A FRAMEWORK FOR PRESERVATION OF DIGITAL RESOURCES IN ACADEMIC LIBRARIES IN SOUTH AFRICA

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ABSTRACT

The aim of the study was to examine the implementation of digital preservation practices in academic libraries in South Africa in the light of the rapid changing information environment. The study looked into the strategies, systems and tools being employed to support digital preservation programmes and the costs associated with the various digital preservation programmes. The study was guided by various digital preservation theories and models,namely Davies' (2000) Policy, Strategy and Resources (PSR) troika model, Kenney and McGovern's (2003) three leg stool, Corrado and Moulaison's (2014) preservation triad and the Carnegie Mellon University's (1990) Digital Preservation Capability Maturity (DPCM) model and Open Archival Information System (OAIS) model by OCLC (2002), underpinned by the survey research design, triangulation of questionnaires and document analysis as data collection methods. Out of 27 questionnaires distributed to academic institutions, 22 (81.5%) were completed. Quantitative data was analysed using descriptive analysis whilst content analysis was used for qualitative data obtained from document analysis. Findings revealed that academic libraries in South Africa were significantly affected by the changes to the digital environment. Most academic libraries face many challenges that hinder the effective implementation of digital preservation. The problems include: lack of funding, lack of skills and training and technology obsolescence. The study identified migration, bit preservation, replication and risk management approaches as the most widely implemented preservation strategies to address preservation challenges faced by academic libraries in South Africa.

Although various preservation systems and tools are being developed to enable description, discovery, delivery and preservation of digital collections, there was expressed lack of awareness about digital preservation standards and preservation support organisations. The study also observed that, in some instances, the academic institutions were not fully involved in collaborative and partnerships with other institutions. By collaborating and partnering with other institutions, they would be exposed to new ideas, strategies and tools, and be able to acquire knowledge and skills needed to successfully preserve and manage their digital resources. The findings revealed that the implementation of policies and strategies, provision of adequate resources, sufficient funding and digital preservation knowledge and skills are some of the major factors influencing digital preservation sustainability in academic libraries. This study, therefore, recommends that these institutions can address some of the digital preservation challenges if they leverage on these factors. The study also made several recommendations on how digital preservation can be successfully implemented, and it

further proposed a framework for preservation of digital resources in academic libraries, mapped to international preservation models and standards.

KEYWORDS

Digitization, digital preservation, digital resources, academic libraries, digital technologies, digital libraries, preservation strategy, technology obsolescence, metadata.

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DEDICATION

This work is dedicated to my family and my late dad:

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“I am so glad I did it, partly because it was worth it, but mostly because I shall never have to do it again.”- Mark Twain

DECLARATION

Student Number: 49125303

I declare that this study, **"A Framework for preservation of digital resources in academic libraries in South Africa"** is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

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Signature Date

Tlou Maggie Masenya

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LIST OF ABBREVIATIONS

AAU	Association of African Universities
ADL	African Digital Library
AIIM	Association of Information and Image Management
ALA	American Library Association
APARSEN	Alliance for Permanent Access to Records of Science in Europe Network
ARMA	Association of Records Managers and Administrators
ARNO	Academic Research in the Netherlands Online
BRTF	Blue Ribbon Task Force
CCSDS	Consultative Committee for Space Data Systems
CEDARS	CURL Exemplars in Digital Archive
COSALC	Coalition of South African Consortia
CSIR	Council of Scientific and Industrial Research
CURL	Consortium University Research Libraries
DAITSS	Dark Archives in the Sunshine State
DANS	Data Archiving Networked Service
DATAD	Database of African Theses and Dissertations
DCMI	Dublin Core Metadata Initiative
DCC	Digital Curation Centre
DISA	Digital Imaging South Africa
DPE	Digital Preservation Europe
DPC	Digital Preservation Coalition
DPCMM	Digital Preservation Capability Maturity Model
DPM	Digital Preservation Management
DROID	Digital Record Object Identification
DSA	Data Seal of Approval
eIFL	Electronic Information for Libraries
ERPANET	Electronic Resource Preservation and Access Network
FEDORA	Flexible Extensible Digital Object Repository Architecture
IFLA	International Federation of Library Associations
IRMT	International Records Management Trust
JISC	Joint Information System Committee

