

**TRENDS IN DIGITAL SCHOLARSHIP CURATION
IN
PUBLIC AND PRIVATE HIGHER EDUCATION IN SOUTHERN
AFRICA:
A SOCIO-TECHNICAL APPROACH TOWARDS SUSTAINABILITY**

By

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I would like to dedicate this thesis to:

My father, Ben Rautenbach. I wish you could be here with us.

And to my Promotor, Prof Adeline Du Toit.

Thank you for your guidance and support.

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ACRONYMS AND ABBREVIATIONS

Acronym	Name, Wording or Description
AHERO	African Higher Education Research Online
AJOL	African Journals Online
AODL	African Online Digital Library
ArXiv	Cornell University repository of electronic ePrints
BOAI	Budapest Open Access Initiative
CARL	Canadian Association of Research Libraries
CISC	Consejo Superior de Investigaciones Cientificas
COAR	Confederated Open Access Repositories
CSIR	The Council for Scientific Research and Industrial Research
DATAD	The Database for African Dissertations and Theses
DEST	Department of Education Science and Training
DIKW	Data, information, knowledge & Wisdom
DOI	Digital object identifier
DRIVER	Digital Repository Infrastructure Vision for European Research
ETD	The Database for Electronic Theses and Dissertations
HEI	Higher education institute
ICT	Information and communication technology
IM	Information management
INASP	The International Network of Availability of Scientific Publications

IR	Institutional repository
IT	Information technology
KM	Knowledge management
KMS	Knowledge management strategy
NDLTD	The Networked Digital Library of Theses and Dissertations
OA	Open access
OAH	Open access harvester
OAI	Open Access Initiative
OAI-PMH	Open Archive Protocol for Metadata Harvesting
OAIS	Open Archival Information System
OAIster	Open Access union catalogue
OECD	The Organisation for Economic Co-operation and Development
OPAC	Online public access catalogue
OpenDOAR	Directory of Open Access Repositories
RIMS	Research information management system
ROAR	Registry of Open Access Repositories
ROI	Return on investment
SARIS	The South African Research Information Services
SEALS	South East Academic Library System
SERVQUAL	Scale for assessing customer quality perceptions
UNESCO	United Nations Educational, Scientific and Cultural Organisation
URN	Uniform resource name

GLOSSARY

A list of definitions is given to describe key concepts. Although these are not the only definitions applicable or used for this study, it forms a conceptual framework. These definitions will be further explored and unpacked in later chapters. For the purpose of this study the key concepts will be seen as follows:

Term	Definition
Content management	Content management is the set of processes and technologies that support the creation, dissemination and use of content (Mutula: 2005). Maier (2007:274) sees content management as the control of electronic documents through their life cycle from initial creation to archiving. This includes creation, storage, organisation, transmission, retrieval, manipulation, update and withdrawal
Digital scholarship	Building digital collections of information with appropriate tools and generating new intellectual products can be described as digital scholarship. Digital scholarship is a networked, scholarly or academic environment extensively integrated with digital and IT technologies in teaching and research (Mutula, 2010). For the purpose of this study digital scholarship will be seen as research output housed in digital collections.
Information ethics	Ethics has to do with the ability to distinguish between moral right and wrong (Ocholla, 2008). Ethics must be part of the environment where information content is generated and stored. Information ethics is thus the set of standards that will result in trust in the product, by the users and contributors.

<p>Information management (IM)</p>	<p>Information management is the process of facilitating use and exchange of information (Tihamiyu & Aina, 2008). Du Plessis (2004) states that both knowledge management and information management are concerned with the handling, directing, governing, controlling, coordinating, planning and organizing of all information and knowledge processes of an organization as well as its delivered products.</p>
<p>Institutional repositories (IRs)</p>	<p>Institutional repositories are the digitisation as the availability, accessibility and irretrievability of documents in digitised format (Lor, 2005). Drijfhout (2006) describes Institutional repositories as: an organization which is overall committed to the stewardship of digital information resources. Sulemann (2007) sees institutional repositories: as digital libraries run by educational/research institutions to archive documents owned/produced locally.</p>
<p>Knowledge management (KM)</p>	<p>Knowledge management is the process of identifying, documenting, organizing, storing and sharing knowledge. Tihamiyu and Aina (2008) describe Knowledge management as the process of identifying, documenting, organizing, storing and sharing knowledge. Pinho, Rego and Cunha (2012) cites Claver- Cortes <i>et al.</i> who defines knowledge management as a set of policies and a cause of action to create knowledge in an organisation. This definition includes the transfer of knowledge, the users as well as how the knowledge will be applied</p>

	to innovate for long term competitive edge for the organisation.
Open Access (OA)	Open access refers to the free and unrestricted access on the World Wide Web to digital scholarship with no prerequisite of payment for access. The source of software is freely available for inspection, unlike proprietary (Chaffey & Wood: 2005).
Sustainability	Sustainability refers to the cost to value ratio of a product or service in an organization. Chengalur-Smith <i>et al.</i> (2010) define sustainability as the ability of a system to survive and profit over time, both economically as well as environmentally. Sustainability pertaining to digital collections and services is defined by Rieger (2011) as being the ability to secure access to all resources needed to protect, maintain, develop and increase the value to a product's content and service have for the user there of. In short it is the ability to sustain longevity and usability. Anbu (2007) adds to this definition that sustainability must include long term preservation and curation of content and services.
Sustainable Knowledge Management	De Oliveira and Rodrigues (2010: 806) sees the foundation of sustainable knowledge management as being a trichotomy of economy, society and environment, and calls it the sustainability triad.

LIST OF WEBSITES

	Full Name	Responsibility	URL
DATAD	Database of African Theses and Dissertations	Association of African Universities	http://www.aau.org/page/database-african-theses-and-dissertations-datad
NDLTD	The Networked Digital Library of Theses and Dissertations	Board of Directors	http://www.ndltd.org/
OpenDOAR	The Directory of Open Access Repositories	University of Nottingham	http://www.opendoar.org/
ROAR	Registry of Open Access Repositories	University of Southampton	http://roar.eprints.org/
Ranking Web of Universities	Ranking Web of Universities	CSIC	http://www.webometrics.info/en
Ranking Web of Repositories	Ranking Web of Repositories	CSIC	http://repositories.webometrics.info/

ABSTRACT

Universities and higher education institutions (HEIs) are knowledge intensive environments. Research and scholarship created here are institutional knowledge capital and must be managed as assets to give the institution a competitive edge in research and academic stature. The status and prestige of HEIs depend on the quality, visibility and accessibility of their research. As such, knowledge capital must be managed as assets that will ensure return on investment (ROI).

Scholarship availed in dissertations, theses, proceedings and publications form part of the institutional knowledge capital. Digitised institutional repositories (IRs) are the preferred method of showcasing scholarship on the internet, adding to the HEI's web visibility. IRs developed over the past twenty years to become sophisticated networked digital research collections.

Research intensive universities and institutions reap benefits from showcasing scholarship digitally in well-developed IRs, as well as in peer reviewed academic journals. HEIs with well-developed and maintained IRs rank consistently higher on webometrics ranking sites. All HEI sectors have not benefited equally from IR developments, and many African HEIs still do not perform according to world trends observed on ranking sites and directories.

Globally, recent research indicates that valuable research output originates from both public and private HEIs, but scholarships are often not archived and curated sustainably in all cases. Despite rapid growth and developments in digital scholarship curation some private and public HEIs are lagging behind. Private HEIs in Southern Africa are still not visible and readily accessible on the web. Southern African private HEIs rank significantly lower than comparative public HEIs. Poor scholarship curation and lack of research visibility deter HEIs from taking their rightful place in higher education and higher education research communities. Where research collections are not managed sustainably as knowledge capital, full ROI will not be possible.

Recently IR research changed focus, from an initial information management (IM) and information technology (IT) approach, when questions around the role of the human element in the process of scholarship curation came to the fore. Knowledge management (KM) principles such as scholarship as knowledge capital, the value of research and scholarship became topics of recent research. Although HEI are generally slow in implementing KM, the value of KM as an institutional strategy is increasingly being realised by global trendsetting HEIs.

The sustainability of IRs poses challenges in HEIs where the research culture is still not fully developed and the importance of sustainable scholarship collections not yet realised. Here, the benefits and value of research for the HEI cannot be optimised. Research curation is often not supported by the HEI's research strategies, policies, archiving and curation procedures.

This study aimed to investigate digital scholarship curation trends in a purposefully selected target group of private and public HEIs in Southern Africa. Target groups were selected from the Ranking Web of Universities. The identified target groups were from Namibia, South Africa, Botswana, Lesotho, Swaziland and Zimbabwe. This mixed method study investigated digital scholarship curation trends in a purposefully selected target group of private and public HEIs in Southern Africa. Trends in the target group are compared with global IR trends, to identify potential sustainability risk factors. Empirical research data is triangulated with webometric content analysis to derive at solutions and best practices to ensure sustainable scholarship curation in IRs. A socio-technical model towards sustainable scholarship curation is offered, to identify the IR sustainability domain.

This study offers a comprehensive definition of the sustainability domain for scholarship curation. It comprises a list of sustainability threats that must be avoided, and that should be seen as risk indicators present on a governance, infrastructural, and institutional cultural level.

Chapter 1: Introduction and background

1.1 Introduction and conceptual setting

Universities and higher education institutions (HEIs) are knowledge intensive environments. Research and scholarship created here are institutional knowledge capital and must be managed as assets, giving the institution a competitive edge in research and stature. As such knowledge capital must be managed in a way that will ensure return on investment (ROI).

Digital scholarship such as dissertations, theses, proceedings and publications form part of the knowledge capital created in HEIs. Digital scholarship is a networked, scholarly or academic environment extensively integrated with digital and IT in teaching and research (Mutula, 2011). These forms of scholarship are increasingly archived in digital collections and databases, such as institutional and research repositories (IRs) (Drijfhout, 2006; Mutula, 2008; Suleman, 2007). Dearborn, Barton and Harmeyer (2014: 15) posit that research data sharing increases collaboration, interdisciplinary innovation and new solutions to problems. Ideally, digital scholarship should be shared in an open access (OA) environment to maximise impact. The curation of digital scholarship refers to the management, archiving and preservation of digital data over the lifecycle of the data (Yakel, 2007: 335).

The digital curation of scholarship must add value to existing knowledge and assist in creating new knowledge. Both private and public HEIs depend on research and scholarship to earn their increased impact, visibility, presence, excellence and funding, which give them an advantage over their competitors. HEIs are ranked according to their success and standing in the academic community. Indicators of success are used to compare institutions and publish rankings in webometrics websites such as Ranking Web of Universities.

Sustainability of digital collections and services, such as IR, are defined by Rieger (2011) as being the ability to secure access to all resources needed to protect, maintain, develop and increase the value to a product's content and the service they have for the user there of. In short it is the ability to reach longevity, develop and grow consistently and ensure effective usability. Anbu (2007) adds to this definition by stating that sustainability must include long term preservation and curation of content and services in the IR context of the definition. Sustainability is thus seen as surpassing mere successful implementation and content management of an IR. Sustainability in IR and digital scholarship curation require a sociotechnical approach, where decision makers must realise value and align technical and financial operations in support of scholarship curation (Rieger, 2011). IR must expand and develop to answer to the environmental (academic) and socio-cultural (research cultural) needs of the HEI.

The sustainability of IRs poses challenges in institutions where the value of knowledge capital is not realised. Knowledge capital in the form of scholarship must be purposefully and strategically supported by policies, processes and strategies on a high level of management. In some southern African HEIs, especially private HEI, sharing data in OA is slow. This trend reflects in analysis of web ranking statistics, where indications are that private HEIs rank significantly lower than the average public HEIs (Ranking Web of Universities, 2015, 2016).

It could be argued that private HEIs are not as research intensive as traditional and mostly public HEIs, however this trend is changing rapidly. Deacon, Van Vuuren and Augustyn (2014: 32) indicate that private HEIs in South Africa are actively doing research and they are producing important research output and scholarship. More specifically in post-graduate fields of business, commerce and management, where scholarship is currently not visible on the web. Their findings are in line with trends reported by Thuraisingam, Hukam Parvinder, David & Nair (2014) in Malaysian private HEIs.

1.2 Contextual setting

Southern African HEI are publically funded, as well as private, profit driven HEIs. Higher Education Acts generally regulate both public and private HEIs. Quality assurance agencies work toward accrediting HEI programmes. The research done in HEIs needs to be managed, and research output as scholarship, requires both archiving and curation. Research collections are mostly archived in research repositories.

There are 35 IRs in southern Africa registered on OpenDOAR (OpenDOAR, 2016). Public HEIs have most of the IRs in southern Africa. Private HEIs in southern Africa with international ties, such as Monash, are linked to international IRs. Monash also rank higher on the web rankings than any other private university in southern Africa (Ranking Web of Universities).

1.3 Statement of the main problem

Web analysis and recent research results indicate that valuable research output is done in both public and private HEIs in southern Africa. Traditional research institutions reap benefits from showcasing scholarship digitally in well-developed IRs, as well as in peer reviewed academic journals. These HEIs rank consistently high on webometrics ranking sites. Whereas, the research done in some comprehensive- and universities of technology, as well as most private HEIs in southern Africa do not have the benefits of web visibility and the HEI rank significantly lower. The main problem of this study is to investigate how the management of digital scholarship is taking place, and why there currently is a lack of research visibility, ranking and why access to research is restricted. There may be problems and gaps in the curation of digital scholarship. Lack of visibility deters private HEIs and less research intensive public HEIs from taking their rightful place in higher education and higher education research.

This study will explore how the application of IM and KM principles should be applied to ensure sustainable curation of digital scholarship, which in turn will reverse the current state of affairs of low ranking institutions and poor visibility and access to scholarship. The study sets out to explore common challenges in a selection of lower ranking public and private HEIs by asking the following questions:

- What is the profile of the size, visibility, level and content of scholarship produced in the target population?
- What are the challenges preventing HEIs to implement strategies for sustainable scholarship creation?
- Do decision makers in the target population fully understand processes of digital scholarship curation?
- What are the similarities and differences in knowledge creation, curation and access between public HEIs and private HEIs the target group?
- Do participants in the target group understand the socio-technical inter-relationships required for success and sustainability of digital scholarship curation?
- By creating a best practice working model, it is hoped that an awareness can be created for the value of OA repositories, where scholarship curation should take place, especially in the private sector, where it is lacking. Special emphasis will be given to developing a sustainability model for digital scholarship curation in OA IRs.

1.3.1 Sub-problems

The most important sub-problems that will be addressed in the research are:

- What is the nature of data, information and knowledge in digital scholarship and digital scholarship curation in the target population group?
- What are the perceived value and benefits that digital scholarship hold?

- How do IM, IM and KM strategies, content management and digital curation support sustainability of an IR?
- On which level are IM and KM policies and strategies, if at all present, available and are there policies and best practices in place to manage scholarship curation?
- What are the critical factors for successful curation of scholarship and how is IR performance measured?
- Can indicators for sustainability be identified in the current practices of digital scholarship curation?

1.4 Aims and objectives of the study

The aim of this study is to develop a best practice model for sustainable digital scholarship curation in research repositories for private and public HEIs.

1.5 Research aims and objectives

The aim is achieved through the following objectives:

- To investigate current levels of scholarship production and curation practices and strategies;
- To investigate the challenges and factors prohibiting establishing research repositories for digital scholarship curation;
- To draw comparisons between public HEIs and private HEIs in digital scholarship creation, sustainable management and successful curation;
- To develop a best practice model, identify a sustainability domain towards curation of scholarship created in HEIs.

1.6 Significance of the study

Preliminary investigations and a review of recent research, indicate that there is a problem in digital scholarship curation created by scholars in private HEIs and smaller public HEIs in particular. This leaves a gap in the research knowledge base. The study aims to investigate factors preventing HEIs in the target group to

avail their scholarship to a broader community. It sets out to create an awareness and an understanding of the nature of digital scholarship curation, and the potential benefits it holds for the HEI, as well as the scholar. This study will offer solutions and introduce models to support and enhance the sustainable curation of knowledge produced in the form of digital scholarship.

1.7 Delimitation of the field of study

The main focus of this study is to investigate reasons for low visibility and low ranking trends observed in digital scholarship collections in a purposefully selected group of public and private HEIs in southern Africa. Discussions will be limited to the application of IM and KM principles within a sustainability triad for digital scholarship curation of IRs.

1.8 Research methodology

1.8.1 Research Method

The research makes use of both qualitative and quantitative research methods. In the pre-study webometric analysis was used to identify a suitable target population. The methodology will take place as follows:

- Literature review

A literature review of leading research published in peer-reviewed research articles covering aspects of the research topic will be compiled to conceptualise the significance of the research problem. Recent research findings around the socio-technical aspects of IR and digital scholarship curation will be studied.

- Empirical survey questionnaires

An empirical survey questionnaire gathered data on the current level of scholarship creation and curation in the target group.

- Statistical analysis, content analysis and webometric analysis

The profiles of the target group were analysed according to their visibility and performance on web directories and web ranking sites.

1.8.2 Target population

The data on the 2015 and 2016 Ranking Web of Universities was used to identify public and private HEIs ranking below the top ten southern African institutions. Only institutions doing post-graduate studies and who are producing research in the in the form of dissertations, theses, conference proceedings and research articles, were selected. The selection criteria are thus purposefully non-random.

1.8.3 Instruments

Instruments used during data collection were empirical survey questionnaires, web analysis and content analysis of selected web directories.

1.8.4 Data collection

Questionnaires were sent to IR managers and administrators to investigate long term IR operations, growth and sustainability factors influencing digital scholarship curation. A group of public and private HEIs, who are currently producing and curating post-graduate digital scholarship, was observed to ascertain current practises.

1.8.5 Data presentation and analysis

Data is presented in comparative tables, graphs and diagrams, as well as in a narrative form. Analysis will be done manually. Both qualitative and quantitative data analysis techniques will be used.

1.8.6 Ethical consideration

Ethical conduct was observed throughout the study. Any participation in surveys will be strictly voluntary and participants will be fully informed about the objectives of the research. The consent of the respective governing bodies will be obtained in writing.

1.8.7 Structure of the thesis

- Chapter 1: Introduction and background:

Chapter one explains the main research problem and sub-problems. It explains the delimitation of the study. It gives the significance of the study, and briefly explains the selection of the target population. It explains shortly which research method, and which instruments will be used and how data will be gathered and analysed.

- Chapter 2: An overview of digital scholarship curation in open access research repositories:

Chapter two gives an overview of the nature of digital scholarship curation in southern African HEIs. Key terminology, such as digital IRs and sustainability, among other definitions, are explained in context of this study. The development IRs for digital scholarship curation over the past ten to twenty years is discussed. Trends in recent research, as well as challenges in implementing IRs are evaluated. The role of openness and OA is described and the IM and technical aspects of these will be further unpacked in following chapters.

- Chapter 3: Data, information and IM in digital scholarship curation:

Chapter three builds on chapter two, by elaborating on aspects of IM in digital scholarship curation. In chapter three definitions of data will be discussed. Different types of data encountered in digital scholarship curation are explored. Additional aspects influencing the longevity and viability of IRs, such as content management, will be unpacked. The paradox between IM and KM, and the question on why KM plays a cardinal role in IR sustainability will be posited.

- Chapter 4: KM for sustainable digital scholarship curation:

The status quo of KM in HEIs is discussed in chapter four. The role that sociotechnical aspects play in digital scholarship curation is discussed. Global trends in IR are explored. The nature of OA, its influence on IR worldwide, as

well as the value and importance of operating an IR in the open access environment were explored.

- Chapter 5: Theoretical framework:

Chapter five gives an overview of the theoretical frameworks used in library and information science (LIS) research in general, and then explore the different approaches to IR research by studying a number of recent studies which will inform and support the chosen framework for this study. Triangulation frameworks are discussed. Frameworks such as STINT, used in previous studies, will be evaluated. A suitable framework for this study is offered in chapter five.

- Chapter 6: Research methodology and data collection:

Chapter six looks at the research design and methodology followed in this study. A triangulated methodology will be used with webometric analysis, empirical survey questionnaires and content analysis on an IR directory.

- Chapter 7: Presentation of research findings and data analysis:

Sixteen private and public HEIs will be purposefully selected from a web ranking site for their web visibility, post-graduate qualification programmes and their scholarship production. The level KM at the HEI will be researched. KM for sustainable scholarship curation in IRs will be investigated.

- Chapter 8: Summary: Discussion of empirical findings:

Chapter eight summarises the data gathered from empirical survey questionnaires, in order to identify trends in OA scholarship curation in the target group. Trends observed in the target group will be compared with global

trends. Based on the literature review and the survey results, a sustainability domain for OA IRs will be identified and described. Risk factors impacting on the sustainability of digital scholarship curation in OA IRs will be tabled. A sociotechnical model for sustainable IR will be offered. Areas of further research, which emerged during the study will be shared.

1.9 Summary

This chapter gives an overview of the research. The context and aim of the study is explained. Main research problems and sub-problems are stated. Terminology key to the study is explained.

The study addresses a topic that has yet to be researched in depth for IRs in Africa. Successful implementation of IRs has been a popular research topic, but sustainability in southern African HEIs has not yet been researched. Scholarship curation in private HEIs requires more empirical research to offer solution in harnessing valuable research output. Chapter two gives an overview of scholarship, and how digital scholarship are curated in OA IRs. Definitions of key concepts are supplied in Chapter two in order to conceptualise aspects of the study.

Chapter 2: An overview of digital curation of scholarship in open access institutional research repositories

2. 1 Introduction

Digitised institutional repositories databases (IRs) developed rapidly over the past years in most HEIs in the developed world (Smith, Barton, Bass & Branschosky, 2003). These databases were designed to manage, store and give access to an institution's research and digital scholarship, in an organised and widely accessible database.

Parallel to these developments, OA initiatives (OAls), such as the 2003 Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities and The Budapest Open Access Initiative (BOAI) of 2002 emerged and gave momentum to the rapid developments in global IR field. Most IRs subscribe, or aspire to the principles of openness and OA. These databases need to be managed by a multi-disciplinary team, and indications are that the well-established IRs such as the University of Pretoria's UPSpace are operated by multi-disciplinary teams, including the IR managers in libraries, research centers and ICT departments who jointly take responsibility for the planning, implementing and managing of these databases (Olivier, 2007).

Globally, the IR databases have been very successful in improving access to scholarly communication and research output produced at HEIs, as well as research organisations such as The Council for Scientific and Industrial Research (CSIR) in South Africa (Anbu, 2007; Mutula, 2008).

In Europe, the Western world, as well as a number of Eastern developing countries, IRs developed from hard copy research collections in libraries and electronic collections of dissertations and theses (ETDs) (Kuchma & Rosenblum, 2010:3). Previously, scholarship communications and research were housed in departmental collections or ETDs were housed in print copy collections in libraries. Access to information was restricted and limited. The main problem with these closed collections

was that awareness of the availability of this research was minimal. Valuable research information was untapped and undiscovered.

Earlier, researchers such as Mutula (2008), Chisenga (1999) and others have investigated reasons why some IRs do not progress as well as were expected. Looking at the IR rankings of some of the public HEIs, as well as private HEIs on Ranking Web of Repositories in 2015, questions around the sustainability of these scholarly communication collections in IRs are surfacing. A decade ago researchers such as Chisenga (1999) already raised concerns about depriving communities from the completed research and results created at their institutions. It is said that especially African HEIs' research and education are deprived of access to research output done in Africa for Africa. Research output is published globally, often in expensive subscription journals, but that it is not readily accessible to these institutions, mostly due to technical, political and financial constraints (Chisenga, 1999). Since then there has been a gradual growth in African and southern African IRs (OpenDOAR, 2015, 2016). Globally, there are 3090 IRs registered on OpenDOAR, and 119 of these are on the African continent (OpenDOAR, 2016).

Following the concerns of early researchers, subsequent studies by Rieger (2008, 2011), and Kuchma and Rosenblum (2010) looked at how digitally curated research collections could better serve their research communities. The impact of IM and KM principles and practices were widely researched. Management of an IR database requires the application of the elements of IM, KM and the management of information technology (IT). The epistemology of IM and KM will be discussed in greater detail in chapters five and six.

Chapter two gives an overview of the nature of digital scholarship curation in (OA) IRs. Sub-problems of the main research questions around challenges and benefits of availing digital scholarship in IRs will be discussed:

- How did IRs developed, and what is the nature of digital scholarship curation in IRs?
- What is the nature of data, information and knowledge in digital scholarship and digital scholarship curation in the target population group?
- What is sustainability in digital scholarship curation?
- What are the critical success factors in implementing an IR?

The benefits of a well-managed IR in an OA environment will be discussed as aspects that may lead to improved sustainability of the IR. Additionally, key terms and concepts to the study will be defined and discussed. These definitions will look at openness and OA, the nature of scholarship, digital scholarship, content management, curation, and sustainability in IRs.

2.2 Digital scholarship, digital curation and aspects of sustainability

Planning, implementing, and then managing information, knowledge and information technology in an IR project require a dedicated team of knowledgeable members as well as a strategy for implementation, maintenance and development. IR projects cannot develop in isolation and should support the aims and objectives of the organisation or institution as a whole. During their lifecycle they must constantly display academic integrity and ethics to ensure a trusted and sustainable body of knowledge.

An IR project leader or manager would firstly require a thorough understanding of all the relevant elements of IM, KM and IT. Furthermore the IR project manager needs to know what, where and how many of these data sources need to be included. Information and knowledge audits will be required to ascertain extent of projects. Information audits form part of IM and KM processes.

Du Plessis (2004: 34) states that both KM and IM are concerned with the handling, directing, governing, controlling, coordinating, planning and organising of all information and knowledge processes of an organisation as well as its delivered products. This implies that information and data needs to be managed in an integrated, systematical and strategic planned process in order to become useful and deliver results.

Although the four pillars of KM, namely leadership, organisation, technology and learning form the core of the KM, IR management and scholarship curation in IRs are interwoven in several other processes and variables such as global digital trends, sociotechnical and sociopolitical processes. It is clear that IM of IRs is a complex, multi-faceted, multi-dimensional and continued process.

Once an IR is successfully implemented, content management and maintenance of systems, information and data and open source software, adds a further and cardinal dimension to the sustainable IM of the IR. In an IR database this data and information will be research output and digital scholarship, in other words it will form the content of the database.

2.2.1 Digital scholarship

Scholarship produced at HEIs is not found only in IRs, but IRs play a cardinal role in the managing and curation of scholarship in digital formats and collections. Building digital collections of trustworthy information with the application of appropriate tools, and generating new intellectual products can be described as digital scholarship. Digital scholarship is a networked, scholarly or academic environment extensively integrated with digital and IT technologies in teaching and research (Mutula, 2011: 8). For the purpose of this study digital scholarship will be seen as research output housed, availed, developed, curated and maintained in open access digital collections. It can be argued that digital scholarship in IRs forms the foundation of knowledge capital found in HEI.

2.2.2 Digital curation

According to Ball (2010: 7), curation is a relatively new concept in IR management. Ball defines digital curation by stating that digital curation in IRs must be seen and understood together with terms of preservation and archiving. In essence digital curation is seen as those deliberate actions leading to maintaining and adding value to a trusted body of digital information for current and future use. Curation refers to all aspects of managing data over a lifecycle of digital scholarship to further research.

2.2.3 Sustainability

The assumption cannot be made that successfully implemented IRs will survive and prosper over time. Sustainability and success in IRs do not necessarily explain the same scenario. They are interrelated aspects and requirements of an IR and need further clarification.

A number of researchers such as Westell (2006), Kuchma and Rosenbloom (2010) and others looked at the success of IRs, but not many evaluate and explore longer term viability, survival and sustainability of an IR.

Sustainability refers to the cost to value ratio of a product or service in an organisation. Chengalur-Smith, Sidorova and Daniel (2010: 660) define sustainability as the ability of a system, product or service to survive and profit over time, both economically as well as environmentally. Sustainability pertaining to digital collections and services, such as IR, is defined by Rieger (2011) as being the ability to secure access to all resources needed to protect, maintain, develop and increase the value to a product's content and service have for the user there of. In short it is the ability to reach longevity, develop consistently and ensure effective usability. Anbu (2007: 3) adds to this definition that sustainability must include long term preservation and curation of content and services. Sustainability is thus seen as surpassing successful implementation of an IR.

Rieger (2011) indicated that there are more aspects of IR that have not fully been covered in research done so far and has shown that IRs research needed to take a broader approach than database planning, implementation and administration. She is one of only a few researchers who looked at sustainability of an IR and who differentiated between success of an IR and sustainability of an IR.

Westell's (2006) critical success factors are valuable in the planning and implementation of an IR, however, once implemented, effective KM of an IR must ensure sustainability. Indicators for sustainability must be identified to ensure long term growth and development. Factors such as viability, relevancy, trust and quality need to be explored. A sustainability domain must be identified where the interrelated roles of all stakeholders, processes can come together.

2.3. The development and nature of institutional repositories (IRs)

IRs are digitised scholarship databases and were designed to manage, store and give access to an institution's own research and digital scholarship in an organized and sustainable way. Different types of IR databases exist and may include multi discipline databases or subject specific databases. Institutions that currently have IR databases include universities, research institutions as well as industries.

Much of the research in the IR field so far, concentrated mostly on IM, focusing on systems, software and technology. However, effective planning, implementing and managing an IR, and then growing sustainably require more than just technological knowledge and insights. The organisational culture and human elements in social groups may be far more important for sustainable development as was previously afforded in research.

2.3.1 Definitions of IR

The definitions of IR databases are explained by researchers such as Lor (2005), Mutula (2008) and others. Further definitions by Mutula (2008: 4) describe IM as the process of facilitating the exchange and use of information is useful. It can be interpreted in context by looking at definitions of KM and information technology management.

In defining IRs, Lor (2005) focuses on the term digitisation and he posits it implies the availability, accessibility and irretrievability of digitised documents. In *Digital repositories: Helping universities and colleges* (2005) it is stated that a repository supports mechanisms for import, export, identify, store and retrieve digital assets. These definitions focus mainly on the processes involved and access to IRs, while Drijfhout (2006) has a broader approach and describes IR as an organisation which is overall committed to the stewardship of digital information resources. Sulemann (2007) has a more traditional definition and sees institutional repositories as digital libraries run by an educational or research institution to archive documents owned and produced in house.

The South African Research Information Services (SARIS) report of 2008 states that defining IR becomes problematic when there are so many different types of IRs with overlapping services and communities, however the common thread remains collecting and making access possible to the content in an open access environment (Van Deventer & Pienaar, 2008:14).

IR should in short be seen as a collection of research output with a common link to a particular institution. For the purpose of this study IR should not be seen as the same as a subject repository or a funder repository. Lynch (2003) sums up all the arguments by stating: “A university-based institutional repository is a set of services that a university offers to the members of its community for the management and dissemination of digital materials created by the institution and its community members.”

A well-managed IR offers great advantages by providing a coherent and coordinated approach for capturing, identifying, storing and retrieving digitised research managed effectively (Mutula, 2008).

Benefits derived by HEIs from making available their intellectual, educational and research assets by way of institutional repositories includes enhanced utilisation of research, improved learning experiences and teaching methods, the introduction of different learning styles, and the publication and dissemination of publicly funded research results (Forster, Bankier, & Wiley, 2008).

The majority of IR in the world use open source software like DSpace, Fedora and others (Van Deventer & Pienaar, 2008:). IRs make use of metadata harvester such as OAH protocols to enhance their access in the open access arena (OpenDOAR, 2016). Additional costs of registering persistent identifiers or lack of metadata standards compliance could be a reason why smaller and lower ranking IRs struggle to compete. It may also be that government or organisational policies and funding are too restrictive. To be part of the information society's information highway, open access to research should be a priority.

2.3.2 Critical success factors in implementing an IR

Previous research (Christian, 2008; Kuchma and Rosenblum, 2010; Wells, 2009; Westell, 2006) researched the information and technological aspects of IR implementation. Technical management, IM and KM processes play important and interrelated roles in establishing, managing and developing of an IR effectively over time.

Terra and Angeloni (2002) warn that concentrating only on one aspect, that of IM principles, and not considering the broader KM elements which would include human elements will lead to a lack of insight of how people, in this case researchers, share, codify, create and validate information and knowledge. This statement is ratified by Westell's (2006) identification of eight critical success factors which include attitudes,

marketing among others, as well as the technical and systems elements such as open access and software.

Westell (2006) identified eight success factors for a successful IR project which are:

- getting a mandate from decision makers for the IR project;
- integration of the project with the rest of institutional planning;
- funding model, relationship with digitisation centers;
- interoperability with open access initiatives;
- measurement of use and growth, promotion and marketing of the project to create awareness;
- a strategy to support preservation;
- Westell's model does not address measures to look at research ethics and quality of scholarship.

Amongst other success factors, interoperability and open access to digitised research in IRs have been identified as a requirement for an effective IR (Westell, 2006).

Developments and initiatives to promote access to research in the open access environment resulted in the creation of a number of treaties and agreements such as The Bethesda Open Access Statement (BOAI) in 2001, The Berlin Declaration of 2003 and others. From here onwards, IR development expanded and these new initiatives spear headed the rapid developments and improvement of access to research information in IRs in open access.

Although most IRs start off by housing only electronic dissertations and theses, information in IRs may also include self-archived articles, pre-prints, post prints in digitised format, data sets and the information is collectively referred to as open scholarship. Mutula (2008) states that IRs are potentially an enabling factor for many forms of digital scholarship communication.

2.3.3 IR Trends

Researchers, governments, HEIs and research institutions throughout the world started to understand the benefits of improved access and open access to research. Closed ETDs started to develop and evolve into open access IRs freely accessible on the worldwide web.

IRs in United States of America, Canada, Europe and Australia gradually became more developed, relevant and networked. The following forums and networks were among some that developed to give guidance, support and momentum to IR services:

- The DARE project in the Netherlands, as well as the DRIVER program (Digital Repository Infrastructure Vision for European Research) started as early as 1999 to work on open access protocols and standards to share research as widely as possible (Van Deventer and Pienaar, 2008);
- In 2002 the Commonwealth Department of Education, Science and Training (DEST) called for financial assistance to start IRs in Australian HEIs (Genoni, 2004);
- The Organisation for Economic Co-operation and Development (OECD), a forum of democratic governments, compiled guidelines in 2004 to enhance access to research done with public funding (Organisation for Economic Co-operation and Development, 2007);
- In 2003 in Canada, the Canadian Association of Research Libraries (CARL), realised that the rising costs of journals subscriptions is restricting access to research, and establishing OA IRs were seen as an important strategy to enhance access to research (Shearer, 2006).

The trend was to make use of the more cost effective open source software such as DSpace or EPrints instead of expensive proprietary software.

