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Institutional Repositories: Towards the Identification of Critical Success Factors

Abstract: Institutional repositories (IRs) are digital collections that capture and preserve the intellectual output of a single or multi-university community. Their aim is to provide access to scholarly material without the economic barriers that currently exist in scholarly publishing. If successful, IRs hold the promise of being very advantageous to researchers everywhere, especially those in the developing world. The IR concept is very new and has yet to be studied in any comprehensive way. This paper describes a study being conducted by the Canadian Association of Research Libraries to determine some success factors of institutional repositories. Through the CARL Institutional Repositories Pilot Project, several variables are being examined to determine whether they contribute to the input activity and use of the IRs being implemented at several Canadian research libraries. The project is in its initial stages, and has yet to show significant results. However, the paper presents a detailed description of the IR concept; identifies and explains the variables that are being studied; and discusses some of the challenges involved in the study.

I. Introduction

The presence of a dynamic academic community is an important prerequisite for any civil society. One of the major barriers faced by scholars and researchers in many countries is their lack of access to the current literature in their field. Although no definitive statistics exist, anecdotal evidence suggests that the situation is critical in the developing world. Library budgets in most developing countries are extremely small and as a consequence the teaching and research in these countries is being performed without the essential input of research being conducted internationally. The case is most extreme in sub-Saharan Africa, where the majority of libraries do not subscribe to even one journal (Arunachalam, 2000). It may have been expected that, with the advent of electronic publishing, the prices of academic journals would have decreased significantly, however, this has not been the case. The grossly uneven availability of information resources around the world is well known, and a matter that a growing number of initiatives seek to remedy.

While the high costs of academic literature is not the only access barrier for scholars in developing countries (the lack of computers and Internet connectivity are also crucial issues), it is a significant one. The open access movement addresses this barrier, by arguing for the "free availability of (scholarly) literature 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"[1]. In a recent report, the OECD also expressed its support for open access. "Given that OECD countries spend tens of billions

of dollars each year collecting data that can be used for research and for other social and economic benefits, ensuring that these data are accessible so that they can be used as often and as widely as possible, is a matter of sound public stewardship of public knowledge."[2] The philosophy of open access grew out of dissatisfaction with the traditional pricing system of scholarly publishing in the west, where universities and research institutions have been forced to cancel a significant number of subscriptions over the past decade, particularly in the fields of science, technology and medicine. That being said, developing countries stand to gain much from the growth of open access.

II. Defining an Institutional Repository

Developments in information and communications technologies hold great potential for the advancement of knowledge and the good of humankind through the open access of scholarly literature. Of late, a number of alternative strategies to the traditional scholarly publishing system have been developed. Among these is the *Institutional Repository* (IR) model, which promises to be extremely advantageous to scientists and scholars everywhere, especially to those in the developing world. Institutional Repositories adopt the same open-access and interoperable framework as e-print archives (e.g. www.arxiv.org), but rather than being discipline-based, represent the wide-range of research output produced by one institution. An institutional Repository is a relatively new model for storing research output of a given university or research institute. The term was coined by Scholarly Publishing for Academic Resources Coalition (SPARC), and has been defined by SPARC (Crow, 2001) as "digital collections capturing and preserving the intellectual output of a single or multi-university community"[3] that have several important defining characteristics: digital; institutionally defined; scholarly; cumulative and perpetual; open access; and interoperable (Crow, 2001). The characteristics are discussed in greater detail below which is based to a large extent on the IR description provided by the Association of Research Libraries in *"The Case for Institutional Repositories: A SPARC Position Paper"* (Crow, 2002)

Digital
First and foremost, the content of IRs is restricted must be digital. Unlike a university archive, whose mandate it is to collect all types of content related to the university, IRs collect digital material only. In some cases, IRs accept all types of digital material, while in others only certain formats may be deposited.