LAM	Libraries, Archives and Museums
LOCKS	Lots of Copies Keeps Stuff Safe
NDIIP	National Digital Information Infrastructure Preservation Programme
NEDLIB	Networked European Deposit library
NDLTD	Networked Library of Theses and Dissertation
NESTOR	Network of Expertise in long-term SToRage
OAIS	Open Archival Information Systems
OECD	Organisation for Economic Co-operation and Development
OCLC	Online Computer Library Centre
PSR	Policy, Strategy and Resources
PREMIS	Preservation Metadata: Implementation Strategies
SCAPE	Scalable Preservation Environments
SPSS	Statistical Package for the Social Sciences
TDR	Trusted Digital Repository
TRAC	Trusted Repositories Audit and Certification
UNESCO	United Nations Educational, Scientific and Cultural Organization
XML	Extensible Markup Language

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CHAPTER ONE

BACKGROUND TO THE STUDY

1.1. Introduction

The increasing application of digital technologies has transformed the way information professionals create, disseminate and use information in the library world. As noted by Raju (2014) the explosive growth of digital devices and related applications have collectively altered the traditional academic library beyond recognition. These dramatic changes, largely the result of rapidly evolving digital technologies, have led to the creation of electronic resources within the academic institutions in South Africa. A huge amount of information is now available in electronic format and this includes institutions' books, journal articles, manuscripts, theses, dissertation and other library materials. However, academic institutions are running a risk of losing vital digital information due to rapid technology obsolescence, absence of accurate and complete metadata, inadequate resources, lack of policies and procedures and fragility of storage media.The Council of Canadian Academies (2015) also observed that libraries, archives and museums (LAM) are facing numerous challenges as they attempt to adapt to the digital age, including dealing with rapid obsolescence of the technology used, making accessible mass quantities of digital data and remaining trusted as repositories that hold documentary evidence of scholars and citizens.

The change to the digital world therefore raises serious and pressing issues on how to organize, access and preserve digital materials or resources into perpetuity, as created by academic institutions. As a result, an increasing number of academic institutions in Africa and South Africa, in particular, have embarked on digitizing their library materials in order to improve access and longevity of their digital resources, including institutions' books, research papers, theses and other works which were born digital and those which can be digitized (Van Deventer & Pienaar, 2008). Library digitization has thus become part of the work of information professionals to ensure that information will be accessible to all instead of a group of researchers.The Digital Preservation Coalition (2002) described digitization as the process of creating files by scanning, digital-photographing or otherwise converting analogue materials into digital materials. It is also described as the process of converting analogue materials to machine-readable format for the purpose of providing electronic access and preservation (Lampert & Vaughan, 2009). Digitization of analogue material can thus be used to create surrogates for rare or fragile originals as

well as to improve access to this material. The cultural heritage conservation community has also embraced digitization as a means to safe-guard cultural heritage materials from occurrences of natural disaster (McDowell, 2007).

The amount of digital content or resources generated through digitization of analogue materials or content being “born” digitally and other non-digital materials has thus increased during the past decade. For example, the Department of Manuscripts and Archives at the University of Cape Town (UCT) digitized several interesting collections housed in university archives and special collections in 2001(Dunlop & Hart, 2005). One such project is the digitization of photographs of the San people between 1910 and the late 1920s and this collection is possibly the most unique and one of the most important of UCT’s special collections. It attracts researchers from all over the world and it has also been listed as being a heritage of international importance on UNESCO’s Memory of the World register. Digital Imaging South Africa (DISA) is another innovative project aiming at making Southern African materials of high socio-political interest, such as anti-apartheid materials, accessible to scholars and researchers worldwide. Its vision is to digitize and create a freely accessible online scholarly resource focusing on the socio-political history of South Africa, particularly the struggle for freedom during the period from 1950 to 1994.

