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Trustworthiness of institutional repositories in academic libraries in South Africa

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Abstract

The open access movement in scholarly communication has grown considerably over the past two decades and it has driven an increase in the number of Institutional Repositories (IRs). Academic libraries in South Africa have so far made great advancement towards developing IRs to preserve, manage and to provide open access to digital scholarship of the universities. Open access's fundamental principle is to make the intellectual output more visible, accessible, searchable and useable by any potential user, and that is indispensable in the quest for long-term access and delivery of authentic digital information. Although many researchers believe that open access has positive implications for research, open access platforms such as IRs are often not trusted, especially because they are offering free access to digital scholarship. Therefore, the question is whether the institutional repositories implemented in South African academic libraries can be regarded as Trusted Digital Repositories (TDRs) to achieve their mission as to provide reliable, long-term access to managed digital resources to its designated community, now and in the future, and if they meet the criteria and requirements of the TDRs. This underscores the need to assess the trustworthiness of IRs by looking at the entire system in which the digital scholarship is managed, including the institution running the repository; its governance; organizational structure and staffing; policies and procedures; financial fitness and sustainability; legal issues, security issues, compliance with standards, liabilities under which IR must operate and trusted inheritors of data, as applicable. Recommendations suggest the need for implementation of policies and strategies, provision of adequate resources, sufficient funding, collaborative approach and capacitating IRs managers and administrators.

Keywords: Institutional Repository, Academic Library, Open Access, Digital Scholarly Communication, Trustworthiness.

Introduction

Institutional Repositories have existed ever since human begin collecting and storing important information and artefacts for safekeeping and long-term use (Ashikuzzaman, 2018), and the long and rich history of libraries, museum and archives provide the foundation for any type of repository program. Two contemporary developments in particular have however, helped shape the nature of today's institutional repositories, namely, the emerging knowledge management movement and the maturing, but they are still rapidly advancing technologies of content or asset management in the digital information management, as noted by Ashikuzzaman (2018). As noted by Drucker (1988) knowledge had become its most important asset and that the organizations best able to manage and exploit their corporate knowledge assets would be the most successful in the marketplace. The researchers in the multidisciplinary fields of information science and business management have elaborated on Drucker (1988)'s ideas about the importance of knowledge management in the organization and developed models, conceptual structures and systems for managing knowledge in the modem organization (Ashikuzzaman, 2018).

Academic institutions are using modern technologies and systems for knowledge management and sharing. As a result, books, articles and any other type of published documents are viewed as obvious manifestation in a wide range of explicit and tacit knowledge assets that need to be managed in an organization. Institutional Repositories thus play an important and supporting role as knowledge management system or knowledge repositories and have now becoming a platform for the sharing of knowledge. Universities, libraries, research institutions and scholarly societies are using IRs to register, disseminate and preserve documents, datasets and other media as valuable scholarly assets (Lynch, 2003). Van de Sompel, Payette, Erickson, Lagoze and Warner (2004) also mentioned that scholars deserve an innately digital scholarly communication system that is able to capture the digital scholarly record, make it accessible and preserve it over time. Mower and Chaufty (2009) described the capacity of IRs as to enhance opportunities for academic libraries to support and participate in the scholarly communication through digital information channel among research communities. Heath (2009) further described the institutional repository as the key factor for networked scholarly communication in the digital environment to

enhance the visibility of research output and providing access through intranet or internet to the scholars. Therefore, most of institutional repositories serve as archives for pre-print or post-print versions of articles published in traditional journals, by providing green open access to scholarly output. In this way, institutional repositories' role as a scholarly publishing platform has not been fully recognized by most of the institutions.

Rationale for the study

Although it was established from this study that most of academic libraries in South Africa have implemented IRs as a way to capture, preserve and provide free access to their members' intellectual output, the question has thus arisen as whether these repositories meet the requirements of the Trusted Digital Repositories (TDRs), whose mission is to provide reliable, long-term access to managed digital resources to its designated community, now and in the future (RLG-OCLC Report, 2002). Literature reveals a dearth of empirical studies on assessing IRs capabilities as most of the studies and literature have largely focused mainly on the development of IRs in order to manage and preserving digital information. Little has thus been done in examining if their institutional repositories meet the criteria for trusted digital repositories, in academic libraries, particularly in South Africa and neither accepted standards identifies explicit performance metrics to assess the current capabilities of institutional repositories. Nor do these institutions explicitly support an incremental IRs capability improvement plan.

There is therefore a need to assess the capabilities of current IRs, to specify minimum requirements in respect of policies, processes, metadata and standards required to measure and validate repositories' trustworthiness in respect of authenticity, integrity and reliability of the digital materials in academic libraries in South Africa. In order to build a trusted digital repository in any organization or institution, the following attributes or elements are required: Organizational viability; Financial stability; Technological and Procedural suitability and System security (RLG-OCLC,2002). The objectives of this study were therefore formulated in line with the factors that are also mapped with the function requirements of the OAIS reference model and the attributes of the TDR model, namely:

- to establish the extent to which IRs were implemented in academic libraries in South Africa;
- to establish the policies and procedures in place for successful implementation of IRs (organizational viability);
- to determine the systems and technologies are used to support the implementation institutional repositories in academic libraries in South Africa (financial sustainability);
- to determine the mechanisms or strategies that are used in safeguarding digital scholarship communication ingested into IRs in academic libraries (technological and procedural suitability); and
- to determine the security measures that are taken by academic libraries to protect unauthorized access to digital scholarly communication (system security).

An overview of literature review

Academic libraries are a key part of the scholarly communication cycle that focuses on the creation of new knowledge through research and scholarship, the submission of findings to a journal in the discipline, rigorous peer review to ensure the contribution meets minimum standards, publication and dissemination (usually through library subscriptions), making the new knowledge available to the next community of researchers, who will further build on it (Cullen & Chawner, 2008)**.** However, in response to rising journal costs, libraries responded by cancelling subscriptions, particularly in science and medicine, and as a result, researchers lost access to key materials**.** In 2001, the Budapest Open Access Initiative published a manifesto calling for open access to peer-reviewed journal literature (Open Society Institute, 2002). This initiative recommended two strategies, namely: self-archiving of refereed journal articles in open electronic archives, and publishing in open access journals, which publish their content freely on the Web. The basic idea of open access was providing online access to scholarly publications and making that access free of charge and without most copyright and licensing restrictions. Open access emerged as a direct outgrowth as well as a solution to the scholarly communication crisis, that provides no-cost access to research while returning control of that research to its creators by