The value of OA was communicated and encouraged and soon became the norm in IRs. The awareness of the importance of OA research is growing and gradually more institutions worldwide, and in southern Africa, joined OA initiatives and movements by signing treaties and advocating OA. Recently, The University of the Free State and Stellenbosch University signed the Berlin Declaration (Berlin Declaration, 2016). Hereby displaying the top management support of the institution and committing their institutions to promote the use of OA publishing and archiving routes for improved access to research and to be an example to the rest of the research communities.

The same progress and rapid growth of IRs did not take place in the greater Africa and the continent is still not on par with Europe, the United States of America, Canada and the rest of the developing world in providing OA to research in IRs (Christian, 2008; Ford, 2005). African IR managers are also slow in participating in initiatives such as interest groups, where support and guidance are readily available to improve visibility and interoperability. Examples of these are low patronage of The Networked Digital Library of Theses and Dissertations (NDLTD), Registry of Open Access Repositories (ROAR) and OpenDOAR. In Table 2.1 only 4% of African IRs participate and register on OpenDOAR compared to 22.2% in Asia. (See Table 2.1).

Table 2.1 Comparative table of IRs per geographic area on OpenDOAR, (openDOAR.org, 2015)

Geographical Areas	Total IRs per area registered with openDOAR	Per centage per area of global total
Europe	1058	43.6
North America	423	17.7

Asia	538	22.2
South America	208	8.6
Australasia	59	2.4
Africa	116	4
Caribbean	14	0.6

From 2008 to 2015 African IRs grew with approximately 2.5 %. Van Wyk (2015: 64) reports the current distributions of the 2424 repositories globally.

2.3.4 Challenges in IR implementation

Researchers such as Mutula (2008), Anbu (2007) and others have identified a number of reasons for the lack of progress, of which lack of internet infrastructure is paramount.

The following challenges are reported amongst reasons for lack of progress by authors (Ford, 2005, and Mutula, 2008).

- Lack of knowledge of IR projects;
- Lack of technical support;
- Lack of funding;
- Inefficient project planning and management;
- Lack of networking and industry support;
- Lack of connectivity;
- Nonexistence of institutional strategies and policies;
- Resistance to sharing of information;
- Lack of open access visibility of existing IRs;
- Abandoning of IR projects.

Visibility and accessibility could be challenging for some of the less research intensive universities, such as private HEIs. Nyambi (2011:1) reports that there are thirteen HEIs in Zimbabwe. Of these, only seven have IRs, but only one is visible in the open access environment. OpenDOAR statistics (2015) show that only 4% of IRs in the world is situated in Africa. Nyambi (2011: 2) laments that the impression is created that there is only a few IRs in Zimbabwe, because of low visibility. Reports such as those of Anbu (2007) and Nyambi (2011) raise questions about the success and sustainability of recent attempts to establish IRs in southern Africa. Lor (2005) says that digitisation projects, organisations and initiatives in the rest of Africa are often limited to smaller projects such as The Database of African Theses and Dissertations (DATAD) and African Online Digital Library (AODL).

2.3.5 IR Benefits

Researchers agree that despite challenges of planning and implementing IRs, the advantages they offer make their presence and services imperative to HEIs. Mutula (2008) and Olivier (2007) acknowledge the potential benefits of managing research output, as well as other digital scholarship, in an IR. Ford (2005) outlines benefits of IRs as:

- Increased citation impact and sophisticated searching;
- Accelerated research and enhancement of education;
- Improved visibility and exposure of researchers and authors;
- Increased utilisation of scholarship;
- Support for teaching and learning.

Even though IRs on the African continent grew to 62 during 2015 and 119 by 2016, (OpenDOAR, 2015, 2016), southern African scholars are still not optimally benefitting from research done on the continent. The whole of Africa still has less than 5% of the global total of IRs (OpenDOAR, 2015, 2016). For this reason, a

number of projects was started to develop and enhance access to digital research information in Africa.

In many cases these organisations and projects were funded by HEIs and cooperatives from the developed world. These include International Network of Availability of Scientific Publications (INASP), The Data Base for African Dissertations and Theses, (DATAD), The Database for Electronic Theses and Dissertations (ETD). The Association of African Universities is responsible for DATAD. Participating countries include Nigeria, Ghana and Zimbabwe. These initiatives provide frameworks, standards, and in many cases also funding.

Most of these organisations and projects offer guidelines in the form of membership, manuals, committees and frameworks. The DATAD platform (tool kits and manuals to assist universities and researchers to make their research more accessible. The NDLTD has, as one of its mission statements, the bridging of gaps for global access to dissertation and theses (NDLTD, 2016).

The first developments towards electronic submission, storage and dissemination of theses and dissertations in Southern Africa date back to the early 1990s (Lor, 2005), followed by the establishment of the South African Research Information Services (SARIS) Project which aimed at providing a framework for e-research services to all South Africans researchers (Van Deventer & Pienaar, 2008).

This was followed by similar developments at the University of Pretoria in 2000. The UPSpace project, as it was known, concentrated mainly on archiving theses and dissertations at that time (Olivier, 2007). In 2006 the University of Pretoria expanded their sources to the Africana collection, digital learning objects as well as Arts and Culture objects and also digitised historical and archival materials donated to the university (University of Pretoria: Institutional Toolbox: 2008). The

Council for Scientific Research and Industrial Research (CSIR), though not a university, but a major research institute with a wealth of research documentation available, also forms part of the development of South African institutional repositories (Van Deventer & Pienaar, 2008).

Initial trends show that the IRs in southern African public HEIs proved to develop and survive better than many in private HEI research collections. The reasons for the better performance need to be explored in more depth during this study.

2.3.6 Content management and IR

The content archived in IRs must follow content management principles. Content management is the set of processes and technologies that support the creation, dissemination and use of content (Mutula, 2008). Maier (2007: 274) sees content management as the control of electronic documents throughout their life cycle from initial creation to archiving. This includes creation, storage, organisation, transmission, retrieval, manipulation, update and withdrawal. In IR the curation of content in different formats over time, is a part of content management and has a direct influence on sustainability of the IR. In curating scholarship in IR, the local content in research has a special value. Vosloo (2005: 24) cites Balantyne where he refers to local content as content produced either locally or adopted from external sources and assimilated into the knowledge base. The process of content management in IR will be discussed in greater detail in chapter three.

2.4 Openness, open access and the accessibility of scholarship

OA refers to the accessibility of digitised resources that are available without payment requirements, paid subscription or authorisations on the Internet. Smith *et al.* (2003) sees OA as the free, immediate, permanent, full text, online to digital research information. OA information has fewer copy right and licensing restrictions than pay for publish subscription options (Smith *et al.*, 2003). OA and publishing research in the open environment developed as a counter measure for closed access to expensive

and restrictive paid subscriptions, which benefited publishers more than it promoted research and researchers per se (Waaiker, 2007). The development and emergence of new technologies coupled with the need of researchers to avail access to their intellectual- and research output freely, ultimately realized the advent of open access initiative (OAI) (Smith *et al.* , 2003).

Traditional or subscription based publishers were initially of the opinion that only emerging and second rate researchers would publish in the OA environment of the World Wide Web (WWW) and the internet (Waaiker, 2007). Waaiker refers to various programmes, declarations and initiatives, including the Cream of Science project, headed by Professor Ostrom in Netherland, which proved this initial skepticism wrong.

OA digital repositories can be accessed through the World Wide Web and is responsible for a higher citation rate and impact for researchers (Mutula, 2008).

Oppenheim (2008) refers to the two types of OA namely the gold route and the green route. The green route refers to articles that are published in journals as well as making them available in the open access environment and the gold road refers to publishing in open access journals route. IRs and self-archiving will resort under the green route where costs are significantly lower. The perception is created that the green route is free, however there are standard costs that cannot be avoided.

Information and knowledge technologies are only completely freely available to those who can connect to the digital infrastructure and the Internet (Mutula, 2008). Mutula (2008) laments the fact that African HEIs perform poorly in global web rankings, because researchers publish in low impact journals with no or limited internet links. He states that 80% of African HEIs suffer from no or poor internet connection (Mutula, 2008).

2.4.1 Open access initiatives (OAI): an overview

Several OAIs have been established. These initiatives mainly promote free and unrestricted access by encouraging authors and right holders of information to avail these in the open access terrain of the internet (Mossink, 2006). OAIs serve as a watchdog to maintain standards, assisting with software development and metadata creation and open access publishing (Mossink, 2006)

The Berlin Declaration was drafted to promote the Internet as a functional instrument for a global scientific knowledge base and human reflection and to specify measures which research policy makers, research institutions, funding agencies, libraries, archives and museums need to consider (Berlin Declaration, Open Access: Max-Planck-Gesellschaft, 2016). The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities was drafted in English on 22 October 2003. Since then it has been translated in many languages including Arabic and Chinese (Berlin Declaration, Open Access: Max-Planck-Gesellschaft, 2016). It was drafted in accordance with the spirit of the Declaration of the Budapest Open Access Initiative (BOAI), the ECHO Charter and the Bethesda Statement on Open Access Publishing.

The Berlin Declaration currently boasts 562 signatories (Berlin Declaration, Open Access: Max-Planck-Gesellschaft, 2016). Perusing the lists reveals that only a handful of southern African HEIs support the initiative and actively support availing scholarship in OA. The declaration urges HEIs and research institutions to support OA to scholarly communication and to:

- Increase the support for and interoperability of OA repositories for scholarly communication and research output;
- To actively endeavor publishing scholarship without signing away copyright, be restricted by paid research journals;
- Improving the ability to re-use works;
- Develop and support new and innovative OA publishing models;

- Strive for the highest possible scholarly standards;
- Invest into a publication infrastructure optimised for the needs of research and scholarship;
- Cooperate for an open scholarly publishing system, including access to scholarly source and cultural heritage data (Berlin Declaration, Open Access: Max-Planck-Gesellschaft, 2016).

Although these initiatives originated in the West and in some Eastern countries, it is a step forward in combatting the digital divide experienced throughout the African continent. It appears however that despite these enhancements the African continent is slow to become part of the global research community (Ford, 2005; Nyambi, 2011).

A national research and development strategy was published in 2002 in South Africa, inviting input from all stakeholders concerned with the challenges posed by increasing economic growth and the improvement of the quality of life for all South Africans. This resulted in the establishment of the South African Research Information Services (SARIS). The impetus for the development of individual OA research repositories for southern Africa was formed (Van Deventer & Pienaar, 2008).

2.4.1.1 Open access and digital scholarship

Digital scholarship is a networked, scholarly or academic environment extensively integrated with digital and IT technologies in teaching and research (Mutula, 2011). The development of ICTs and the internet have revolutionised the research process in making the process electronically. Information seeking behaviour has changed dramatically and both primary and additional resources used in research are increasingly accessed electronically. Digital scholarship is wholly dependent on the Internet. Mutula (2008) states that digital scholarship is enhanced by the Library 2.0 concept. Search engines, online public access catalogues (OPACs), discovery services and digitisation projects have enabled researchers and users of information to access a multitude of information sources at one single search point. In 2005 Lor

reported that digitisation projects on the African continent are limited to a handful of specialised digital collections. Such an example is the African Online Digital Library (AODL). AODL was a joint project between the Michigan State University and the African Presidential Archives and Research Centre (Lor, 2005). In Southern Africa the Digital Imaging Project of South Africa (DISA) was established in 1997 (Lor, 2005). African Journals Online (AJOL) is another example of a relative successful online initiative (Muswelanto, Van Der Merwe & Van Deventer, 2009).

2.5 Southern African IRs and digital scholarship today

Most HEIs in the developed world have fully incorporated and adapted to e-learning and digital scholarship. In the whole of Africa only five libraries rank in the top 500 in the world (Mutula, 2009). Lack of access to information and technology has a profound negative effect on the African digital scholarship. Mutula (2009) warns that southern African HEIs who neglect to deploy e-learning and e-research in their institution, do it at their own peril. Collaborative research cannot take place without digital scholarship curation.

It should also be noted that many African HEIs seem to be unable to start projects without the assistance of a partner or funding from the developed world. Examples are the DATAD and AJOL (Lor, 2005). Among the developing countries, India, Brazil and South Africa were able to establish a significant number of sustainable IRs (OpenDOAR, 2015). Shearer (2006) reports that The Canadian Association of Research Libraries (CARL) started their IR project in 27 HEI libraries in Canada, with the aim to act as watch dog over the progress and development of IRs in Canada. The same progressive actions and national efforts are still not seen in Africa. Africa seems to be unable to initiate projects such as CARL in Canada (Conway, 2008). African HEIs need to develop their own e-strategies to provide the framework needed to establish digital repositories, and so doing create a mandate for African digital scholarship. Without the virtual research environment in an institution the digital data curation cannot take place.

2.6 Summary

Chapter two gave an introduction and definition to concepts of OA and IR. The advent of OAs, such as the Berlin Declaration and BOAI were addressed. Challenges and benefits of OA IRs were highlighted. The importance of local content in research output was highlighted.

Other relevant concepts such as content management of IRs and the value research output, legal and ethical issues will form part of discussions in chapters to follow.

Taking all the concepts and definitions discussed into account, IM and KM of open access digitised institutional repositories for the purpose of this study is seen as the planned, multi-disciplinary and cooperative process of managing and availing local research and research related data to all potential users on the world wide web by following an officially approved strategy.

It is very important that the decision to embark on an IR project is approved and monitored by a statutory body of HEIs such as a library committee, research committee or Senate. If the IR project forms part of the broader institutional planning it will add a great deal to the success of the project. It is always better to register the IR project as a research project through the institution's research committee. Many IR's were started with initial funding from their research support structures.

For the purpose of this study the evaluation of IRs in the southern African context must not only look at IM, which will include the technological aspects of information, but must also explore variables in the wider field of KM, in order to ascertain what makes an IR survive over time and be viable and sustainable.

In chapter three IM in IRs will be discussed. Aspects of data, metadata, content management, the digital curation life cycle and information strategies pertaining to IR and IR management will be addressed.

Chapter 3: Data, information and information management in digital scholarship curation

3.1 Introduction

Chapter two gives an overview of historical developments of digital scholarship curation in IR. The value and importance of operating an IR in the OA environment were explored.

Chapter three builds on this information and elaborates further on how IM, in general and as it applies to the scholarship curation in IRs, can contribute to the success, sustainability, viability and development of scholarship curation in IR.

In this chapter sub-problems around the nature of data and information in IR will be explored and discussed. Definitions for data as applies to this study will be addressed. Key terms in IR and scholarship curation, such as metadata, research data and datasets, are explained. KM and KM strategies will be discussed in chapter four, but KM will briefly be referred to here to illustrate the relationship between data, IM and KM in the context of this study. Therefore the KM triad: data, information and knowledge will be discussed in this chapter.

Different types of data such as metadata used in the process of scholarship curation, challenge the narrow definitions of data, as well as the traditional hierarchical view of data, information and knowledge. The relationships between data, information and knowledge in research scholarship and the research scholarship curation are complex and interwoven processes, which necessitates a different approach from the hierarchical KM views. Sub-problems are:

- What is the nature of data, information and knowledge in the context of research data and research scholarship curation?
- What do concepts such as metadata, research data, and datasets mean in terms of scholarship curation in IRs?

- What is IM, IT, content management and digital curation in IR?
- What are the indicators for successful curation of scholarship?

3.2 The relationship between data, information and knowledge

Early research presented by Zeleny (1987), Ackoff (1989) and others addressed the hierarchical relationship of data, information and knowledge (Hey, 2004). Different researchers refer to this relationship as the KM triad, the DIK (data, information, knowledge) discourse or the DIKW (data, information, knowledge and wisdom) relationship. Liew (2007) says that despite the many attempts to describe the relationship between data, information and knowledge they are still incomplete and relationships varies from discipline to discipline.

The study by Girard & Girard (2015:1) confirms this statement and refers to over 100 different definitions which include concepts of data, information and knowledge used in definitions of KM. They looked at definitions of KM over the last 30 years in inter alia disciplines such as development, education, information science, science and technology.

Looking at the existing definitions of data, information and knowledge, it is clear that basic elements are described, but the deeper and applied meaning varies greatly from discipline to discipline (Girard & Girard, 2015). Data is best understood when seen as part of a continuum of understanding as described by the model (*figure. 3.1* below).

Figure. 3.1 The continuum of understanding: A DIKW hierarchy(Clark, 2004 in Hey, 2004),

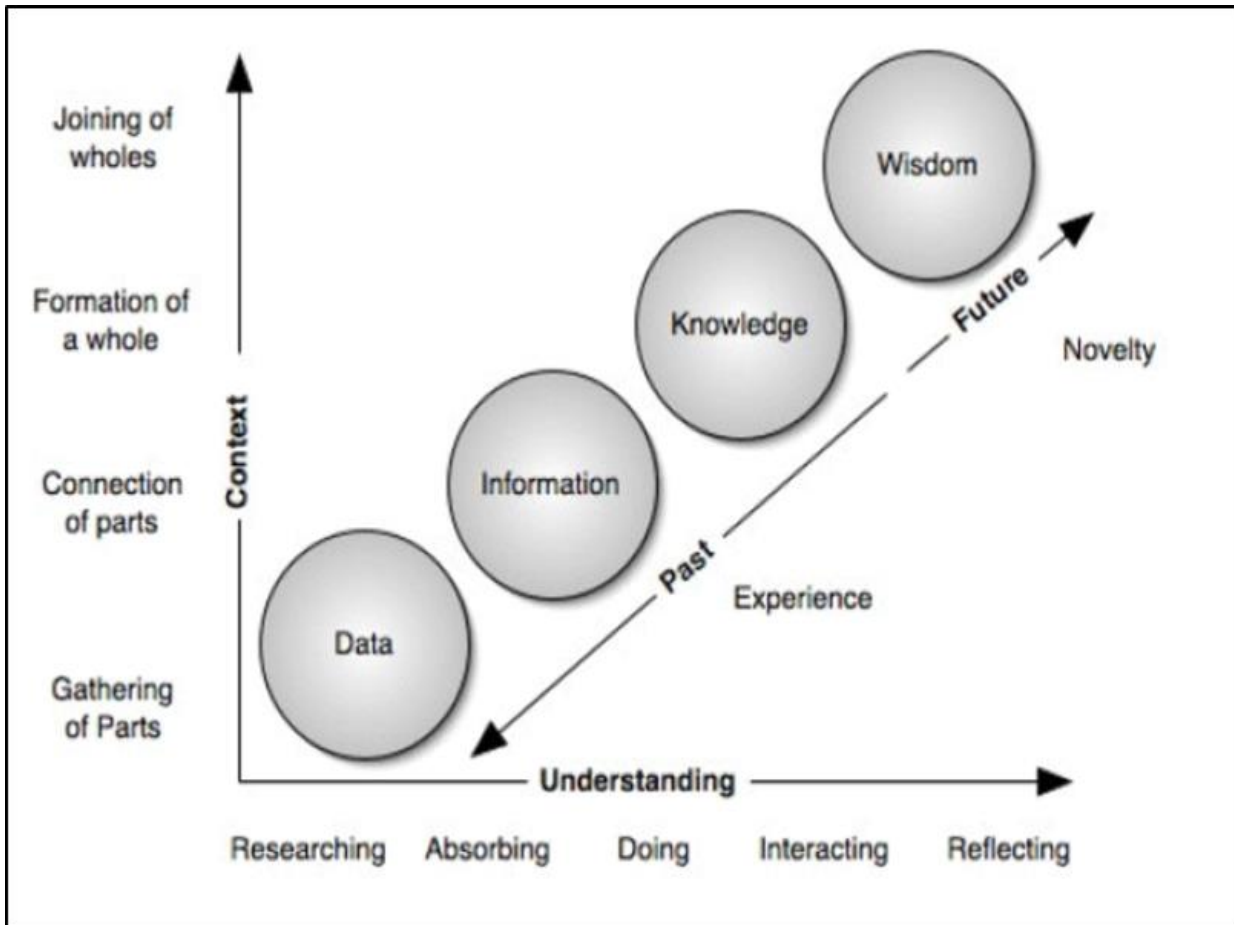


Table 3.1 Clark’s DIKW model: “Continuum of understanding” (Adapted from Hey, 2004).

- **Data** originates from research, creation, gathering, and discovery processes.
- **Information** - Data turned into information by organising it so that we can draw conclusions and derive meaning. Information has context. Data is also turned into information by "presenting" it, such as making it visual or auditory.

- **Knowledge** has the complexity of experience, which come about by seeing it from different perspectives. Knowledge is built from scratch through experience. Information is static, but knowledge is dynamic.
- **Wisdom** is the ultimate level of understanding. As with knowledge, wisdom operates within us. We can share our experiences that create the building blocks for wisdom, however, it need to be communicated with even more understanding of the personal contexts of our audience than with knowledge sharing.

Clark's model explains a linear process, and although most useful for the IR environment, requires further explanation to describe the different layers and types of data and information that ultimately lead to wisdom via sustainable digital scholarship curation.

3.3 Data in IR

“Data is a set of discrete, objective facts about events. In an organizational context, data is more usefully described as structured records of transactions” (Davenport & Prusak, 1998). Jifa (2013: 713) cites Bellinger, Castro and Mills who describe data as symbols. They state that raw data has no significant meaning on its own. April and Izadi (2004: 3) prefer the definition given by Davenport and Prusak, which states that data can be seen as a set of objective facts.

Various types of data are present in the different phases of the digital scholarship lifecycle:

- Metadata is used for access, use and reuse of scholarship in IR
- Research data is used for validation of research findings as well as preservation for later use
- Data standards and descriptors, such as Dublin Core, are used for preservation and interoperability of scholarship in IR.

The question is whether data in IR, such as research data, datasets and metadata used in IR can be seen as data in the sense of the original definitions of data? The curation of research data deals with raw data and datasets. Generally, data is seen as building blocks for information. Information has meaning when it has context. When data starts to create meaning through various trends and patterns it becomes information.

Higgins (2008: 137) opines that data in the digital curation process can be any data in binary digital form. It may also include digital objects. Digital objects are items in digital format and may include files, images along with the metadata that describes these objects. This is seen as simple digital objects, whereas complex digital objects can be a combination of several digital objects such as websites (Higgins, 2008: 137). One could argue that the lines between data and information, as seen in IRs, can at times become difficult to distinguish. It is not uncommon for IR managers to use the terms data and information interchangeably, although this may not be theoretically correct.

3.3.1 Research data and datasets

IRs store and archive digital scholarship such as research tools, research data and datasets. The research data spectrum according to the definition of The University of Leicester (2012) are: raw data, research ready data, published output data, and published output datasets. Research data covers a range of data including spreadsheets, images, test responses, algorithms, transcripts and questionnaires. Research data and datasets are important building blocks of scholarship in IR and in research it is used to validate findings. Research data is collected, observed or created to enable analysis thereof and which will in time become original research results. Research data can be qualitative or quantitative of nature. It may present in different formats such as print, digital or physical format.

Chiwere and Mathe (2015: 1) observe that research funding agencies are increasingly insisting on preserving research datasets and research data in IRs to make it available

for further use and research. Data citation becomes the means in which data is aligned with the scholarly communication. In data citation reference is made to the data or dataset where data properties are described to enable rediscovery, re-use and validation of data used in scholarship. As with the actual information in the IR, the data and dataset are also described with a set of metadata descriptors.

3.3.1.1 Data centers and data repositories

A new trend to develop infrastructure to preserve and archive research data is fast becoming the norm at research institutions and research funding organisations, as funders want to see ROI. Where research repositories are curating research and scholarly output, more and more data centres are developing strategies and implementation plans to house research data and original datasets (Baegrie, Chruszcz & Lavoie, 2008: 3).

Castelli, Manghi and Thanos (2013: 2) explain the phases in the research and publishing process: -

- Scientific research produces raw data
- Data is analysed and produces secondary data
- The secondary data is refined, evaluated to produce information for scholarly communication
- The scholarly communication is archived in IRs while the datasets is housed in data centres.

The relationship between the IR and the data centre is depicted in the model by Castelli, Manghi and Thanos (2013: 3) in *Figure 3.2*.

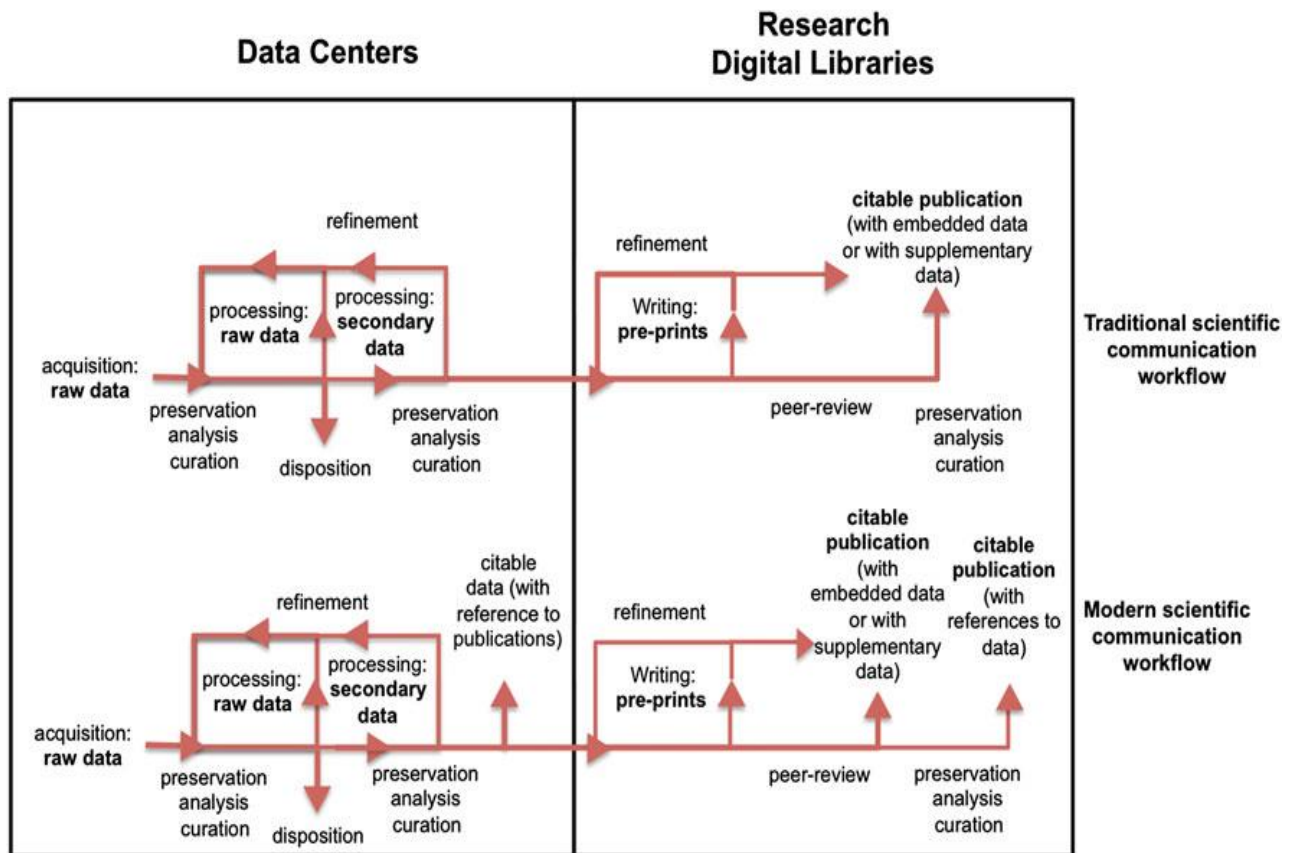


Figure. 3.2 Changes in scholarly communication processes (Castelli, Manghi & Thanos, 2013: 3)

3.3.2 Metadata and metadata standards in IR

Metadata is documentation for datasets, or data about data. Metadata uses formal syntax and is attached to data to enable future use of the data. Metadata plays an important role in preservation of digital scholarship. Systems curating data must keep additional information or data about the original data or object to enable effective management and retrieval over time irrespective of changing technologies.

3.3.2.1 Metadata initiatives

Day (2003: 5) states that the sustainability of IRs hinges on the availability and quality of their metadata. He posits that digitisation of scholarship could be expensive and requires metadata to support the long term management of, inter alia, digital

scholarship. Ball (2010: 28) alludes to the importance of metadata and metadata standards in digital scholarship repositories. Digital curation and preservation of scholarship in IR require metadata strategies to decide which metadata should be captured and maintained to achieve the best preservation standards.

The Reference Model for an Open Archival Information System (OAIS) (ISO 14721:2003) acts both as a functional and information model. Functionally it guides and outlines the functions needed in IR pertaining to access, administration, storage, intake and data management as well as preservation planning in digital curation (Day, 2003). This describes the data, object or digital object fully.

Many of the IRs use Dublin Core standards as metadata standard (OpenDOAR, 2016). It is a set of terms that acts as descriptors for the web formation. The Dublin Core Application Profiles creates an understanding of digital records according to content. Its application profiles are metadata schemas consisting of data elements drawn from namespaces, added to implementers (Higgins, 2008). The Open Archives Initiative (OAI-PMH) requires that data, or objects be described by the 15 elements of the Dublin Core Metadata Element Set (See Table 3.2).

Table 3.2 Dublin Core metadata sets (ISO 15836, 2006), Higgins, (2008).

<ul style="list-style-type: none">• Title – the formal name of the resource• Creator – the author• Subject – the topic or subject heading of a controlled classification scheme• Description – describing the content structure of the record e.g. table of content, abstract etc.• Publisher – the body or HEI making the record available and who has the right to do so.

- Contributor – person or institution contributing to the content of the record
- Date - the original date of creation
- Type – the genre of the record
- Format - the format or media type of the record
- Identifier – the unambiguous reference to the record
- Source – where did the record originate
- Language – the language of the source
- Relation – referring to related sources
- Coverage – geographical scope of the resource content
- Rights – copyright and intellectual property rights (ISO 15836, 2006)

Most IR software platforms, such as DSpace and EPrints open source software, have metadata as part of their workflow process when records are uploaded to the repository.

3.4. IM development in IR

The importance of information has been evident since the use of clay tablets in Mesopotamia 40 000BC, through to the inception of the internet in 1991 and beyond. Maier (2007) reflects on how IM developed from early says of database administration to the stage where researchers such as Du Plessis (2004) view IM and KM as interrelated concepts and processes. Maier (2007) explains further how isolated applications for data developed into KM. He summarises as follows:

- In the mid 70's technical data integration took place as database administration. In the 80's data standardization led to data administration.

- In the late 80's data management became separate responsibilities in organisations.
- These processes led to the origins of IM in the 90's in the form of document management, data warehousing and enterprise resource planning.
- In the early 90's information was viewed as an organisational resource and was managed as an asset. At this stage it was referred to as information resource management.

3.4.1 Definitions of IM

Definitions of IM are formed around the concept of data, while KM definitions focus more on the human element of total belief systems and values (Rieger, 2011; Terra & Angeloni, 2002). IM is more recognizable in an organization such as HEIs, and therefore easier to organise. Relevant research will be analysed and referenced to explore recent research to determine current trends, globally.

Today, IM is viewed from within particular schools of thought such as the information technology school. Chaffey and Wood (2005) state that the information technology school of thought corresponds with the IM school of thought as both follow information-led and technology-led approaches to IM. In contrast to this, the behaviour- and control schools of thought see the management of staff behaviour as a necessity for effective IM, adding the human component. Chaffey and White (2011: 6) stress that information was increasingly valued as 'capital' in both business and HEIs. Research output and scholarship forms the knowledge capital of HEIs, but are not always valued and managed accordingly. It stands to reason that this value can be created by marketing and managing knowledge capital in appropriate ways, such as curating research data, scholarship and datasets in institutionally owned and managed databases of which IRs are one example.

Issues around different views on the relationship between IM in IR management are getting significant attention in recent IR research. IR management is no longer viewed as mere administration of research documents. Both IM, IS and KM principles form part of curation of scholarship in IR.

Du Plessis (2004: 35) refers to Boon's definition of IM and describes it as the process of managing resources such as media, manual or computerized, information systems (IS). It has to do with storage and manipulation of information as meaningful data. It includes the handling, directing, governing, controlling, coordinating, planning and organizing of information. Chaffey and White (2011: 3) refer to the recent trend to view both IM, IS and IT, coupled with the human element and appropriate skillsets, as adding value to an institutions' business activities and outcomes. There is agreement that managing information is more than merely focusing all institutional efforts on technology alone. However, in many HEIs this is not yet the case, as in many institutions' strategy, planning and funding concentrate on technology maintenance and development rather than IM. This is erroneous as value is derived from better flow of information and not technology *per se* (Chaffey & White, 2011:3). IM happens around the management of information resources, technology resources as well as people resources can be made.

IM in IR databases includes aspects of the behaviour and control school, but in the early stages of IR development IM depended far more on the technology approach to IM (Rieger, 2011; Van Deventer & Pienaar, 2008). IM in IR can be described as the process of facilitating (open) access to research data initially, and later facilitating more digital scholarship information in HEI as a support to the core function of teaching, learning and research, and more specifically to research output as a result of teaching and learning.

3. 5 IT in IR

During the past sixteen years IRs endeavoured to make use of open source software, offering flexible platforms to IR developers to manage and house their research

collections at marginal costs. According to OpenDOAR (2016) DSpace is still the most popular open source software in use globally with 43.6% of IRs, whilst EPrints stands at 13.7% globally. The open source software Digital Commons is relatively new, but is winning ground fast as it offers many new capabilities such as publishing and peer review functions. It stands at 4.8% of global repositories using it as their preferred IR software. In the beginning these applications were locally installed and managed by the institution. Due to maintenance challenges of software systems hosted by the HEI itself, more and more HEIs and research institutions opted for hosted solutions such as DURACloud for DSpace. Preservation strategies and practices in IR must be able to keep up with technological developments and changes. It has to be able to outlive current systems by being able to migrate data to newer systems and not lose data integrity.

The 2014 UNESCO Institutional Repository Software Comparison Report (2014: 3), indicates significant developments in five major software solutions resulting in richer feature sets and capabilities. Most of the software packages now have hosted solutions as an available option, adding greatly to sustainable development and management of the IR software. The UNESCO Report (2014: 4) supplies invaluable information comparing available IR open source software in terms of 11 criteria:

- Infrastructure – installation, hosting and customer support
- Front-end design – allowing institutional branding
- Content management – how the software support content and access control
- Content discovery – tools and functionality enhancing research discovery
- Publication tools – allow editorial workflows for better quality
- Reporting - providing valuable information and reports to monitor performance
- Handling multi-media – capabilities of storing images, video and streaming in greater depth

- Discoverability and search engine optimization – have tools to follow, share and bookmark scholarship in the IR.
- Interoperability – integration with discovery services and researcher profiles
- Authentication – regulating login credentials
- Accessibility – allowing access as wide as possible
- Preservation – how IR content is preserved to be accessible over time.