As observed by Sigauke and Nengomasha (2011), for the past few years, academic institutions have been grappling with how to manage and preserve the digital intellectual output they produce. Academic libraries have managed their information in various analogue formats for centuries, and now that they have entered the digital age, preserving digital content for the same length of time has become a complex task. As a result, some digitized materials have been lost and to date remain inaccessible due to the original software being outdated or incompatible with modern operating systems. There are numerous examples of digital data loss, for instance, the American National Aeronautics and Space Administration(NASA) lost track of Martian Viking Lander experimental done in 1976(NASA-NSSDC, 2010). The original data was stored on technology that is old and inaccessible. Another example is Newham Museum Archaelogical Service in United Kingdom that has also lost some of digital data due to technology obsolescence.Its digital archive represents some of ten years of filedwork and consists of about 230 floppy disks containing over 6000 files, as noted by Simpson (2004).The files were in a variety of proprietary software and versions which are now archaic and some of digital materials stored in these files have become inaccessible.The digital information is therefore at great risk of loss if digital preservation is not a consideration and prioritized. As a result, academic institutions in South Africa have recognized a need for long-term preservation of their fast growing number of digital collections. Rosenthal, Robertson, Lipkis, Reich and Morabito (2005) described the goal of any digital preservation system as to ensure that the information it contains remains accessible to users over a long period of time.

UNESCO's charter on the preservation of digital heritage also states that the purpose of preserving the digital heritage is to ensure that it remains accessible to the public and, accordingly, access to digital heritage materials, especially those in the public, should be free of unreasonable restrictions (UNESCO, 2003). Digital preservation has, however, become a significant problem facing academic libraries today and it posed immense challenges for libraries and archives attempting to preserve their digital materials and data repositories. As observed by Raju (2014), these dramatic changes have also impacted significantly on the knowledge and skills requirements for information professionals practicing in this environment. Therefore, the skills of information professionals have to be as relevant to the electronic milieu created by technological changes as to that of print. These preservation challenges have therefore entrenched the dire need for a trusted system to manage and preserve the digital resources, and the need to thoroughly understand and assess the preservation strategies in ensuring on-going access to digital resources in most academic institutions in South Africa.

The change to modern digital environment has also prompted several projects and initiatives such as developing institutional repositories and digital libraries.Institutional repositories (IR) are noted to collect, manage and disseminate digital materials produced at an institution for long-term preservation and future access (Chapman, Reynolds & Shreeves, 2009). In this regard, an increasing number of academic institutions in South Africa implemented institutional repositories in order to collect, disseminate, manage and preserve scholarly and research outputs in their libraries, including the institution's books, papers, theses and other works which were born digital and for those which can be digitized (Smith & Pienaar, 2007). For example, the University of Pretoria (UP) started a project of making theses available online in 2000 by establishing institutional repositories (IRs) known as UPeTD and UPSpace, using an open access ETD-db software for the management and dissemination of digital research materials donated to or created by the community publications (Van De Venter & Pienaar, 2008). University of Cape Town (UCT) library, together with libraries at the universities of the Witwatersrand and Kwa-Zulu Natal also developed a new digital initiatives unit with up-to-date equipment and expert staffing that is in charge of spearheading the establishment of IRs to digitize and preserve their library materials (Macha & De Jager, 2011).

A digital library has been described as an environment to bring together collections, services and people in support of the full life cycle of creation, dissemination, use and preservation of data, information and knowledge, that forms an integral part of the services of a library and applying new technology to provide access to digital collections (IFLA/UNESCO, 2010). For example, the European Commission (2005) revealed its 'i2010 digital libraries' initiative as part of its strategy for the digitization, online accessibility and preservation of Europe's cultural and scientific heritages as set out in the 'eEurope' and 'i2010' action plans. However, the change to digital environment has

also raised serious issues on how to access and preserve into perpetuity digital materials that are kept in the institutional repositories and digital libraries. International and national initiatives have also been put in place in response to digital preservation challenges. Although these initiatives attempt to address the issue of accessibility to information and recognize the potential role of digital technologies in the institutions and organizations, very little has been done on developing a digital preservation framework for academic libraries in South Africa.Therefore, no serious effort has been made to implement a framework for digital resources or it is because the concept is still evolving and more awareness is needed. The study thus looked into international and national initiatives, preservation strategies, the audit and certification standards, models, systems and technologies used in preserving the digital resources in order to enhance digital preservation in academic libraries in South Africa.