allowing them to maintain copyright. Budapest Open Access Initiative (BOAI proposed two strategies to achieve open access to research information, namely: self-archiving of refereed articles in open electronic archives, and publishing articles in open access journals, which publish their content freely on the web. Open access movement has so far strengthened and its success is marked by open access mandating by governments, funding agencies, international bodies, associations and organizations (UNESCO, 2015). Studies confirm that North American, European and many other countries passing law requiring open access to articles and data from federally funded research (Chadwell & Sutton, 2014). An institutional repository has thus been comprehended as a way to guarantee that the distributed work of researchers is accessible to the scholarly network even after increments in membership expenses or spending cuts inside libraries. As noted by Lynch (2003) the intellectual life and scholarship of our universities will increasingly be represented, documented, and shared in digital form and IRs are one of the tools that make this possible. Institutional repositories have since become a global phenomenon and they are now established on all continents, with the largest repositories being found in Europe, North and South America, Japan, India and Australia.

Lynch (2003) defines institutional repository as a set of services that an institution provides to the members of its community for the management and dissemination of digital materials created by the institution and its community members. Institutional repositories were first developed in an effort to reclaim previously published scholarship at individual institutions (Riddle, 2015). As a result, most of the existing repositories have become archives for pre-print or post-print versions of articles published in traditional journals. As stated by Prosser (2004) depositing an article in an institutional repository meets the following functions that are integral to scholarly publishing:registration, that is identifying the 'owner' of the intellectual property; certification, establishing the quality of the research as the most important elements of the scholarly communication model; awareness, as making the research available to others and archiving as long-term preservation to make the results available to future researchers.

Development of institutional repositories in South Africa

The evolution of digital technologies and the shift from print to digital collections has resulted in more innovations such as digital libraries and institutional repositories. The United States (US) dominates the world of digital libraries with some of the biggest projects concentrated in its university libraries including the University of Michigan digital library project, the University of Illinois at Urbana-Champaign digital library research project and the University of California at Berkeley digital library research project. In practice, the majority of African libraries, particularly in South Africa, have already digitized their scholarly output and established institutional repositories and digital libraries, and a few are at some intermediate stage. For the past few years, considerable efforts have been made to ensure that university communities in Africa are able to access the growing quantities of digital resources.

In 2005, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Coalition of South African Consortia (COSALC) held a workshop known as Building Digital Library Collections using the green stone at the University of Cape Town (UCT), attended by delegates from Ethiopia, Lesotho, Namibia, New Zealand, Swaziland, Sudan and the host country, South Africa. The workshop aimed at:

- raising awareness on open access models for information exchange;

- building capacity of information and communication technologies (ICT) professionals in African institutions; and

- supporting the creation of digital libraries and providing archivists and librarians in Africa with the skills to utilize electronic information tools and resources in their work and enhance access to online resources (UNESCO, 2005).

The institutional repository appeared as a new mechanism and a solution for managing scholarly production, dissemination and preservation of digital resources in academic institutions in South Africa. A substantial number of academic institutions as well as information centres have now implemented Institutional Repositories in order to adapt with changing library environment. Digital preservation has also been regarded as an important motivation for building IRs within academic libraries and to ensure digital materials are available and accessible in the long-term. Memory

institutions such as libraries, archives and museums are thus actively building institutional repositories and participate in national and international digital preservation initiatives in an attempt to preserve their digital resources for future access. Ngulube (2012), UBC Project (1997) and NLA (2007) also suggested that developing institutional repositories in academic libraries will preserve and sustain digital information for the present and future generations. Johnson (2002) describes an IR as a digital archive of the intellectual product created by the faculty, research staff and students of an institution and accessible to end-users both within and outside of the institution with few if any barriers to access. According to Lynch and Lippincott (2005), institutional repositories have emerged in North America and Western Europe primarily because they are regarded by the university communities as a means of having access to products of scholarship and research and as a locus for preserving such resources and maintaining access to them over the long-term. As stated by the American Council of Learned Society (2006), an IR sits firmly within the digital scholarship landscape, which includes building digital collections and creating tools for collecting, analysing and authorizing digital information and analytical tools to generate new intellectual products.

Scholars thus deserve an innately digital scholarly communication system that is able to capture the digital scholarly record, make it accessible and preserve it over time (Van de Sompel, Payette, Erickson, Lagoze & Warner, 2004). Gibbons (2004) also identifies the functions of institutional repositories to include access control, preservation, discovery support metadata application and materials submission. Many academic libraries are playing a leadership role in their institutional repository projects (Anunobi & Okoye, 2008). Such projects include:

- Academic Research in the Netherlands Online (ARNO) project implemented by the library staff of the University of Twente, the University of Amsterdam and Tilburg University;
- DSpace which is a collaborative project of the MIT libraries and Hewlett-Packard;
- Ohio State University's Knowledge Bank; and Utrecht University institutional repository.

In South Africa, the majority of academic institutions have therefore developed institutional repositories (IRs) in an attempt to manage and preserve scholarly outputs in their libraries (Pienaar & Van De Venter, 2008). Macha and De Jager (2011) stated some of the reasons for the establishment of Institutional Repositories in South African academic institutions as to help to preserve the institution's intellectual property and increase the institution's visibility and prestige. As reported by Macha and De Jager (2011), the University of Cape Town (UCT) implemented institutional repositories in four different departments, namely: UCT Law Space (Department of Law), UCT Computer Science Research Document Archive, Department of Manuscripts and of Archives in the library and open educational resources.

In 2005, the Carnegie Corporation of New York has awarded the UCT library, together with the libraries at the universities of the Witwatersrand and Kwa-Zulu-Natal, a grant amount of $2.5 million for a three-year project directed at supporting research and library staff development at these institutions (Macha & De Jager, 2011). According to Macha and De Jager (2011) this grant also provides funds to develop a new digital initiative unit with up-to-date equipment and expert staffing. This digital initiative unit is in charge of spearheading the establishment of an IR with the following strategic plans and priorities: "To attract, preserve, digitize and make available via a sophisticated web portal, key African archival and other resources and digitize these resources as a contribution to African scholarship, as an incentive for digital collaboration on the continent and as a showcase for UCT's research presence" (Rapp, 2009:2).