Institutionally-Defined
In contrast to discipline-specific repositories and digital libraries, institutional repositories capture the research output generated by an institution's constituent population, that are active in many fields. Defined in this way, institutional repositories represent the intellectual life and output of an institution. The definition of "institution" is used in a very broad sense in much of the literature. An institution in this sense can represent a group, an institution, or a group of institutions. While much of the literature about IRs refers to academic institutions, in fact any organization that generates research and wishes to capture and openly disseminate its intellectual product can implement an IR.

Scholarly
IRs aim to collect scholarly content exclusively, however, the word scholarly is used in a very broad sense. According to SPARC, while the main focus for IRs is directed at collecting research output of an institution, an IR may collect any of the other many types of content produced at an institution including classroom teaching materials, the university annual reports, video recordings, computer programs, data sets, photographs, and art works-virtually, in fact any digital material that the institution would like to preserve (Crow, 2003). A scan of the various IRs in existence shows that collection policies are much stricter than those outlined by SPARC. For instance, DSpace's collection policy restricts deposits to that material which is scholarly or research oriented; not ephemeral; and ready for "publication" (The DSpace Project, 2003).

Cumulative and Perpetual
Institutional repositories make a commitment to preserve and make accessible digital content on a long-term basis. In most cases, the content, once submitted cannot be withdrawn-except in presumably rare cases involving allegations of libel or plagiarism, etc. The cumulative nature of institutional repositories also implies that the repository's infrastructure is scaleable, but does not necessarily mean that all content will be universally accessible in perpetuity.

Open Access
Another of the key defining features of IRs is that they provide free and open access to their content. In most cases, IRs have no barriers to their content or very low-barrier access (such as registration requirements).

Interoperable
IRs belong to a larger group of digital repositories called "open archives", which refers to an architectural interoperability based on the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). In 1999, the Open Archives Initiative developed a standardized architecture for exposing multiple forms of metadata through a harvesting protocol. The OAI-PMH supports interoperability via a fairly simple two-party model. At one end are the data providers, who employ the OAI-PMH to expose metadata, in various forms and at the other end are the service providers who use the OAI-PMH to harvest the metadata from data providers and then subsequently automatically process it and add value in the form of services. Initially, the OAI-PMH was developed to facilitate interoperability between E-Print archives. However, since its inception, it has emerged as a very popular foundation for archival interoperability. The OAI-MPH is one of the most exciting new developments in the area of information dissemination in that it facilitates the interoperability of repositories, allowing them to contribute to a larger global system.

These are the main identifying characteristics of an institutional repository, as they are generally agreed to now. However, there is another important characteristic of the institutional repository that separates it from other types of digital archives. As with e-prints archives, most IRs require the author, or someone associated with the author to deposit the content directly into the archive. This is referred to as "self-archiving" and is an important aspect of an IR. Of course, the institutional repository may change as the

concept matures, and more of these types of repositories are borne. Indeed, a repository developed by an academic institution may evolve and be modified to serve the individual requirements of that institution. In the past two years, a growing number of institutional repositories are being built in North America, Europe, and Australia and we have seen some fairly large financial commitments in several countries towards the institutional repository model.

In the Netherlands, the Dutch government has given 2 million Euros to set-up the infrastructure for IRs at several of the Universities, the Dutch National Library, and the Dutch Academy of Arts and Sciences (Surf, 2003). In the UK, the Joint Information Systems Committee (JISC) is funding the development of institutional digital repositories for several of their leading research institutions (University of Nottingham, University of Edinburgh, University of Glasgow, Universities of Leeds, Sheffield and York, University of Oxford, British Library, and Arts and Humanities Data Service) (Sherpa, 2003). And in the US, two big Institutional Repositories were launched in the past year. The eScholarship Repository was launched at the University of California, which now contains over 1200 papers and since its inception in April 2002, 65,000 papers have been downloaded from the repository. And, and the other is the institutional repository at MIT (called DSpace), which went public in November 2002. The DSpace platform was developed by MIT and Hewlett Packard and the software is being offered free of charge. According to recent statistics, 2500 organizations have downloaded the DSpace software since November.

