
   g. Other

5. Who funds ICT projects in your institute?
   a. The institute
   b. Government
   c. Internally generated funds
   d. Foreign funding
   e. Other

6. What are the biggest problems that your institute faces regarding ICT?
   a. Funding
   b. Training
   c. Low bandwidth
   d. Acceptance
   e. Other

8. Has your Institute changed Internet Service providers? If so, how many times have you had to change? Did this disturb your work flow, and for how long?

9. Which foreign databases do you use, and how relevant are they to your work? Check here _____ if you do not use any foreign databases.

10. Who pays for the foreign databases?
   a. The Government
   b. International Organizations
   c. Internally generated funding
   d. The Institute
   e. Other

11. Which local databases do you use, and how relevant are they to your work? Check here _____ if you do not use any local databases.

12. Which communication methods or social networks do you use for your work?

   a. Email
   b. Twitter
   c. Facebook
   d. LinkedIn
   e. Other

13. ICT and Library Services are used by the scientists and researchers in the Institute that I work for the following reasons:

14. Please indicate to what extent you agree with the statements below.

<table>
<thead>
<tr>
<th></th>
<th>Daily</th>
<th>Often</th>
<th>Occasionally</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>To enhance access to resources.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To promote new types of resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To encourage new forms of peer review</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To aid in institutional information management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To promote data sharing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For the preservation of digital resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. How problematic do you perceive the following issues to be in relation to institutional repositories?

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repositories should contain peer reviewed articles.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repositories should contain books and journal articles.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repositories should contain a wide variety of electronic resources such as images, datasets, and software.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If everything is allowed in the repository, it will be difficult to navigate and filled with junk.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Someone should maintain strict control over what goes into the repository.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
16. Who do you think should manage an institutional repository?
   a. A librarian
   b. Scholars
   c. A committee
   d. Users
   e. Other(s):

17. Do you provide education to scholars about Institutional Repositories?
   a. Yes, we provide quarterly or bi-annual training (please describe if you would like).
   b. We provide annual or irregular training (please describe if you would like).
   c. No, this is not something that we are interested in or are able to do.

18. Do you discuss or work with other librarians who are interested in institutional repositories?
   a. Yes, informally.
   b. Yes, at conferences or through formal collaborations.
   c. No.

19. What kind of education do you think you or the scientists and researchers at your institution need to be able to most effectively share their data, findings, and papers?

20. How would you like to see institutional repositories monitored? You can choose more than one answer. Please also describe why you chose your answer.
   a. Server transactions
   b. Google analytics
   c. User surveys
   d. Download history
   e. Other

21. Is there anything else that you would like to say about ICT or IR either in general or in your institute? Please continue onto the back of this paper if you would like.

N.B. Questions 17, 18 and 19 as worded above were not included in the Survey for Scientists and Researchers (see below).

Appendix 3: Survey for Scientists and Researchers about Institutional Repositories

N.B. The questions in the Survey for Scientists and Researchers were in all essential respects the same as those in the Survey for Librarians, above, except where indicated below.

Part 1. Demographic Information
4. What is your profession?
   a. Scientist
   b. Other:

Part 2. Use of ICT
4. What do you use Internet and Communication Technologies (ICT) for?
   a. The library system (local resources in my library)
   b. Databases
   c. Sharing my research
   d. Other

17. What kind of education or training would help you to be able to most effectively share your data, findings, and papers?

18. Is there anything else that you would like to say about ICT or IR either in general or in your institute? Please continue onto the back of this paper if you would like.

Note
1 The Ghanaian database was called the Ghana AGRIS Pilot Project (GAPP), and is now called GAINS, which
was the result of an incrementally completed local version of the AGRIS database.

References


Russell IG (2009) Electronic resources and institutional repositories in informal scholarly communication and


**Author biographies**

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