The Carnegie thus played a major role in establishing the IR at UCT and also enabling the purchase of equipment such as scanners, cameras and the DigiTool software (Macha & De Jager, 2011). The contents in this repository are divided into three categories: digital collections, finding aids and theses and dissertations. Another example is the University of Pretoria (UP) that also started a project of making theses available online in 2000 (UPeTD website) and established an institutional repository (IR) using an open access ETD-db software. UP established another IR in 2006, known as UPSpace, for the management and dissemination of digital research materials donated to or created by the community publications (Pienaar & Van De Venter, 2008). According to Olivier (2010) this institution has the total of two

repositories, UPeTD and UPSpace and these repositories offer open access to the full text of research articles published by staff, students and affiliates of the University of Pretoria. As noted by Macha and De Jager (2011), UP became a member of the international body the Networked Library of Theses and Dissertations (NDLTD), which provides access to all the world's theses and dissertations and which holds annual conferences. UP has also contributed to nine workshops in South Africa, Botswana, Lesotho, Ghana and Ethiopia, sharing expertise and enthusiasm and helping colleagues to start their own operations, and also assisted the Council of Scientific and Industrial Research (CSIR) to develop a digital repository (Pienaar & Van De Venter, 2007). As a result, various types of digital materials have been digitized and made publicly accessible. Digital scholarly outputs such as scholarly publications, pre-prints, post-prints and digital versions of theses and dissertation are now managed and preserved in the IRs with the use the open-source software such as DSpace, ETD-db and Eprints.

According to Prosser (2003:168) an IR also provides a central archive for a researcher's work and increases its dissemination and potentially its impact on the research community, and can act as a researcher's curriculum vitae' as all their output is gathered in one place. The IRs have therefore become a vehicle through which South African collections could be made accessible to the rest of Africa and ultimately to the rest of the world. Table 1 shows the list of academic institutions with institutional repositories in South Africa as well as the content and application software they use (OpenDoar, 2019).

Table 1: List of academic institutions with IRs in South Africa

Institutions	Typical content	Application
University of Pretoria (UP)	Electronic theses and dissertation Publication output of the university As well as digitized historical and archival materials donated to the university	ETD-db.
University of Johannesburg (UJ)	Electronic theses and dissertation	ETD-db.
University of Western Cape (UWC)	Electronic theses and dissertation Materials related to the governance of higher Education in South Africa	ETD-db. and AHERO
University of Cape Town (UCT)	Electronic theses and dissertation	ETD-db.
Stellenbosch University (SUN)	Electronic theses and dissertation Maps and items from university's special and manuscript collections	DSpace
University of Northwest (UNW)	Articles and theses	DSpace
Central University of Technology (CUT)	Electronic theses and dissertation	DSpace
University of Kwa Natal (UKZN)	Electronic theses and multimedia	DSpace
University of Free State (UFS)	Articles and theses	Apache
Tshwane University of Technology (TUT)	Articles and theses	ContentPro
University of South Africa (UNISA)	Articles and theses	DSpace
University of Forthare (UFH)	Theses and dissertation	DSpace
University of Limpopo (UL)	Theses and dissertation	DSpace
University of Zululand (UNIZULU)	Theses and dissertation	DSpace
Vaal University of Technology (VUT)	Theses and dissertation	DSpace
Nelson Mandela Metropolitan University (NMMU)	Theses and dissertation	DSpace
Walter Sisulu University	Theses and dissertation	DSpace
Rhodes University (RU)	Articles, conferences and theses	E-prints
Durban University of Technology (DUT)	Electronic theses and dissertation	DSpace

Adapted from OpenDoar (2019)

The growth of open access IRs has therefore been remarkable in South Africa and it shows that their academic libraries are currently the leader among African universities in terms of the development of IRs, growing from a total of fourteen (14) registered and active repositories to the current twenty-three (23) IRs. However, efforts by many African institutions to establish digital repositories to facilitate the capture, storage, preservation, and dissemination of an institution's intellectual outputs are very often faced with challenges (Lor, 2005), eventually rendering the repositories unsustainable (Ngulube, 2012). In many African countries digitization and setting up of IRs has faced serious problems ranging from low internet connectivity, software and hardware challenges, lack of highly skilled personnel, inadequate power supply, low bandwidth, legal copyright laws, poor funding, lack of organizational infrastructure and policies, project sustainability and many others (Ezeani & Ezema, 2011; Rosenberg, 2006). Hughes (2004) also noted that despite all the efforts to create digitization programmes, roadblocks such as copyright issues, funding, institutional support and technical drawbacks have always hampered meaningful progress in building digital libraries and institutional repositories.

However, OECD (2017) recommended the actions needed to develop a successful research data repository business model that should be revisited regularly during a repository's life-cycle that includes understanding the life-cycle phase of the repository's development (i.e. the need for operational funding), identifying who the stakeholders are (i.e. data depositors, research funders and policy makers) and identifying revenue sources (i.e. structural funding and value-added services). As noted by Patil (2015) factors such as financial background of the institutional and the library as well, manpower, infrastructural requirements of the project, policy, management committee and monitoring the implementation should also be considered**.** Parsons (1995:13-14) defines a policy as the manifestation of considered judgment, plan, role, action, tactics and strategy adopted by a government, a party or an organization. Academic librarians are knowledge workers and they also need to constantly update or acquire new skills and knowledge to remain relevant and drive the organization forward.

The benefits of institutional repositories

One of the main reasons to persuade academics in placing their output in an institutional repository is exposure, that by having their research and publications openly available on the Web, not just in fee-based databases, scholarly journals, or books, so that their work is likely to be used and cited more. Other benefits to researchers include stewardship and preservation of their publications in digital form, which frees them from the need to maintain this content on a personal computer or website (Lynch, 2003). In Japan, the Ministry of Education, Culture, Sports, Science and Technology has encouraged Japanese university libraries to develop institutional repositories to promote sharing of knowledge throughout Japan and internationally (Cullen & Nagata, 2008). The development of institutional repositories in Africa is seen as a way of making institutional research outputs available to a community with less than optimal access to resources (Musoke, 2008). Crow (2002) also noted improving long term preservation of the institution's digital assets as another benefit to be realized through centralizing content in known, standardized formats.

Notwithstanding the various benefits of an institution repository, there are some drawbacks to its prosperity as it appears that members of the academic and research community do not see repositories as part of the publication process. Academics have little awareness of opportunities for open access publishing and continue to publish in traditional venues and identify a major obstacle to change as the existing reward systems of tenure or promotion which favors traditional publishing forms and venues (University of California, 2007). Given the reluctance of academics to deposit their research output, whether through lack of interest, lack of knowledge, or through concern over the purpose and function of repositories, it is clear that tertiary institutions wanting to increase their rate of deposit and use need to actively market the concept of the institutional repository within their institution. Advocacy is an ongoing task to ensure that new depositors are being recruited and that previous depositors continue to contribute updates of their research output, and remain committed to the overall success of the repository.