The main objective of IR is to make research available as soon as possible, and not wait for lengthy publishing delays. The content discovery capability of IR software is one of the most important criteria. Table 3.3 presents a comparison between the five most used open source software platforms DSpace, EPrints, Digital Commons, Fedora and Islandora.

Table 3.3 Content Discovery of Five Popular Open Source IR Software (UNESCO, 2014: 4).

Content Discovery Comparison Between Five OS Platforms					
	Digital Commons	D Space	E prints	Fedora	Islandora
Integrated search engine	Yes	Yes	Yes	Yes	Yes
Advanced search with Facets	Yes	Yes	-	Yes	Yes
Full text search indexing	Yes	Yes	Yes	Yes	Yes

Browse options	Discipline, community, publication year, document type, author, and institution	Communities & collections, publication date, author, title, subject, and document type	Department, subject, year	Collections and search facets	Collections and search facets
Graphical navigation of content	Image, Icon, Geolocation, and discipline wheel navigation	Add-on services available	Image	-	Image and icon
Geolocation	Yes: integration with google maps	-	Yes: google maps export	-	Add-on services available
Search engine optimization	Yes	Limited	Yes	-	Add-on services available
Indexed in Google scholar	Yes	Yes	Yes	-	Add-on services available
DOI and persistent URLs	Yes: persistent URL and DOI	Yes: handle system	Yes: DOI	Yes: persistent identifiers	Yes: persistent identifiers
Citation export	Yes; Zotero, endnote, and Refworks	Yes: COinS support	Yes, BibTex, rotor, Endnote and additional	Yes: COinS support	Yes: COinS support

			bibliography managers		
Link resolver integration	Yes	Yes	Yes	Yes	Add-on services available

Most of these systems allow for integrated searches, browsing options, link resolvers and full text indexing making the scholarly research widely available and accessible.

3.5.1 Interoperability and IR

Hakimjavady and Masrek (2013: 34) discuss interoperability models for exchanging data between different systems, describe it as exchanging data among different IR systems involving metadata protocols and standards, such as open archive initiative protocol for metadata harvesting or OAI-PMH. According to Day (2003) interoperability of IR content hinges on three axes namely:

- Managing the capture and re-use of existing metadata in IR;
- Managing metadata standards;
- The transfer of metadata to other services and IR via harvesters.

IR systems must be able to provide access to scholarship via different search engines by adhering to interoperability requirements such as persistent naming and metadata harvesting protocols.

3.5.2 Formats

Digital scholarship curation systems (IRs) must be able to handle various digital file formats such as TIF, PDF, images, as well as streaming media. When deciding and

choosing preferred formats into submission policies of IR the ease of migrating these formats must be preempted. Technical specifications must be agreed on.

3.5.3 Digital scholarship curation for improved access to scholarship

A key objective of curating scholarship in IRs is to ensure long term accessibility regardless of technology changes, even where and when systems and software may become obsolete. Persistent naming and digital object identifiers (DOI) serve to make this possible. Unique and persistent reference identifiers must be assigned to each digital record according to standards and systems (Crow, 2002). The CNRI Handle System allows for this by providing and managing persistent identifiers called handles. These include an open set of protocols, a namespace and implementation protocols. As this information could be changed when to reflect a new environment or location. These handles may be used as Uniform Resource Names or URNs.

3.5.4 IR integration with institutional research operations and systems

IRs are part of the research environment of an institution and this relationship needs constant re-engineering to ensure relevancy. Improving the viability and usefulness of IRs by creating linkages with researcher pages or integrating with other research systems contributes to the sustainability of IR. Russell and Day (2010) say that at present research information systems and IRs are two separate entities, but they do form part of the same information infrastructure in higher education institutions, addressing different institutional needs.

IR content and metadata aspire to make research available by using open access protocols such as Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) and other aggregator services (Russell & Day, 2010). IR could be potentially be able to handle a wider field of grey literature, such as technical reports. But research IM systems (RIMS) are increasingly used by HEIs to administrate and manage the total research process. RIMS potentially manages research holistically from funding stage through to completion of the research. RIMS has the capability to link up and

interface with other institutional programs and systems such as finance systems. The National Academic Research and Collaboration Information System (NARCIS) in the Netherlands is one example of a project to link repositories with a RIMS (Russell & Day, 2010). NARCIS gives access to information to all Dutch HEIs IRs. In southern Africa these developments are still in its infancy and more research is required.

3.6 IM for IR sustainability

With a better understanding of the unique IM elements in IR, trends in IR strategy development can be explored. Currently there are a number of IM frameworks providing guidelines for creating a strategy towards better and cost-effective management of institutional information. The Hawley Committee Guidelines and Elizabeth Orna's Guidelines both provide models and actions that form the basis of developing an information strategy (Chaffey & Wood: 2005). Both sets of guidelines are useful and can be adapted and applied in creating an information management strategy to manage an IR database. Informed by these models the following adaptation is offered to form the first step towards creating a strategy for managing information in an IR database and are summarised as:

- Identify relevant data to include in the database by conducting an audit;
- Assemble, record and store data in the form of metadata on system;
- Decide on and assign roles responsibility;
- Plan information flow and accessibility of resources;
- Put measures in place to control and secure information quality;
- Plan networking;
- Identify IT support;
- Consider cost and value;

- Indicate IRs contribution to main goal and objective (Chaffy & Wood, 2005).

3.7 Content management

Early IR research and IR implementation projects focused on content management. Han (2004: 356) refers to the definition of Boiko describing content management as the process of collecting, managing and publishing content. Content management requires a content management system. In short a digital content management system is a software system catering for the preservation, organisation, and dissemination of digital scholarship collections (Han, 2004: 355). Genoni (2004: 302) posits that in managing content in IR, one should also borrow from best practices from other library collection development and management principles, as well as replicating quality standards as applied in traditional scholarly publishing such as the peer review process. There seems to be no consensus on who would be responsible for monitoring these quality standards. Genoni (2004: 304) proposes the following broad guidelines which add to quality in content management:

- Select IR content in relation to the priorities of the users by avoiding duplication of content found in other departmental or institutional archives
- Describe and define priorities in policy, procedure and relation to existing collections
- Continuously evaluate content performance
- Decisions relating to access, still supporting OA but managing versions, formats and rights
- Management of conservation and preservation.

3.7.1 The digital curation process and lifecycle

Researchers (Angevaere, 2009; Ball, 2010; & Higgins, 2008) warn that digital collections developed rapidly, but curation of these objects and collections are often neglected. The management of an IR will determine the sustainability and will impact either positively or negatively on the performance of the IR in terms of growth, longevity and performance on data base monitoring sites such as Ranking Web Repositories. Generally the focus in IR was on improving dissemination of digital scholarship and wider impact of research (Ball, 2010). As such, The Digital Curation Centre of the University of Bath (DCC), broadly defines digital curation as “... maintaining and adding value to a trusted body of digital information for current and future use” (Ball, 2010). Anbu (2007) proposes that curation tasks should be incorporated into the life cycle of IR content. However, digital curation cannot be defined in isolation, as archiving and preservation form an integral part of this process and life cycle. Ball (2010) sees digital curation as the management of data from creation, constant maintenance for current as well as re-use.

Ball (2010:5) mentions that IRs were not initially tasked with preservation responsibilities, but as the content of repositories evolved to include more aspects of scholarship than just being a temporary storage until papers or research were officially published in mainstream publishing, this function became increasingly important.

Digital curation and preservation need to be planned and managed with great care. Higgins (2008) stresses the importance of managing the lifecycle of digital scholarship to ensure consistence and continuity. See *Figure 3.4*, where the digital life cycle is illustrated. With data central to the process, the model graphically explains the dynamics and flow of the elements of the curation process.

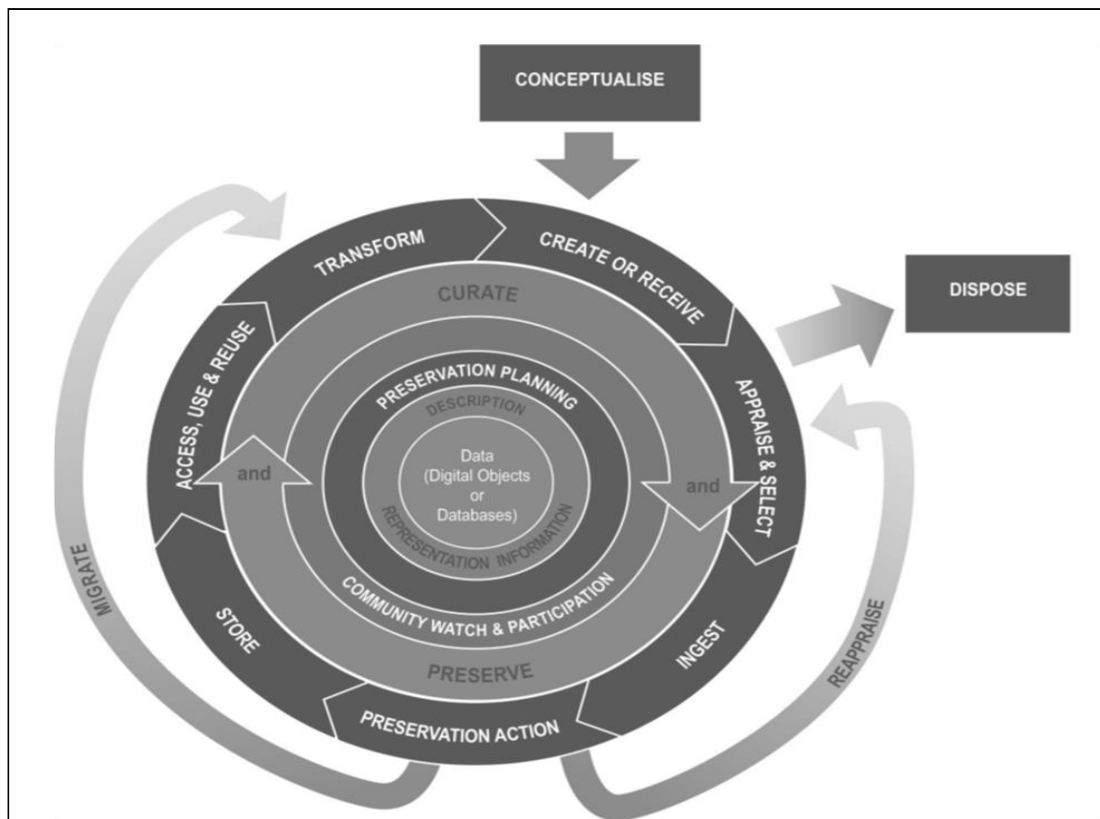


Figure 3. 4 The Digital Curation Centre lifecycle model (Ball, 2010: 6)

With digital objects such as digital scholarship, at center stage to this lifecycle this model explains how the curation activities take place.

Three pivotal activities around digital scholarship curation are (Ball, 2010):

- Curation: managing content for retrieval, re-discovery and re-use over time;
- Archiving: archiving is part of curation activities, ensuring effective storage ensuring data integrity and security for retrieval and re-use;
- Preservation: ensuring maintenance and re-discovery anticipating technological changes that may hamper later access to data.

3.8 IM, IR indicators of success and measuring IR performance

Establishing an IR constitutes a long term commitments and investment by all levels in HEI. Performance of IR must be monitored. Lagzian, Abrizah and Wee (2015) report that repository managers based in library and information service departments are largely responsible for the successful planning and implementation of IR. When IR developments started over a decade ago, research concentrated on the critical success factors that will ensure successful implementation of IR.

Westell (2006) coined the eight elements or processes required for successful implementation. In Table 3.4 these indicators for successful implementation of IRs was tested on Canadian IRs in universities taking part in the Canadian Association of Research Libraries (CARL) during 2005. (See Table 3.4).

Table 3. 4 Westell's eight indicators of IR success, (Westell, 2006).

Mandate	The purpose of the IR must be clearly defined and must not be too wide as it will not be sustainable. Institutional need must determine mandate and growth strategy.
Integration into institutional planning	IRs must align with HEI research strategy
Funding models	Funding models must surpass the implementation or start-up funding
Relationship with digitisation centers	Where a HEI has an central digitisation facility to manage formats, metadata and digital rights management, the IR will

	benefit from a working relationship with the center
Interoperability	Having an IR accessible on the web by means of OA protocols and harvesters such as OAI-PMH lend the IR towards openness to scholarship
Measurement	Input, output, usage and citation of digital records and monitoring these statistics will form a benchmark to underline the importance and success of the IR.
Promotion	The value of the IR must constantly be re-affirmed in the HEI to be a pivotal part of the research environment.
Preservation strategy	Long term preservation strategies must keep up with changing technologies to ensure access in perpetuity.

Table 3.4 illustrates these critical success factors. IR managers constantly need to revisit and strategize along these lines to ensure long term sustainability. Westell's research on critical success factors is widely used by repositories globally.

Lagzian, Abrizah and Wee (2015) used Westell's indicator for success and researched over 359 IRs to ascertain what the perceived importance and understanding of actual success indicators are. A survey was sent to over 359 IRs worldwide. Their study identified that implementers do not fully understand the successful implementation factors, and implement IRs without taking into consideration of the consequences of not planning effectively. Lagzian Abrizah and Wee's study effectively identifies the gap

between the importance of successful implementation factors and their perceived importance.

3.8.1 Monitoring and measuring performance of IR

Once an IR has been implemented its performance, both in-house and ranked against global IR performance indicators, must be monitored by the IR manager. IR survival and viability requires not only commitment by the IR manager, but sustainability hinges on the perceived importance of the IR in scholarship communication, not only by potential contributors such as scholars and researchers in HEI, but also by strategic decision makers.

Directories, registries and ranking services such as Ranking Web repositories, OpenDOAR and Registry of open access repositories (ROAR) assist with the monitoring IR performance. OpenDOAR is a directory of academic OA repositories, hosted by the University of Nottingham from the Centre for Research Communications (CRC) funded by Jisc. Jisc is a HEI NGO for skills development in digital services (ROAR, OpenDOAR 2016). Ranking Web of Repositories is an initiative of The Cybermetrics Lab, a research group in Spain. They make use of quantitative analysis such as cybermetrics and webometrics on scholarly repositories. ROAR is hosted by the University of Southampton in the United Kingdom. It was established with funding from Jisc, and collates important information on growth of repositories using the open software EPrints (Registry of Open Access Repositories, 2016).

3.9 Summary

In chapter three the background information to IM and IM development were given to create context to the role that IM plays in all aspects of digital scholarship curation in IR. The sub-problems of the nature of data in IR were discussed, with special reference to metadata, research data and datasets in IR.

Different approaches to IM and IT management of IR were discussed. The particular form and type of data found in digital scholarship collections such as datasets and metadata was explained and the importance of metadata standards in an open access environment explained its relevance to IR interoperability, development and sustainability.

The process of content management was described, and it was mentioned that this marked the start of IR development, while further development to include the human element and value add to HEI is required in depth investigation. The digital curation process was discussed, which forms the building block to discussing sustainability aspects in the next chapter.

Critical success factors for IRs were discussed and a short overview of methods for measuring IR performance through OpenDOAR, ROAR and others using webometrics were given. The description of how cybermetrics and webometrics form part of the qualitative analysis of bibliometrics forms the background for the information on the chosen research methods that will be used in this study.

New trends and emerging practices of data centres, and their interaction with IR are evolving. There is a shift from traditional scholarly communication and research process to one where data and datasets need to be preserved for re-use. The inter-relations between IRs, data centres and RIMS in the research and scholarly communication process in HEIs would have to be studied and developed to prevent processes from developing in silos.

KM in IR in HEIs cannot divorce itself from IM. IM and KM are part of the same process, albeit distinct in nature and objectives. The challenge is to align these to processes to make IR sustainable, create ROI, and ultimately add to the sharing of research information. Chapter four will address the KM elements in IR and will look at sustainability in more detail. In chapter four the nature, role and function of a KM and KM systems in managing an IR will be discussed. The relation between KM in IR and sustainability will be clarified.

Chapter 4: Knowledge management for sustainable digital scholarship curation

4.1 Introduction

In chapter three IM development and IM in IR management of digital scholarship were explored. Content management of IR databases was discussed. The nature of data, research data and datasets in scholarship curation was explained. The digital curation lifecycle of digital scholarship was explained. The DIKW model explained how data, information and knowledge creates wisdom. In chapter four knowledge management for sustainable digital scholarship curation will be discussed.

The early research and development of digital scholarship curation in IRs focused mainly on IM, IT and content management aspects. Initially the implementation of IRs were handled as departmental and library digitisation projects. The main objectives of these projects were to find successful ways to plan and implement IRs for the purpose of archiving post graduate dissertations and theses, and to disseminate scholarship in OA and these trends were also reflected in early research.

As the field of IR study evolved and developed, researchers in the developed countries (Rieger, 2008 & 2011) and developing countries such as India and Japan (Kuchma & Rosenblum, 2010; Tian, Nakamori & Wierbicki, 2009;) embarked on further research, exploring KM in HEIs. The impact of the human element in social groups and organisations' research cultures were increasingly becoming subjects for further research. The interaction of the human elements and how these are influenced by the technical aspects became questions raised. As KM approaches developed and started to build on existing IM practices, concepts such as managing knowledge capital in HEIs and the competitive edge of research results became areas of interest for further research. New trends emerged that prompted researchers to look at issues around value and the value add of research; value systems; research culture and the level of trust in scholarship and research output. Issues around the role these concepts impacted on the way digital scholarship curation thrive or perish prompted new

research. Digital scholarship emanates not only from the well-funded, research intensive HEIs. Smaller HEIs and private HEIs have research output and scholarship to contribute to an existing body of knowledge (Deacon, Van Vuuren & Augustyn, 2014: 3).

Chapter four looks at global trends, signifying a transition and further development from a technology focus in research and scholarship curation to a sociotechnical approach. Authors such as Anbu (2007); Chisenga (1999); Mutula (2011) and Nyambi (2011) highlighted the need for African HEIs to add their research, rich in local content, to OA repositories and actively take part in OA initiatives and networks. This study aims to ascertain whether these global trends can be seen in southern African private and public HEI scholarship curation practices.

Chapter four looks at the concept of KM in sustainability, viability and development of scholarship curation in HEIs. The following sub-problems are addressed:

- What is the current level of KM and KM strategies in HEI?
- What is the nature of the sociotechnical approaches and sociotechnical systems in IR?
- What is the relationship between KM and IR sustainability?
- How is sustainability of IRs measured?
- What are value creation, ethics and trust in IR?

Both success indicators as well as factors impacting sustainability will be evaluated and compared in chapter four. The role of information ethics and trust in digital scholarship quality will be explored as part of sustainability indicators of IR. Discussing the background of KM will assist to understand how KM elements of value, knowledge capital, competitive edge, trust, ethics, culture and social groupings affect IR sustainability.

4.2 The IM - KM debate

Definitions of IM are formed around the concept of data while KM focuses more on the human element of total beliefs, culture, social groupings and values (Rieger, 2011; Terra & Angeloni, 2002). The need for IM is more recognisable in an organisation and therefore easier to organise. Terra and Angeloni (2002: 2) sees KM as: "... essentially limited to creating the right conditions for individuals to learn.... and apply their knowledge to the best of the benefit of the organisation". IM systems are process and technology centered, while KM systems are human centric. IRs are technology intensive and therefore Terra and Angeloni (2002) warn that developing technology intensive projects without taking the organisational situation into account, may be to the detriment to the success and longevity of such a project. There is a need for KM projects to be more value driven. Dogan, Henshaw and Ragsdell (2011) warn that there is a great risk of value loss where IM practices take place without incorporating and considering KM principles. IRs driven exclusively by IT, without taking due consideration of the institution's values and beliefs on knowledge, will in the long run encounter difficulties for sustainability.

Terra and Angeloni (2002) say one of the most important differences of IM and KM is how their performance is measured. IM projects rely on ROI figures, whilst KM projects rely more on the willingness of people to take part in a project. However, KM in IR in HEIs cannot divorce itself from the necessary elements of IM and IT. IM, KM and IT in IR and digital scholarship curation are part of the same process, albeit distinct in nature and objective. The challenge is to align these processes to make IR sustainable and have ROI.

4.3 KM and HEIs in knowledge intensive environments

Rowley (2000: 324) draws from Davenport's definition of KM and interprets the essence of KM as being concerned with use and development of knowledge as an asset of a particular institution (HEI) in order to further the goals of that institution. Notably, the institution recognises knowledge as an asset, intellectual or knowledge

capital, and acknowledge the management of this asset in its policies, values and norms.

Rowley (2000: 325) maintains that institutional knowledge must be embedded in KM. Embedded KM could become a reality provided that clear answers for the following are known:

- What is the central object or reason for knowledge in the institution?
- What are the different organisational or institutional levels where KM must be implemented?
- What is the type and scope of the KM?
- What technology and skills are required?
- What are the support roles needed by KM?

Rowley (2000: 326) opines that the answers to these questions are at the core of all HEIs. She concludes that HEIs must embrace Davenport's four types of KM namely:

- Create and maintain knowledge repositories
- Improve access to knowledge
- Enhance the knowledge environment and lastly,
- Value the knowledge as intellectual and capital assets (Rowley, 2000: 326).

Both Davenport and Rowley (2000) give these descriptions for the total knowledge existing in HEI and not just scholarship. They do however see scholarship and digital scholarship repositories as important subsets of the sum of all knowledge assets in HEI.

Rowley (2000), as well as Rees and Protheroe (2009) believe that the same business principles apply to HEIs as for any other business for profit, but laments that HEIs have no experience in valuing the knowledge capital.

4.3.1 The status quo of KM in HEI

Mutula (2007: 396) posits that KM transforms into new products and innovations. It is evident that this process must be managed on a continuum in order to produce consistent and constant innovation. The challenge of achieving sustainability lies not only in the IR project itself and how information and data are managed, but how the project relates to the bigger HEI objectives. In other words, sustainability of IRs are dependent on how knowledge is seen, valued and managed on all HEI operational and decision making levels. It also depends on how knowledge is valued and managed on all the institution levels. Blackman and Kennedy (2009) say that traditionally HEIs and their governance structures, such as councils, were hesitant to plan strategically. They state that there often is a lack of KM strategies. The research of Tian, Nakamori and Wierzbicki (2009) in Japanese IRs confirms the views of Kennedy and Blackman by stating that effective sharing of knowledge created at HEIs remain a challenge. HEIs are knowledge intensive organisations and their relevance and success depend on how knowledge is created, managed and communicated. There are HEIs, such as a growing number of Australian (Blackman & Kennedy, 2009) and Japanese HEIs (Tian, Nakamori & Wierzbicki, 2009) who do value knowledge as a strategic asset with capital value, and valuable lessons can be learnt by studying trends. Most of the developing world yet need to understand the importance of giving access to recent research scholarship in OA. The role that IR should play in the managing and curation of knowledge capital need yet to be formalised in policy and strategy by HEIs decision makers and governance processes.

Arntzen, Worasinchai and Ribiere (2009: 129) allude that although KM benefits were under-appreciated until recently, HEIs are beginning to see the value of KM and how research visibility can benefit the institution's goals. The value of competitive edge in

the race for funding and prestige is being realized. They stress that knowledge sharing and knowledge sharing mechanisms, as part of the KM processes, must be integrated into a holistic approach (Arntzen, Worasinchai & Ribiere, 2009: 129), as it will lose momentum in departmentalised projects. Their model (See *Figure 4.1*) of a knowledge-based learning environment helps to understand the concept of social grouping and knowledge stakeholders in HEIs.

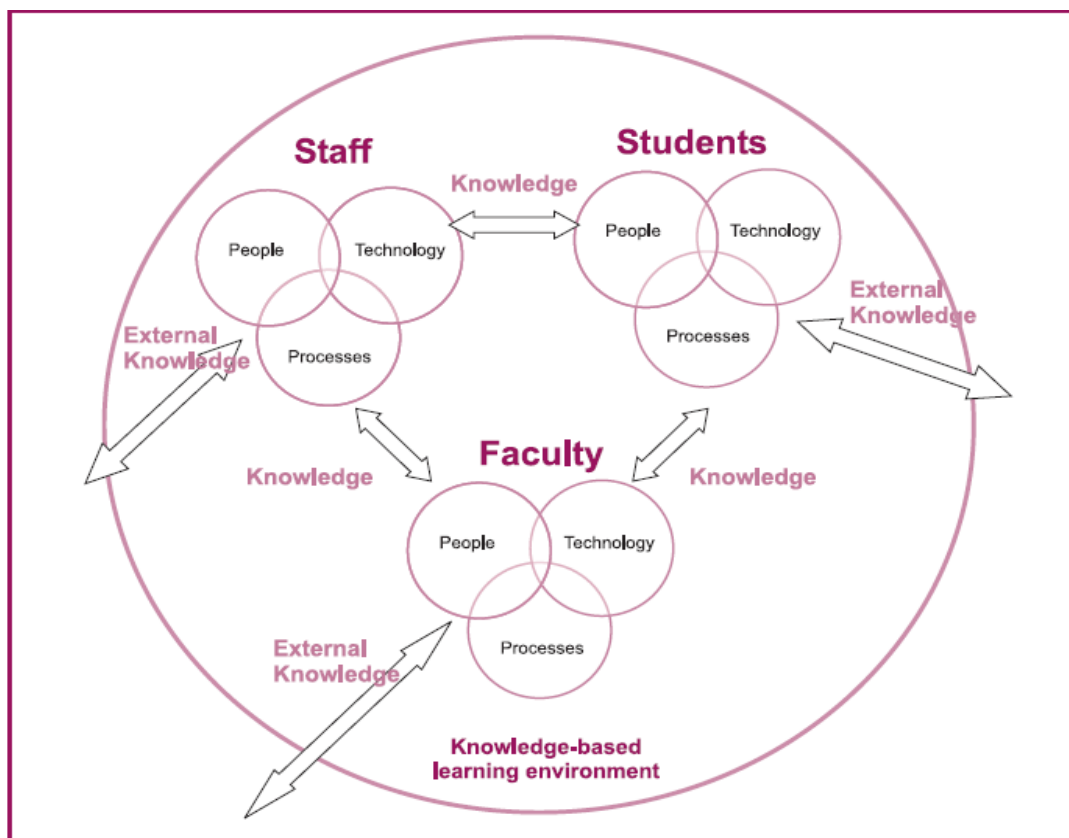


Figure 4.1 A model of a knowledge-based learning environment (Arntzen, Worasinchai & Ribiere, 2009)

Snowden's (2002: 7-11) explains the flow of knowledge on different levels. In the model by Arntzen, Worasinchai and Ribiere (2009) these complex interrelations between academic social groupings can clearly be seen in this model (See *Figure 4.1*). It indicates the levels of abstraction between staff, students/researchers and faculties. They incorporated triads similar to that explained by Sadler's sustainability

triad (1990) and as explained further by De Oliveira and Rodrigues (2010) indicates how people, technology and processes in the academic learning environment interlink in order to create shared meaning from internal and external knowledge.

4.4 A sociotechnical approach to KM

According to Pan and Scarborough as cited in Jelavic, (2011), KM processes are socially constructed. It takes place during the interaction of the technological and social factors, taking form between tacit and explicit knowledge forms in the institution. The layers where this interaction in the institution takes place is shown in *Figure 4.2* and can be described as:

- **Infrastructure:** hardware/software required for communications;
- **Infostructure:** formal rules governing the information exchange between actors in the network;
- **Infoculture:** prior knowledge, found in social relations in work group processes, that describes the cultural of knowledge and information sharing (Jelavic, 2011: 9).

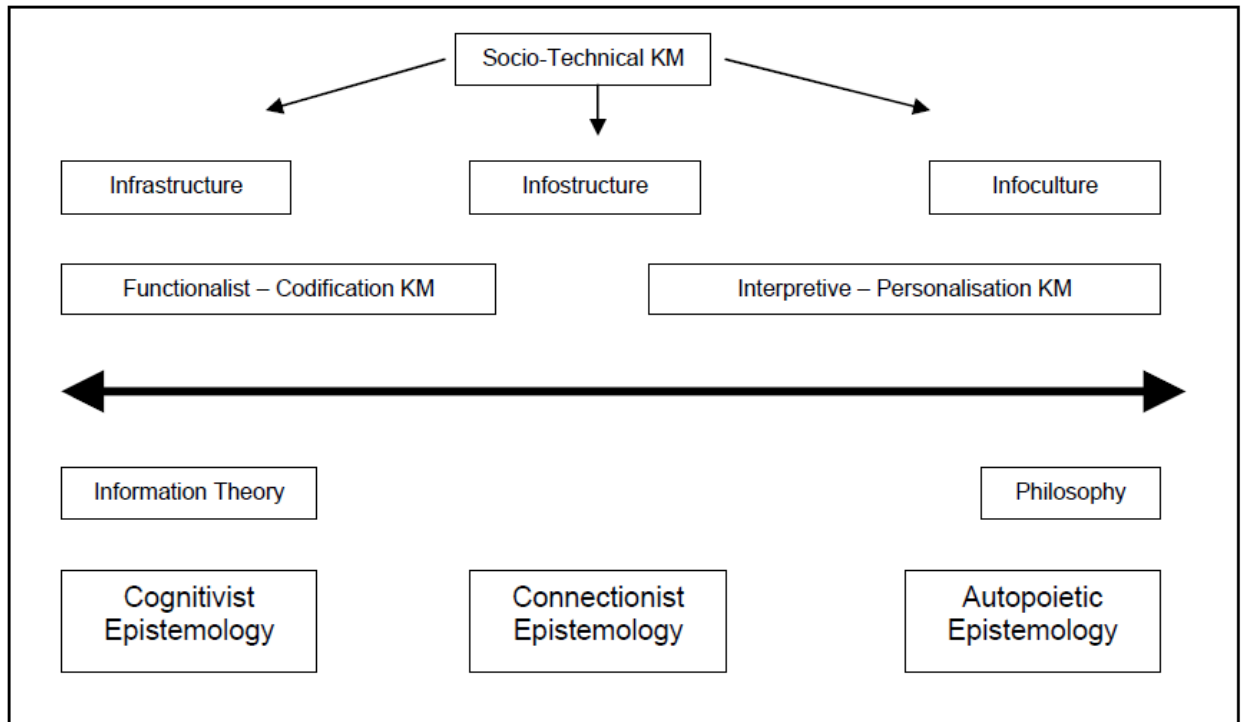


Figure 4.2 The Knowledge Management Epistemological Synthesis Model. (Jelavic, 2011: 9)

4.4.1 IRs as sociotechnical systems

Rieger’s studies (2008, 2011) on sustainable business models for sustainable management of digital scholarship collections such as ArXiv, a subject repository, provide an insight into a new trend in viewing IR sustainability. Her work provides valuable foundations and explains why mere technological management of IR will suffice over time. She says: “The concept of a sociotechnical system involves the interrelatedness of social and technical aspects of an information system.” (Rieger, 2011: 490).

IRs are networks of people, content, practices and policies which exist beyond and within the scope of technology. For the purpose of this study it is where knowledge, knowledge production, HEI goals and social groups meet. Where previous studies saw infrastructure as the foundational framework of successful IR, Rieger sees social

grouping, their goals, skill, objectives, values and motivations as the foundation of an IR sociotechnical system, sharing a particular set of meanings about a technology or an information system (Rieger, 2011: 490).

In the case of IRs in HEI the relevant social groups include a wide range of stakeholders who have different interpretations according to their roles and interactions with the IR. Rieger (2011: 491) says that the stakeholders also vary in their ability to influence the development, application, and acceptance of IR as long term scholarship repository. In *Figure 4.3*, Rieger gives an illustration of the complexity of interactions between these stakeholders in their said groupings.

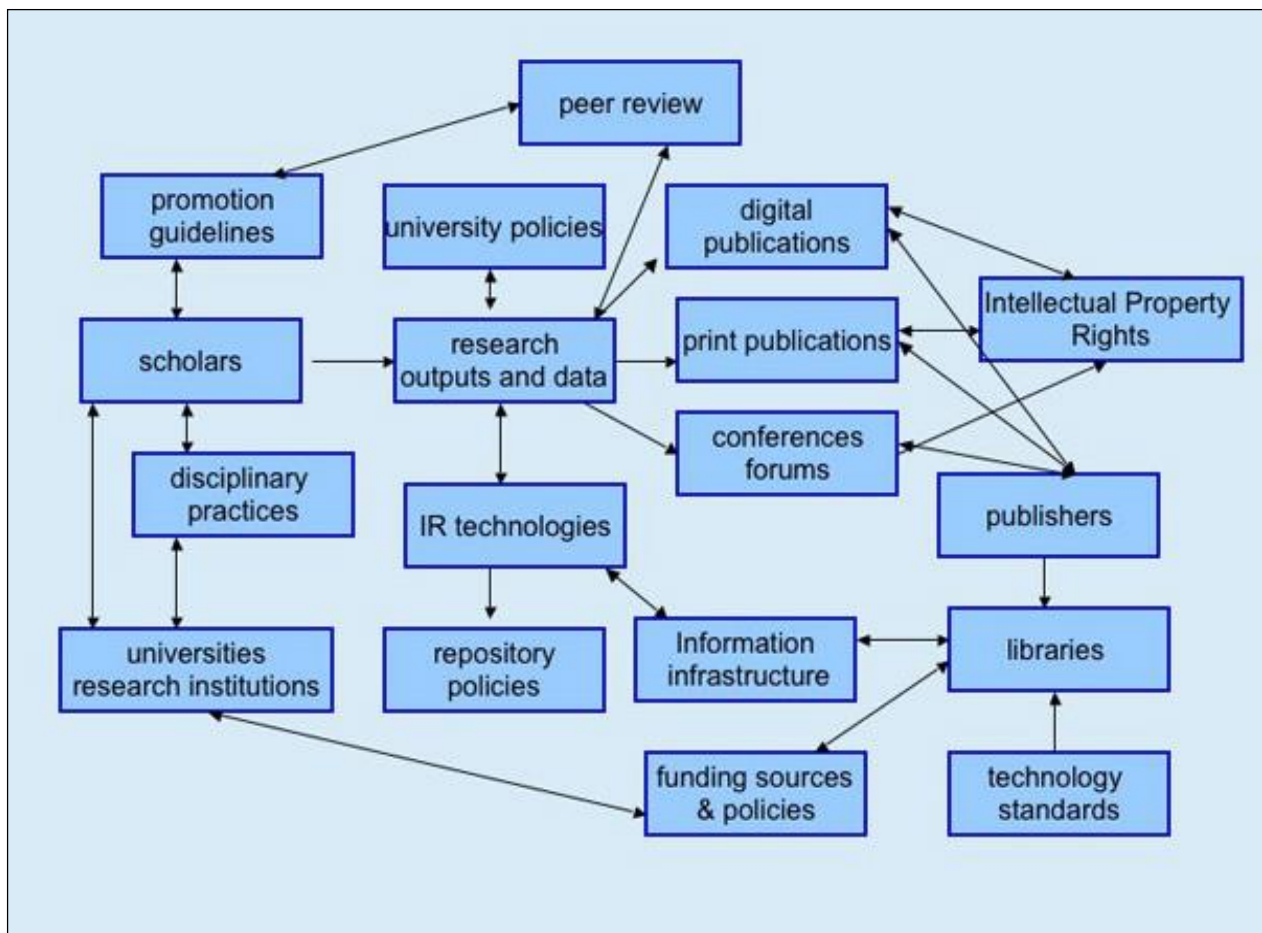


Figure 4.3 Rieger's relevant social groups in IR interaction (Rieger, 2008:10)

Russell and Day (2010) state that the most important user of the IR is the researcher. They warn that the researcher is often not consulted in the planning stages of the IR, but that there are rather a "... if we build it, they will use it" approach (Russel & Day, 2010:127). This assumption may lead to a misalignment between needs of the researcher and goals of the IR. It may also lead to a duplication of research and scholarship in less sophisticated departmental collections. Looking at *Figure 4.3*, it is clear that libraries are only one of many HEI groupings in the scholarly communication process. It graphically illustrates the potential for an IR in the library to be departmentalised, with the added danger of being sidelined in further research developments.