In Canada, Twelve Canadian research libraries have begun a pilot project to implement institutional repositories, which is being coordinated by the Canadian Association of Research Libraries. The participating libraries are experimenting with a variety of software platforms, disciplines, and policies in order identify best practices for implementing IRs.

The momentum for these types of repositories is growing so quickly, that some predict that in the next ten to twenty years, it is likely that the scholarly communications system will have evolved into some form of unified global archive system, without the current partitioning and access restrictions familiar from the paper medium, for the simple reason that it is the best way to communicate knowledge and hence to create new knowledge. (Ginsparg, 2000)

III. Previous Studies
Few would deny that a federation of institutional repositories containing the scholarly output of a large number of the world's research institution is a worthy goal and would be of great benefit to researchers, especially those in the developing world. However, the real challenge will be to figure out how to achieve this. Because IRs are so new, little research has been conducted into the essential elements required to build a successful institutional repository. The current body of literature about institutional repositories focuses, for the most part, on advocacy and promotion of IRs. However, institutional repositories have similar characteristics to other types of digital repositories, such as e-

prints archives and thesis or dissertation archives, as well as electronic databases, and some relevant information can be gleaned from previous studies done on these archives.

Much of the research conducted into the use of electronic databases and journals points to three major characteristics: Accessibility, satisfaction, and usefulness. One of the most important factors that has been associated with the use of an information source is access or perceived access. Numerous studies report that convenient, comfortable, easy, and inviting access is a determining factor to the use of online-journal collections and databases (Baldwin, 1998; Bishop et al. 1996; Bishop, 1998). In particular, toll-access has been found to seriously inhibit use of material, but also, authentication and registration barriers such as password and login requirements. In the case of institutional repositories, such access barriers do not apply because they are open access and do not require users to register. However, these types of barriers could inhibit depositors (or authors) from submitting their work into the repository, and thus may affect the input activity of content contributed to the repository. Analysis of the usage of some electronic journals and archives has shown that even the slightest access barriers inhibit their use (Oldyzko, 1996).

Both usefulness and satisfaction of information are also cited as important determinants of information use. Perceived user satisfaction may be defined as "the extent to which users believe a system meets their information needs"[4] and for self-archiving systems, satisfaction is closely related to input activity. For open access systems that rely on self-depositing for content, it has been said that there are two major factors that govern their ultimate viability: (1) the *input activity*, or submission of content supplied by authors; and (2) *usefulness*, which is typically assessed via usage statistics (Luce, 2001). These two variables are inextricably linked. On the one hand, scholars are more likely to use (or access the content) an archive if it has significant input activity, and on the other, they are more likely to deposit their work if an archive is highly used, thus providing greater visibility to their research.

Much of the e-prints literature indicates that, indeed, input activity is a key success factor for e-prints archives. These studies point to the accumulation of a certain critical mass of content before the archive experiences much use. Once a certain level of content has been achieved, the archive is able to maintain a high level of usage (Carr, et.al, 2000; Kritchel and Warner, 2001). This in turn encourages others to deposit, and the momentum for both input and use activity continues to grow. The critical mass of any archive will differ greatly depending on the discipline. For instance, the azXiv archive in high energy physics, which began in 1991 and was intended for usage by a small sub-community of less than 200 physicists who were then working on a so-called "matrix model" (Carr, et. al. 2000) achieved critical mass almost immediately, because the field of study was so narrow and the number of interested scientists so small. This is one of the major challenges for many discipline-specific archives—achieving this critical mass. However, it is an impossible task for an institutional repository, as institutionally defines archives are not likely to collect a high percentage of literature in any field. Thus, at this time, it is unknown whether input activity will have as large an effect on usage of IRs, as it does in the e-prints world.