Theoretical framework

Theories and models were reviewed in this article to give grounded coherence and to understand the attributes that constitute a trustworthy digital repository in academic libraries. The researcher considered it appropriate to use the Trustworthy Digital Repository model by (RLG-OCLC, 2002), Carnegie Mellon University's (1990) Digital Preservation Capability Maturity (DPCM) model and Open Archival Information System (OAIS) model by OCLC (2002) in ascertaining the attributes of a trustworthy digital repository in academic libraries.

Trusted Digital Repositories

Trusted Digital Repositories (TDRs) was used in this article as a guide to identify the components of a trustworthy digital repositories. TDRs are considered as widely accepted standards of curation processes for digital data by libraries and archives (RLG-OCLC, 2002) and are used by different organizations as guidelines that need to be followed by libraries providing digital reference services in order to ensure the uniformity of digital reference services provided by libraries worldwide. RLG-OCLC (2002) describe TDR as the one whose mission is to provide reliable, long-term access to managed digital resources to its designated community, now and into the future. The first attempt to identify specific evaluation criteria for TDR came in 2002, through the collaboration between the Research Libraries Group (RLG) and Online Computer Library Center (OCLC) and published a set of attributes (RLG-OCLC 2002) as follows:

- *compliance with OAIS model-* to ensure that the implementation complies with the model;
- *administrative responsibility-* to advise on the adoption of appropriate standards, respond to the demands of evolving standards and requirements, and document decisions and actions as needed in support of organizational objectives;
- *organizational viability-* to define feasible technical requirements for depositor agreements and advising on and providing text to address the technical aspects of policies, procedures and practices;

- financial sustainability, to provide sound recommendations on the technical infrastructure to support the program, the cycle of replacement for hardware and software, the appropriate technical solutions for preservation strategies and supporting technologies for archival storage with associate cost information for these aspects;

- ***technological and procedural suitability-***to develop plans that will meet each requirement for the infrastructure or the necessary preservation strategies and to ensure that the plans are executed successfully and fully with complete documentation and in compliance with established policies and standards, including the organization's responsibility to actively seek and evaluate appropriate preservation solutions and provide the means to implement them;

- ***system security-*** that requires technical solutions, ongoing upgrades and enhancements and means for auditing processes; and

- ***procedural accountability-*** to respond to ongoing managerial needs, to anticipate those needs when possible and to develop mechanisms for automatically generating and capturing the necessary documentation.

These attributes work together to retain the trusted digital repository's status as being OAIS compliant. Nordland (2007) concur that in order to build a trusted digital repository in any organisation or institution, the following attributes or elements are required:

- ***organizational infrastructure***, that is expressed in a comprehensive policy framework and it include governance, organisational structure and viability, staffing, accountability, policies, financial sustainability and legal issues;

- ***technological infrastructure and security risk management***, that entails a flexible preservation plan that can incorporate changing technological platforms over time and security issues;

- ***resources framework***, that focuses on the staffing, technological, operational and other costs associated with maintaining the organization; and

- ***digital object management,*** covering acquisition and ingest of content, preservation planning and procedures, information management and access.

Nordland (2007) regarded these elements as the core requirements necessary for the long-term preservation of digital information and a trusted digital repository. However, Rosenthal, Robertson, Lipkis, Reich and Morabito (2005) identified various threats to digital repositories and these include media failure, hardware failure, software failure, communication errors, failure of network services, media and hardware obsolescence, software obsolescence, operator error, natural disasters, external attacks, internal attacks, economic failure and organizational failure. Ngulube (2012) suggested that these factors should be considered and monitored when creating trusted repositories. Therefore, to be considered trustworthy, a digital repository must be able to maintain the integrity of its research documentation and material for both the potential stakeholders, for example, its depositors and funding agencies, and its designated user community. As such, a trusted digital repository must be sustainable and identify essential organizational, curatorial and operational responsibilities, address high-level agenda recommendations such as certification, requisite tools, cooperative models, comprehensive archival system design and development and intellectual property rights.

The following elements need thus to be considered in order to determine the trustworthiness of a digital repository: its means of governance based on a long-term commitment to comply with prevailing standards, policies, and practices; the organizational structure required to support the various functions; the creation of staffing policies to ensure trained staff capable of sustaining the digital repository; the development of policies and procedures: current written policies should be reviewed at regular intervals; its financial fitness and sustainability: business planning processes should be in place to sustain the repository over time; data security issues: security needs should be assessed and implemented; and the necessary technological infrastructure: adequate hardware and software should be provided and these systems must conform to ISO 17799. The Alliance for Permanent Access to the Records of Science in Europe Network (APARSEN) also produced a brochure on trust to help answer this question: What does it mean to be trustworthy digital repository? and further identified the following key questions related to the trust that need to be addressed: whether the data has been preserved properly, if it is of high quality, if it has been changed in some way and if the pointer get user to the right object. It is

worthwhile to reflect on these four questions in turn when thinking about the importance of demonstrating the trustworthiness of a digital repository.

Digital Preservation Capability Maturity model

The Digital Preservation Capability Maturity (DPCM) model was also used in this study as a guide to measure the capabilities of digital repositories as well as assessing its maturity. This model outlines the best practices in operational digital preservation repositories and it organizes the digital preservation requirements of the ISO Standards into fifteen components with metrics to assess maturity. The DPCM model consist of three interdependent domains: digital preservation infrastructure (that includes policies, strategies, governance, collaboration, and technical expertise and designated community), trustworthy digital preservation repositories and digital preservation services (that include electronic records survey, ingest, archival storage, media/device renewal, integrity, security, preservation metadata and access) (Carnegie Mellon University,1990).

Digital preservation infrastructure

Digital preservation infrastructure consists of seven infrastructure components including policy, strategy, governance, collaboration, technical expertise, Open Standard Technology Neutral (OSTN), formats and designated community (Carnegie Mellon University, 1990). These components focus on what an organization as a distinct entity does to sustain digital repository or how a trusted preservation repository executes services within the constraints of the organization's infrastructure (Dollar & Ashley, 2014). However, not all aspects from the DPCM model by Carnegie Mellon University (1990) were applied in this study. The study focused only on key elements that will contribute to the implementation of sustainable institutional repository in academic libraries, namely: policies, strategies, governance, technical expertise and designated community), trustworthy digital preservation repository and digital preservation services (security).