In a study at the Southampton University, Russell and Day (2010) showed that continuous personal contact by the IR administrators with the researcher improves the perceptions of importance of the IR to the researcher. Russell and Day (2010) are of the opinion that more research needs to be done on the usability of IR for and by researchers. Often researchers experience IRs as fulfilling an institutional function rather than a service to the researcher self, in improving their research visibility. In many cases, the researcher still has more trust in the traditional publishing model or departmental collections and repositories. Their main objective to publish in journals is to promote their research careers, and studies show that the perception is that IR does not fully answer to that need. In addition, researchers (Rieger, 2008; Russel & Day, 2010) report that the option to self-archive in the IR is slow in being taken up by researchers.

4.4.2. The information society as social group

The question can be raised whether the concepts of the information society is applicable to IM applicable in the research environment. Both De Beer (2005) and Zuccula (2006) lament that concrete and widely accepted definitions of the concepts invisible college and information society remain elusive. Zuccula (2006) defines the invisible college as: "... A set of interacting scholars or scientists who share similar

research interests concerning a subject specialty, who often produce publications relevant to the subject and who communicate both”. The UK INSINC Working party on Social Inclusion in the Information Society defines the information society as: “a society characterized by a high level of information intensity.....; by the use of common or compatible technology to transmit and receive digital data rapidly between places irrespective of distance, formally and informally with one another to work towards important goals.” (Chaffey & White, 2011: 4).

The similarity and relationship between the invisible college concept and the more recent concept of the information society is important in the history and development of scholarly communication. Zuccula (2006: 17) refers to the definition of Price, who describes the invisible college as a group of interacting scientists sharing information even though they are geographically separated. Zuccula mentions that earlier most of these communications were informal ways of communicating preprint scholarship and research. As these invisible college groupings were exposed to more technology such as emails, and even groupings such as Research Gate, Google Scholar and the advent of IRs, communication became more structured, organized and formal.

The focus in information society is on content, services and finance of scholarly communication, while the invisible college focuses on the sharing of scholarship. De Beer (2005: 17) posits that the concept of the information society plays an important role in understanding the nature of scholarship communication and research communication. De Beer (2005: 18) observes that information communication technologies (ICTs) underpin information society activities these days, but continue that it has merely become a means to an end, as the focus within HEIs has shifted to a more content driven approach. Hence the importance of content management in IRs.

The work of Zuccula (2006) is particularly informative for the purpose of this study as it gives perspectives on the relationships between scholarship communication, the social aspect and value added. It gives insight into the use of bibliometrics as research

tool in scholarly communication studies. The elements of the researcher, scholarship, organisations and technology are effectively shown in *Figure 4.4*.

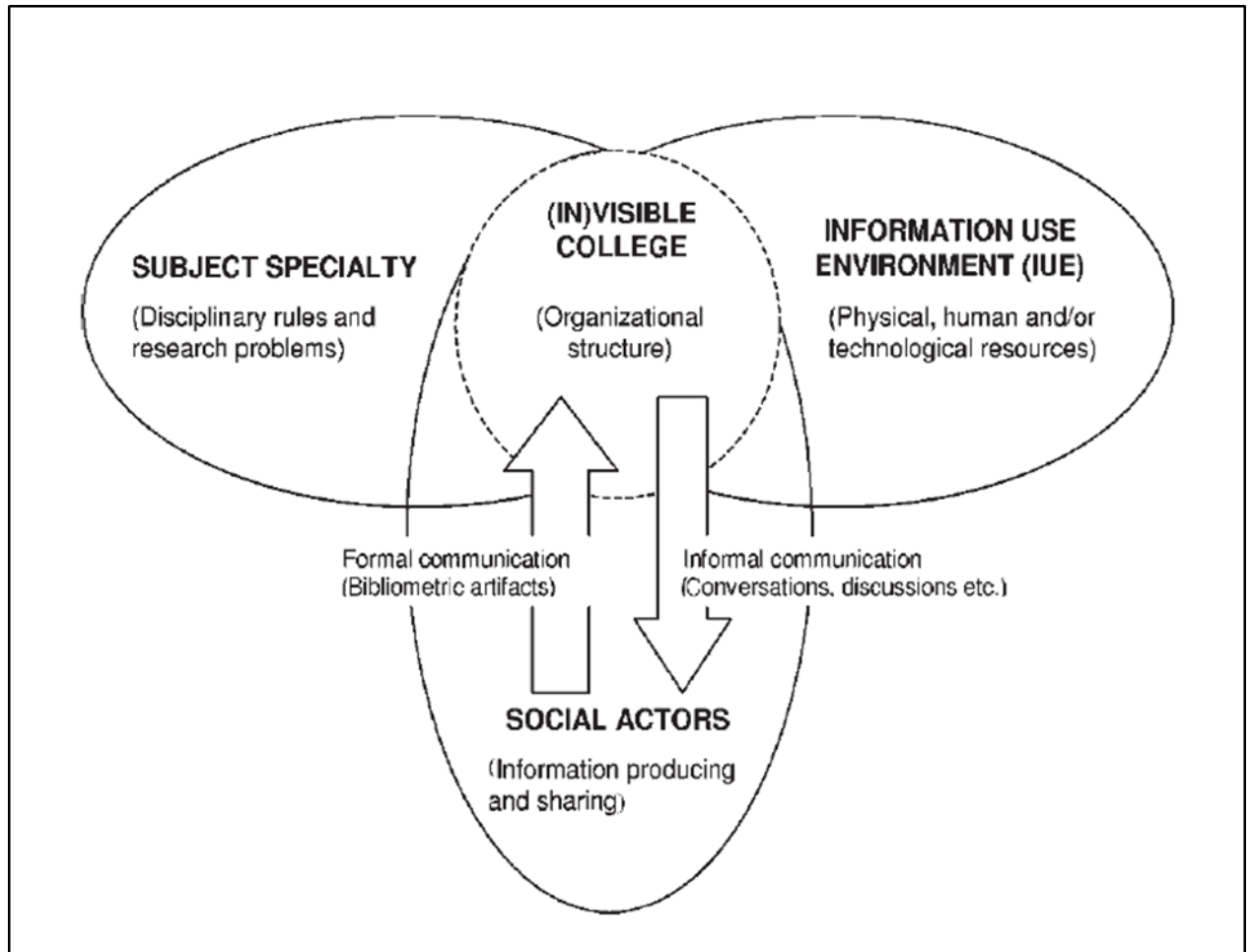


Figure. 4.4. A structural informed value-added model for the study of scientific organisations (Zuccula, 2006).

In this model Zuccula sees researchers as social actors, as their interaction and collaborative work is a form of social behaviour, adding value to their field. Zuccula's work combine elements of IM, KM and IT. It explains one of the aspects of scholarly communication, namely the role of invisible college. His views are synonymous with those of Rieger (2008, 2011) of the social groupings impacting on digital scholarship communications and IR.

4.5 KM in digital scholarship curation practices

Rowley (2000: 326) sees IR and scholarship collections as subsets of knowledge in HEI. The knowledge capital in HEI and in IR is research output and scholarship. Even today only a few HEIs have clear KM strategies, while many of the IRs registered on the OA directories and registries such as OpenDOAR and ROAR state that they are existing policies, such as preservation policies in place. Roknuzzaman and Umemoto (2009: 644) state that the library practitioners still have conflicting and different understandings about KM and the perception still prevail that it is not applicable to the library and IR environment. IR research confirm that this has not yet changed. The majority of research, approach IR only from an IM point of departure or even from a project management approach, and it could be argued that there are also varied ideas about KM in IR.

Rieger (2008, 2011) is one of a small group of researchers who are following a KM approach in her research of IR and so doing look at where IR fit into the bigger picture in knowledge sharing. Rieger (2011) refer to the concept of sociotechnical groupings as found in the KM practice of IR implementation and IR management. Davenport, Koenig and others are cited as having said that KM is librarianship in another form (Roknuzzaman & Umemoto, 2009). They state that: “Its primary aim is to facilitate knowledge-rich relations and to ensure ongoing development and innovation” (Roknuzzaman & Umemoto, 2009: 645).

There is a global lack of research in IR studies as far as studying KM of IR, in its broadest institutional sense. Yet authors Mutula (2011), Chisenga (1999) and Nyambi (2011) lament that institutional support remains a problem when planning to implement an IR, referring here mainly to the southern African experience. Middleton (2005) adds that sustainability of digital projects depends on a multi-faceted approach, where all role players or groupings must be considered. He continues by stating that the greatest challenge to ascertain sustainability is, not as one would anticipate, the technical

challenges as so often mentioned in literature, but the social and organisational cultural challenges. It is clear that where an organisation, in this case a HEI, does not manage their knowledge as a capital asset, value and sustainability of that asset will be at risk.

It is becoming evident that sustainability of IR depends on effective and integrated KM across the institution, as well as IM and content management of the IR. It is therefore important to briefly revisit this scenario to enable expansion of the concept of KM in IRs and its sustainability.

4.6 Sustainability of IRs

Chengular-Smith, Sidarova and Daniel (2010) see sustainability, firstly as the ability of an organism or system to remain and operate on its course over a period of time. They add to this statement that this would furthermore include both survival and economic viability of the system (IR) within the bigger context of the institution it serves. Sustainability and success of IR is clearly related to project activity over time. Rieger (2011) draws the comparison between sustainability and scholarly publishing, and states that traditional publishing has succeeded to be sustainable as researchers, institutions, libraries and scholars have been supporting its activities. It is common knowledge that libraries have played a particular role in this sustainability process of traditional scholarly publishing via their resources and subscription budgets.

4.6.1 Sustainable KM and IR

Notably, the role and importance of KM in IR has been demonstrated in researcher findings of Rieger (2008, 2011). KM in IR has been explored, as well as what the concept of sustainability in IR is. The difference between success of an IR and the longer term viability and survival potential of an IR namely sustainability have been addressed. The correlation between sustainability in IR and KM of IR must be investigated and explored further to develop informative frameworks towards improved scholarship curation in IR.

Chengalur-Smith, Sidarova and Daniel (2010) explain sustainability as the ability of an entity, such as an organism or ecosystem, to maintain its activity overtime. Anbu (2007) says that sustainability in IR refer to the long term survival of the IR. De Oliveira and Rodrigues (2010) see sustainable KM as an event taking place in a sustainability triad. They refer to three separate but intersecting spheres of values under pinning sustainability (see *Figure 4.5*):

- Economy
- Society
- Environment

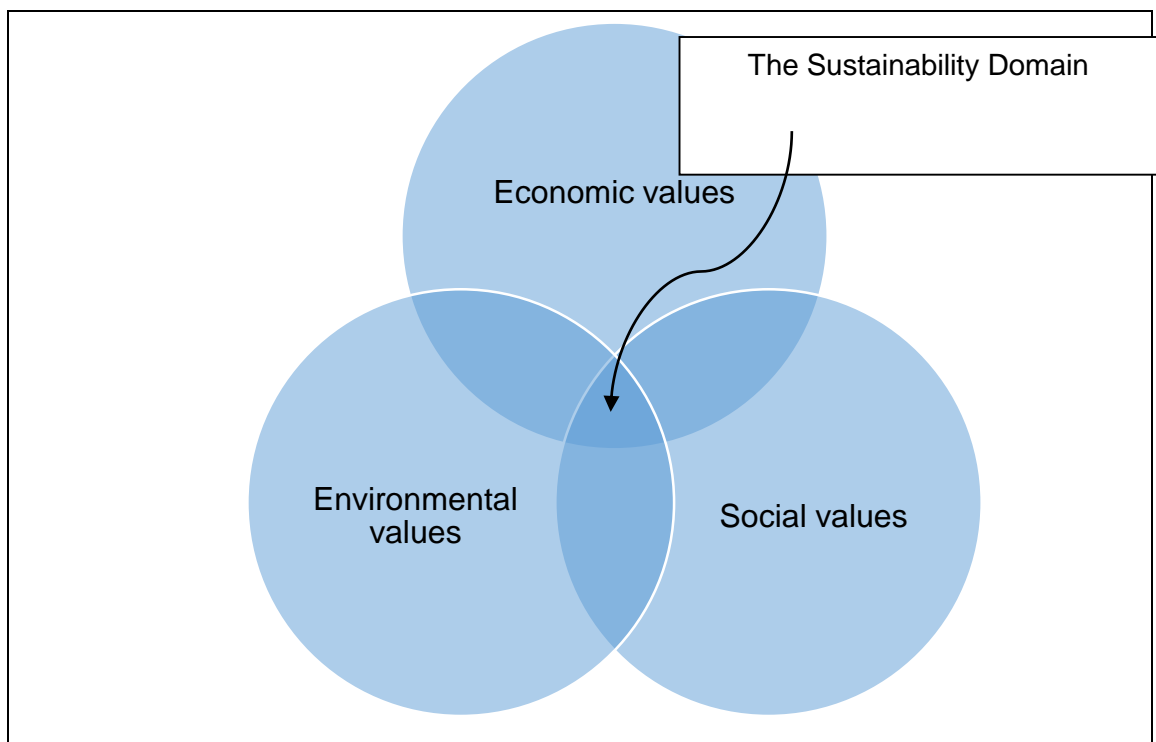


Figure 4.5 The sustainability triad (De Oliveira & Rodrigues, 2010)

De Oliveira and Rodrigues (2010) in defining KM for sustainability see sustainability broadly as being any process involved with the creation, capture, sharing and use of knowledge. This definition is very broad and does not capture the essence and importance of KM for sustainability in IR in HEIs on a more applied and detailed level. The model does however serve as a departure to explain values which in HEIs could

be translated to institutional objectives, namely the research culture and environment, support services and governance. These three elements will be discussed further in chapter five as strata in the focus groups of the field research. The sustainability domain for IR in HEIs can be seen in the model of De Oliveira and Rodrigues (2010), and can be explained by an adapted model where, for the purpose of this study, environment is the HEI; the economy is the funding models and budgets of the university and the IR project; and social values is researchers' attitude to quality research and research sharing.

4.6.1.1 Requirements for IR sustainability

Rieger (2011) says that ensuring OA IR sustainability, requires not only an operational budget, but also requires constant adding of value by growing and developing the IR to comply with needs of the users and new developments in research and technology on a wider scale.

She warns that OA does not imply that there are no costs involved. IR sustainability depends on business models which take into account the value and cost of running an IR while aligning this business model with the goals of the institution's (Rieger 2008). Middleton (2005: 146) supports this argument and sees business planning as a critical element towards sustainability of IR projects. It is clear from research done, that sustainability cannot be imposed externally, but rests internally with IR managers, IR business or project plans, answering the needs of the user and adding value to the goals of the institution (Anbu, 2007; Chengalur-Smith, Sidarova & Daniel (2010); Nyambi, 2011; Rieger, 2011) Sustainability depends on the management of data on various levels in the IR, the institution as well as the external environment of OA. The important roles that various levels of institutional decision makers have to fulfill must be stressed in the value of the IR for the institution as a whole. Middleton (2005: 149) calls this a multi-faceted approach towards sustainability where people from various departments need to co-operate.

Anbu (2007) adds three elements of sustainability in IR:

- Long term preservation and digital archiving (in other words data curation as discussed in chapter three)
- IR to be part of the academic main stream processes of the institution
- Mandatory submissions of digital scholarship created at the institution

Nyambi (2011) expands and add one more element namely, the importance of visibility of the digital scholarship and IR in OA. Active and continuous development and enrichment of the IR content, technology and services to users are further indicators for success and predictions of longevity of the IR (Chengalur-Smith; Sidarova, & Daniel, 2010). Middleton (2005: 146) summarizes the elements necessary for sustainability as:

- A strategic and multi- faceted business approach
- Thorough market research of current and potential users
- A sound financial plan that goes beyond initial funding
- Building collaborative networks
- A broad-based group to sustaining the project after initial implementation

4.6.1.2 Measuring sustainability in IR

Sustainability indicators need to be identified to measure impact, progress and longevity potential of an IR. Sustainability indicators monitor positive growth and movement of an IR. Rieger (2011) says that sustainability indicators are essential for the institution to measure ROI. In turn, this information should be used in policy making and project planning. IR sustainability factors build on IR success factors.

4.7 Value and quality of IR

Certainly one of the most important aspects that will determine the success and sustainability of an IR is the value it offers for the HEI community it serves. Cullen and Chawner (2010) report that IRs are created with great initial enthusiasm, but it soon becomes just another task to be done. Herein lies a possible threat for the sustainability of IRs.

The benefits of IRs are well reported in literature and include higher citation rates for researchers, visibility of research among others. These benefits are mostly at institutional level and the question must be asked: does the academic community comprehend these benefits and value and subsequently support IR on an institutional level? IRs should be evaluated and their relevance and acceptance should be monitored constantly. Cullen and Chawner (2010) warn that many researchers still prefer to publish in traditional peer reviewed subscription journals, and do not necessarily see the value of IR. This notion is strengthened by the international trend to rate universities according to their publication rate (Cullen & Chawner, 2010). The findings of a study by Abrizah (2009) support the concerns of Cullen and Chawner in that academics are greatly unaware of the value OA publishing. His study reports that many researchers are concerned with plagiarism and copyright infringements and consequences of publishing in the open access environment (Cullen & Chawer, 2010: 31)

4.8 Quality of scholarship and sustainability

Ball (2010: 33) refers to a trusted body of digital scholarship collections. The issue of trust in digital scholarship brings principles of information ethics to the fore. The ease of information availability created by digitization and OA protocols may create the misconception that permissions to use the information from the right full owner or author are no longer required. The moral principle of what is good and right in availing digital information is addressed in information ethics frameworks. The principle of fair

use or fair dealing of information must prevail and digital libraries must be managed in such a way that this principle is honoured and trust in the product results.

Ethics depends on norms and standards. Mutula (2011: 264) cites Mason by identifying the main ethical issues in the electronic information arena:

- Privacy, accuracy of information;
- Property and intellectual property;
- Accessibility to information;
- Security of systems and information;
- Efficiency of processes, services and systems;
- Consistency of delivered information products.

Courtesy and credibility are elements added from the SERQUAL model of management (Mutula, 2011: 265). Mutula refers to the Information Systems Success Model (Mutula, 2011: 265), where the technical elements are addressed and included are elements of:

- System quality
- User satisfaction
- Quality of information system output.

This model has a practical approach which is very appealing to the content management of digital libraries, but does not address the issues of permissions to use, copy and publishing licenses, ownership of research, and intellectual property fully.

4.9 Information ethics, academic integrity, trust in IR sustainability

Prieto (2009: 593) states that effective content management will ensure sound application and adherence to information ethics in IR. He sees user communities and their needs as central to ethical and trustworthy body of knowledge in IRs. He continues by stating that in a HEI environment quality, integrity and data curation of IR content is critical to the success and performance of IR (Prieto, 2009: 599).

4.9.1 Trust and digital scholarship

Mutula (2011: 261) laments that accuracy, confidentiality breaches and currency of information of the African digital library are compromised, as African researchers often do not have access to the latest research. Based on his research, the deduction may be made that ethical issues of trust will also impact on trust in and the viability of an IR.

Not only are developments in and of digital libraries and IR in Africa behind those of their Western counterparts, trust in existing libraries needs to improve. Mutula (2011: 264) explains that elements of trust addressed in models such as: Social-psychological Model, the Social-Cultural model and The Institutional Performance Model. The main elements of trust however can be summarised as:

- Reliance on integrity;
- Ability or nature of a particular digital library;
- Reliance on an institution governance, codes and practices;
- Re-assurance that the digital library will deliver desired results and add value.

Trust in African digital libraries needs to be built, not only for the African information seeker, but also the information seeker in the global research areas. Mutula (2011) and Ocholla (2008) use an integrated model for trust which has five pillars:

- Ethical/human;
- Information/content;
- Technical aspects;
- Policy/ legal frameworks;
- Political governance considerations.

In developing a management strategy for IR, these concepts on trusts and ethics must be incorporated as contributors to IR sustainability. It must link and be supported by institutional policies and processes on research ethics, plagiarism and copy right.

4.9.2 Legal and policy frameworks for IR

Effective management of the legal elements of a digital library firstly requires knowledge of applicable laws and regulations both nationally as well as internationally. Furthermore, an awareness of the consequences of not adhering to these should be known. Solutions for these requirements must be built into the content management systems and procedures of digital libraries.

A foremost legal issue where digital libraries are discussed, is intellectual property, of which copy right forms a significant part. The difficulties arise where an author gives his copyright to a publisher. Should the author wish to rather publish in the OA arena, copy right is not forfeited. The Nottingham University offers a service, SHERPA/ROMEO (2016) to assist authors with negotiating copyright in open access publishing. Proper acknowledgement of use of an author's work, that is freely available in opens access, protects the rights of an author and gives recognition and protection to the originator.

Copyright is not the only legal aspect that needs to be addressed in managing content in the digital library. Others not yet mentioned are: commitment, right holders,

publishing agreements and license agreements, embargoes periods, liability, and most neglected the preservation options of information.

4.10 Summary

Researchers Middleton (2005), and Rieger (2008, 2010, 2011) agree that there is an ever increasing emphasis on more than just technical sustainability of IR and IR development. The level of KM and KM strategies in HEI determine the amount of support and appreciation that IR in HEIs will get. Notably not many HEIs have well established KM strategies or a good understanding of the nature of KM in HEI.

New trends are developing to ascertain the impact and success of IRs in HEI. Rieger (2008, 2011) is at the forefront of deploying a sociotechnical approach for studying sustainability in digital scholarship collections. She underlines the complex social groupings that exist in the IR environment, and posits that sustainability indicators will strongly be influenced by values and organisational culture.

The general approach is looking at the added value, ROI and usability of IR content, and with that, a greater realisation of the impact of institutional-cultural aspects determining IR sustainability. Rieger (2010, 2011) is one of a handful of researchers who focuses on the social groups and the range of stakeholders, their needs and how the IR develop around these role players. She investigated how these relations intersect with the technological aspects of IR, and what the importance of the relations are on the performance of the IR.

Studying sustainability of IRs goes far beyond content management and technological management and considerations. If the value and ROI is not realised by the institutional governance, sustainability will be impaired. The quality and integrity of scholarship content are determining factors for the value that HEIs will see in IR, which in turn will have an impact in the trust that researchers will have in IR.

In chapter five theoretical frameworks will be discussed. The difference between theory and theoretical frameworks will be explained. The multi-disciplinary nature of sustainability of IRs will be addressed, and suitable frameworks will be evaluated.

Chapter 5: A theoretical framework for researching sustainability of digital scholarship curation in IRs

5.1 Introduction

Chapter four looked at KM and uptake of KM strategies in HEIs. The importance of good governance on the sustainability of IRs was discussed. The value of a socio-technical approach to sustainable IR management were highlighted. The question is which frameworks would support the socio-technical study of KM in IR? Chapter five gives an overview of the different theoretical frameworks supporting the research problems of digital scholarship curation. Theories and theoretical frameworks used in recent studies will be discussed to ascertain their value to this study. A framework for studying the sustainability of digital scholarship curation in HEIs will be adapted from existing frameworks. Sustainability is a key focus area of this study and sustainability frameworks used in previous research must be evaluated to derive at a suitable framework.

During the past two decades IM theory and IM frameworks were used in many IR studies (Day, 2010). KM theory started to influence research trends in HEIs, including IRs and scholarship. Social and human variables such as culture, values, social groupings and socio-technical aspects were the focus of ground breaking studies where KM frameworks were used (De Oliveira & Rodrigues, 2010; Middleton, 2005; Rieger, 2008).

Webometrics and infometrics frameworks were evaluated and drawn from to derive at a suitable theoretical framework. Webometric services, such as OpenDOAR, ROAR and Ranking Web of Repositories, play an important role in monitoring IR performance, IR growth, age, size and trends in digital curation databases. Frameworks for webometrics research, as a subset of the infometrics and bibliometrics, are still developing and evolving, resulting in not many of the available frameworks pertaining to digital scholarship curation in IR.

Potential frameworks capable accommodating the complexities of the multi-disciplinary nature of IR research and scholarship curation, are discussed. Existing models for IR research are discussed. Special consideration is given to research models using sustainability criteria and indicators. The criteria for a suitable multi-disciplinary framework catering for IM, IT, KM and webometrics to study the sustainability of digital scholarship curation in southern African public and private HEIs will be presented.

5.2 Background

Neuman (2003) states that theoretical frameworks are orientations to look at the research problem. Ocholla and Le Roux (2011: 2) explain that the role and purpose of a theoretical framework is to answer two basic questions namely:

- What is the research problem of the study?
- What makes the chosen approach to find answers to the research question the most feasible?

Ocholla and Le Roux (2011: 3) underline the importance of the literature review which serves to inform the theoretical framework. Theoretical frameworks provide clarification of concepts, assumptions and forms of explanations (Ocholla & Le Roux, 2011: 3).

Theories within the same framework have shared assumptions and shared meaning of concepts (Neuman, 2003). Frameworks tend to have similar approaches to research methodology.

5.3 Theory versus theoretical framework

An understanding of the concept: theoretical framework is only possible when the concept of theory is clearly understood. Theory should not be confused with theoretical framework, as theory is seen as a conceptual explanation of a phenomenon (Ocholla

& Le Roux, 2011: 3). Theoretical frameworks may include many formal or substantive theories. These theories overlap on important concepts and assumptions (Neuman 2003). Research is done to uncover new information and build on existing knowledge to solve problems and create new knowledge. Knowledge is gained by deductive logic and inductive reasoning (Ocholla & Le Roux, 2011: 3) and this constitutes scientific methods.

5.4 Multi-disciplinary theories

Researchers often approach research from diverse angles (Fleischmann, 2007; Ocholla & Le Roux, 2011). IR research is no different, which resulted in the use of diverse theoretical models over the past two decades. To date, IR implementation and management projects were mainly the responsibility of LIS. LIS frameworks were considered for this study. However, Ocholla and Le Roux (2011: 3) refer to Kulthau, underlining a paradigm shift in LIS research that occurred in the 21st century: a shift from technology towards the use of information as applied in everyday life. Similarly, IR research changed and developed significantly, from a project management perspective of early studies done by Chisenga (1999), Lor (2005), Anbu (2007) and Christian (2008) concentrating on LIS, IT and IM frameworks. Later research used more KM theories and frameworks such as studies conducted by Rieger in establishing sustainability strategies for the ArXiv repositories in 2010 (Rieger, 2011: 490).

KM studies need to consider the nature of organisational culture and research culture of HEI. KM studies in HEI was evaluated. An early study by Saad, Alias and Rahman (2004) researched the formulation of KM strategies (KMS) in four Malaysian private HEIs. Their study focused on organisational knowledge, including scholarship, and how it could be leveraged through supportive technology (Saad, Alias & Rahman, 2004: 1). They used a multiple perspective theory in their research, encompassing three generic elements: technical, personal and organisational to solve real life problems. This theory assists in formulating KMS on an organisational level, going

beyond technical systems, departmental or project level and incorporates the decision making and governance levels, which were lacking in prior approaches (Saad, Alias & Rahman, 2004: 2). They state that KMS should include a combination of organisational systems, where various KM processes are combined to solve business problems (Saad, Alias & Rahman, 2004: 2). Their components of a multiple perspective theory are useful in the knowledge intensive environment of HEI, where different and often duplicated systems are currently in use to manage the knowledge creation process and curation.

5.4.1 Theories informing the choice of framework: Sociotechnical interaction networks theory and Social construction of technology theory

Both Meyer (2006) and Rieger (2008) refer to Kling's work, where he builds on the social construction and actor-network theories to identify and include relevant social groups, communicating on choices, consequences and value of information communication systems. Meyer (2006: 38) explains Kling's definition of socio-technical interaction networks theory (STIN) as: "an emerging conceptual framework identifying, organizing and comparatively analyzing patterns of social interaction, systems development and the configuration of components that constitute an information system" (Meyer, 2006: 38). The socio-technical interaction networks theory addresses problem solving and argues that sustainability of technological systems will not be sustainable if the social construct of the organisation is not taken into account (Rieger, 2008). Social-technical interactions networks theory is an interdisciplinary theory, addressing the concept of economics in evaluating sustainability of IRs (Rieger, 2008). This theoretical framework offers potential to be used in the study of criteria for sustainability in IRs.

Wells (2009) warns that there is a lack of standardised sets of criteria to evaluate performance and sustainability of IRs, and this study sets out to offer more insights to close this gap. The study of Rieger (2011) is one of only a few studies identifying a theoretical framework for researching IRs in terms of sustainability. She states that

social constructivist theories aid researchers not to focus only on the technical or functional, but also to the social-cultural phenomena (Rieger: 2011: 492). She continues by saying the evolving nature of scholarship necessitates a socio-technical approach to the study of IR.

This approach helps to clarify the role of social behaviour and acknowledge that technology does not function without social interaction. This theory looks particularly at the human interactions that makes systems sustainable. The STIN theory has three main assumptions:

- Social and technological variables are not meaningfully separated;
- A normative assumption that social and institutional behaviour will influence system design and sustainability of the system;
- There is a multiplicity of social relationships and commitments for participants of the system.
- Within sustainability models this refers to the ecological sustainability circle (Meyer, 2006: 38).

Meyer (2006: 38) refers to this as STIN strategy for social informatics research. STIN strategy models draw from the social construction of technology theory. Rieger (2008) says that the key assumption of this theory is that innovation is a process of negotiation between the relevant groups responsible for, or reliant on the innovation. As is the case in this study researchers, repository managers, IT administrators and HEI decision makers form relevant social groups, directly or indirectly responsible for the innovation of digital scholarship collections in IR. Rieger (2011) says that according to this theory, culture will determine how technologies are used: “Repositories are not mere information technologies; they exist as networks of content, people, practices and policies” (Rieger, 2011: 490). They form a part in a socio-cultural environment. She laments the paucity of IR studies with a comprehensive and holistic view point. Little attention has been given to negotiating business models with top management of institutions. Social groups within an institution such as research committees, senate,

and library and technical committees play a pivotal role in the development, support, usage and ultimate sustainability of the IR.

5.5 Identifying suitable frameworks for IR sustainability research

Many studies in LIS and IR make use of social sciences frameworks. Researchers such as Ocholla and Le Roux (2011), as well as Fleischmann (2007) lament the lack of LIS theoretical frameworks. It is not surprising that many IR studies moved to find grounded theory and frameworks in the IM, IT and KM. Rieger (2008) posits that most IR research in the early 2000 concentrated on IT and ICT concepts, models and theories of systems management, design, and technology. Fleischmann (2007: 411) supports this view and add that previous techno-scientific frameworks assumed that the nature of IT is neutral and objective phenomena, and thus not influenced by other variables.

Researchers (Fleischmann, 2007; Ocholla & Le Roux, 2011) are of the opinion that valuable knowledge is found in Science and Technology frameworks (STS). STS is an interdisciplinary field and includes in its research concepts such as social, cultural, ethical and even political factors. Fleischman (2007: 412) uses the agency framework together with boundary objects to study digital libraries His research signifies that technologies exist in social worlds, and he connects social culture with social constructivism. His study established that values are an important factor in the design, application and promotion of systems and programmes and he refers to it as technologies with embedded values (Fleishmann, 2007: 409-410). He posits that values are highly individualised and personalised. They are cognitive elements of orientation in the working world. There are four embedded values referred to the fact that technologies have values based on social meaning:

- moral/metaphysical;
- support;

- material;
- expressive.

Fleishmann (2007: 412) refers to Hess, stating that all research should be guided and governed by values and ethics. Fleischmann's approach is significant for this study, as many IR research studies focus only on single aspects of IR, for example metadata standards or content analysis of digital scholarship housed in the IR database.

Wells (2009), as well as Fleishman (2007), is of the opinion that IR research is based in the theoretical framework of digital library studies. Fleishmann sees IRs as subsets of digital libraries (Fleishmann, 2007: 423). His framework adds value as far as the embedded values in the technical world of IR is concerned, but lacks addressing sustainability factors such as the necessity of a KMS on governance level. An intersecting framework between KM, IM and IT is to cover all factors impacting on the sustainability of IRs.

5.5.1 Sustainability frameworks

Studying and evaluating sustainability of southern African IRs pose a number of challenges, as conditions in institutions often differ in the developing- or the developed world (Nyambi, 2011). A combined theoretical perspective, borrowing from infometrics/webometrics, KM and KMS for sustainability and IM/IT frameworks will be required to give insight into developments and trends in digital scholarship curation in the target group. This makes an approach of triangulation, not only as research methodology, but also as a framework a viable option, as it allows for a rich analysis of the research problem from varying departure points looking at the same problem.

Westell's (2006) model of critical success factors (as discussed in chapters three and four) addresses some of the indicators that determine the success and sustainability of IR in the CARL libraries in Canada, but does not fully answer questions of longer

term growth, value add, trust, performance and continues development issues found within the southern African HEI context of IR.

Sustainability in the context of this study refers to the feasibility and long term value, growth and development of IR. The nature and value of knowledge capital, cost, cost-benefits of digital scholarship curation, makes a case for including economics into the sustainability framework. Sustainability research in different fields of study lends itself to economical frameworks and Sadler's 1990 sustainability triad of intersecting social, environmental and economic circles is well known and applied in sustainability studies in HEI (Dani, 2011). His conceptual framework looks at the social circle, the environmental circle and the economic circle.

For the purpose of this study the conceptual framework includes:

- **The social circle:** setting standards, maintaining and improving standards and monitoring standards;
- **The environmental circle:** concerned with improving systems and sub-systems, creating strategy to improve systems and outcomes;
- **The economic circle:** financial viability cost, cost avoidance and cost benefit, organisational gain (knowledge capital) and competitive edge for the greater goals of HEI.