While input activity has been shown to be an important success factor for e-prints archives, other factors have also been found to affect their usage. Archives have been known to "fail" (low usage) despite the fact that they had collected a significant number of deposits. One example of this is the Networked Computer Science Technical Reference Library (NCSTRL). NCSTRL started as early as 1993 and by 1996 had about 10,000 papers available in electronic format, but was not used in the computer science community (Kritchel and Warner, 2001). At the University of Glasgow, they have discovered two key elements required for the development and launch of successful Open Archives services: The support, endorsement and most critically, the content produced by our academic colleagues and partners; The resources [staff, equipment, expertise] to ensure that it is developed, marketed and launched properly.

IV. Methodology

Clearly the open access community could benefit from more information regarding the factors which determining the success use of institutional repositories. The institutional repository is a new model for collecting, storing, and disseminating scholarly material that promises to be vary advantageous to the global research community. The purpose of this study is to identify some of the critical success factors of an institutional repository. Among the research questions that we intent to address are:

1. Does input activity affect the use of an institutional repository?

Based on studies conducted of e-prints archives, we hypothesis that one of the major success factors for usefulness will be input. But, we would like to know what other variables affect the usefulness of an institutional repository. Similarly, if our hypothesis is shown, we would also like to know what variables affect the input activity of an institutional repository.

2. If so, what factors affect input activity?

We would like to determine what factors contribute to the input activity of an IR. If use of institutional repositories are found to be determined to a large extent by input activity, then it will be important to also know what are the factors that affect this input and whether these input factors are similar to those of discipline-based archives, or because IRs are institution-based, will the input activity dependent on different factors.

3. What other factors affect the use of an institutional repository?

And, finally, we would like to examine what other factors, besides input activity (if this is found to be a determinant), affect the use of an institutional repository. In particular, are the factors that determine the success of other types of archives the same for IRs.

For the purposes of this study, success is being defined as use. The major goal of the institutional repository, as it grew out of the open access movement, is to disseminate

scholarly material. Thus, the success of an IR will ultimately be determined by the use of the material within. While some may argue that collecting a significant amount of content is sufficient for determining the success of these archives, storage and preservation is a secondary aim of IRs.

Based on a review of the existing literature a number of variables were identified as either having an affect on the input activity and use of an archive. Most of this literature is based on the experience of discipline-based archives, rather than institution based ones. However, it is assumed here that the variables affecting the usage of both would overlap considerably. The emphasis here is placed on policy aspects of the institutional repository rather than technical aspects, as many of the repositories will be using the same software applications to implement their IR. Because all of the institutional repositories are open access and no financial barriers, this type of access will not be monitored. Other types of access barriers, such as technical or self-archiving, will be monitored by other individual variables. The variables being assessed in the study are as follows:

Input Activity
As mentioned earlier in this paper, input activity, is closely related to perceived satisfaction, and has been cited as one of the most important variable in determining the use of information systems. This data will be measured as the number of deposits into the IR at any given time and indicates the number of "documents" or metadata sets contained in the archive.

Disciplines
This variable is expected to affect both input activity and use. Until now, self-archiving has been very successful in certain disciplines, and much less so in others. It is well know that there are significant difference in communication methods exist amongst fields. Will the speed of uptake of an institutional repository depend on the disciplines chosen as early adopters?

Advocacy Activities
There is strong indication that the nature and amount of advocacy activities on campus will contribute to the success of an IR. It is speculated that scholarly participation will have an affect on both input activities, as well as use.

Archiving Policies
It is expected that submission barriers may inhibit the input activities of an IR. The major distinction here is between self-archiving, which refers to authors (or author's representative) depositing their own work and mediated archiving, which refers to authors submitting articles to IR staff for mediated archiving.

Copyright Policies
Copyright restrictions have been cited as of reasons why authors are reluctant to submit their works open access repositories (Crow, 2003). Thus, certain copyright policies may positively affect the input activities of the IRs, while others do not.

Content Type
Content type refers to the type of material (rather than format) that is accepted into the repository. The type of content is likely to have an affect on both input activities, in that the greater the content types accepted, the greater the input activity, however, it may have the opposite effect on use. If the IR contains too many types of material, such as working papers conference proceedings, images, datasets, it may become too diverse to be usable.