- **Implementation of policies and strategies**

Policies are high level documents reflecting the mission of the institution and they guide in the creation of action plans or guidelines and best practices. Therefore, any successful digital repository and its future benefit may be heavily dependent on strategies being in place and underpinned by relevant policy and procedures. As also observed by Davies (2000:9), the goals and objectives set by policy cannot be achieved without the strategy. Strategy refers to the plan of how the goals will be achieved and it is articulated by policy, but without resources strategy cannot be implemented. The essence of the strategy is to provide a plan that employs multiple inputs, options and outputs to achieve policy goals and objectives. A well-formulated strategy thus helps to properly allocate the organization's resources into a unique and viable situation based on its relative internal competencies and weaknesses, anticipated changes in environment, and contingent moves by intelligent opponents (Chakravarthy et al., 2003:2). In order for organizations to achieve sustainable digital repository, three key elements that require equal consideration must be considered and these include policy, strategy and resources.

- **Governance**

An organization with a digital preservation mandate should have a formal decision-making process aligned to its enterprise information governance framework that assigns accountability and authority for the preservation of electronic records with permanent value, and articulates approaches and practices for preservation repositories sufficient to meet stakeholder needs (Dollar & Ashley, 2014). Gartner (2014) defines information governance as the specification of decision rights and an accountability framework to encourage desirable behaviour in the valuation, creation, storage, use, archival and deletion of information. It includes the processes, roles, standards and metrics that ensure the effective and efficient use of information in enabling an organization to achieve its goals. The governance framework enables compliance of the preservation repository with applicable laws, regulations, record retention schedules, disposition authorities, and standards. Therefore, this study acknowledged governance as one of key elements of successful digital preservation.

- **Technical expertise**

In order for academic institutions to practice an efficient digital preservation system, it should have competent information professionals and staff that have knowledge, skills and technical expertise. Anunobi and Okoye (2008) also noted that resources today occur in hybridized form (print and electronic) and therefore services provided and skills possessed by professionals in academic libraries should reflect that trend. A viable digital preservation capability also requires organizations to have sufficient technical expertise in electronic records management and digital preservation to support all of the infrastructure and requisite key processes. The Society of American Archivists (SAA) (2013) has also created a list of core competencies that a digital archivist should have, which includes the ability to communicate the requirements related to digital archives; to formulate the strategies needed to best organize and preserve them, and to integrate technologies, tools, software, and media within existing functions for appraising, capturing, preserving, and providing access to digital collections.

- **Designated community**

The organization that has responsibility for preservation and access to permanent electronic records is well served through proactive outreach and engagement with its designated community of records producers and users (Dollar & Ashley, 2014). As observed by the Council of Canadian Academies (2015:58) Libraries, Archives and Museums (LAM) institutions are working to establish meaningful relationships with a diverse set of designated communities so that people are aware and trusting of opportunities awaiting them. These institutions are seeking new ways to retain their relevance by encouraging a participatory culture, contributions from the public range from simple tagging activities to sharing of historical knowledge to design of software by expert volunteers (Council of Canadian Academies, 2015:61). For proper implementation of trustworthy digital repositories, academic institutions should thus engage with designated communities and users who will assist in understanding their needs and implement the repositories according to these needs.

Digital preservation repository

The digital preservation repository ensures the continuity of electronic resources and enables the design, operation and management of these resources. Preservation repositories require the integration of people, processes, and technologies and the most complete preservation environment is based on models and performance criteria which include ISO 14721, ISO 16363, and generally accepted operational practices (Dollar & Ashley, 2014). According to Dollar and Ashley (2014) a preservation repository may range from a simple system that involves a low-cost file server and software that provides non-integrated preservation services to complex systems comprised of data centers and server farms, computer hardware and software, and communication networks that are interoperable.

Digital preservation services

Digital preservation services consist of eight key business process areas needed for continuous monitoring of external and internal environments in order to plan and take actions to sustain the integrity, security, usability and accessibility of electronic records stored in trustworthy preservation repositories (Dollar & Ashley, 2014). All these digital preservation services focus on a range of actions required to ingest and sustain long-term and permanent electronic records and continuously monitor the technical environment upon which they depend.

- **Security**

While this study concedes that repositories and archives containing digital materials that are useful to institutions and user communities, they can pose a threat if proper security protections are not put in place. As observed by Dollar and Ashley (2014), digital preservation requires processes that restrict access to the physical repository where digital content is stored, ensure the security of electronic records through techniques that block unauthorized access, protect the confidentiality and privacy of records and intellectual property rights, support periodic backup of electronic records

that are stored at offsite storage repositories, and support disaster recovery and business continuity. Again, a digital preservation system should also include and apply controls on access to ensure that the integrity of records is not compromised. Copyright issues should be well managed, and therefore academic institutions must identify all content that is part of the project as there may be content in the public domain and acquire permission to use copyright-protected content.

Open Archival Information System model

Quist (2008) described the Open Archival Information System (OAIS) model as the most widely used reference in the development of digital libraries and digital repositories. The OAIS model was proposed by the Consultative Committee for Space Data Systems (CCSDS) to standardize and provide a set of recommendations for preservation programme implementation (CCSDS, 2002). It is simply a set of standardized guidelines intended to aid the people and systems behind a repository that has been designated with the responsibility of maintaining documents for archival purposes over a long period of time (CCSDS, 2002). As stated by Hockx-Yu (2006) the OAIS model provides a complete functional and information specification of a repository and establishes mandatory responsibilities that an organization must discharge in order to operate an OAIS archive. It is also concerned with all technical aspects of a digital object's life cycle including ingest, archival storage, data management, administration, access and preservation planning (CCSDS, 2002). Figure 1 shows a summarized version of the OAIS reference model.
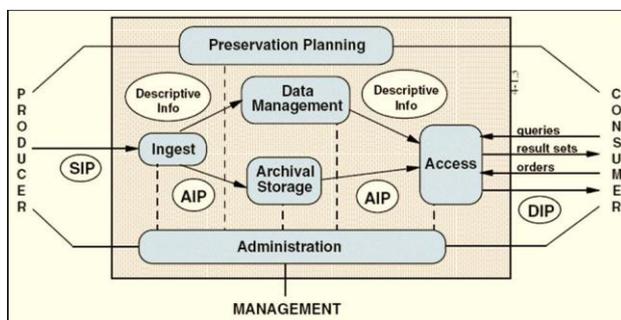

Figure 1: The OAIS reference model (Lavoie, Henry & Dempsey, 2006)

The OAIS functional entities (ingest, archival storage, data management, administration, access and preservation planning) manage the flow of information from information producers to the archive, and from the archive to consumers. Therefore, any system built according to this model should contain the following six functional entities:

Ingest - it represents the incorporation of submitted information into the archive and its functions are: to receive submission information packages (SIPs) from the producer and subject them to quality assurance; to generate appropriate archival information packages (AIPs) and descriptive information; and to co-ordinate the requisite updates to the archival storage and data management entities. According to Bantin (2016) the ingest function includes receiving and accepting digital objects as SIPs from producers or creators and preparing and managing the contents for archival storage and management.