For the purpose of this study the assumption is that where environment, economy and social spheres intersect you are bound to find a sustainability domain for the process of digital scholarship curation in IR in HEIs. The sustainability triad framework will form part of the theoretical framework of this study.

The study of Chengular-Smith; Sidarova and Daniel (2010) gives important insights into sustainability frameworks in an open source software environment (FLOSS), offering valuable insights and information not found in many studies. The sustainability indicators in this study could be applied to the open source software choices in IR.

FLOSS is also used in a number of Zimbabwean IRs. Using the organisational ecology framework for sustainability, Chengular-Smith, Sidarova and Daniel (2010) look at particular variables of newness, smallness and niche areas as factors influencing long term viability of projects or organisations. These three concepts will also be used in the theoretical framework for this study as it is particularly the new and smaller IRs that do not feature on web rankings such as Ranking Web Repositories, and OpenDOAR.

5.5.2. KM frameworks

The research problems of this study cut across disciplines and intersect with KM, IM, legal, quality, ethical as well as technical fields. A suitable framework for this study needs to address all these variables.

Researchers, Blackman and Kennedy (2009: 547) state that KM policies and strategies were generally slow to be adopted and implemented by HEI governance structures. Saad, Alias and Rahman (2004: 694) confirm this and lament that it adds to the compounding problem of lack of KM and KM strategy research and frameworks in academic institutions worldwide. KM frameworks in HEI is still in the early stages of development. KMS is needed to enable organisational knowledge with IT support. Table 5.1 shows some of the KM research done who contributed to the formalisation of theoretical frameworks in HEI as well as IR and digital scholarship curation studies.

Table 5.1 Summary of HEI and IR research using KM frameworks or sustainability models

Researchers	Research	Year	Theoretical approach
Tian, Nakamori & Wierzbicki	KM and knowledge creation in academia: a study based on surveys in a Japanese research university	2009	KM micro-theories of knowledge creation
Mohamed, Stankosky and Murray	KM management and IT: can they work in perfect harmony?	2006	Stankosky's four pillars of conceptual framework
Rieger, O.Y	Opening up IR: Social construction of innovation in scholarly communication	2008	Social construction of technology, actor-network, socio-technical interaction network theories
Rieger, O.Y	Assessing the value of open access information systems: making a case for community based sustainability models	2011	Sociotechnical systems framework
Middleton,	Collaborative digitization programs: a multifaceted approach to sustainability	2005	Collaborative network model

Chengular-Smith, Sidarova & Daniel.	Sustainability of free/Libre Open Source projects.	2010	Ecological sustainability models
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5.5.3 Triangulation frameworks

Triangulation has significance to this study, both as a framework as well as a research method. Berg (2009) warns that many researchers doing qualitative research, view their research tool as being a-theoretical. As a result, they err in not acknowledging that research methods go hand in hand with a specific perception of reality. Every method has different facets of the same symbolic reality (Berg, 2009). Berg (2009) says: “By combining several lines of sight, researchers obtain a better more substantive picture of reality” This approach is referred to as triangulation, where looking at a problem from different angles or positions gives a deeper understanding of the problem where intersecting lines connect.

Researchers (Berg, 2009; Rieger, 2010; Wells, 2009) opine that using a multiple-theoretical approach broaden and strengthen conceptual linkages.

5.6 Towards an inter-disciplinary framework for researching sustainability of digital scholarship curation

Narrow frameworks fail to address the complex factors impacting on sustainability of an IR such as:

- The contributor of scholarship expectations and awareness;
- IR compliance to policy, ethical and legal aspects;
- Monitoring quality of IR database management ;

- Monitoring standards and content of scholarship deposits;
- Institutional support, attitudes, standards and policies;
- The effect of research culture on IR success;
- The HEI's value orientation towards scholarship and scholarship curation;
- Cost and cost-benefits of the IR for the institution;
- Interdepartmental cooperation;
- Skills of IR managers;
- The interrelatedness of groupings within the institution.

The above mentioned variables will impact on the sustainability of an IR either positively or negatively.

5.6.2 The institutional KM relationship model for evaluation of IR sustainability

For the purpose of this study aspects of the following frameworks will be used:

- Kling's STIN frameworks (Meyer 2006 Rieger, 2011);
- Sadler's sustainability triad (Dani, 2011);
- Triangulation theory (Berg, 2009)
- Multiple perspective theory (Saad , Alias & Rahman; 2004)

5.7 Summary

It is evident that traditional LIS frameworks as well as digital library frameworks are not comprehensive enough to accommodate all the aspects of sustainability research of digital scholarship in IR. The technical aspects and content management aspects

of IR cannot be negated. They are important, but must be seen in relation to social aspects. Although valuable foundations were laid by earlier research using traditional and mainly technical theories and frameworks, the study of digital scholarship curation must address organizational or institutional culture pertaining to scholarship creation and meaningful research sharing. With this comes a value orientation to knowledge capital. Once there is a culture of producing and sharing scholarship, institutional strategy needs to drive this culture.

In chapter six the research design and methodology for this study will be explained. A mixed method approach, with empirical survey questionnaires, content analysis and webometric analysis will be used for this study to triangulate findings.

Chapter 6: Research design and methodology

6.1 Introduction

In chapter five the different theoretical frameworks supporting digital scholarship curation research were discussed. The emerging trend of adopting KM and KM strategies in HEI was discussed. Previous research on IRs were evaluated and reported. These insights informed the decision to use a socio-technical approach to study sustainability of IR in the target group.

In chapter six the research design and methodology for this study will be explained. A mixed method approach, using empirical survey questionnaires, content analysis and webometric analysis were used. During the first phase of this study webometrics were used to purposefully select IRs. A triangulation methodology was used to analyse data collected from completed survey questionnaires, web visibility via webometric ratings on Ranking Web Repositories and content analysis of IRs appearing in the global IR directory, OpenDOAR. Three focus areas of social, cultural and technical aspects impacting on the sustainability of digital scholarship curation formed the foundation of the questionnaire.

The three focus areas or spheres are:

- Social sphere: Organisational and research culture of the HEI, cross-departmental collaboration in managing the IR and research scholarship;
- Environmental sphere: HEI type, governance structures, strategies, standards pertaining to scholarship;
- Economic sphere: Cost, cost benefit and perceived value of IR in the HEI.

The assumption is that where these three environments successfully and purposefully integrate and collaborate, areas of cooperation and joint planning could be identified and a sustainability domain will be identified. The elements of sustainability domain need then be described to inform a sustainability framework.

Effective KM strategies, a research culture valuing scholarly communication and good governance of IRs will ultimately have a substantive impact on the performance, value and longevity of IRs. For the purpose of this study the sustainability triad, coined by Saddler in 1990, as cited and further described by Dani (2011:114) will be adapted.

6.2 Methodology

This study used of both quantitative and qualitative research, therefore a mixed method approach will be used. According to Berg (2009) quantitative research is often seen as being more respected and valid. Qualitative research, however results in more in depth studies, it takes longer and the objectives or research question need to be clear. Qualitative research refers to the nature of things (Berg, 2009).

The mixed method research methodology of this study targets 16 purposely selected IRs as focus areas to observe their trends in scholarship curation. According to Best (2012: 267) mixed method research stems from pragmatism and is seen to strengthen the study by interrelating qualitative and quantitative methodologies (Best, 2012). Data analysis in mixed method research allows for quantitative analysis of descriptive and inferential statistics. Researchers could also make use of data transformation where qualitative and quantitative data analysis are integrated (Best, 2012: 268). Maree (2007) cites Creswell in explaining four reasons for using a mixed method approach:

- To use qualitative data in developing new ways to measure data or develop a new theory;
- By means of comparing different data sets to improve validity and increase the depth of findings;
- Strengthen the study findings by supplementing either qualitative or quantitative data;
- Use qualitative findings to explain quantitative findings (Maree, 2007: 269)

Best (2012: 270) adds to these reasons, additional advantages, including the availability of more data when qualitative and quantitative methods are combined, allowing the research to draw on the strengths of either approach to compensate for potential weakness of the other (Best, 2012). It allows for the triangulation method to compare and contrasts statistical data. More than one paradigm can be use.

This study is both quantitative and qualitative of nature, and includes quantitative webometric analysis, qualitative content analysis of IRs registered on the IR directory OpenDOAR, as well as data collected from the survey questionnaire with both qualitative and quantitative questions.

6.2.1 Quantitative and qualitative data measurement methods

Qualitative as well as quantitative research methods were used to get a better and deeper understanding of scholarship curation trends in the selected target group.

Whilst measuring data, the researcher takes a concept and create ways to observe the nature of this concept. Quantitative measurement is done by deduction and qualitative measurement is by looking at raw data via induction (Neuman, 2003). Best (2012: 270) says via deductive approaches assumptions are made. This takes place when the researcher uses a specific theory in data analyses to identify a pattern, whilst an inductive approach is when the researcher looks for the pattern in data after collection.

Theory is grounded in data (Neuman, 2003). Grounded theory was developed by Glaser and Strauss in 1967 (Best, 2012:99). Grounded theory often starts research without a clear hypothesis, and as categories of data emerges through systematic observations, concepts are clarified and categorised (Best, 2012:99). Grounded theory is useful when a new concept is being researched, such as KM in HEI and sustainability of IRs.

During a quantitative data collection process information and data are obtained via experiments, surveys, content analysis, observations or existing statistics from inter alia webometric sites and directories such as Ranking Web Repositories and OpenDOAR. During the qualitative process, data is obtained through field research which can include looking at specific case studies.

A group is chosen and observations are done around the research questions. Formal and informal interviews can aid observations (Neuman, 2003). From the observations done in the field, reports are drawn. The reports are often descriptive and explore situations in depth. It can take considerable time to collect the data. New concepts are created as data is collected and measured.

Many IR studies focused on deductive methodology and qualitative research in IM and systems design (Middleton, 2005; Wells, 2009; Yiotis, 2008).

Berg cites Denzin (2009) who says that each research method reveals various and different aspects of the empirical reality, and for this reason it is best to use triangulation methods (Berg, 2009). Best (2012: 276) states that triangulation was first used by Webb in 1966, and the benefits that triangulation offers, are often the main reason why researchers use a mixed method approach. The researcher is then able to employ different data collection options to get an understanding of the specific research problem in hand by using a combination of methods such as:

- Observation and focus group studies;
- Formal interviews;
- Surveys;
- Unstructured interviews
- Document analysis, content analysis, and web analysis

According to Berg (2009), Denzin identified the following types of triangulations:

- Data triangulation – the use of a number of different sources;
- Investigator triangulation – a number of researchers investigate the same research problem;
- Theory triangulation – more than one theory is combined to interpret data;
- Methodological triangulation – data from both qualitative and quantitative methods are collected and compared

Triangulation allows the researcher to use multiple data collection techniques, and also consider using multiple research theories (Berg, 2009; Hastings as cited in Salkind, 2010:1537).

Wells (2009) used this mixed method of research in his study of user groups of IRs in the United Kingdom. Aspects of his framework offers solutions in addressing the complex field of sustainability of IRs. Wells successfully combines the quantitative aspects of webometrics and web analysis with the qualitative approach of content analysis in studying IRs (Wells, 2009:1). He uses performance indicators to evaluate IRs, and allude to the fact that investigations into IR sustainability have so far concentrated only on evaluating the contributors or depositors of scholarly communication archived in IR database and not the organisational decision makers or the user groups of the IRs (Wells, 2009: 30).

For this study quantitative data was collected from completed empirical survey questionnaires. Webometrics analysis and IR content analysis were used to get deeper insight into the data collected from survey questionnaires. The data is collected not to prove or disprove a view point, but to observe the trends in scholarship curation of IRs in an operational reality. Analysing this data against webometric rankings will give insights into the inherent sustainability or lack thereof in the chosen target group.

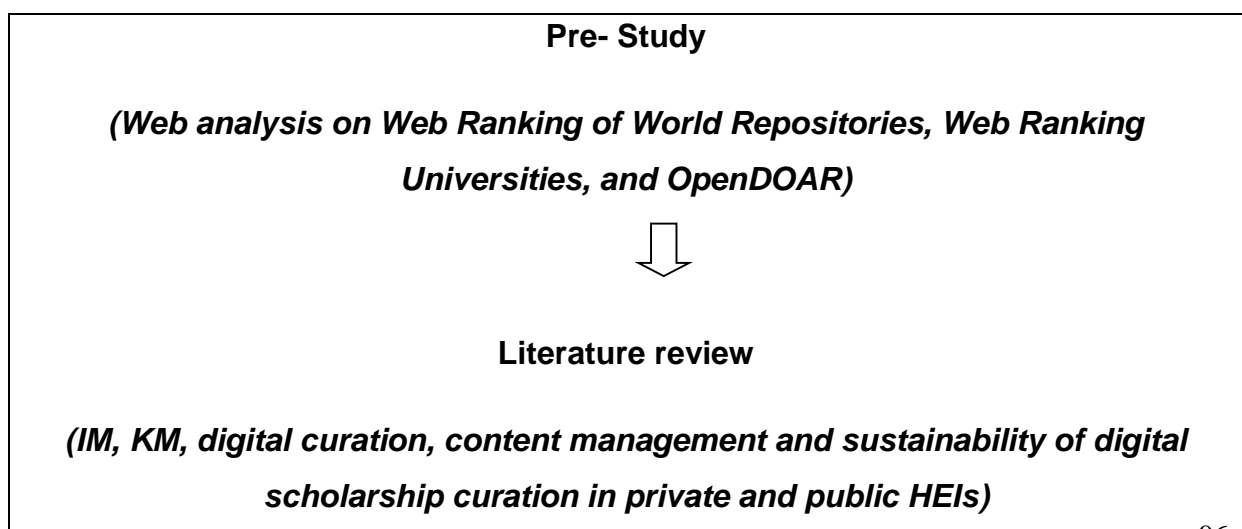
6.3 The research design

Both Neuman (2003) and Berg (2009) state that approaching a study from various venture points has merit, and may give better insights, understanding and may result in more research solutions. This can be done by applying an action research design (Berg, 2009). Jacobs (2010) sees action research as a process of planning, acting, observing and systematic reflection (Jacobs, 2010). The inclusion of various elements of research with a broad approach allows the researcher to incorporate methods such as various forms of surveying, observations and analysis.

The research design of a research project is the detailed plan of how the study will be conducted (Berg, 2009). It can be portrayed as a concept and process map explaining how data will be collected from the identified target group and via which means.

6.3.1 Concept map and data analysis

Researchers often make use of diagrams and maps to organise and structure the research area (Neuman, 2003). In the process map below the flow of this study is explained. In the first part of this study, web analysis was used to delimit the study and HEI IRs and exclude any HEI falling within the top 10 southern African IRs ranking on Ranking Web Repositories. Lower ranking IRs are purposefully selected for observation.





Establish theoretical framework (*Triangulation, STINT*)



Sampling of target population

(Purposeful selection IRs in southern African HEIs not ranking in the top African on Web Ranking Repositories, but do rank on Web Ranking Universities)



Identify HEIs

(16 private and public HEIs offering post graduate qualifications)



Design empirical survey questionnaire



Distribution of survey questionnaires



Capture data, analysis of data



Use survey results for content analysis on OpenDOAR



Figure 6.1 Research process map

Neuman (2003) states the importance of reviewing accumulated knowledge in the early stages of research. This is important regardless of the chosen method or theoretical framework of the study.

6.4 Data collection

In this study data was collected from completed empirical questionnaire surveys, web analysis from Ranking Web Repositories and content analysis from OpenDOAR. Data was triangulated from web directories and completed questionnaires. Berg (2009: 30) states that triangulation can be a rigorous form of research. This form of research may include multi-data collection methods as well as multi-theoretical and methodological departure points to research the same research questions. Data collection techniques can be quantitative (in the form of numbers) or qualitative (in the form of words) (Berg, 2009; Neuman, 2003).

In *Figure .6.1* the triangulated data collection methods for this study is graphically displayed.

6.4.1 The literature review

An extensive literature review of recent studies was done to provide a back ground on IR development globally. Attention was given to research concentrating on IM and KM strategies of IR in HEIs. The literature review explains how digital scholarship curation in OA IRs are planned, developed and managed by HEIs. The literature review includes document analysis of OA initiatives and agreements such as the Berlin Declaration of 2003 and BOAI of 2002.

Prior research on relevant LIS, IM, KM and IR research are discussed and used to clarify the complex and often diverse concepts that influence sustainability of IRs in general and in the chosen focus groups.

The literature review includes a historical review of IR development, as well as a context review to place the research problem in context of the variables influencing the study. OA, digital scholarship curation in IRs, KM and IM are contextualised. The literature review provides an overview of theories on IM and KM globally, as well as in Africa. Inferences from the literature review resulted in a socio-technical theoretical framework for this study as discussed in chapter five.

6.4.2 Empirical questionnaire survey

Sixteen questionnaires were sent to the relevant respondents identified as the most equipped to answer the questionnaire. These included research officers and repository managers. Data is collected via respondents' direct observation and experience. The questionnaire includes both structural and descriptive questions. Structured, or closed questions allows the respondent to choose one or more responses offered. These closed questions may include list, ranking, grid or scaled answers to choose from (Maree, 2007:161). Structured questions are easier to analyse, but the researcher must take care not to pre-empt an answer from the respondent. In this study, each structural question has an option, other, as a descriptive option to allow the researcher any possible answer not foreseen by the researcher. According to Guthrie (2010: 134)

scaled questions are used to measure attitudes or perceptions (Guthrie, 2010). The Likert scale allows the respondent to choose between options of strongly agree to strongly disagree. Questions should ideally have one to five options for the respondent to select in order to prevent fence sitting (Guthrie, 2010).

According to Neuman (2003) descriptive questions should be asked early to aid the researcher to familiarise herself with the setting and the participant. Contrast questions were asked after structural questions in order to verify, analyse or get clarity on similarities and differences in the field. The questionnaire consists of four sections:

Section A: Consists of direct questions to gather background on the HEI;

Section B: Gathers data on HEI environment and governance, containing direct and open ended questions;

Section C: Gathers data through scaled questions, value of scholarship, institutional and research culture of the HEI;

Section D: Measures performance, openness and institutional integration of IRs.

Questionnaires were emailed or hand delivered to the respondents.

6.4.3 Bibliometrics, infometrics and webometrics

Bibliometrics is a scientific tool to measure research output (Jacobs, 2010:1). Jacobs reports that Eugene Garfield's science citation index made analysis of research possible. As the internet developed, bibliometrics developed into scientometrics. Eventually webometrics developed as a powerful measurement of performance of scholarly communication. As such, OpenDOAR and Web Ranking Repositories are authoritative examples and sources of reliable IR statistics and performance monitoring worldwide.

Catell and Fernberger as cited in Jacobs (2010: 2) researched the systematic use of bibliometrics and laid the foundation for further research. Their work started the notion

to rank researchers according to their performance and led to the science citation index (Jacobs, 2010). There are three types of bibliometrics namely: descriptive, relational and evaluative bibliometrics. For the purpose of this study evaluative bibliometrics is important, as it is a tool to assess impact of scholarly work as well as the quality of digital scholarly contributions to OA collections.

Infometrics is the study of quantitative elements of information. The growth and multi-disciplinary application of infometrics is evident in the importance of the information society (Jacobs, 2010:3). The field of infometrics is developing and expands more and more where data is collected and evaluated electronically.

Infometrics, bibliometrics and scientometrics are interrelated (Jacobs, 2010:4). Webometrics can be seen as a subset of bibliometrics, as this tool analyses web data. In Figure 6.2 this interrelatedness is graphically explained, indicating where webometrics fit in. Webometrics studies the nature and characteristics of websites such as IR sites. Inlinks and outlinks to the webpage are calculated and analysed (Chakravarty & Wason, 2015:3).

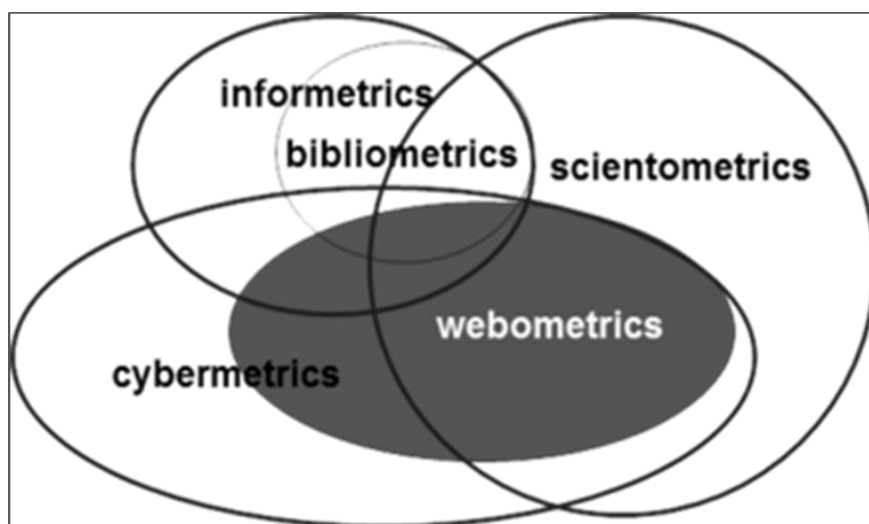


Figure 6.3 The interrelatedness of infometrics, bibliometrics, cybermetrics, scientometrics and webometrics. (Jacobs, 2010: 6)

Webometrics is a part of cybermetrics. Chakravarty and Wasan (2015) summarise some definitions for webometrics:

- The definition of Bojorneborn and Ingwersen which states state that webometrics as a quantitative analysis of construction and use of information resources and technologies is a web-based phenomena, drawing on bibliometric and infometric approaches;
- The definition of Thelwell, who sees webometrics as the study of web-based content by means of social science quantitative approach;
- Anwarul and Alam, cited in Chakravarty and Wasan, (2015:3), mention the four areas of webometrics: Web page content analysis, web link structure analysis, web page usage analysis, web terminology analysis

The web impact factor (WIF) evaluates the quality of the information on the website, as well as the popularity of the site. WIF was coined by the researcher Rodriguez Gairin in 1997(Chakravarty & Wasan, 2015:3), and it is of importance to this study as quality of information of scholarship in IR will impact on performance, sustainability and the value it adds to research and scholarship curation in HEIs. WIF is also an indicator and a measuring tool of success of a website. Ranking Web Repositories supply valuable information on IR performance. HEIs and managers of IR should be aware of their university rankings, as well as repository rankings to regularly gage and evaluate impact and success of IRs. These trends need to be reported to decision makers in the HEI. Chakravarty and Wasan (2015) warn that where the IR performance is too low, policies and strategies must be reviewed to increase volume and quality, making IM strategies a critical component of sustainable developments of Wasan, 2015:4).

6.4.3.1 Ranking Web of Universities and Ranking Web of Repositories

Consejo Superior de Investigaciones Científicas (CISC) manages the Ranking Web of Universities and Web Ranking of Repositories web directories as a research project.

Here, the Cybermetrics Lab makes use of quantitative analysis to evaluate HEIs performance and the directory data is updated every six months. In Ranking Web of Repositories web global content of scholarship communication measures universities' web activities and web visibility. This project developed applied cybermetrics techniques based on the positioning on search engines of web domains and analyses information usage through web data mining of log files.

6.4.4 Content analysis of IRs on OpenDOAR

Krippendorff in Salkind (2010: 234) describes content analyses as a research technique used often for making valid inferences from text in communication, but states that it can also be used in other meaning full sources such as maps, art, websites whether these sources are mass produced or private. Kim and Kuljis (2010: 369) refer to content analysis as a useful qualitative methodology to examine web-based content provided it is sampled and coded correctly. They cite Krippendorff's definition of content analysis as a valid technique to make inferences about data in their context (Kim & Kulis, 2010:369).

It is important to note that Krippendorff feels content analysis intends to take the user beyond the physicality of the source (Salkind, 2010:234). It is not the source itself being evaluated. Answers are inferred from the available information and interpreted. This is what differentiates content analysis from observations and measurements.

Based on the findings of the questionnaire, the IRs of the respondents will be examined to ascertain the presence, size openness, and policy and standards adherence on the OpenDOAR repository directory, Open DOAR. OpenDOAR was

developed by The University of Nottingham's Centre for Research Communication in the United Kingdom and is managed as a SHERPA research project. It aims to:

- Survey the growing field of academic OA IRs and categorise them in terms of e-content, content policies and standards;
- Produce a descriptive and authoritative list of global OA IRs as a benchmark for academic scholarly curation;
- Play a prominent international role in the organisation of and access to OA scholarship collections;
- Support OA awareness in HEIs. (OpenDOAR, 2016)

Open DOAR provides raw data for qualitative content analysis.

6.5 Sampling

Neuman (2003: 40) states that field researchers select samples from a smaller and selective grouping. This is called theoretical sampling and it differs from survey research sampling. The field researcher selects specific situations, locations, groupings and contexts.

6.6 Delimitation

Ranking Web of Universities was used to identify HEIs' IRs falling below the top 500 global ranking universities and below the African top ten IRs on Ranking Web Repositories. The target group includes both public and private HEIs in southern Africa, offering post graduate qualifications and actively producing scholarly communication and research. Consortiums, research institutions such as South East Academic Library System in South Africa (SEALS), African Higher Education Research Online (AHERO), among others, were excluded as these repositories fall outside of the parameters of the institutional nature of this study. These consortia will not provide insights into the KM strategies in the HEI. Only HEIs mentioned on Ranking

Web of Universities were selected, as these HEIs has a web presence. Sixteen HEIs were selected to form part of this study.

6.7 Quality and reliability of data

Both internal and external consistency will determine reliability of data (Berg, 2009; Neuman, 2003).

6.8 Reliability and validity

Reliability refers to the potential consistency of findings should the research be conducted by another researcher. The triangulation method used in this study enhances the credibility of the findings. The validity of research depends on the researcher's analysis and representation of the data.

6.9 Research ethics

Only HEIs who's Registrars gave written permission to conduct research were included in the study. Confidentiality in research is very important. The participating HEIs are referred to alpha-numerically and will not be identifiable. Sensitive information on quality and information ethics must be handled with the due considerations. The data collected will be reported anonymously, numbered with the prefix as private HEI B (plus numeric) and public HEI A (plus numeric). When reporting on ratings on Ranking Web Repositories, a range will be used, as not to expose a HEI.

6.10. Summary

Chapter six presents the research design and methodology used in the study of IM and KM for sustainability in IR. A triangulated methodology was used to gather the data. The nature a triangulation was explained. This study will apply triangulation both in method and in theory.

The process map in Figure 6.1 presents a summary the research process followed. Both quantitative and qualitative methods were used. Data was gathered from

empirical questionnaires, web analysis on ranking of HEIs and their IRs, as well as inferences and interpretation from content analysis of an IR directory, OpenDOAR. In Figure 6.3 the triangulated methodology used to evaluate the trends in the selected private and public HEI in southern Africa is graphically explained.

A socio-technical approach where all aspects of IR technology and social aspects such as research culture, perceived value and trust of research scholarship are included and covered in this study. This is the first study of its kind in southern Africa, using a sociotechnical approach and looking at IM and KM for sustainability in both private and public HEIs IR. The aim is to identify factors that negatively impact on sustainability, and to derive at a sustainability strategy or model suitable for less research intensive institutions, as their research output have value for the global research and knowledge society.

In chapter seven data obtained will be analysed and reported. Chapter seven will give a report of the research findings of the empirical survey questionnaire, webometric analysis and the content analysis.

Chapter 7: Presentation of research findings

7.1 Introduction

Sixteen HEIs in southern Africa were purposefully selected to include both private HEIs and public HEIs to participate in this study. Eight were selected from public HEIs and eight from private HEIs all of them actively producing post-graduate scholarship. They were selected from the Ranking Web of Universities. This directory of world universities rank HEIs according to their web presence. The two selected types of HEIs for this study fall below the top ten ranking research HEIs, but they do fall within the 50th per centile of the ranking universities in Sub-Saharan Africa. HEIs falling within the top half of HEIs have a vested interest in growing their web visibility, and increase the prestige of their institution. The statistics on Ranking Web of Universities are updated every six months and is managed by the Spanish National Research Council (CSIC). It is largest academic ranking site and has been in operation since 2004 (Ranking Web of Universities, 2016). Research output, research repositories and scholarly communication are among the key factors playing a role in calculating an institution's performance, and the following statement on Ranking Web of Universities explains the importance thereof:

“We intend to motivate both institutions and scholars to have a web presence that reflect accurately their activities. If the web performance of an institution is below the expected position according to their academic excellence, university authorities should reconsider their web policy, promoting substantial increases of the volume and quality of their electronic publications” (Web Ranking of Universities, 2016).

Very little research has been conducted around southern African private HEIs and their research culture. This study offers an opportunity to investigate the nature of scholarship curation in a selection of private and public HEIs, producing research and scholarship output. Furthermore, emerging and current trends in public and private HEIs in the target group were observed and evaluated. The participants in the target

group produce research and scholarship, but not on the same level of traditional research HEIs.

Empirical survey questionnaires were sent to all sixteen selected participants, after ascertaining who the most appropriate respondent responsible for IRs and other forms of scholarship curation in the HEIs are. Official permissions were obtained from all Registrar offices to include their HEI in this study. The target population was selected to fall below the top ten HEI ranking universities on Ranking Web of Universities. The top ten HEIs and their IRs are already well established and scholarship curation proved to be managed sustainably (OpenDOAR, 2016). Both private and public HEIs in the target group already have established a web visibility and are ranking on Ranking Web of Universities, falling just below the top ten HEIs on the Sub-Saharan list of Ranking Web of Universities. The first eight private HEIs and public HEIs falling below the top ten were selected for this study and their ranking ranges is presented in Table 7.1 (See Table 7.1). Only HEIs with post-graduate programmes and qualifications were filtered and selected for this study.

Four out of eight private HEIs completed questionnaires and six out of eight public HEIs responded and completed the questionnaires. Two private HEIs responded, but omitted to complete the questionnaire. Following up with those HEIs, the reason given for their non-participation is mainly due their realisation that their scholarship curation and collections fall outside of the sophistication, scope, nature and interoperable standards, generally practised in ranking OA IRs. Their scholarship curation processes are too rudimentary to participate meaningfully. It is hoped that the results and recommendations stemming from this study would assist them to improve their scholarship curation practices.

Data was collected from Ranking Web of Universities, Ranking Web of Repositories and OpenDOAR and a triangulated method was used to analyse data from these metrics. The responses of the questionnaire were used to determine trends in scholarship curation in terms of openness, visibility, interoperability, and integration with institutional research activities. Trends supporting sustainability and successful

scholarship curation were investigated. Based on these results a sustainability framework or model for scholarship curation in typically smaller and lower ranking HEIs will be offered. Sustainability risk factors were identified.

7.2 Data analysis of Ranking Web of Universities

There is a total of 862 HEIs in Sub-Saharan Africa registered on Ranking of Web Universities. This figure includes private and public HEIs. Not all ranking HEIs offer post-graduate qualifications. (Ranking of Web Universities, 2016). Private HEIs rank on Ranking Web of Universities, albeit significantly lower than most public HEIs. This is evident in the summary in Table 7.1 where the selected public and private HEIs are displayed, with their ranking levels showing as interval ranges. This is done to provide the ranking of a HEIs without compromising their identity and to ensure anonymity. Both the world ranking as well as the Sub-Saharan rankings are displayed. The world ranking is given in intervals of 500, and the corresponding Sub-Saharan rankings are given in intervals of 10 for each HEI. All the HEIs in the target group offer post-graduate qualifications on a masters and/or doctoral level.

Table 7.1 World and Sub-Saharan ranking of HEIs in the target group (Ranking Web Universities, May 2016),

HEI	Type	Ranking Universities	World Ranking falling between intervals of 500	Sub-Saharan Ranking falling between intervals of 10
A1.	Public	Yes	3500-4000	50-60
A2.	Public	Yes	3000-3500	40-50
A3.	Public	Yes	500-1000	10-20
A4.	Public	Yes	3000-3500	40-50
A.5	Public	Yes	2500-3000	20-30

A.6	Public	Yes	6500-7000	70-80
A.7	Public	Yes	4000-4500	60-70
A.8	Public	Yes	7000-7500	90-100
B.1	Private	Yes	4500-5000	60-70
B.2.	Private	Yes	9500-10 000	120-130
B.3.	Private	Yes	15000-15500	200-210
B.4.	Private	Yes	7500-8000	90-100
B.5.	Private	Yes	12500-13000	170-180
B.6	Private	Yes	21500-22000	250-260
B.7	Private	Yes	15500-16000	280-290
B.8	Private	Yes	16500-1700	390-400

The rationale for selecting HEIs ranking below the top ten on the Sub-Saharan list of Ranking of Universities are:

- The KM of HEI IRs in less research intensive HEIs must be evaluated to ascertain the how and if scholarship collections are managed towards sustainably, growth and development;
- Private HEI creates new knowledge, research and scholarship;
- HEIs ranking on Ranking Web of Universities already have a web presence.

The information extracted is a true reflection of statistics on Ranking Web of Universities as on May 2016. One private HEI, B.1 compares favourably with the rankings of the public HEIs, but the rest of the seven private HEIs rank significantly lower (See Table 7.1).

7.3 The empirical survey questionnaire results

The questionnaire consists of four sections:

- Section A asked questions to establish the background of the selected HEIs to contextualise the target group. A detailed summary of all survey answers is presented as Annexure A;
- Section B asked questions around governance, strategy and policy;
- Section C looked at perceived benefits and the value of scholarship in the HEI;
- Section D sets out to measure openness and integration of scholarship curation management with institutional goals and strategies.

Coefficient alpha, or Cronbach's alpha, quantifies reliability and represents the proportion of observed score variance that is true score variance (Salkind, 2010).

Credibility of the research was measured by the Cronbach Alpha Coefficient and the scale employed is 0% to 100%, with the higher per centage indicating a higher credibility rating:

$$\alpha = \left(\frac{n}{n-1} \right) \times \left(\frac{SD_X^2 - \sum SD_i^2}{SD_X^2} \right)$$

n equals the number of respondents in the target group.

The individual sections in the questionnaire were rated as follows:

- Section A: 0,654
- Section B: 0,753
- Section C: 0,780
- Section D: 0,783

An overall coefficient of 74.25 was calculated for the results obtained and this is considered to be in the range of scores considered as being reliable

7.3.1 Background information: the nature of scholarship production and curation in the target group

Section A of the survey questionnaire gathered background information on the type of HEI (university), level of qualification and programmes offered, nature of scholarship production. The nature of data, information and knowledge in the target pertaining to scholarship curation was investigated.