Staff Support
The number of staff assigned to manage the IR is likely to affect the visibility and growth of the repository, resulting in greater input, and perhaps greater use.

Quality Control Policies
The level of quality control of material submitted is likely to affect input activity and use. While quality of format and metadata may have little affect on inputs because it is usually undertaken by IR staff, it may have a positive effect on use. On the other hand, quality of control, through some type of peer-review process would surely negatively affect input activity.

Software
The specific software application used for IRs is also likely to have an affect on the input activity and use of the repository.

Use
As discussed earlier, use of the repository is likely to have an affect on input activity. As authors overwhelmingly report that they deposit their works in open access archives in order to more widely disseminate it, the greater an archive is used, the higher the input activity is likely to be.

Thus, nine variables will be monitored to see whether they have an affect on either the input activities or the use of institutional repositories. While, it is expected that there may be many other characteristics that also affect the growth and use of IRs, such as organizational culture, etc., this study will limit its examination to these nine variables.

V. The Study
Based on information provided by members of the CARL Institutional Repositories Pilot Project, the aim of this study will be to record the variables described above over time, in order to discover whether there exist causal connections between them and either input activity or use of the IRs. The variables are being monitored through the survey method. The pilot project to implement repositories began in September 2002. The first survey results are from in February 2003. Ten of the twelve participating institutions responded to the survey, and of the ten responders, five answered some or all of the survey questions. The results of this survey are summarized in Table 1.

Table 1: Results of the IR Implementation Survey: 6 Months

Institution					

	1	**2**	**3**	**4**	**5**
Input Activity	0	20	1	10	1
Disciplines	N/A*	Physics, Law Faculty, Medicine	N/A	Renaissance & Reformation Studies	N/A
Advocacy	Hosted a workshop on alternative publishing, Articles from which will be published in our campus newspaper. Annual Information Resources Retreat will have IRs as the focus. In process of developing a communications plan for more promotion of the repository.	Multiple demonstrations performed at the internal level to librarians and faculty members. Also planning to put more information on the library web site regarding IR and open access.	N/A	Presentations about IR to Library and University committees and to departments identified as potential early adopters. IR staff, in conjunction with staff from other library will begin solicitation of other departments.	N/A
Archiving policies	Not yet determined, but we are open to a number of models depending on the need of the research group	Self-archiving with mediation for quality control of the document. Only certain departments will be invited to submit.	N/A	Self-archiving by faculty who are members of a recognized "community" within the University.	N/A
Copyright policies	N/A	The contributor is responsible for including	Likely to be retained wholly by author(s)	Submitters must "sign" (i.e., click through) a	N/A

		a copyright notice he/she wants on the document. If needed, the contributor must ensure any copyrighted material has received approval for distribution from third parties involved.		distribution rights agreement that affirms that the submitted item does not infringe on copyright or that copyright clearance has been obtained.	
Type of content	Pre-prints; Journal Articles; Conference Proceedings; Dissertations; Learning Objects	Pre-prints; Journal Articles; Conference Proceedings; Dissertations; Learning Objects	Anything deposited by users	N/A	N/A
Staff support FT=full time PR=part time	1FT + support staff	2 PT	1PT	5PT	N/A
Quality control policies	Submission buffer monitored by IR staff and possibly peer-review at departmental level	Submission buffer monitored by IR staff	N/A	Submission buffer monitored by IR staff and Peer-review at departmental level with the details of the review process are determined by each "community"	N/A
Software	DSpace	EPrints	DSpace CDSware (http://cdsware.cern.ch)	DSpace	DSpace Eprints Zope
Use	N/A	N/A	N/A	N/A	N/A