Archival storage - it covers the storage of the AIPs, and its functions are therefore to receive AIPs from the ingest entity, to manage the storage hierarchy, to replace media as necessary, error checking; disaster recovery and providing copies of AIPs to the access entity on request.

Data management - its functions are maintenance of the database of descriptive information and system information, answering queries passed by the access entity, generating reports as requested by the ingest, access or administration entities and updating the database with descriptive information from ingest and system, and review updates from administration.

Administration - its functions are negotiating a submission policy with producers, managing the system configuration, performing archival information updates, physical access control, establishing archive system policies and standards, auditing submissions to ensure at least minimum standards are maintained, activating requests and customer service.

Preservation planning - it ensures that the policies and procedures are in place at the OAIS to adequately protect it from issues arising from technological changes. Its functions are monitoring the designated community for changes in requirements, monitoring technology, standards and platforms to track the emergence of new ones and the packaging designs and migration plans.

Access-it covers the search and retrieval of archived information and its functions are: co-ordination of access activities into a single user interface, including methods

for search queries, report requests and orders for DIPs; generation of DIPs from AIPs; and delivery of result sets, reports, DIPs and assistance to consumers.

The current study thus found it appropriate to use the OAIS model as it highlights the various roles and functions of the active participants of the designated community and can facilitate implementation of successful digital repository in academic libraries because it has the capacity to reliably store information, migrate it and provide access to digital information.

Institutional repositories assessment and certification tools

Given the growing reliance on institutional repositories in the past decade (OpenDOAR, 2019), the need for researchers to be able to trust that their research output is safe is becoming increasingly important. This need was also recognised by Deakin University Library in 2013, with the establishment of a project to determine the compliance of its research repository. An institutional repository can only be said to be successful if it fulfils its stated purpose, which includes to preserve information and make it available for a designated community (Thibodeau, 2007). However, undertaking an assessment against international standards and certification tools is not a trivial task, and is likely to be beyond the ability of smaller repositories to manage. In assessing and testing the trustworthiness of institutional repository, evidence of compliance with policies and procedures will be required to confirm that the repository's preservation-related functionality was indeed operating as expected. This article therefore elaborates on issues regarding assessment and certification toolkits for a successful institutional repository such as**:** Trustworthy Repositories Audit and Certification: Criteria and Checklist (TRAC), Digital Repository Audit Method Based on Risk Assessment (DRAMBORA) and European Framework for Audit and Certification of Digital Repositories. These standards and tools are reviewed in this article to determine whether the South African academic libraries are following these international standards in implementing and maintaining their IRs, if not to recommend some guidelines based on these standards and tools.

Trustworthy Repositories Audit and Certification: Criteria and Checklist

In 2003, RLG and the US's (NARA) Task Force on digital repository took on the challenge of creating one of the first sets of criteria and checklists for long-term digital preservation. The criteria and checklist document created by this Task Force is known as the Trustworthy Repository Audit and Certification: Criteria and Checklist (TRAC), which is the basis of the current international standard, ISO 16363 (TRAC 2003), and it allows digital repositories to assess their capability to reliably store, migrate, and provide access to digital content. TRAC provides tools for the audit, assessment, and potential certification of digital repositories, establishes the documentation requirements required for an audit, delineates a process for certification, and establishes appropriate methodologies for determining the soundness and sustainability of digital repositories (TRAC 2003). TRAC is based upon existing standards and best practices for trustworthy digital repositories and incorporates a set of 84 audit and certification criteria arranged in three sections: Organizational Infrastructure; Digital Object Management and Technologies, Technical Infrastructure, and Security (OCLC & CRL, 2007). It defines criteria in several aspects that are of specific interest for preservation planning, which, among others, include: procedures, policies and their evolvement, review and assessment, documented history of changes, transparency, accountability, monitoring and notification. TRAC checklist was regarded as the most widely accepted criteria for assessing the trustworthiness of digital repositories, and many Organizations used the checklist and supporting evidence to prove the effectiveness of their digital repositories and to support the development of preservation improvement plans (CRL & OCLC 2007). For example, Deakin University Library undertook a self-assessment against the ISO 16363/TRAC criteria. ISO 16363 includes a section on security entitled "Security Risk Management" and this section outlines security criteria for Trustworthy Digital Repositories (TDRs) (CCSDS, 2012), and therefore the staff seeking a "trustworthy" status for their digital repositories must maintain "a systematic analysis of security risk factors associated with data, systems, personnel, and physical plant. Therefore, a TDR must also implement controls to address defined security risks and have suitable written disaster preparedness and recovery plans.

Digital Repository Audit Method Based on Risk Assessment

Digital Repository Audit Method Based on Risk Assessment (DRAMBORA) was another assessment toolkit introduced by the Digital Curation Centre (DCC) and Digital Preservation Europe (DPE) in 2007. DRAMBORA offers a methodology and a toolkit for digital repository self-assessment by identifying assets, activities and potential impact of risks on the repository. It is designed to facilitate an internal audit that assists organizations in identifying their capabilities, strengths and weaknesses of their digital repositories. Ball (2010) added that this auditing tool is required to describe and document the repository's role, objectives, policies, activities and assets in order to identify and assess the risks associated with these activities and assets and define appropriate measures to manage them. DRAMBORA includes a list of examples of objectives for digital repository staff members to choose from. IRs managers should therefore, identify the activities that are necessary to achieve their objectives and assets, including human resources and technological solutions, that are central to achieving repositories' objectives. IRs managers should assess and treat risks by characterizing each risk's "probability, impact, owner, and the mechanisms or proposed mechanisms by which it can be avoided or treated (ISO 16363), and also self-audit their repositories to determine what threats are most likely to occur and identify areas where improvement is required. DRAMBORA toolkit can thus be used as a means of guiding repository administrators and other staff to identify the risks that are associated with the organization's business continuity and to anticipate, avoid, mitigate and maintain appropriate evidential documentation (DCC & DPE, 2007).