Sixteen survey questionnaires were distributed, 12 institutions consented in writing to indicate their willingness to take part, making the participation rate 75%. However, after receiving the documents and considering the level of the survey questionnaire, two private HEIs indicated they have scholarship collections, but regrettably their expertise and level of curation is not yet fully developed and they prefer to retract from the study. The feedback ratio was then 62.5% of HEIS who completed and returned the questionnaire.

7.3.1.1 Target population

The target population consists of:

- 30% Public research HEIs
- 30% Comprehensive and Universities of Technology
- 40% Private HEIs

Although both comprehensive universities and Universities of Technology in South Africa are public universities, receiving and operating on public funding, a differentiation is made between comprehensive HEI and universities of technologies. For statistical purposes they will all be considered public HEIs as opposed to private HEIs.

7.3.1.2 Knowledge and scholarship creation

All participating HEIs were purposefully selected, and the target population only includes HEIs with post-graduate diplomas, honours, masters and/or doctoral offerings, who actively create research output and scholarship communication. All

respondents confirmed to offering post-graduate qualifications. For the purpose of this study post-graduate qualifications include post-graduate diplomas, honours degrees, masters and doctoral degrees. *Figure 7.1* depicts the qualification offering totals.

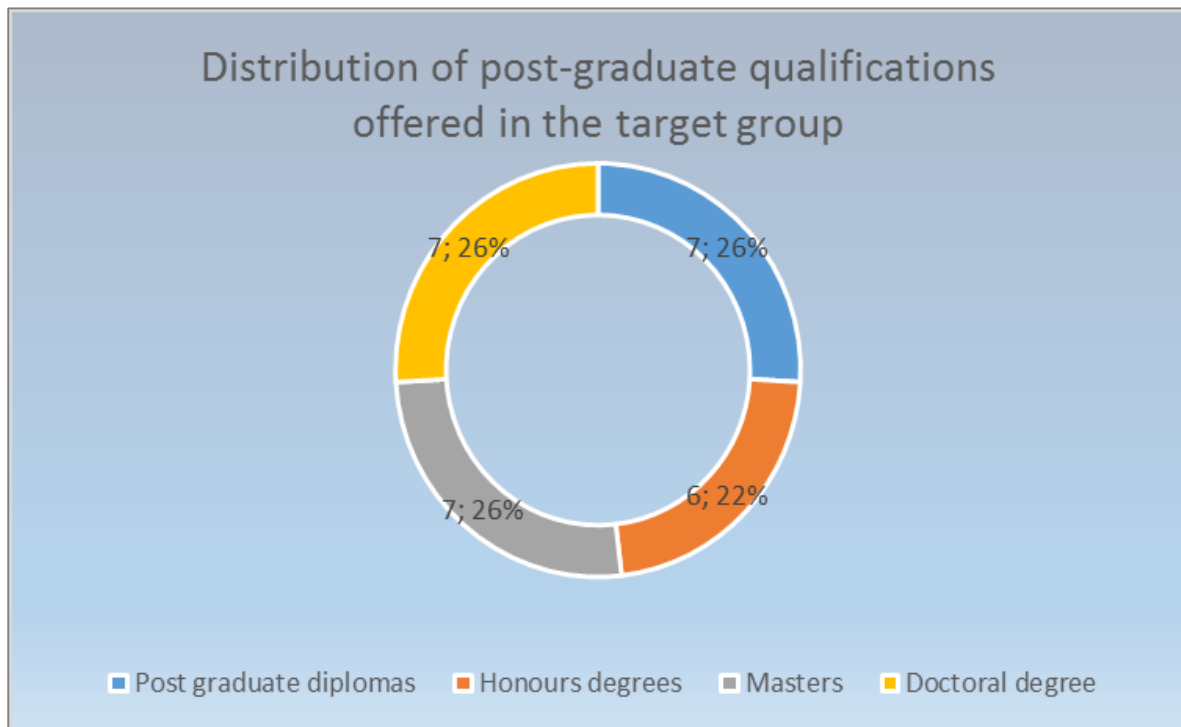


Figure 7.1 The distribution of post-graduate programmes in the target group

All respondents indicated that both post-graduate students and academic staff members produce scholarship and communicate this scholarship via academic research platforms and publications. The list of sources and formats where research are presented or published can be seen in Table 7.2. Academic journals are the preferred source for scholarship at fifty per cent (50%) in both private and public HEIs indicating that they have their own journal at the HEI. Public HEIs indicated that all produce scholarship in dissertation and theses, where fifty per cent (50%) of private HEIs indicated that they have scholarship in theses. housed and curated in IRs.

Table 7.2 Sources for scholarship communication used by HEIs in the target group

Source	Public HEI	Private HEI
Journal articles for own journal	50%	50%
Journal articles for accredited research journals	100%	75%
Journal articles for other/ non-accredited journals	16,6%	25%
Mini dissertations	33,3%	50%
Research projects	83,3%	25%
Dissertations	100%	25%
Theses	100%	50%
Conference proceedings	83,3%	50%
Conference papers	83,3%	50%
Other (Please elaborate)	0%	0%

Trends for preferred sources of scholarship communication correlated between public and private HEIs, however scholarship creation appears to be higher in public HEIs in the target group (See *Figure 7.2*).

All the HEIs in the target group produce scholarship in dissertations and theses, Seventy five per cent (75%) of the private HEIs in the target group have scholarship in dissertations and thesis. The next popular source to house scholarship is conference papers and conference proceedings.

Private and public HEIs

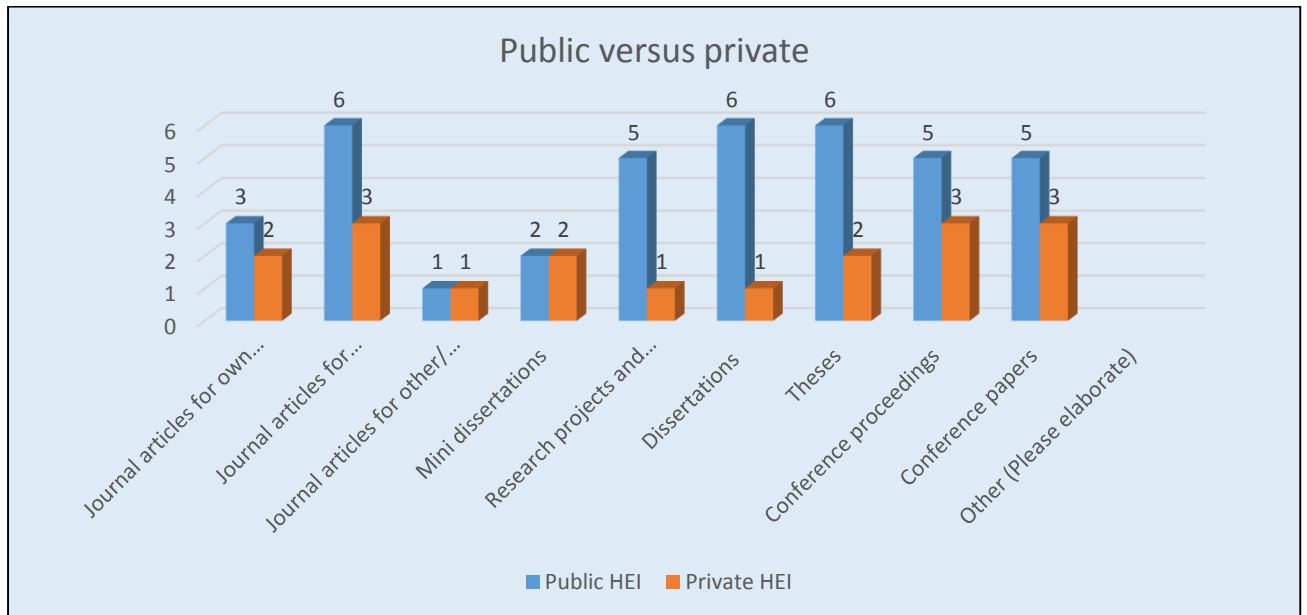


Figure 7.2 A comparison of scholarship production between public and private HEIs

7.3.2 Institutional governance of scholarship

Section B gathered information on the level of institutional governance in terms of decision making structures, support, strategies, and policies. It interrogates the level of support to scholarship curation and determines the organisational/institutional level of decision making around IRs. The presence and awareness of IM and KM practices, or the lack there of, in supporting and promoting digital scholarship curation were investigated.

7.3.2.1 Strategies for sustainable curation of scholarship and research output

Figure 7.2 provides an overview of the existing strategies in HEIs impacting on scholarship production and also is currently available in the target group. Fifty per cent (50%) of HEIs have a research strategy, IT strategy and an OA strategy. Only twenty

per cent (20%) indicated that they have KM strategies in place. This corresponds with the study by Blackman and Kennedy (2009: 560) stating that HEIs are generally slow to take up KM strategies despite their potential benefits. Strategies in private HEIs are less developed. One private HEI respondent did not answer this question. Only one respondent from a private HEI indicated that they have an OA policy in place. Recent globally studies into the research role and activities of private HEI are showing an upward trend in OA policies in HEIs (Thuraisingam *et al.*, 2014; Casani, De Filippo, Garcia-Zorita & Sanz-Casado). The results of this study indicate that southern African HEIs are not yet on par with global trends.

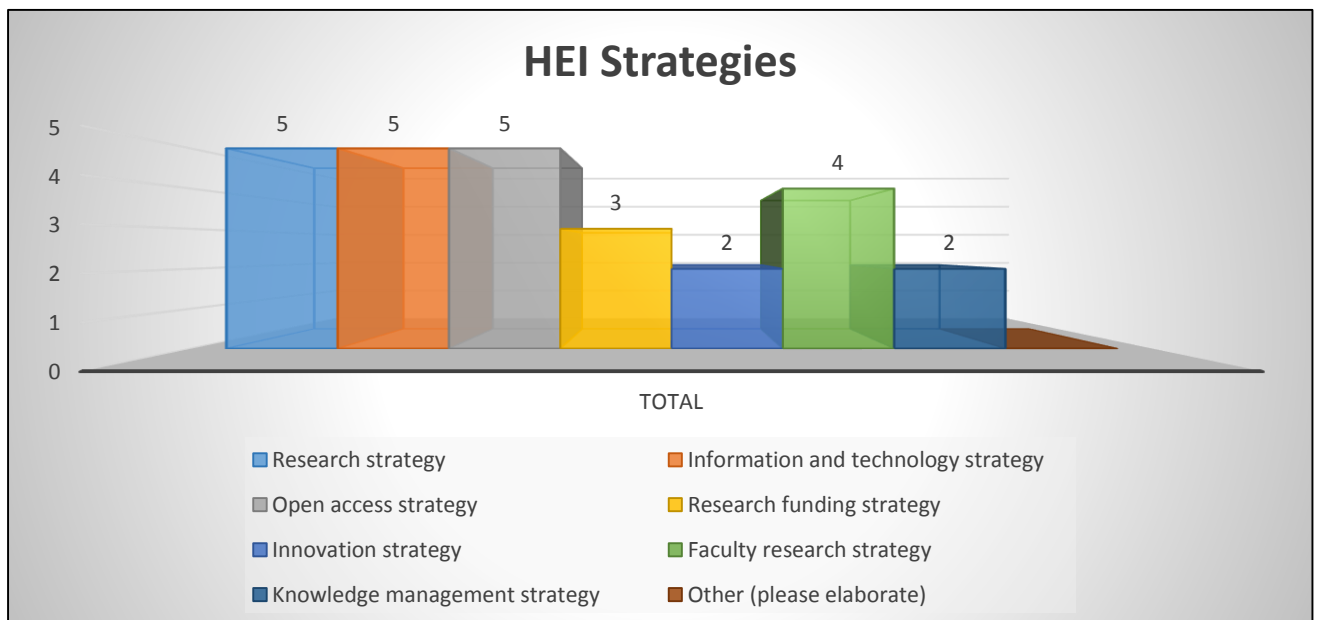


Figure 7.3 Existing HEI strategies in the target group

7.3.2.2 Institutional governance and scholarship

Rieger (2011) followed a socio-technical approach in studying sustainability in the ArXiv, a subject discipline IR, managed by Cornell University, where she identified six assessment principles to enhance sustainability of IRs:

- The IR requires a clearly defined mandate and governance structure;

- Deep integration into the scholarly community and scholarly processes on all levels and departments in the HEI;
- Systematic development, revision and updates of content policies;
- Technology platform stability and innovation;
- Reliance on business planning strategies;
- Implementation of user-based strategies and feedback cycles. (Rieger, 2011:502)

Having strategies in place do not ensure best practice. Policy and procedure documents should be aligned with all HEI strategies. The nature of policies impacting on scholarship and research output and communication in the target group sees only fifty per cent (50%) of respondents stating that IR policies are in place. Only twenty per cent (20%) have an OA policy in place. According to the answers no one has a RIMS policy in place, indicating that the IRs in the target group are not staying abreast of innovations.

7.3.2.3 Scholarship curation, policy and procedure

The level of decision making regarding all aspects of IR is an important factor in the efficiency and longer term development and sustainability of IRs. Tian, Nakamori and Wierzbicky found in their 2009 study at a Japanese university that the biggest stumbling block in establishing KM for the enhancement of research knowledge creation lies in the lack of HEI governance recognition, understanding and support (Tian, Nakamori & Wierzbicky, 2009:90). Forty per cent (40%) of the target group indicated that their Library Committee makes the only decision around IRs. Mostly the private HEIs reported other, but similar, structures such as research boards or joint committees.

7.3.2.4 KM in scholarship curation

In the absence of KM strategy as reported within the target group, the study needed to ascertain if KM concepts are addressed in existing policies. Table 7.3 summarises

the most important KM terminology and concepts in policies and strategies around scholarship and the responses on their presence in decision making.

Table 7.3 KM terminology and concepts in existing policies (* responses per HEI type; ** overall target group response)

	Yes (Public)	Yes (Private)	No (Public)	No (Private)	Not sure (Public)	Not Sure (Private)
Knowledge management	4 *(66.7%) **(40%)	0 *(0%) **(0%)	0 *(0%) **(0%)	3 *(75%) **(30%)	1 *(12, 5%) **(10%)	1 *(25%) **(10%)
Knowledge capital	2 *(25%) **(20%)	0 *(0%) **(0%)	0 *(0%) **(0%)	2 *(50%) **(20%)	2 *(50%) **(20%)	0 *(0%) **(0%)
Intellectual capital	4 *(50%) **(40%)	0 *(0%) **(0%)	0 *(0%) **(0%)	1 *(25%) **(10%)	1 *(12.5%) **(10%)	1 *(25%) **(10%)
Knowledge creation	4 *(50%) **(40%)	0 *(0%) **(0%)	0 *(0%) **(0%)	2 *(50%) **(20%)	1 *(12.5%) **(10%)	0 *(0%) **(0%)
	3 *(37.5%)	0 *(0%)	0 *(0%)	1 *(25%)	1 *(12.5%)	1 *(25%)

Competitive edge	** (30%)	** (0%)	** (0%)	** (10%)	** (10%)	** (10%)
Totals	17	0	0	9	0	3

Findings in Table 7.3 indicate a low level of KM strategies, or KM concepts and tangents in other policies present in the environment of the target group. In *Figure 7.4* only 26% of respondents refer to KM, only 27% refer to scholarship as knowledge or intellectual capital. Research on knowledge capital is still largely undefined in the target group. In a related study conducted across thirteen countries, Lagzian, Abrizah and Wee (2015) found that IR could not be managed successfully without good governance policies, plus managerial directive and support (Lagzian, Abrizah and Wee, 2015:201). From their study on KM strategies in a Bangkok University, Blackman and Kennedy (2009: 143) summarised that socio-organisational as well as KM factors remain critical in designing and developing a learning environment conducive knowledge creation.

The presence of KM terminology in HEI policy and strategy documentation

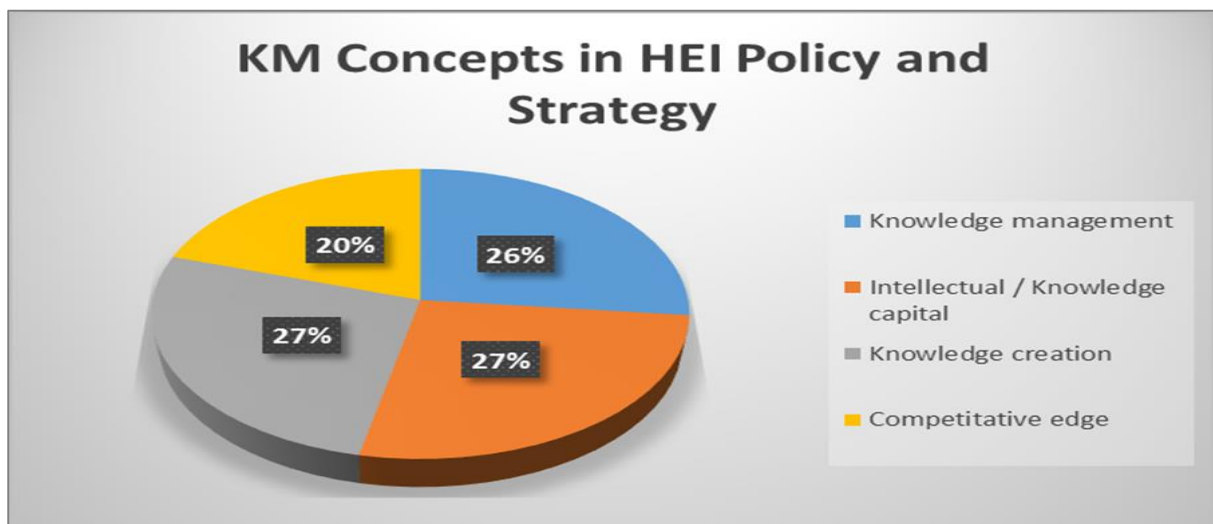


Figure 7.4 The presence of KM terminology in HEI policy and strategy documentation

7.3.3 Value, trust and quality of scholarship curation

Section C explored the perceived benefits of having digital scholarship in OA IRs and gages the value it has in the HEI. It probes the research culture and research support in HEI. It sets out to measure the knowledge and awareness of this phenomena in the HEI. Table 7.5 shows the level of IR awareness, value and perceived IR benefits reported by respondents in the target group.

Seventy per cent (70%) of respondents feel they are informed about all research related digital projects in their respective HEI. Eighty per cent (80%) of respondents are of the opinion that digital curation in IR should be centralised function in the HEI.

Sixty per cent (60%) of respondents reported that their HEI supports and funds research production. Forty per cent (40%) is of the opinion that research is secondary to teaching and learning at the HEI. This corresponds with a study done in 2014 in Malaysian private universities by Thuraisingam *et al.* (2014: 527), where they found that the research culture was not well established, and research and knowledge creation were indeed secondary to teaching and learning. They feel that it could be prescribed to a lack of standards, structure, research incentives and research support at the HEIs (Thuraisingam *et al.* 2014). Subsequently Malaysia developed research standards, designed to give the necessary support to researchers in private HEIs.

Eighty per cent (80%) of respondents indicated that their research and scholarship output is curated and preserved in some or other form. The lack of presence of their IR on OpenDOAR raises questions whether HEIs are knowledgeable in scholarship curation standards and best practise. One private HEI indicated that their scholarship is only available on their website, and that they are unfamiliar with scholarship curation practises.

Table 7.4 Awareness, value and perceived IR benefits

IR awareness, benefits and value of digital research and scholarship repositories	Strongly agree	Agree	Unsure	Disagree	Strongly disagree
I am fully aware of all digital scholarship projects and databases provided by my institution/ university/ college	4 (40%)	3 (30%)	0 (0%)	1 (10%)	0 (0%)
I believe that quality research should not be housed in different departmental databases, but rather in well-coordinated and centrally managed repositories	8 (80%)	1 (10%)	0 (0%)	0 (0%)	1 (10%)

My university/institute/ college actively promotes and gives open access to research housed in a digital repository	4 (40%)	2 (20%)	2 (20%)	0 (90%)	2 (20%)
My university/institute/ college encourages and supports research in terms of funding, study leave and other incentives to promote research	2 (20%)	4 (40%)	1 (10%)	0 (0%)	3 (30%)
Research and scholarship are secondary to teaching and learning	0 (0%)	4 (40%)	2 (20%)	2 (20%)	0 (0%)
Research is not curated or digitised in scholarship repositories or other research collections	0 (0%)	1 (10%)	0 (0%)	3 (30%)	5 (50%)

7.3.4 Critical success factors in IR management

Section D seeks answers on how scholarship collection management and IR management, planning, awareness, integration and interoperability enhance success and sustainability. *Figure 7.5* displays the mandating structures for IR. The answer correlates with the policy answer in question 8 where 50% of IR management takes place in Library Committees. Respondents indicated that Senate governs IR and IR policy. Thirty per cent (30%) said that the research committee would play a part in IR planning.

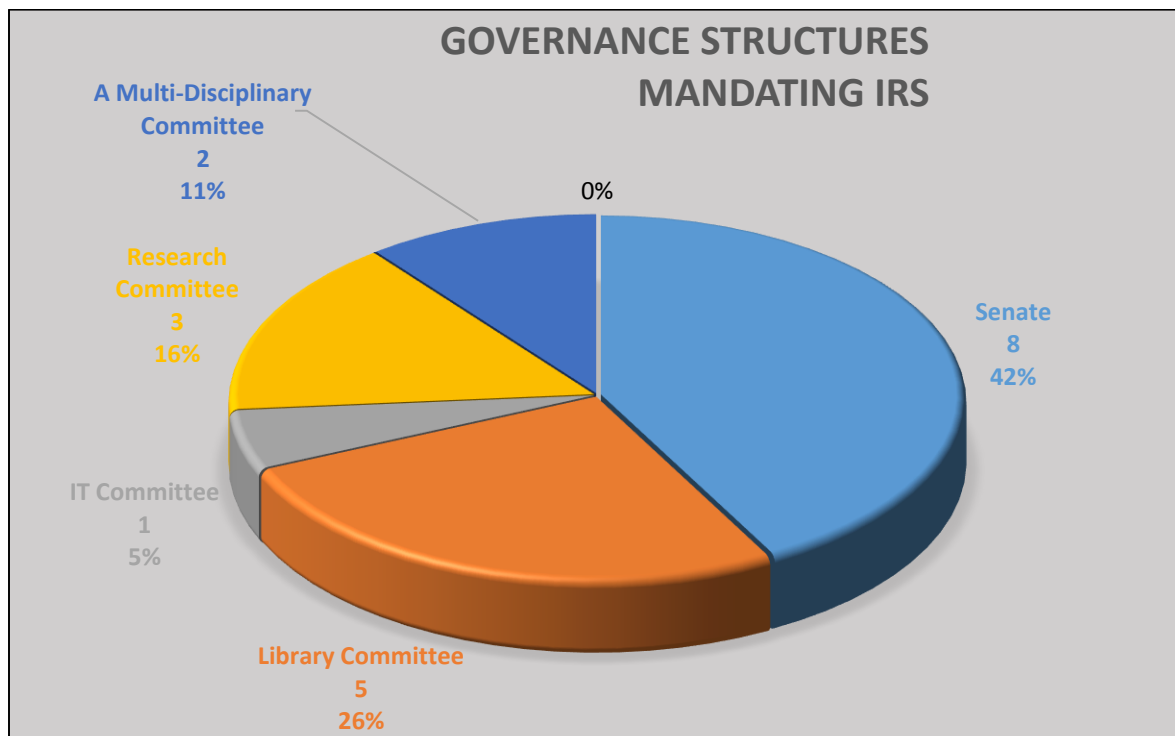


Figure 7.5 Governance structures in planning and maintaining IRs

7.3.4.1 IR relevancy in HEI

The nature, scope and importance of digital scholarship collections in the target group was interrogated to ascertain if curation is understood and supported by management

structures. Only one respondent from a private HEI indicated that digital scholarship collections are not known or supported by management structures. One respondent, also from a private HEI, was not sure. Eighty per cent (80%) of respondents answered affirmative and feels that their management and governance structures are informed about scholarship collections.

7.3.4.2 IR funding

Both Westell (2006) and Thuraisingam *et al.* (2014) recognise funding as a critical success factor for IRs. On the question if budgeting and separate funding for IR are in place sixty per cent (60%) of respondents indicated that there is no separate budgets for IR. Fifty per cent (50%) was public HEIs and ninety per cent (90%) of private HEIs do not have a separate budget for IR. One respondent from a public HEI indicated that an allocation is made on the general library budget. One respondent did not supply an answer to this question.

7.3.4.3 Institutional integration of IR

The level of integration of IR with other institutional and research related activities, systems and projects is an indicator of both success and sustainability.

Interdepartmental collaboration in forums/committees, where all stakeholders are present and participate meaningfully, is an indicator for success: sixty per cent (60%) indicated that this is not in place in the IR management structures. In a study by Middleton, (2005: 150) it was found that networking across skills areas increases expertise, resources and extended funding. He calls it the multi-faceted approach to sustainability (Middleton, 2005:150).

Two private HEIs indicated that their IR is managed by a range of collaborating professionals sharing expertise, which makes up 20% of the total responses. Middleton

(2005; 145) stresses the importance of networking and cross-departmental collaboration towards sustainable IRs (Middleton, 2005:146).

Constant development and innovation is a requirement for success and development. Respondents indicated that new developments such as research information management systems (RIMS) and digital scholarship collections are jointly planned and managed: only twenty per cent (20%) indicated that these innovations are happening. Rieger (2011) expressed the importance of constant innovation and alignment with institutional developments as a critical factor in the sustainability of IR (Rieger, 2011:250). Innovation is taking place in public HEIs but not in private HEIs. There is an indication of poor integration with research developments across departments as IRs are not linked to further research planning and developments in the HEIs.

7.3.4.4 Marketing of scholarship curation in IR

Sixty per cent (60%) of all respondents feel that their IRs are well known in their HEIs and research community. Eighty per cent (80%) of respondents indicated that their scholarship collections are visible on their HEI website. However, content analysis on OpenDOAR indicates that even though scholarship is available on the HEI's website, web visibility is compromised where OA harvesting and interoperability standards are not adhered to and implemented (OpenDOAR, 2016) (See Table 7.5).

Marketing and awareness are critical to IR success and sustainability. On a question if there are regular calls for participation and contribution of research output for submission to the repositories, a total of 40% of respondents indicated that there are proactive efforts to populate their IR (Table 7.5). This leaves 60% of the target group open to random and inconsistent contributions by researchers' and students' scholarship to be curated in an organised and controlled way.

7.3.4.5 Networking and openness

This survey probed if HEIs are aware of benefits as well as the level of trust in the quality of OA scholarship curation. The question looked at the nature of networking both internally and externally with likeminded stakeholders from other HEIs and repository managers (See Table 7.6).

Fifty per cent (50%) of the total population group indicated that their research is freely available in OA. Seventy-five per cent of private HEIs indicate that their scholarship is available in OA, a statistic that does not correlate with their visibility on OpenDOAR, and the answer of networking with institutions such as NDLT in the next question, where only twenty five per cent (25%) of private HEIs indicates that they are networking. It could be that there is a lack of understanding of OA research within private HEIs. Only 30% of public HEIs and 20% of private HEIs indicated that their researchers are informed on the benefits of OA research.

Thirty per cent (30%) of public HEIs said yes, while only two private HEIs said yes. Forty per cent (40%) of respondents are not sure. This despite previous answers that their HEI value OA.

Comments added to the open question:

- A1: Advocacy and marketing of IR is done rigorously and trust is improving;
- A3: Researchers are concerned about copyright in OA;

B3: Researchers are aware of OA scholarship, but do not trust quality of research.

Table 7.5 IR web awareness, visibility, and advocacy

Awareness, visibility, advocacy	Yes	Public	Private	No	Public	Private	Not sure	Public	Private
Research repositories and scholarship collections are general knowledge to all staff, researchers and students	1	3 *(50%) **(30%)	3 *(75%) **(30%)	1	3 *(50%) **(30%)	0 *(0%) **(0%)	1	0 *(0%) **(0%)	1 *(25%) **(10%)
The research/scholarship repository is visible and accessible on my institution's website	2	5 *(62.5%) **(50%)	3 *(75%) **(30%)	2	1 *(16.6%) **(10%)	1 *(25%) **(10%)		0 *(0%) **(0%)	0 *(0%) **(0%)
There are regular calls for participation and contribution of research output created for submission to the repositories	3	2 *(25%) **(20%)	2 *(50%) **(20%)	3	3 *(50%) **(30%)	1 *(25%) **(10%)		0 *(0%) **(0%)	0 *(0%) **(0%)

Table 7.6 IR networking and openness

	Yes	A	B	No	A	B	Not sure	A	B
My institution/ university/ college's research is freely available in the open access environment	1	5 *83% **50%	3 *75% **30%		1 *16.7% **10%	1 *25% **10%		0 *(0%) **(0%)	0 *(0%) **(0%)
My institution/university/ college actively promotes and takes part in initiatives such as Open Access week, ND LTD and other research repository networking opportunities	2	5 *(83%) **(50%)	3 *(75%) **(30%)	1	0 *(0%) **(0%)	1 *(25%) **(10%)		0 *(0%) **(0%)	0 *(0%) **(0%)
Researchers at my institution are aware of the	3	3 *(50%) **(30%)	2 *(50%) **(20%)		1 *(16.7%) **(10%)	0 *(0%) **(0%)		2 *(33%) **(20%)	2 *(50%) **(20%)

benefits of publishing in open access									
Researchers at my institution do not trust the quality of open access research sources.	4	1 *(16.7%) **(10%)	1 *(25%) **(10%)		2 *(33%) **(20%)	2 *(50%) **(20%)		3 *(50%) **(30%)	1 *(16.7%) **(10%)

(* per centage per HEI type; ** per centage of total respondents)

7.3.4.6 Preservation, curation, interoperability of IR

Westell (2006) mentioned that long term curation and preservation poses challenges for IR managers and affect success negatively. Table 7.7 reports respondents' answers on preservation, curation and interoperability. Fifty per cent (50%) of repositories have a long term preservation plan in place, but forty per cent (40%) have no preservation plans in place.

Fifty per cent (50%) of public HEIs uses a form of OA standards such as OAI-PMH and OAIster, while forty per cent (40%) of public HEIs do not. This fact is corroborated by the content analysis on OpenDOAR where only four respondents (40%) adhere to the OA interoperability standards, and thereby open their collections up for harvesting.

Answers to the open ended questions for this section reported that one public HEI only provides access in-house via the HEI intranet and not on all the available OA platforms, thereby also not adhering to OA protocols

7.3.4.7 The importance of IR performance monitoring

After successful implementation, successful performance monitoring of IR growth and usage is cardinal for successful management of IR. Table 7.8 reports responses on ranking, application of standards and measuring of performance of the IRs in the target group. Seventy per cent (70%) of respondents feel that their IRs are monitored in terms of usage, growth and performance.

Table 7.7 IR preservation, curation and interoperability.

Preservation, curation and interoperability	Yes	Public	Private	No	Public	Private	Not sure	Public	Private
Do you have a long term preservation strategy for your digital records?	1	4 *(50%) **(40%)	1 *(12,5) **(10%)	1	3 *(75%) **(30)	1 *(25%) **(10%)	1	0 *(0%) **(0%)	0 *(0%) **(0%)
Are you subscribing to standards for web content interoperability such as OAI-PMH,	2	5 *(62.5) **(50%)	0 *(0%) **(0%)	2	1 *(25%) **(10%)	3 *(75%) **(30%)	2	0 *(0%) **(0%)	0 *(0%) **(0%)

and OAIster in your digital repository?									
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(* per centage per HEI type; ** per centage of total respondents)

. Table 7. 8 IR ranking, standards and performance

IR Ranking, standards, performance	Yes	Public	Private	No	Public	Private	Not sure	Public	Private
Regular statistical analysis takes place to measure usage, growth and performance trends of the research repository	1	5 *(62.5%) **(50%)	2 (50%) **(20%)	1	1 *(12.5%) **(10%)	1 *(25%) **(10%)	1	0 *(0%) **(0%)	1 *(25%) **(10%)
The institution/ university/ college research repository is	2	4 *(50%) **(40%)	2 *(25%) **(20%)	2	1 *(25%) **(10%)	1 *(25%) **(10%)	2	0 *(0%) **(0%)	0 *(0%) *(0%)

registered with directories such as OpenDOAR									
The research repository ranks on a web site such as Ranking Web Repositories	3	2 *(25%) **(20%)	0 *(0%) **(0%)	3	2 *(50%) **(20%)	1 *(25%) **(10%)	3	2 *(50%) **(20%)	1 *(25%) **(10%)

(* per centage per HEI type; ** per centage of total respondents)

Four public HEIs and two private HEIs indicated that their IR is registered at a reputable OA IR directory. This constitutes 75% of public HEI and 50% of private HEI.

A total of twenty per cent (20%) respondents indicated that they are aware that their IR rank on Ranking Web of Repositories. Thirty per cent (30%) indicated that they do not rank, and another thirty per cent (30%) is not sure. Not all respondents answered this question. (See *Figure 7.6*)

IR on Ranking Web of Repositories

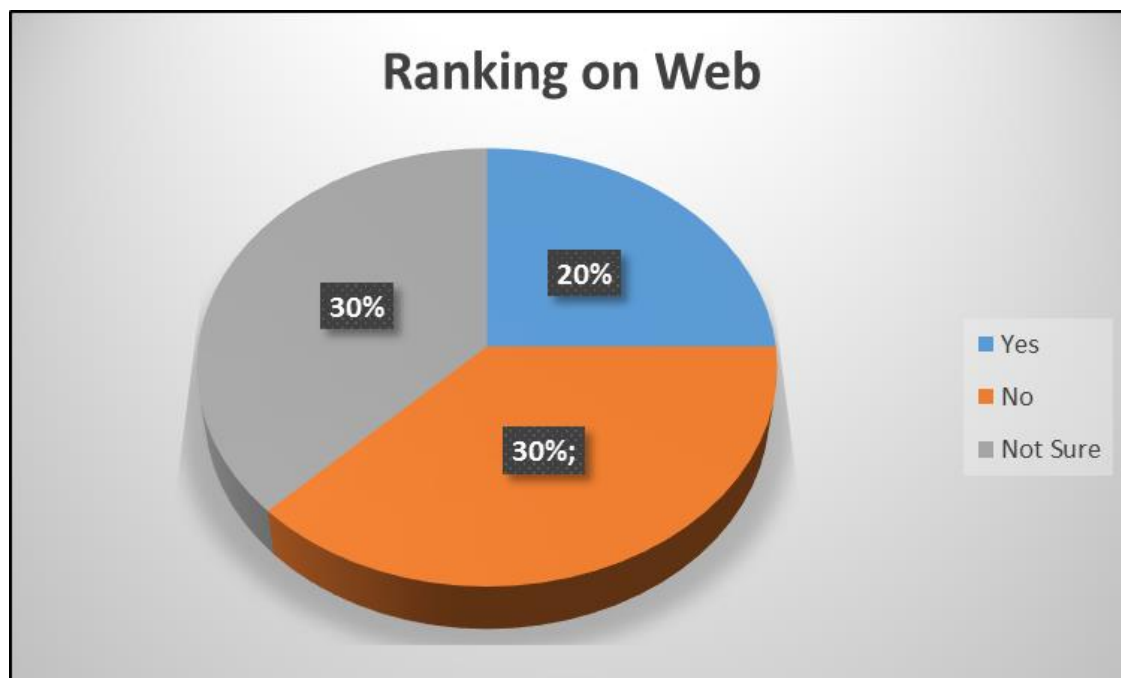


Figure 7.6 IR on Ranking Web of Repositories

- **Other comments**

A1: It is one of the reasons why our HEI ranked very well in 2015;

B1. Our repository is newly created.