*N/A signifies the institution had nothing to report for this variable

- Input activities in all archives were insignificant to this point in the project, with one institution having 20 deposits, another having 10 and the rest having one or nothing deposited as of yet.
- Only two institutions had recruited faculty partners, from very different disciplines. One institution from several disciplines in the sciences and the other Renaissance & Reformation Studies
- Advocacy Activities so far have include workshops and meetings with committees and departments**.**
- Two institutions have implemented self-archiving policies, as opposed to mitigated archiving, while the rest have not yet implemented archiving policies as of yet.
- At the time of the survey, three institutions had implemented copyright policies. In all cases, authors will be required to investigate the copyright restrictions that may already exist for the content they are publishing; and for content that has not already been published, authors will retain copyright for material deposited.
- Of the three institutions that reported on content types, the IRs are accepting a wide variety of contents including working papers (pre-prints), articles, etc. One IR accepts any content the faculty wishes to deposit.
- Staff support varies quite a bit between institutions, of those who reported some staff support, one IR had 1 full-time, one had 2 part-time, one had 1 part-time, and one had 5 part-time staff member working with the IR.
- All three institutions that replied to this measure reported that they had some sort of submission buffer where the quality of the format of the content could be monitored by IR staff, and two are considering some peer-review process at the departmental level for submission.
- DSpace software is being used by four of the five institutions. Several institutions have implemented more than one software application, presumably to assess which platform is best for them. One institution is using Eprints software.
- At this time, use statistics as measured by number of downloads are not being gathered by the institutions.

After six months into the pilot project it is still to early in the study to draw any inferences from the results. Significant results are not expected to be forthcoming several years.

One of the concerns for the study will be to establish and maintain consistent, accurate, and comparable measures for each of the repositories. In particular measuring use statistics may be a challenge if a variety of software systems are used to house the repositories. In the future, it may be necessary to limit the study participants to those who are using the most common software system (DSpace). Evern with that, measuring online activity is not easy. Correlating use with number of downloads is not the most accurate measure for use, as it does not prove that the item is actually used after it has been download, but it is more accurate than measuring use by the number of "hits" often on a website.

Another issue that may be encountered in this study is that the use of the IRs is increased significantly due to their interoperability with other archives. When put together, archives that use the Open Archives Initiatives Protocol for Metadata Harvesting form one large repository of material. Once the repositories involved in this project begin to list themselves with various harvesting services, the size (input activity) of each IR will be hidden to the user. This may be a tremendous advantage for the IRs in that even if they have not been able to accumulate a significant amount of content, they may find that their usage statistics are quite high.

VI. Conclusion
The results of the study presented here are very preliminary, as the institutions involves are just beginning to implement IRs and to develop the policies that will govern them. Only five of the twelve participating libraries had information to report on any of the variables, and the five that did, had very little to report at the time of the first survey. The real purpose of this paper was not to provide the results of the study, as significant results are not anticipated for several years, but rather to introduce the concept of the institutional repository, and outline the theoretical background for this study. The current global momentum for open access is growing. UNESCO, the OECD, national governments, and many not-for-profit organizations have put forth the argument for the free distribution of publicly funded research. Institutional repositories are one proposed method of providing access to scholarly research, through the research institution. Despite the growing strength of the open access movement, it is difficult to predict whether the IR model will survive in the long term. And in the future, as IR models become more established, their defining characteristics may evolve and change due to the practical considerations of the institutions implementing them. Ultimately the success of institutional repositories will be determined by their uptake and use by researchers. Thus, one of the major challenges for IRs will be to identify researcher interest can be generated. Because IRs are institutional-based, the variables that contribute to their uptake may be very different from those of discipline-based archives. The IR concept is so new that at this time there exists little information about their input and use by researchers. The known determinants of other types of archives, such as access, satisfaction, and usefulness may or may not be relevant for IRs because they differ from other archives in significant ways.

Notes
[1] Budapest Open Access Initiative. *FAQs*.(2002).
http://www.earlham.edu/~peters/fos/boaifaq.htm

[2] Organization for Economic Cooperation and Development. (2002) *OECD Follow Up Group On Issues of Access to Publicly Funded Research Data: Interim Report*.
http://dataaccess.ucsd.edu/Final_Interim_Report_20Oct2002.doc

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[1] Budapest Open Access Initiative. 2001
[2] OECD. 200
[3] Crow, 2003
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