European Framework for Audit and Certification of Digital Repositories

As noted by Corrado and Moulaison (2014:10) one needs to look no further than the international guidelines for trusted institutional repositories to see most of what is required to becoming certified or receiving a Seal of Approval. In 2010 the chairs of the CCSDS, Repository Audit and Certification working group (RAC), the Data Seal for Approval (DSA) board and the DIN trusted archives certification working group signed a memorandum of understanding, stating that they would work together to create standards for trusted digital repository certification. This effort is known as the European Framework for Audit and Certification of Digital Repositories, and it is

intended to help organizations in obtaining appropriate certification as a trusted digital repository and establishes three increasingly demanding levels of assessment. The framework designates three levels to represent increasing degrees of trustworthiness and these levels are:

- level 1: basic certification, a self-assessment using 16 criteria of the DSA;
- level 2: extended certification, a Basic Certification and additional externally reviewed self-audit against ISO 16363 or DIN 31644 requirements; and
- level 3: formal certification, a validation of the self-certification with a third-party official audit based on ISO 16363 or DIN 31644 (APARSEN, 2012).

Research methodology

The study critically reviewed literature in order to understand the nature of the implementation of institutional repositories in academic libraries in South Africa as well as its trustworthiness, based on qualitative document analysis. Document analysis is a form of qualitative research in which documents are interpreted by the researcher to give voice and meaning around an assessment topic (Bowen, 2009). It is a systematic procedure for reviewing or evaluating documents both printed and electronic materials. Like other analytical methods in qualitative research, document analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding and develop empirical knowledge (Corbin & Strauss, 2008). The analytic procedure entails finding, selecting, appraising (making sense of) and synthesising data contained in documents. Whereas document analysis has served mostly as a complement to other research methods, it has also been used as a stand-alone method and there are some specialised forms of qualitative research that rely solely on the analysis of documents (Bowen, 2009). Wild et. al (2010) concur that even though document analysis has traditionally been used to supplement other qualitative techniques, contemporary research has used this technique as the sole method for research. Wild, et al. (2010) conducted a study that examined engineers' information needs and a test of a related software system, based solely on document analysis.

For this current study, document analysis begun with researcher identifying and selecting documents on the basis of their usefulness and relevance to the study.

Documents were collected for review and analysis in this study as a way of assessing the trustworthiness of IRs and also if they are in compliance with prevailing standards and models included library guides and reports, policies, acts, procedures, strategies, accountabilities, guidelines, related journals, best practices, systems, standards, tools, right to information law, copyright and intellectual properties law, security risks, IRs planning and implementation, related journals, open access to information. These types of documents were found in libraries, newspaper archives, organisational or institutional websites and relevant databases while others were requested from academic institutions of South Africa.

Findings and discussion

This section provides the findings on the extent to which IRs were implemented in academic libraries and the factors that influence the successful implementation of trustworthy institutional repositories.

Implementation of institutional repositories

As observed by Ngulube (2012) and NLA (2007) developing institutional repositories in academic libraries will preserve and sustain digital information for the present and future generations. The IRs have become a vehicle through which digital collections could be made accessible to the rest of Africa and ultimately to the rest of the world. Therefore, to fully appreciate the state of the art of IRs, it was considered necessary to first investigate the extent of implementation of IRs in academic libraries. The evidence from the documents shows that academic libraries recognize the changing library environment and the global reach of digital assets. As a result, the majority of academic libraries in South Africa developed IRs in order to collect, preserve, manage and disseminate institutionally produced scholarly materials and research outputs. An increasing amount of digital scholarly communication is thus made available to a wide range of users through IRs, and these institutions identify, acquire and evaluate digital records of long-term historical, administrative and evidential value in order to serve as an institutional memory.

Organizational viability

Developing a trusted digital repository require the implementation of policies, standards and best practices as well as models for sustainable funding to guarantee long-term commitment to these materials. A clearly documented, realistic and achievable preservation policy is a critical part of the pursuit of digital preservation and it is an essential foundation for any sustainable digital preservation programme. Therefore, without the development of policies to ensure the longevity of digital resources, academic libraries cannot be said to be undertaking digital preservation. The library policy documents were thus reviewed to determine which aspects of policy and procedures were in place. The aspects of policy that were documented to be in place included selection, open access to materials, copyright and intellectual rights, digitization and preservation policy, metadata policy, collection development and management policy, storage policy and institutional repositories, research policy. Management and preservation of IRs and other archives in many institutions are thus aligned with these policies, and in order to ensure compliance with policies and risk abatement, some of the institutions indicated that they perform a compliance audit with the guidance of an internal audit. As a result, annual performance and quality management of the digital preservation programme transpired in some of the institutions to ensure the quality and integrity of the programme. In most institutions, the IRs have been developed in line with international interoperability, metadata standards and policies, and the collection in IR is harvested on an international level by other major repositories using the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH).

Library policy documents also outline the institutional goals, guiding principles, selection criteria, management and access to digital collections, digital standards and guidelines, governance of digitization and preservation initiatives, digital preservation and digital curation, facilitating the long-term access and use, management and long-term preservation and sustainability. Analysis of the documents also indicated that most of the institutions are reviewing their preservation policies every five years while some are reviewing them every two years. The implementation of a successful digital repository also relies on availability of resources and skills, and suitability of equipment. Therefore, some of academic libraries perform auditing to identify a critical

mass of resources for digitization and preservation, existing useful hardware or software and required staff skills and training, skills availability and capacity in supporting functions such as intellectual property rights management, metadata development and cataloguing, systems and database development.

However, in order to remain relevant and up to date with the digital trend, the services provided and skills possessed by information professionals in academic libraries should also reflect this trend and, as a result, continuous learning and training of staff are necessary. Institutional annual reports also emphasized that all staff members should receive additional training or professional development throughout the year as part of the institution's strategies and plans. Library documents also confirmed that generic and specific training and workshops in digital preservation are offered in some institutions. As a result, identified staff in most of the institutions attended training in digitization and digital preservation as provided by their institutions, and this practice enhanced the knowledge and skills of information professionals. However, there is no evidence of succession planning, even if the institutional documents noted that there were career development practices. As noted in library documents, some of academic institutions are offering the following modes of training: online (self-help) training, face-to-face training, e-classroom training and virtual training to help information professionals to manage and preserve their digital materials.