7.3.4.8 IR age, support and projected longevity

Table 7.9 reports on the age of IRs in the target group, coupled with maintenance regimes such as regular software updates and the skills levels of staff responsible for IR maintenance.

Fifty per cent (50%) of respondents indicated that there is a clear development for their IR. Forty per cent (40%) indicated that there are no plans for maintenance and development.

Despite low rankings, limited web invisibility and a lack of innovation; eighty per cent (80%) of respondents feel that IR managers are suitably skilled. It raises questions on IR levels, inter-departmental cooperation and benchmarking/networking with industry partners to gauge and monitor performance.

Sixty per cent (60%) of respondents are using an open source software package to run their IR. Seventy per cent (70%) of respondents indicated that their software has been upgraded during the past three years.

Fifty per cent (50%) of respondents indicated that their repository is older than five years indicating that the other fifty per cent of IRs are still new.

Respondents answered most of the questions. Understanding no-responses are important in the analysis of survey results. Best (2012: 250) says there are first level non-response and second level, or item non-response. These may influence the validity of the questionnaire. For this reason first level non-responses were followed up with two private HEI via email and telephonic conversations. Item non-response or second level non-response is where a specific item went unanswered. This was only experienced in one question on open access standards for interoperability.

Table 7.9 IR maintenance and development

IR Maintenance and development		Yes		No		Not sure	
		Public	Private	Public	Private	Public	Private
The repository management has an approved development and maintenance plan with clear goals and set time lines	1	3	2	3	1	0	0
		*(50%)	*(50%)	*(50%)	*(25%)	*(0%)	*(0%)
		** (30%)	** (20%)	** (30%)	** (10%)	** (0%)	** (0%)
Staff responsible for managing the digital scholarship collection is suitably skilled and stay abreast of technological changes	2	4	3	2	0	0	0
		*(66.7%)	*(75%)	*(25%)	*(0%)	*(0%)	*(0%)
		** (40%)	** (30%)	** (20%)	** (0%)	** (0%)	** (0%)

Are you using open source software such as Dspace or EPrints	3	5 *(83.3%) **(50%)	1 *(25%) **(10%)	1 *(16.7%) **(10%)	0 *(0%) **(0%)	1 *(16.7%) **(10%)	1 *(25%) **(10%)
Has your software been upgraded during the past three years	4	5 *(83.3%) **(50%)	2 *(50%) **(20%)	1 *(16.7%) **(10%)	0 *(0%) **(0%)	1 *(16.7%) **(10%)	0 *(0%) **(0%)
Is your repository older than 5 years	5	3 *(50%) **(30%)	2 *(50%) **(20%)	1 *(16.7%) **(10%)	0 *(0%) **(0%)	0 *(0%) **(0%)	0 *(0%) **(0%)

(* per centage per HEI type; ** per centage of total responses)

7.4 Data analysis of Ranking Web of Repositories

There are fifty-two Sub-Saharan IRs registered on Ranking of Web Repositories. Nine of the top ten repositories are situated in South Africa. They are all from public universities. These IRs were explicitly excluded from this study as the assumption based on their ranking and OpenDOAR profiles are that they are well funded, planned and managed. The ranking of top IRs correlate with the ranking of top universities.

Nineteen IRs on Ranking Web of Repositories are registered in South Africa, two in Namibia, one in Botswana, four in Zimbabwe. The HEIs selected for this study ranked on Ranking Web of Universities site, but do they rank and correlate as the top 10 HEI IRs? Table 7.10 indicates the web visibility of the target group on Ranking Web of Repositories.

Table 7.10 World and Sub-Saharan ranking and web presence, (Ranking Web of Repositories, 2016)

HEI	Type	Ranking Universities	World Ranking falling between intervals of 500	Ranking Web of Repository presence Sub-Sahara with intervals of 5	World Ranking Web of Repositories with intervals of 50
A1.	Public	Yes	3500-4000	0	0
A2.	Public	Yes	3000-3500	20	850
A3.	Public	Yes	500-1000	20	950
A4.	Public	Yes	3000-3500	20	850

A.5	Public	Yes	2500-3000	0	0
A.6	Public	Yes	6500-7000	25	1200
A.7	Public	Yes	4000-4500	25	900
A.8	Public	Yes	7000-7500	0	0
B.1	Private	Yes	4500-5000	50	1200
B2.	Private	Yes	9500-10 000	0	0
B.3.	Private	Yes	15000-15500	0	0
B.4.	Private	Yes	7500-8000	0	0
B.5.	Private	Yes	12500-13000	0	0
B.6	Private	Yes	21500-22000	0	0
B.7	Private	Yes	15500-16000	0	0
B.8	Private	Yes	16500-1700	0	0

Fifty-two IRs in Sub-Saharan Africa rank on Ranking Web of Repositories. Five of the sixteen IRs chosen for this repository rank on Ranking Web of Repositories. Only one private HEI IRs rank.

In total six repositories in the target group rank, comprising 37.5 % of the target population. Sixty-two point five per cent (62.5%) of IRs in the target group do not rank on Ranking Web of Repositories. However, eighty per cent (80%) of HEI respondents indicated that scholarship is visible from their institutional website. Despite the respondents' optimism in their responses to questions on web visibility and openness, the lack of ranking does not reflect in directories and it does not aid to IR sustainability. The following inferences are made:

- There is a gap between the perceived web visibility and the actual visibility;
- There is an apparent lack of understanding on the nature of web visibility and nature and purpose interoperable standards such as OAIster;

- Valuable research lies undetected and untapped for the knowledge society of researchers;
- A significant number of HEIs in the target group rank on Ranking Web of Universities, but do not rank on Ranking Web of Repositories. This affects web visibility and their scholarship is not enabled to aid the bigger HEI goals. (See *Figure 7.6*)

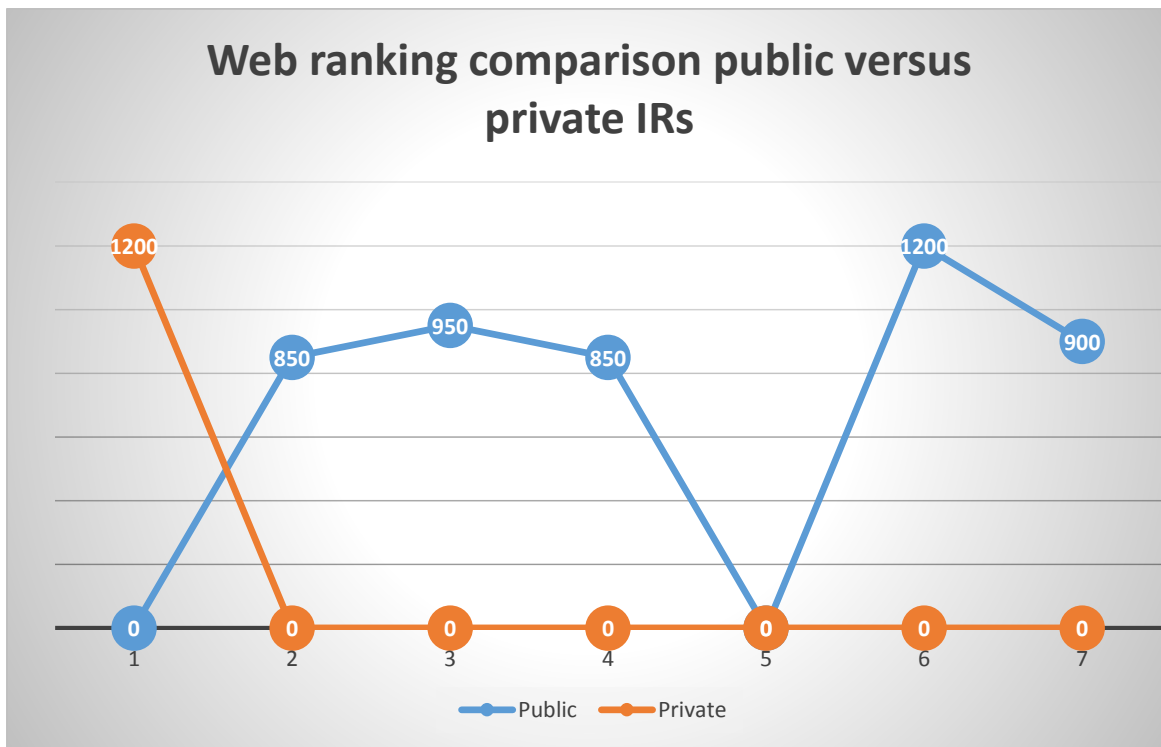


Figure 7.7 A comparison between web ranking of private and public HEIs: Sub-Saharan ranks on Ranking Web of Repositories (2016)

In *Figure 7.7* the difference in ranking on Ranking Web of Universities between the sixteen public and private HEIs in the target population is displayed. (See *Figure 7.7*). Only two private HEIs rank the same as a public HEI.

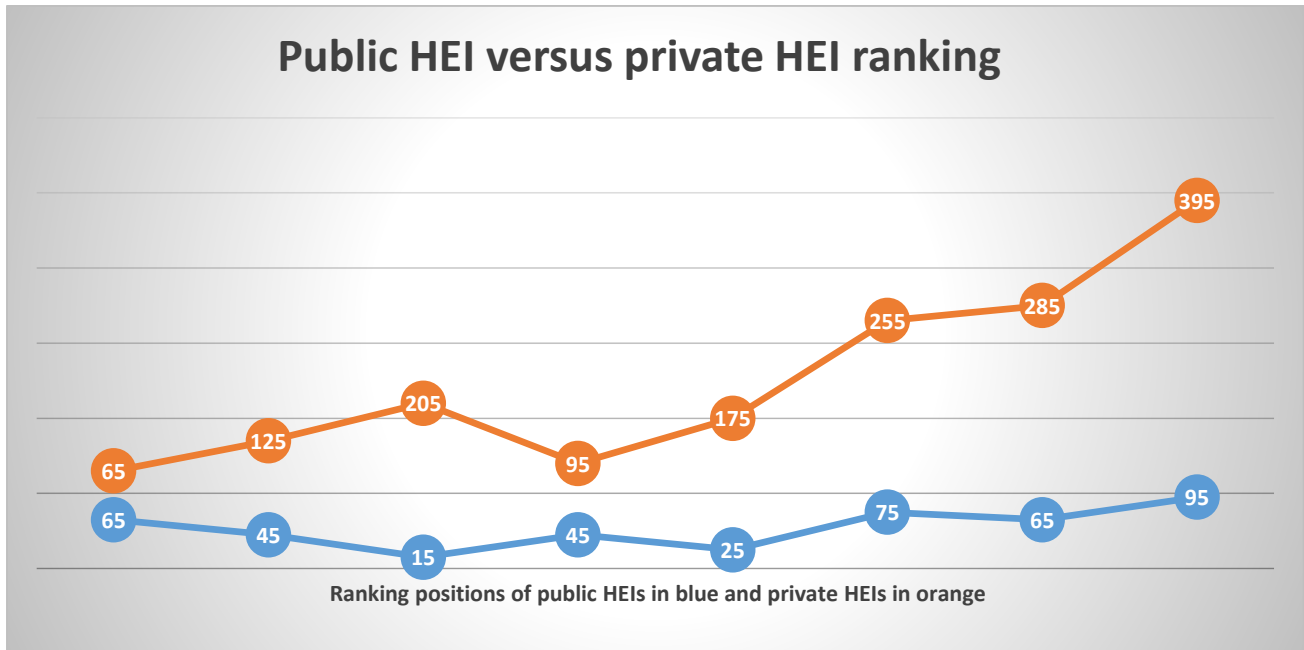


Figure 7.8 Public versus private HEIs on Ranking of Web of Universities (2016)

7.5 OpenDOAR content analysis

A background to OpenDOAR was discussed in depth in previous chapters. There are 138 African IRs registered on OpenDOAR (OpenDOAR, 2016). It is an IR directory listing quality-assured OA IRs around the world. Before an IR can be registered on OpenDOAR the IR will be evaluated for quality of content and consistency. There are 3093 OA IRs registered on Open DOAR, 138 African IRs registered on OpenDOAR, South Africa has 31 IRs, Lesotho 2, Namibia 2, and 4 in Botswana (OpenDOAR, 2016). Seven out of the sixteen IRs in this study is registered on OpenDOAR. Only one private HEI is registered on OpenDOAR.

Although all respondents indicated that the benefits of OA, and adherence to OA standards is beneficial, 65% of the target group is not registered on OpenDOAR. Harvesting analyses done by Millington in (OpenDOAR, 2016) indicated that two-thirds of repositories do not have correct metadata or full-text re-use policies in place to be harvested (OpenDOAR, 2016). This hampers web visibility as harvesters and service providers do not know what they are allowed to do with the data that they can harvest.

Table 7.11 IR registered on OpenDOAR, (OpenDOAR, 2016)

HEI	Type	OpenDOAR	Metadata specified	Re-use policy provided
A1.	Public	No	No	No
A2.	Public	Yes	No	No
A3.	Public	Yes	Yes	No
A4.	Public	No	No	No
A.5	Public	Yes	Yes	No
A.6	Public	Yes	No	No
A.7	Public	Yes	No	No
A.8	Public	Yes	Yes	No
B.1	Private	Yes	No	No
B2.	Private	No	No	No
B.3.	Private	No	No	No
B.4.	Private	No	No	No
B.5.	Private	No	No	No
B.6	Private	No	No	No
B.7	Private	No	No	No
B.8	Private	No	No	No

Although respondents indicated their participation and appreciation of scholarship in OA, content analysis on OpenDOAR reveals that only three of all the HEIs in the target group supply metadata standards information. Not one of the HEIs in the target group provides use and re-use policies. Resulting in reputable academic search engines such as CORE and BASE not harvesting valuable research and scholarship available in these IRs (OpenDOAR, 2016). The absence of reputable academic harvesters has a serious negative impact on web visibility and is one the reasons for low ranking and low impact.

Only three of the private HEIs in this sample are registered on OpenDOAR, two public and one private HEIs. It would appear that the IR managers are not familiar with the procedure and minimum standards required, such as OAI-PMH to be considered for registration on OpenDOAR. These findings correlate with the Wells study in 2009.

Findings indicate that respondents in this study are not OAI compliant. The OAI Protocol for Metadata Harvesting (OAI-PMH) is a machine-to-machine interface provided by most repository software platforms (OpenDOAR, 2016). This allows specialist search services such as BASE and CORE to harvest and process metadata for the items in your repository. OAI-compliant repositories have an 'OAI Base URL' in addition the URL for human users. Base is one of the world's most voluminous search engines especially for academic web resources.

BASE is managed and offered by Bielefeld University Library. BASE collects and indexes the metadata of web documents, but requires OAI-PMH protocol compliance (OpenDOAR, 2016).

Over and above OA protocol compliance, the majority of IRs in this study do not state their policies on OpenDOAR. Missing policies that would otherwise have improved visibility include:

- the re-use of metadata policies;

- the re-use of full texts policies;
- permitted content - i.e. the subjects and types of item that can be deposited;
- submission requirements.

In contrast with the IRs who participated in this study, content analysis revealed that the top ten Sub-Saharan IRs subscribe to, and benefit fully from benefits of being registered on OpenDOAR. They all indicate the metadata standards and re-use policies (OpenDOAR, 2016). OpenDOAR offers clear guidance on how these policies can be added and also explains the benefits it has for increased web visibility. Inferences made from this analysis are:

- Although the willingness is there to avail scholarship via IRs in OA, the readily available OA tools to make this possible are not utilised optimally in the target group;
- Private HEIs display fundamental gaps in their understanding and application of OA in availing scholarship;
- A gap has been identified between the perceived skills of IR managers and actual performance results of IRs. Respondents reported that 80% of public and private HEIs felt that IR staff is suitably skilled, but if this were to be the case a valuable tool such as OpenDOAR should have been used to its full potential.

7.6 Summary

Looking at the top HEIs ranking on Ranking Web of Universities and their corresponding ranking on Ranking Web of Repositories, a clear correlation between their web visibility, their presence and OA compliance on OpenDOAR is observed (OpenDOAR, 2016; Ranking Web of Repositories, 2016 & Ranking Web of Universities, 2016). The same correlation is not seen in the target group of this study.

To get a better understanding of the nature of scholarship curation in the target group, an empirical survey questionnaire gathered data from 10 HEI IRs on their research culture and governance of IRs. Ten respondents completed the questionnaires. The data gathered were analysed. Findings were reported in tables and graphs. This information was triangulated with statistics on Ranking Web of Repositories and OpenDOAR. Content analysis on OpenDOAR in terms of Metadata standards and re-use policies revealed a gap between perceived OA knowledge and IR web visibility and performance.

The study reveals a number of gaps affecting IR effectiveness. Gaps were identified in terms of a true understanding of the nature and importance of interoperability in OA. Collaboration within the HEI as well as external networks are lacking. Although respondents were of the opinion that IR staff are well qualified, and that their HEI is supportive and knowledgeable of OA, triangulation with webometric analysis indicated the presence of factors impacting negatively on sustainability of the IR.

The study revealed that there is still not sufficient understanding and support of scholarship curation at a governance level. The study revealed serious gaps in the understanding OA and application of OA protocols and standards. Private HEI research is not curated sustainably, while public HEI scholarly communication in the target group has much room for improvement in terms of networking and advocacy to promote access to scholarship. Although the value and benefits of scholarship curation in IRs are well known, sustainable management and planning of IRs appears to be in peril. In summary the following shortfalls could be isolated in the target group:

- An absence and/or lack of KM of IR on all governance levels;
- Integration into research activity is lacking;
- Although IRs are established in most of the target group HEIs there are serious gaps in maintenance and development practices and IR managing skills;

- There is a lack of knowledge and understanding of interoperability and OA standards.

In chapter eight findings will be discussed further to identify trends in current scholarship curation and recommendations will be made. A sustainability framework and guidelines towards sustainable KM of IR will be presented.

Chapter 8: Summary of findings and recommendations

8.1 Introduction

The main aim of this research study was to evaluate trends in digital scholarship curation in a purposefully selected target group. Global trends were evaluated and discussed. These trends were benchmarked against the trends observed in the target group. Participants in this target group were, chosen for their existing web visibility and level of scholarship creation. Sixteen HEIs were selected, of which the eight top ranking private HEIs on the Sub-Saharan list of Ranking Web of Universities formed fifty per cent (50%) of the target population. The next half of the target group was chosen from public HEIs just below the top ten ranking HEIs on Ranking Web of Universities.

The main research problem of this study is: Is scholarship curation in the targeted IRs managed sustainably? The conclusion of this study is that they are not sustainably managed.

In this chapter an overview of survey results and research findings to the main research problem and sub-problems, are presented. Drawing from the literature review, where previous and related research were discussed, patterns and statistics are analysed, and new trends were identified. With the knowledge and a better understanding of these trends, a sustainability model was designed and offered as an answer to the identified gaps and challenges experienced in the target group. A sociotechnical sustainability model, is offered to address sustainability risks and shortcomings identified scholarship curation for this study.

The literature review gave a background of IR implementation and development progress over the past ten to twenty years. IRs started as departmental digitisation projects and in time evolved into research showcases, supporting OA initiatives. Lately, global IRs started to evolve from initial IM focused approach to managing IRS to adopting and

including a sociotechnical focus, involving KM principles. Taking into account the institutional/organisational aspects of research culture, value, trust, institutional integration, collaboration and sustainable governance on all levels of the HEI.

More and more IR research focussed on the role that the human element play in a technical process. Although HEI are generally slow in implementing KM, the value of KM as an institutional strategy is increasingly being realised by trendsetting HEIs such as the Bangkok University as reposted in a study by Arntzen, Worasinchai and Ribiere in 2009. The sustainability of IRs poses challenges in HEIs where the research culture is still not fully developed and the importance of sustainable scholarship collections is not fully grasped. In such cases the benefits and value of research for the HEI, the researcher and research knowledge society are not fully realised, resulting in shortcomings in existing research strategies, policies, planning, archiving and curation procedures. The literature review referred to, and discussed ground breaking research in countries such as Australia, Japan, Malaysia and others, indicating that KM trends are being adopted in their public and private HEIs. This may not yet be the case in all sectors of southern African HEIs, as indications are that IR are still departmental library projects, generally lacking visibility and integration with institutional research processes. New innovations and ICT developments, such as RIMS implementations, are either absent or exclude existing scholarship collections and IRs. Research and scholarship is not the main focus in the target group, but is supported and encouraged

Triangulating the findings of the questionnaire survey results with the recent statistics obtained from the reputable web directory OpenDOAR, all indications are that the IRs in the target group may be at a peril, as serious sustainability threats surfaced.

The study aimed to get answers to why:

- Access to digital scholarship appears to be restricted,
- Lack of IR web visibility

- Low ranking or no ranking of IRs on authoritative ranking sites.

This study explored how IM and KM principles could improve the archiving, preservation and curation of digital scholarship, to ultimately enhance access to valuable research produced in southern African HEIs.

Research problems included:

- What is the size, visibility, level and content of scholarship produced by the target population?
- What are the challenges preventing HEIs to have strategies for sustainable scholarship creation?
- Do decision makers in the target population understand processes of digital scholarship curation?
- What are the similarities and differences in knowledge creation, curation and access between public HEIs and private HEIs in southern Africa?
- Do participants in the target group understand the sociotechnical inter-relationship required for success and sustainability of digital scholarship curation?
- Sub-problems to the main research problem in the literature review included:
- What is the nature of data, information and knowledge in digital scholarship and digital scholarship curation in the target population group?
- What are the perceived value and benefits that digital scholarship hold for different users/ user groups?
- How do IM, IT and KM strategies, content management and digital curation add to value and sustainability of an IR?
- On which level are IM and KM policies and strategies decided and implemented and are there policies and best practices in place to manage scholarship curation?
- What are the critical factors for successful curation of scholarship and how is performance measured?

- Can indicators for sustainability be identified in the current practices of digital scholarship curation?

8.2 An overview of findings

Chapters two to five looked at literature on IM, IT and KM in IRs. The development of IR over the past ten to twenty years were discussed to learn from previous research and to be aware of current trends.

Recent IR research was interrogated to identify trends and developments in scholarship curation. A change in global trends was observed: HEIs are moving away from focussing only on IM and IT focussed IR management. There is a change towards a sociotechnical approach. Here, the value of scholarship, the importance of scholarship curation, top management support and governance, institutional integration and alignment with other research practises and innovations such as RIMS, are key to the success and sustainability for IRs. As such scholarship preservation, curation and improved access and utilisation via OA platforms can take place. KM strategies will enhance the value of research created at the HEI. It will create trust in the quality of scholarship produced and assist scholarship to be treated as valuable capital assets. It will give HEIs the competitive edge required to build their reputation and assist in establishing a sound research culture.

Despite the fact that HEIs are knowledge intensive institutions, where new knowledge is constantly created, researchers agree that KM in HEI in the form of KM strategies, policies or even KM awareness and conceptualisation are surprisingly rudimentary in most HEIs. It was also the finding of this study among the majority of respondents in the target group.

8.2.1 Chapter two

Chapter two explained and defined key concepts to be used throughout the study. A background to OA initiatives was discussed with examples of recent research around the

benefits of a well-managed IR in an OA environment. These definitions looked at openness and OA, the nature of scholarship, digital scholarship, content management, curation, and sustainability in IRs.

Chapter two gave an introduction and definition to the concepts of IM, KM and IT and how they apply to the management of IRs.

It became evident that the management of explicit knowledge present in research output can only be managed effectively in IRs of HEIs by compiling and implementing relevant IM and KM strategies.

After considering all IM and KM factors implicating OA IRs an IR definition was constructed to conceptualise IR for this study:

An IR is an OA scholarship database being a planned via a multi-disciplinary and cooperative institutional process to managing, curate and availing local research and research related data to all potential users on the World Wide Web, following international interoperability standards whilst being supported by an officially approved institutional strategy with clear linkages to, and integration with all other research related strategies and policies. Being answerable to a statutory body such as Senate Committee or Senate Sub-Committee adds value to an IR project, improves the value of the project when it is viewed as a part of research activities and not only as a departmental project.

The sociotechnical aspects of scholarship curation in IR include not only IM or IT principles, but also KM principles. IRs need to adopt a KM sustainability approach where all environmental/institutional, social and economic factors integrate to create a sustainability domain for IR growth and development over time.

8.2.2 Chapter three

Chapter three looked at how IM of IR contributes to the success, sustainability, viability and development of digital scholarship curation. Sub-problems around the nature of data

and information in IR was explained. Definitions for data in relation to this study was discussed and new forms of research data were discussed. Other key terms in IR and scholarship curation was defined: metadata and metadata standards such as Dublin Core were explained. The importance of the KM triad: data, information and knowledge was explained. It became clear that the different types of data, such as metadata used in the process of scholarship curation, challenge the narrow definitions of data, as well as the traditional hierarchical view of data, information and knowledge. The relationships between data, information and knowledge in research scholarship and the research scholarship curation are complex and interwoven processes, which necessitates a different approach from the hierarchical KM views.

IT in IR management and the preference to use open source software such as DSpace was discussed. The findings of this study confirms that DSpace is still the preferred open source software. However, scholarship collections in some private HEIs are housed in unsophisticated digital collections hampering visibility and access. The necessity of effective content management of IR adds another dimension to IR management and the importance of understanding the content management lifecycle in digital scholarship was explained.

Critical success factors for IRs were discussed and an overview of methods for measuring IR performance by utilising IR directories OpenDOAR, ROAR and others were discussed.

A background to bibliometrics, infometrics, scientometrics and how webometrics is related to these were explained. The importance of metric sites such as Ranking Web of Universities, Ranking Web of Repositories and OpenDOAR were stressed and IR managers should harness these tools more effectively.

New trends and new practices of data centres, and their interaction with IR are emerging. There is a shift from traditional scholarly communication and research process to one where data and datasets need to be preserved for re-use. The inter-relations between

IRs, data centres and RIMS in the research and scholarly communication process in HEIs would have to be studied and developed to prevent processes from developing in silos.

KM, IM and IT processes must be aligned if IRs endeavour to attain sustainability and longevity, create ROI for the HEI, and ultimately increase web visibility for both research scholarship and the HEI.

8.2.3 Chapter four

During the first ten years of IR developments, research focussed mostly on the successful implementation of IR. Global research produced various indicators for success. These were largely dependent on IM and IT principles. The early research and development of digital scholarship curation in IRs focused mainly on IM, IT and content management aspects. Initially the implementation of IRs were handled as departmental and/or library digitisation projects. The main objectives of these projects were to find successful ways to plan and implement IRs for the purpose of archiving post-graduate dissertations and theses, and to disseminate scholarship in OA and these trends were also reflected in early research.

Lately, research progressed towards a more social view which includes KM principles. As the field of IR study evolved and developed, researchers in the developed countries such as Australia, and developing countries such as India and Japan embarked on further research, exploring KM in HEIs. KM for sustainability is trending in global research and progressive HEIs and IRs are incorporating the findings of this research in the development of their IRs. Southern African IRs are not keeping up with these new developments, more so the IRs in this study.

The impact of the human element in social groups and organisations' research cultures are increasingly becoming subjects for further research. The interaction of the human

elements and how these are influenced by the technical aspects are subjects of current research.

As KM approaches developed and started to build and expand on existing IM practices, concepts such as managing knowledge capital in HEIs and the competitive edge of research results became areas of interest for further research. New trends emerged that prompted researchers to look at issues around value and the potential value add that scholarship can offer the HEI. Value systems, research cultures and the level of trust in scholarship and research output are being explored. These are factors impacting on the way digital scholarship curation thrive or perish, and more research in this area is required, especially in African HEIs. Digital scholarship emanates not only from the well-funded, research intensive HEIs. Smaller HEIs and private HEIs have a growing contribution of research output and scholarship to contribute to an existing body of knowledge. Authors such as Anbu (2007), Chisenga (1999) Mutula, (2010), and Nyambi (2011) highlighted the need for African HEIs to add their research, rich in local content, to OA repositories and actively take part in OA initiatives and networks. Yet, the findings of this study indicate that interoperability of IRs to participate in OA to research at a peril. Global trends cannot be seen in southern African private and public HEI scholarship curation practices.

Chapter four looked at the concept of KM for sustainability, viability and development of scholarship curation in HEIs. The study interrogated the presence and awareness of KM, KM strategies and KM concepts in existing policies and processes in the target group. In chapter four the shift towards a sociotechnical approach in managing access to scholarship in IR was explained. It became evident that there is a great need for KM sustainability strategies. A better understanding is required of sustainability indicators over and above success indicators. The role of information ethics and trust in digital scholarship quality were explored as part of sustainability indicators of IR.

Chapter four provides a background of KM to facilitate an understanding of how KM elements of value, knowledge capital, competitive edge, trust, ethics, culture and social groupings affect IR sustainability.

The level of KM and KM strategies in HEI determine the amount of support and appreciation that IR in HEIs receives. This study revealed that HEIs do not have well established KM strategies, nor a good understanding of the nature of KM in HEI.

Globally new trends are developing around the impact and success of IRs in HEI. Rieger (2011) is one of the researchers at the forefront of deploying sociotechnical approaches for studying sustainability in digital scholarship collections. She underlines the complex social groupings that exist in the IR environment, and posits that sustainability indicators will strongly be influenced by values and organisational culture.

The general approach is looking at the added value, ROI and usability of IR content, and with that, a greater realisation of the impact of institutional-cultural aspects determining IR sustainability. She investigated how these relations intersect with the technological aspects of IR, and what the importance of the relations are on the performance of the IR. Her findings are a point in case for this study, as the IRs in the target group showed to rank lower in the absence of supporting governance policies.

Studying sustainability of IRs goes far beyond content management and technological considerations. If the value and ROI is not realised by the institutional governance, sustainability will be impaired. The quality and integrity of scholarship content are determining factors for the value that HEIs will see in IR, which in turn will have an impact in the trust that researchers will have in IR.

8.2.4 Chapter Five

Chapter five gave an overview of the different theoretical frameworks supporting the research problems of digital scholarship curation. Theories and theoretical frameworks

used in recent studies were discussed to ascertain their value to this study. A framework for studying the sustainability of digital scholarship curation in HEIs will be adapted from existing frameworks. Webometrics and infometrics frameworks, sustainability and sustainability frameworks used in previous research were evaluated and informed the triangulated framework chosen for this study.

During the past two decades mostly IM theory and IM frameworks were used in IR research. KM theory started to influence research trends in HEIs, including IRs and scholarship curation. Social and human variables such as culture, values, social groupings and sociotechnical aspects became the focus of research globally.

Frameworks for webometrics research, as a subset of the infometrics and bibliometrics, are still developing and evolving, resulting in not many of the available frameworks pertaining to digital scholarship curation in IR.

LIS frameworks as well as digital library frameworks are not comprehensive enough to accommodate all the aspects of sustainability research of digital scholarship in IR. Potential frameworks capable accommodating the complexities of the multi-disciplinary nature of IR research and scholarship curation, are discussed. Existing models for IR research are discussed. Research models using sustainability criteria and indicators were explored. The criteria for a suitable multi-disciplinary framework catering for IM, IT, KM and webometrics to study the sustainability of digital scholarship curation in southern African public and private HEIs were offered in chapter five.

Early IR research provided valuable foundations using technical theories and frameworks. They were useful to build new a framework where the organisational or institutional research culture is the focus point. With this comes a value orientation to knowledge capital. Once there is a culture of producing and sharing scholarship, institutional strategy needs to drive and direct this culture.

The most suitable framework for studying the sustainability of selected southern African IRs is an adapted triangulation model of the economic triad with a strong foundation in business models and sociotechnical systems, such as the STIN strategy model.

8.2.5 Chapter six

In chapter six the research design and methodology for this study was explained. A mixed method approach, using empirical survey questionnaires, content analysis and webometric analysis were used. During the first phase of this study webometrics were used to purposefully select IRs. Both a triangulation theory and a triangulation method was used in this study. This method made it possible to analyse data collected from completed survey questionnaires, investigate web visibility via webometric ratings on Ranking Web Repositories and using content analysis of IRs appearing in the global IR directory, OpenDOAR to make inferences on the content and quality of IRs in the target group. Three focus areas of social, environmental and economic aspects impacting on the sustainability of digital scholarship curation formed the foundation of the questionnaire.

The assumption is that where these three environments successfully and purposefully integrate and collaborate, tangents could be identified and a sustainability domain was identified and described.

Effective KM strategies, a research culture valuing scholarly communication and good governance of IRs will ultimately have a substantive impact on the performance, value and longevity of IRs.

A sociotechnical approach, where all aspects of IR technology and social aspects, such as research culture, perceived value and trust of research scholarship was followed in this study. This is the first study of its kind in southern Africa, using a sociotechnical approach and looking at KM for sustainability in both private and public HEIs IR. The aim

is to identify factors that negatively impact on sustainability, and to derive at a sustainability strategy or model suitable for less research intensive institutions, as their research output have value for the global research and knowledge society.

8.2.6 Chapter seven

Sixteen public and private HEIs in southern Africa were purposefully selected to participate in this study. They were selected from the IRs falling below the top ten ranking HEIs on Ranking Web of Universities, but not lower than the 400th ranking position on Ranking Web of Universities.

These HEIs produce scholarship and house them in scholarship collections and IRs to a varying degree of sophistication and development. All the public HEIs have IRs, operating with open source software, of which DSpace is the most used. The scholarship collections in private HEIs are less developed than the IRs in public HEIs in the target group and most of them are not freely available in OA. Although they were successfully implemented a number of concerns around their projected sustainability became evident from web analysis, findings from the survey and the content analysis on OpenDOAR.

Very little research has been done around southern African private HEIs and their research culture. This study offered an opportunity to investigate private HEIs' scholarship creation and curation practices as per the target group. Comparisons can be drawn between curation in public and private HEIs.