Again, from analysing the documents, it was also clear that management of academic libraries formally considered digital preservation as a strategic objective. In some of the academic institutions, the evidence shows that management is supporting the mission of the university to ensure long term access to their digital resources. Management documented preservation policies and is promoting digital preservation services and the use of institutional repositories in these institutions. It was also noted that management liaises and cooperates with other archival institutions and collection repositories on an academic and provincial level. Digital preservation awareness campaigns are also presented at regular intervals. However, digital preservation awareness was still lacking in other institutions as they did not appear to have documents in place to promote their digitization and preservation services as well as the use of IRs.

Financial sustainability

In order to ensure trustworthy digital repository, the institutions should look at implementing tools, systems or software to support various digital preservation strategies. This is important as it is part of library and archives' mission to prevent the loss of cultural and historical material, important scientific and research data, and institutional records. Examples of preservation software or technologies mostly used by academic institutions include Archivematica, Dspace, Eprints, ETD-db, Greenstone, AHERO and MyCore. The document review revealed that some of the institutions had a budget for implementing IRs and the costs were thus managed to make optimal use of resources, including training of staff members. However, some of the institutions did not have a specific budget for preservation practices and depended on donor funding in implementing and maintaining their institutional repositories Funding and costing is, however, recorded as one of the compelling problems because a sustainability digital repository depends on it.

Technological and procedural suitability

Digital preservation is still a relatively new field for libraries, and academic libraries have yet to implement all of the necessary solutions such as a method of checking the integrity of a digital object's bit stream to verify it has not become corrupted, a way of identifying and validating formats, programmes to migrate materials at risk of obsolescence to new formats, a system of replicating digital materials in various locations, or methods for collecting all of the technical and administrative metadata for preservation. This implies that institutions must create mechanisms that allow for the determination of authenticity based on the trustworthiness of the source of the digital entities and the chosen method of their transmission through time, and then adopt the necessary methods and strategies to preserve them in a sustainable way. The development of these strategies and guidelines can aid in designing a preservation framework applicable to academic libraries in South Africa.

Several strategies therefore exist to preserve digital materials for the long-term including bit preservation, normalization, emulation, migration, replication and risk management approach. Analysis of library documents also revealed that most of

academic libraries were using migration, bit preservation, risk management, metadata and backup as common strategies used for effective preservation of their digital resources. Other strategies that were used are checksum and functional preservation. Checksum was used to verify the integrity of full text file overtime. With the functional preservation strategy, the file does change over time so that the material continues to be immediately usable in the same way it was originally while the digital formats evolve over time. As also indicated in institutional documents, most of academic libraries also employ widely accepted international standards for creating, managing and providing access to digitized materials and they adhere to established standards. Most of these institutions recorded using Dublin Core Schema to collect metadata from the item, and the reasons for collecting metadata was to aid in the retrieval process and for use in later products in their institutions.

Review of library documents also indicated that in many institutions metadata is harvested by Google, Google scholar, Worldcat, ROAR, OpenDOAR, NETD and OATD. However, one of the institutions noted that most of their digital resources are available on WorldCat and are downloaded from the OCLC database. Most of the institutions comply with the Promotion of Access to Information Act (No. 2 of 2000) (PAIA) and the broad principles of records management that are required by the National Archives and Records Service Act (No. 43 of 1996), the International Standard for Records Management (ISO15489) and the South African National Standard for Records Management (SANS 15489). The majority of institutions have also expressed their commitment to openness and have signed the Berlin Declaration on Openness to Knowledge in the Sciences and Humanities, a mechanism to commit institutions to promote an open access approach to institutional research outputs and knowledge. This declaration asserted that scholarly research outputs and cultural heritage be freely accessible and usable for scientists and the public. As a result, most IRs provide access in compliance with legal requirements and standards, and follow the principles of the Berlin Declaration on Openness to Knowledge in the Sciences and Humanities.

System security

Evidence from document analysis also shows that academic libraries are striving to maintain the highest standard of security both in the creation and protection of their digital files and in their delivery to ensure that the authenticity of the digital version of the original work is not compromised. The majority of the institutions have developed and maintained systems of internal control to safeguard their digital assets against unauthorized access and also created databases from the public domain in order to secure and protect access to their vital materials. However, it was established that there were no policies and procedures in place regarding security issues and it is therefore highly appreciated that security policies be developed as it helps in protecting institutional records from unauthorized access.

Conclusion and recommendations

The analysis of document indicated that academic institutions in South Africa meets most of the criteria for being considered a Trusted Digital Repository but as expected, they still need to improve. The main catalysts are: strengthening of national and funder policies that serve to both mandate open access (green or gold) and raise awareness of open access amongst faculty; the alignment of repositories with current research information systems within universities; and the development of metadata and open archives initiative harvesting that will improve discoverability and usage data. As noted by the Council of Canadian Academies (2015:82), collaboration with private companies and academia may allow memory institutions to become involved in exciting activities that enhance their visibility and enable them to undertake large projects that they could not otherwise resource on their own, to share resources, knowledge and operate on the same technical standards. Collaboration can make core services more convenient for users, reduce the workload for individual institutions and increase standardization of policies and digital platforms.

Review of institutional documents also revealed that academic libraries in recognizing its role within its communities will mean that it will share its experience and expertise of digitization and digital preservation practices with others. This implies that these institutions aim at increasing the quantity and diversity of digital content available to

users at the national level by working collaboratively with other national and international institutions. This will also include: providing expertise to other institutions in the development of digitisation and preservation capacity, partnering in order to develop digital collections in areas of common interest, providing a centre for learning, research and skills development, and involvement in outreach for the preservation of 'at risk' heritage material.

However, only a few of the institutions are partnering with international institutions or organizations to explore the long-term effectiveness of digital preservation. One of these institutions reported engaging with the British Library, which involves collaboration in terms of staff exchange and research. Management support is also a key to meeting the challenges of managing and preserving IRs. Developing clear policies and processes requires effective leadership or library management that also makes recommendations to staff about preservation standards, technology options, feasibility and training of staff. Library management should help in raising awareness and promoting their digitization and preservation services as well as the use of IRs. These institutions should use tools such as pamphlets, brochures, events, research week, library week, open access week, presentation at conferences, organizing workshops, using university mailing lists and university blogs, social media such as Facebook and Twitter to promote their digital preservation services and benefits of using IRs.

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