Emerging and current trends in HEIs in the target group was observed and evaluated. The participants in the target group produce research and scholarship, but not on the same level of traditional research HEIs.

Content analysis on OpenDOAR helped to validate information obtained from questionnaires. The most important findings of the questionnaire can be summarised as:

- KM and KM strategies in both public and private HEIs are underdeveloped or non-existent;
- IR policies are not in place in most cases;
- The rationale behind AO of research is not understood or realised;
- Interoperability standards are underdeveloped;
- There is a lack of understanding around interoperability standards;
- Performance monitoring needs to be purposefully planned to improve performance;
- Participation and inclusion on open access directories must improve;
- Trust in the quality of OA research must be established;
- Financial planning is lacking;
- IRs are departmentalised and do not align with institutional research innovation;
- External networking with support and interest groups such as ND LTD is not happening.

The study showed that in some instances it appears as if respondents did not evolve beyond the implementation phase of IRs, and that IRs became stagnant.

8.3 Trends in digital scholarship curation: global versus target group trends

The literature review indicated that the most important new trends can be found in progressive developed country HEIs. In these HEIs KM strategies are being implemented on a high governance level, allowing research to be harnessed as knowledge capital.

Curating datasets are new editions to IRs, new standards for data curation is being developed, and data curation centres are established.

The same trends are not yet present in the IRs of the target group. Trends observed in the target group are:

Table 8.1 Main trends in scholarship curation in the target group

Public HEI	Private HEI
IM of research in IR is present	IM of research is mostly absent
KM of research is not present	KM of research is not present
Research and scholarship is not the main focus, but is supported and encouraged	Research and scholarship is not the main focus, but is supported and encouraged
Most of the respondents have some form of OA IR	Most respondents do not have structured IRs or OA scholarship visibility
Most IRs are the responsibility of the library, and do not report to, or are not managed or monitored on high governance levels	Most scholarship collections (manual or digital) are not the responsibility of the library, but a research officer
OA is supported on a departmental level	OA is not supported, mainly due to lack of understanding
OA and interoperability of IRs are present, but weak	OA and access are severely restricted
Integration with research processes are weak and research collections are departmentalised	Integration with research processes are strong, but unstructured and unsophisticated
Scholarship collections are networked and interoperable to some degree	Scholarship collections are not networked or interoperable

The trends observed in the target group and summarised in Table 8.1, does not compare favourably with global trends. Private HEI trends are mostly out of scope with global trends (See Table 8.1).

8.4 A sociotechnical sustainability model for IR

In 2011 Jelavic presented his KM management synthesis model as foundation for an institutional KM system, (as discussed in chapter four). He explains how different groups within the same institution interact with technology in different ways, and on different levels, based on their function in the institution (*Figure 4.2* in chapter four). They become the sum of the parts of institutional KM on a sociotechnical level, where sociotechnical KM spheres of infrastructure, infostructure and infoculture are interrelated. His model was adapted, and combined with that of Sadler's 1998 sustainability triad as cited by De Oliveira and Rodrigues (2010: 806) ,(*Figure 4.5* in chapter four) to graphically illustrate the processes and groupings that will ultimately determine sustainability of IR processes and scholarship curation. Where these three spheres overlap, and in practice cooperate and align with related areas in the HEI, scholarship curation has the best chance to be managed, survive and develop sustainably over time.

The model (*Figure 8.1*) proposes that scholarship curation be monitored on an institutional governance and strategy level, opposed to restricting management of scholarship curation to a department, such as the library. Here, the IR can align strategically with institutional strategy and the probability of stagnation and side-lining is reduced. The principle of research in OA and openness forms the foundation of this model, which would see the institution adhering to interoperability standards, participating in OA networks and initiatives. The sociotechnical sustainability model in *Figure 8.1* can be explained as follows:

8.4.1 Institutional governance and strategy

KM for sustainability needs to begin at a statutory decision making level, where the IR is formally recognised and incorporated into HEI governance processes. IR and function of scholarship curation must form part of all academic planning and research processes. It must be defined, explained and verbatim mentioned in all related strategies e.g.

- Research strategy and policies;
- ICT strategies;
- Funding and budget strategies;
- Library policies;
- Legal and ethical compliance;
- Alignment with research and academic innovation.

8.4.2 Openness

Openness principles create the foundation for scholarship curation. The HEI should preferably have a written statement on its position on OA. OA guidelines must be used to create awareness and understanding of the benefits to the prestige of the HEI, the researcher and students. HEIs must all sign OA treaties and agreements.

8.4.3 Sociotechnical IR processes integrating with related institutional processes

- Infrastructure
Infrastructure in this model deals with hardware and software IR requirements and developments;

An interdepartmental scheduling of hardware and software updates and upgrades need to be in place;

All participants in interdepartmental committees need to be aware of, and adherence to OAI standards;

The prerequisites for interoperability needs to be understood and adhered to by all;

Multi-disciplinary/cross-departmental cooperation to share expertise and align funding and projects is a requirement.

- Infostructure

Infostructure in the context of this model starts with content management:

Decisions on all relative IR policies, such as HEI submission policies of scholarship, scholarship re-use policies to the IR must be in place and added to networked IR directories such as ROAR, COAR or OpenDOAR;

An awareness and thorough understanding of interoperability and OA standards must be present;

All attempts must be made to increase web visibility of scholarship;

Monitoring of the quality of scholarship availed on OA IR must be an integrated collaborative process between IR managers and research ethics departments;

A multi-departmental effort to create trust in scholarship creation and sharing must continuously be advocated on all institutional levels;

Preservation and curation plans must be in place and continuously revised;

IR content management, preservation and curation policies must be in place and shared with all relevant HEI departments;

IR performance monitoring must be rigorously followed and reported, low ranking or a drop in ranking must be investigated and corrective measures taken;

- Infoculture

Understanding the research culture of the HEI;

Making IR part of research culture and research processes;

Increase researcher participation;

Marketing and awareness of IR processes, value and benefits;

Making IR part of ICT, academic and research innovation.

Networking internally and externally to be part of the IR knowledge society and stay abreast of developments;

Create a culture of inter-departmental cooperation and collaboration (See *Figure 8.1*).

8.4.1 Sustainability indicators

There are three institutional tiers that can impact the sustainability domain, where digital scholarship curation could potentially be managed and curated to ensure ROI. They are:

- The governance level of an HEI;
- The operational level of the different departments and processes around digital scholarship curation;
- The networking level where research is shared in OA and information society tangents are formed. (see *Figure. 8.1*)

Based on the survey findings, the literature review and taking from previous studies on critical success factors into consideration, it was decided to come up with a set of factors impeding IR sustainability or sustainability threats. Instead of reporting sustainability factors, a list of risk factors will be offered within a sociotechnical framework (See *Table 8.2*).

A sociotechnical KM model towards sustainable scholarship curation in IR

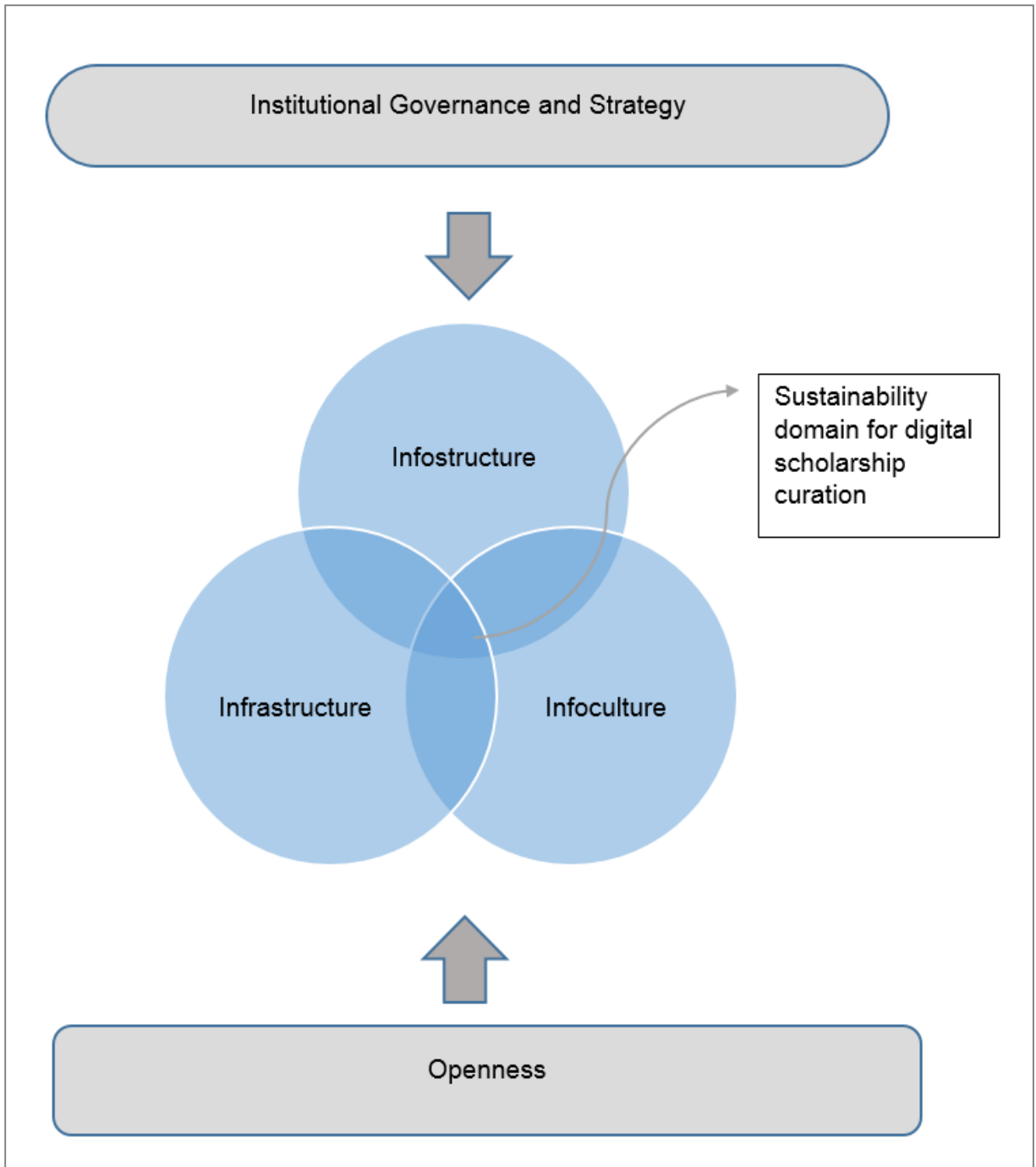


Figure 8.1 A sociotechnical model for IR sustainability

Table 8.2 Sustainability Risk Indicators

HEI grouping	IR Sustainability Risk Factors
Institutional governance level	Underdeveloped KM strategy: HEI not having a KM strategy or does not address KM principles in existing research strategies.
	Strategy and policy exclusion: Exclusion of IR from existing institutional strategies, research initiatives, budget planning and policy.
	Scholarship curation not managed as knowledge capital: Institutional undervaluation of the benefits of IR on all levels, especially at top management level.
	OA non-compliance: Institution uninformed about, or disinterested in OA, not participating in OA initiatives such as signing of OA agreements and treaties.
	Accountability: Management ill-informed on IR and scholarship curation processes, no supervision or accountability of managing curation functions and adhering to standards.
	Ethical and legal dilemmas: Information and research ethics in IR need to be managed on a higher level than departmental level, to ensure compliance and quality of scholarly communication.
	Lack of performance monitoring: No accountability or plan for improving IR performance.
	IP and related legal non-compliance:

	Institutional guidance on the legal compliance in terms of IP of research, copyright compliance affects trust and quality of IR.
2 Infrastructure level	Lack of institutional integration: The absence of inter-departmental planning committees.
	Technical neglect: No planned and scheduled software and hardware updates. Not using tried and tested IR open source software such as DSpace or EPrints.
	Financial neglect: No budget planning for IR, or often having an undescriptive portion of a library budget allocated to IR.
	Institutional isolation: IR only managed departmentally, no linkages to other research or scholarship projects. IR departmentalised/isolated in libraries.
	Ineffective archiving, preservation and curation: Housing scholarship in makeshift and departmental collections.
	Inefficient staffing and contingencies: Unskilled IR staff, low ranking staff without management support, no contingency plans to replace existing staff.
3 Infostructure level	Poor content management of IR.
	Undescriptive submission policies for scholarship.
	No clear guidance for preservation or long term curation of content.

	Lack of networking internally with IR and research departments and externally interest groups such as ND LTD etc.
4. Infoculture or research culture environment	Research culture not yet established, supported or encouraged.
	Lack of knowledge and awareness of the value of OA.
	Tendency not to make research available due to trust and quality concerns.
	IR stagnation after implementation.
	Lack of innovation and keeping up with new developments
	Not sufficient networking with IR interest groups such as ND LTD etc.
5. Openness and OA	Not using OA harvesting protocols and standardised metadata sets to assure access retrievably to scholarship.
	Not opening IR and making it visible on the web
	IR not registered on IR directories such as OpenDOAR
	IR registered on OpenDOAR, but re-use policies and content detail not completed or updated

The presence of any of these risk factors must be seen as warning signs that IR sustainability is under threat. It should be actively addressed in a planned and structured way. Addressing these risks effectively will enhance the value that research holds for the HEI.

8.5 Defining a sustainability domain for scholarship curation in HEIs

De Oliveira and Rodrigues (2010) see sustainability as processes involved with the creation, capture, sharing and use of knowledge. Both Chengalur-Smith *et al.* (2010) and Anbu (2007) describe sustainability as the ability (of an entity, process, project or function) to maintain its activity overtime. Anbu (2007) elaborates that sustainability in IR refer to the long term survival of the IR. There is a functional area where this sustainability derives at an optimal point, called the sustainability domain. Based on previous research and the findings it is clear that a suitable definition for a sustainability domain must include both social and technical aspects of scholarship curation. From the findings of this study a definition for the sustainability domain for HEI scholarship curation in OA digital IRs can thus be described as:

That functional area where an HEI succeeded to strategically and purposefully manage, align, and integrate its relevant human capital, resources, operations and technology to ensure optimal and continued discoverability of networked scholarship, where the HEI acknowledges and treats scholarship, as valued and trusted intellectual and knowledge capital, archived and curated in IRs with ROI as one of its aims.

8.6 Identified areas for further study and research

Scholarship curation in southern Africa IRs need to stay abreast of global trends in order to remain relevant. New areas suggested for further research are:

- The IRs' role in curation research datasets - the complexities of datasets and collaboration with data centres are new areas for research in southern Africa and Africa and requires more research.
- Quality assurance of IRs as part of institutional quality assurance processes in HEIs offers new research opportunities.

- The nature and effectiveness of IR consortiums locally and globally are untapped areas for further research.
- Data security, cyber ethics, research ethics and risk management in IRs.

8.7 Limitations

Although this research study achieved its aims, there were unavoidable limitations:

Three public HEIs did not give permission for the study to be conducted at their institution as too many requests to participate in research studies. This was followed up with an explanation of the importance of the study and two HEIs reverted on the initial decision and allowed the questionnaires to be distributed.

The reservations that a number of private HEIs had to participate in the study, after receiving the questionnaire was a further limitation to be addressed. Communication followed to explain the purpose of the study, as well as how this study could be to their benefit in improving scholarship curation.

The situation highlighted the need for further research in private HEI in Southern Africa.

8.8 Conclusion

Previous research focussed on the planning and implementation of IRs and success indicators of IRs. IM and IT played fundamental roles in early developments of IR and OA scholarship collections, in IR projects. Since then many new developments around IR and scholarship emerged. HEIs who do not keep up with these developments will not reap the benefits of availing research in OA.

Scholarship curation in IR is a field that transforms and evolve rapidly. New trends such as incorporating datasets, collaborating with data centres are just a few of the latest developments mentioned in this study.

Although South African IRs are the top ranking IRs in Africa, much still has to be done for many Africa and southern African HEIs, to take their rightful place in global research community. Implementing KM in southern African HEIs still have a long way to go, and valuable lessons can be learnt from global case studies.

Findings of this study are that particularly private HEI needs to be brought into the OA scholarship picture. There is a lack of awareness and knowledge regarding scholarship curation in the target group. Although public HEIs in the target group fared significantly better than their private counterparts, serious sustainability risk factors have been identified in managing their scholarship in IR.

This study offers IRs a different approach to manage digital scholarship sustainably. The sociotechnical KM model offered here has the potential to involve all levels of the HEI beyond successful IR implementation, to take its place as a research support function aligned and coordinated with all other research activities. The list of sustainability risk factors will serve as an early warning system for IR managers whose IRs need intervention to become sustainable.

The findings of this study will be communicated to the participants. Workshops and information brochures to especially the private HEIs may assist in creating and understanding and appreciation of the wealth of untapped knowledge they are creating.

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ANNEXURE A



DIGITAL SCHOLARSHIP IN SOUTHERN AFRICAN HIGHER EDUCATION INSTITUTIONS QUESTIONNAIRE

Dear Sir/Madam

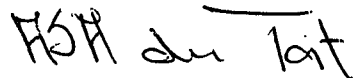
Mrs Brenda van Wyk is a DPhil student in the Department of Information Science at the University of Pretoria. She is conducting a survey on the nature and sustainability of digital scholarship collections in private and public higher education in South Africa. Universities, by their very nature, are knowledge intensive institutions. Research and scholarship are knowledge capital, giving the institutions a competitive edge in research. As such knowledge capital must be managed in a way that will ensure return on investment (ROI).

Digital scholarship such as dissertations, theses, proceedings and publications form part of the knowledge capital created in higher education institutions. Digital scholarship is a networked, scholarly or academic environment extensively integrated with digital and IT technologies in teaching and research. The study aims to explore trends and common challenges in managing, curating and availing digital scholarship in order to create value for the institution and its community. Sustainability of digital scholarship collections is the ability to secure access to all resources needed to protect, maintain, develop and increase the value to a product's content. It is the ability to reach longevity, develop and grow consistently.

You are hereby invited to participate in this survey. Your responses to the survey will be confidential and the survey takes about 10 to 15 minutes to complete.

Mrs. Van Wyk will feed back the results by publishing articles in peer-reviewed journals and she will send you copies of these articles. Thank you in advance for taking the time to complete the survey! If you have any queries, please contact Mrs. Van Wyk at 082 495 9092 or at bvanwyk.uz@gmail.com

Kind regards



Prof Adeline du Toit

Supervisor

Supervisor contact details: adeline.dutoit@up.ac.za

SECTION A: BACKGROUND INFORMATION ON DIGITAL SHOLARSHIP CURATION

- 1) This section collects data on the nature, educational environment and research culture of your institution.

Name your university or institution type

(X one)

Public research university	1
Public comprehensive university	2
Private higher education institution/college	3
University of technology	4

- 2) Does your university/institution offer post graduate qualifications?(X one)

Yes	1
No	2

- 3) If the answer to 2 is yes, on which level are qualifications offered? (X all applicable)

Post graduate diplomas	1
Honours	2
Masters	3
Doctoral	4
Not applicable	5

4) Do your academic staff members conduct and publish research? (X one)

Yes	1
No	2

5) If your answer in 4 is yes, which of the following apply? (X all applicable)

Journal articles for own journal	1
Journal articles for accredited research journals	2
Journal articles for other/ non-accredited journals	3
Mini dissertations	4
Research projects and assignments	5
Dissertations	6
Theses	7
Conference proceedings	8
Conference papers	9
Other (Please elaborate)	10
Not applicable	11

SECTION B: INSTITUTIONAL GOVERNANCE OF SCHOLARSHIP CURATION

**6) Which of the following strategies does your institution have in place?
(X all applicable)**

Research strategy	1
Information and technology strategy	2
Open access strategy	3
Research funding strategy	4
Innovation strategy	5
Faculty research strategy	6
Knowledge management strategy	7
Other (please elaborate)	8

7) Which of the following policies are officially approved by Senate?

(X all applicable)

Research Policy	1
Research information systems policy and procedure (RIMS)	2
Research ethics policy and procedures	3
Institutional repository policy and procedures	4
Information technology policy and procedures	5
Open access/ openness policy	6
Intellectual property policy	7

8) If not approved by Senate, which other governance structure approves policy and procedures on digital scholarship and research collections? (X all applicable)

Library committee	1
Editorial board	2
Registrar	3
IT committee	4
Faculty board	5
Departmental committees	6
Financial committee	7
Other (please elaborate)	8

- 9) Do any of your existing strategies and policies refer to or explain the following concepts or terms in any way directly or implied? (X at each option one)**

	Yes	No	Not sure	
Knowledge management				1
Knowledge capital				2
Intellectual capital				3
Knowledge creation				4
Competitive edge				5
Other comments (please elaborate)				6

SECTION C. THE BENEFITS AND VALUE OF DIGITAL RESEARCH AND SCHOLARSHIP REPOSITORIES

10) Please indicate your experience on the following (X one in each option)

	Highly agree	Agree	Unsure	Disagree	Strongly disagree	
I am fully aware of all digital scholarship projects and databases provided by my institution/ university/ college						1
I believe that quality research should not be housed in different departmental databases, but rather in well-coordinated and centrally managed repositories						2
My university/institute/ college actively promotes and gives open access to research housed in a digital repository						3

My university/institute/ college encourages and supports research in terms of funding, study leave and other incentives to promote research						4
Research and scholarship are secondary to teaching and learning						5
Research is not curated or digitised in scholarship repositories or other research collections						6

SECTION D: SUCCESS FACTORS FOR DIGITAL SCHOLARSHIP REPOSITORIES

11) The planning, implementation and maintenance of the digital scholarship project and repository are officially mandated by: (X one)

Senate	1
Library Committee	2
IT Committee	3
Research Committee	4
A Multi-Disciplinary Committee	5

All of the above	6
None of the above	7

12)The nature, scope and importance of digital scholarship collections are known and supported by management structures (X one)

Yes	1
No	2
Not Sure	3

13)The digital scholarship databases/ project receives a separate annual budget allocation (X one)

Yes	1
No	2
Not Sure	3

14)The integration of digital scholarship collections (X one in each option)

	Yes	No	Not sure	
Digital scholarship curation is managed by an				1

interdepartmental forum/committee where all stakeholders are present				
Digital scholarship curation is managed by a departmental forum/committee				2
Research information management (RIMS) and digital scholarship collections are jointly planned and managed				3
Does your institution have a written academic strategy?				4
Do you think that research scholarship curation processes and strategies clearly link and align with your academic and other institutional strategies?				5
Other comments (please elaborate)				6

**15)The marketing, promotion and awareness of digital scholarship repositories
(X one in each option)**

	Yes	No	Not sure	
Research repositories and scholarship collections are general knowledge to all staff, researchers and students				1
The research/scholarship repository is visible and accessible on my institution's website				2
There are regular calls for participation and contribution of research output created for submission to the repositories				3
Other comments (please elaborate)				4

16) Networking and openness of digital research repositories (X one in each option)

	Yes	No	Not sure	
My institution/ university/ college's research is freely				1

available in the open access environment				
My institution/university/ college actively promotes and takes part in initiatives such as Open Access week, NDLTD and other research repository networking opportunities				2
Researchers at my institution is aware of the benefits of publishing in open access				3
Researchers at my institution do not trust the quality of open access research sources.				4
Other comments (please elaborate)				5

17) Preservation, curation and interoperability of research repositories (X one in each option)

	Yes	No	Not sure	
Do you have a long term preservation strategy for your digital records?				1
Are you subscribing to standards for web content interoperability such as OAI-PMH, and OAIster in your digital repository?				2
Other comments (please elaborate)				3

18) Repository ranking and performance measuring (X one in each option)

	Yes	No	Not sure	
Regular statistical analysis takes place to measure usage, growth and performance trends of the research repository				1
The institution/ university/ college research repository is registered				2

with directories such as OpenDoar				
The research repository ranks on a web site such as Ranking Web Repositories				3
Other comments (please elaborate)				4

19)Repository age, longevity, support and contingency (X one in each option)

	Yes	No	Not sure	
The repository management has an approved development and maintenance plan with clear goals and set time lines				1
Staff responsible for managing the digital scholarship collection is suitably skilled and stay abreast of technological changes				2
Are you using open source software such as Dspace or EPrints				3

Has your software been upgraded during the past three years				4
Is your repository older than 5 years				5
Other comments (please elaborate)				6

Thank you for your time!

ANNEXURE B: Summary of Survey Questionnaire answers

SECTION A: BACKGROUND INFORMATION ON DIGITAL SHOLARSHIP CURATION

1) This section collects data on the nature, educational environment and research culture of your institution.

Name your university or institution type
(X one)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Public research university	1	X		x	x	x	x						3
Public comprehensive university	2		x										1
Private higher education institution/college	3							x	x	x	x		4
University of technology	4												2

2) Does your university/institution offer post graduate qualifications?(X one)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Yes	1	x	x	x	x	x	x	x	x	x	x		10
No	2												0

3) If the answer to 2 is yes, on which level are qualifications offered? (X all applicable)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	A1		TOTAL
Post graduate diplomas	1		x		x	x	x	x	x		x			7
Honours	2		x		x	x	x		x		x			6
Masters	3		x	x	x	x	x		x		x			7
Doctoral	4	x	x	x	x	x	x		x					7
Not applicable	5									x				1

4) Do your academic staff members conduct and publish research? (X one)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Yes	1	x	x	x	x	x	x	x	x	x	x		10
No	2												0

5) If your answer in 4 is yes, which of the following apply? (X all applicable)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Journal articles for own journal	1	x		x			x		x	No answer	x		5
Journal articles for accredited research journals	2	x	x	x	x	x	x	x	x		x		9
Journal articles for other/ non-accredited journals	3						x				x		2

Mini dissertations	4			x			x		x		x		4
Research projects and assignments	5	x		x	x	x	x				x		6
Dissertations	6	x	x	x	x	x	x				x		7
Theses	7	x	x	x	x	x	x		x		x		8
Conference proceedings	8	x	x	x	x		x	x	x		x		8
Conference papers	9	x	x	x		x	x	x	x		x		8
Other (Please elaborate)	10			Consultation with community									
Not applicable	11												0

SECTION B: INSTITUTIONAL GOVERNANCE OF SCHOLARSHIP CURATION

6) Which of the following strategies does your institution have in place?

(X all applicable)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Research strategy	1	x	x		x	x			No answer		x		5
Information and technology strategy	2	x	x		x	x		x					5
Open access strategy	3	x			x	x	x			x			5
Research funding strategy	4	x	x				x						3
Innovation strategy	5	x				x							2
Faculty research strategy	6	x		x		x				x			4
Knowledge management strategy	7					x				x			2
Other (please elaborate)	8												0

7) Which of the following policies are officially approved by Senate?

(X all applicable)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Research Policy	1	x		x	x	No answer	No answer	x	No answer		x		5
Research information systems policy and procedure (RIMS)	2												0
Research ethics policy and procedures	3	x			x					x	x		4
Institutional repository policy and procedures	4	x	x		x			x		x			5
Information technology policy and procedures	5	x			x								2
Open access/ openness policy	6	x								x			2
Intellectual property policy	7	x			x						x		3

8. If not approved by Senate, which other governance structure approves policy and procedures on digital scholarship and research collections? (X all applicable)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Library committee	1	X	X	X	X	No answer	No answer						4
Editorial board	2								X				1
Registrar	3												0
IT committee	4		X										1
Faculty board	5	X							X	X			3
Departmental committees	6				X								1
Financial committee	7								X				1
Other (please elaborate)	8	Research board						Research & Collaborative Committee			Teaching committee		3

9) Do any of your existing strategies and policies refer to or explain the following concepts or terms in any way directly or implied? (X at each option one)

		Yes	A	B	No	A	B	Not sure	A	B
Knowledge management	1		A3, A4, A5 A6				B1 B2 B4		A2	B3
Knowledge capital	2		A4, A5				B2 B4		A2; A3	
Intellectual capital	3		A1; A3, A4, A5				B2		A2	B4
Knowledge creation	4		A1; A3, A4' A5 A6				B2 B4		A2	
Competitive edge	5		A1, A4 A5				B4		A2	B2

	TOTAL		18	0		0	9	0	6	3
Other comments (please elaborate)	6 no further comments were recorded									

SECTION C. THE BENEFITS AND VALUE OF DIGITAL RESEARCH AND SCHOLARSHIP REPOSITORIES

10) Please indicate your experience on the following (X one in each option)

	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	
I am fully aware of all digital scholarship projects and databases provided by my institution/ university/ college	A1 A3	A4 A5 A6		A2		1
	B1 B4				B3	
	A1 A2	A6			A5	2

I believe that quality research should not be housed in different departmental databases, but rather in well-coordinated and centrally managed repositories	A3					
	A4					
	B1					
	B2					
	B3					
My university/institute/ college actively promotes and gives open access to research housed in a digital repository	A1	A2	A3		A4	3
		A6	A5			
	B1				B4	
	B2					
	B3					
My university/institute/ college encourages and supports research in terms of funding, study leave and other incentives to promote research	A1	A3	A6		A4	4
	A2	A5				
		B1			B3	
		B2			B4	

Research and scholarship are secondary to teaching and learning		A2 A3	A4 A5	A6		5
		B1 B3		B2		
Research is not curated or digitised in scholarship repositories or other research collections				A3 A5	A2 A4 A6	6
		B4		B2	B1 B3	

SECTION D: SUCCESS FACTORS FOR DIGITAL SCHOLARSHIP REPOSITORIES

11) The planning, implementation and maintenance of the digital scholarship project and repository are officially mandated by: (X one)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Senate	1	x		x	x	x	x	x		x	x		8
Library Committee	2	x	x	x	x	x							5
IT Committee	3	x											1
Research Committee	4	x			x	x							3
A Multi-Disciplinary Committee	5				x				x				2
All of the above	6												0
None of the above	7												0

12)The nature, scope and importance of digital scholarship collections are known and supported by management structures (X one)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Yes	1	x	x	x	x		x	x	x		x		8
No	2									x			1
Not Sure	3					x							1

13)The digital scholarship databases/ project receives a separate annual budget allocation (X one)

		A1	A2	A3	A4	A5	A6	B1	B2	B3	B4		TOTAL
Yes	1				x				No answer				1
No	2	x	x	x		x				x	x		6
Not Sure	3						x	x					2

14)The integration of digital scholarship collections (X one in each option)

	Yes	A	B	No	A	B	Not sure	A	B	TOTAL
Digital scholarship curation is managed by an interdepartmental forum/committee where all stakeholders are present	1		B1 B2		A1 A2 A3 A4 A5 A6	B3 B4				
Research information management (RIMS) and digital scholarship collections are jointly planned and managed	2	A1 A4	B1		A5 A6	B3 B4	A2 A3		B2	
Does your institution have a written academic strategy?	3	A1 A4 A5	B1		A6	B3	A2 A3		B2 B4	

Do you think that research scholarship curation processes and strategies clearly link and align with your academic and other institutional strategies?	4	A1 A4	B1 B2 B4		A5		A2 A6	B3		
5. Other comments (please elaborate) A1: Digital scholarship is managed by the library. B4. Do not have RIMS										

15) The marketing, promotion and awareness of digital scholarship repositories
 (X one in each option)

	Yes	A	B	No	A	B	Not sure	A	B	TOTAL
Research repositories and scholarship collections are general knowledge to all staff, researchers and students	1	A1 A3 A4	B1 B2 B4		A2 A5 A6				B3	10

The research/scholarship repository is visible and accessible on my institution's website	2	A1 A2 A3 A4 A6	B1 B2 B4		A5	B3				
There are regular calls for participation and contribution of research output created for submission to the repositories	3	A1 A4	B1 B4		A2 A3 A5	B3		A6	B2	
4. Other comments (please elaborate): A1: The IR is accessible via the library website; A3 mainly ETDs in IR.; A6: IR is established but not well patronised										

16) Networking and openness of digital research repositories (X one in each option)

	Yes	A	B	No	A	B	Not sure	A	B	TOTAL
	1	A1 A2 A4 A5 A6	B1 B2 B4	A3		B3				
My institution/university/ college actively promotes and takes part in initiatives such as Open Access week, NDLTD and other research repository networking opportunities	2	A1 A2 A4 A5 A6	B1 B2 B4	A3		B3				

Researchers at my institution are aware of the benefits of publishing in open access	3	A1 A2 A3	B1 B2		A5			A4 A6	B3 B4	
Researchers at my institution do not trust the quality of open access research sources.	4	A2	B1		A1 A5		B3 B4	A3 A4 A6	B2	
5. Other A1: Advocacy and marketing of IR done rigorously; A3: researchers are concerned about copyright in AO; A6 only some research available in OA, OA advocated widely; B1: some researchers are aware of benefits – 50%. Some do not trust the IR- 50%										

17) Preservation, curation and interoperability of research repositories (X one in each option)

	Yes	A	B	No	A	B	Not sure	A	B	TOTAL
Do you have a long term preservation strategy for your digital records?	1	A1			A2	B4				
		A4			A3					
		A6			A5					
		B1	B2							
Are you subscribing to standards for web content interoperability such as OAI-PMH, and OAIster in your digital repository?	2	A1			A3					
		A2								
		A4								
		A5								
		A6								
				B1						
				B2						
				B4						

<p>3. Other comments (please elaborate)A3: IR only accessible on intranet; A6 registered on COAR; A. Our IR is no longer OA. It is a closed collection.</p>	
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18) Repository ranking and performance measuring (X one in each option)

	Yes	A	B	No	A	B	Not sure	A	B	TOTAL
Regular statistical analysis takes place to measure usage, growth and performance trends of the research repository	1	A1	B4		A3					
		A2								
		A4								
		A5								
		A6								
			B1			B4			B2	

The institution/ university/ college research repository is registered with directories such as OpenDOAR	2	A1 A2 A4 A6			A3			A5		
			B1 B2			B4				
The research repository ranks on a web site such as Ranking Web Repositories	3	A1 A4			A3	B4		A2 A5		
					B1			B2		
4. Other comments (please elaborate) A1: It is one of the reasons why our HEI ranked very well in 2015; A3 only on intranet. B1. Our repository is newly created.										

19) Repository age, longevity, support and contingency (X one in each option)

		Yes		No		Not sure	
		A	B	A	B	A	B
The repository management has an approved development and maintenance plan with clear goals and set time lines	1	A1		A2	B4		
		A4 A5		A3 A6			
			B1 B2				
Staff responsible for managing the digital scholarship collection is suitably skilled and stay abreast of technological changes	2	A1 A3 A4 A5	B4	A2 A6			

			B1 B2 B4				
Are you using open source software such as Dspace or EPrints	3	A1 A2 A3 A4 A6	B1	A5		B4	B2
Has your software been upgraded during the past three years	4	A1 A2 A3 A4 A6	B1 B2	A5		B4	
Is your repository older than 5 years	5	A2 A3 A4	B1 B2	A5			

Thank you for your time!