1.2 Statement of the problem

The increasing application of digital technologies in the world has undoubtedly raised various opportunities and challenges in the practice of librarianship. Academic libraries have managed their information in various analogue formats for centuries, and now that they have entered the digital age, preserving digital content for the same length of time has become a complex task. Becoming digital does not necessarily mean being continuously accessible. One instance of the library's sacred role is to provide a sense of immortality, meaning that the library will remain stable and dependable with an ever changing world outside (Maxwell, 2006). Academic libraries are currently suffering from inability to provide permanent access to electronic materials as required by the students and faculties. As a result, scientists and publishers in many countries are facing problems in accessing research information and gaining visibility for their own publications. The long-term access to digital materials has become a question and this uncertainty is a major hurdle which prevents academic libraries from moving fully from the analogue to the digital environment.

The academic institutions are thus faced with the major challenge of making sure that users can access the content that has been ingested into the institutional repository and other archives in the past, and make sense of its intellectual property, despite hardware and software obsolescence. Further, studies undertaken by Kanyengo (2006), Ngulube (2012) and Sigauke and Nengomasha (2011) further underscore the enormous challenges that most organizations in African countries are confronted with when it comes to the preservation of digital resources, despite the efforts that have been put in place to promote digital preservation. The challenges include lack of trained staff or experienced information professionals on preservation of digital resources, lack of awareness of digital

preservation, poor technological infrastructure and adequate resources to enable preservation practices, lack of policies, standards and procedures to regulate the creation, storage, retrieval and preservation of digital information resources and poor collaboration efforts and partnerships. These challenges has underscored the need for digital preservation. Sigauke and Nengomasha (2011) also noted that the digital information is at great risk of loss if digital preservation is not a consideration. Digital preservation aims at ensuring that digital content remains accessible to user communities for a long period of time and for future generations. But what should academic libraries in South Africa be doing to ensure permanent access to their electronic resources? Unfortunately, it seems as if there is no single best way to achieve this aim, nor is there agreement on long-term solutions. Of all the preservation challenges facing academic libraries, none is more pressing than developing workable solutions to digital preservation. Preservation challenges have therefore created an increasing need for best practices and strategies in ensuring long-term preservation of digital objects in academic institutions the world over.

Several preservation strategies, models, frameworks and standards have, however, evolved in academic and research institutions in Europe, Australia, Netherlands and the United State of America. This raises a concern as it is clear that most of the interventions have been carried out internationally. Literature reveals that there are only a few digital preservation projects or studies that have been devoted to develop strategies to ensure long-term accessibility of digital resources in academic libraries in Africa, particularly in South Africa. A review of current preservation strategies shows that there is no specific agreed framework on the preservation of digital resources applicable to academic libraries, in that, these strategies have different purposes, audiences and coverage. Neither preservation standard identifies explicit performance metrics to assess the current digital preservation capabilities of preservation repositories or information systems in academic libraries in South Africa. Nor do they explicitly support an incremental digital preservation capability improvement plan. There is therefore a need for a digital preservation framework that will address implementation level issues to specify minimum requirements in respect of policies, processes, metadata and standards required to measure and validate repositories' trustworthiness in respect of authenticity, integrity and reliability of the digital materials in academic libraries in South Africa.

The study, therefore, sought to evaluate the components or elements of a digital preservation, with a view to propose an integrated framework applicable to academic libraries in South Africa. An integrated digital framework will serve as a useful guide in benchmarking and comprehending digital resources management in academic libraries; and it should also be able to assist these institutions to accurately establish, articulate and prioritize preservation needs and their capabilities in the current digital age. The framework developed in this study was guided by all the theories and models as outlined

in Section 1.3 that are also mapped with the function requirements of the OAIS reference model and the attributes of the TDR model.

1.3 Definition of terms and concepts

The core concepts and terms that are pertinent to this study are briefly defined and discussed in this section, as they form the working definition of this study. These are:

1.3.1 Digitization

In the context of this study, the term ‘digitization’ is used to refer to the following definitional perspectives by different authors:

Firstly, digitization is the process of creating files by scanning, digital-photographing or otherwise converting analogue materials into digital materials, as described by Digital Preservation Coalition (2002). Secondly, digitization is the process of making an electronic version of a real-world object or event, enabling the object to be stored, displayed and manipulated on a computer, and disseminated over networks or the World Wide Web (Eadie, 2005). Finally, Lampert and Vaughan (2009) define digitization as the process of converting analogue materials to machine-readable format for the purpose of providing electronic access and preservation. Digitization of analogue material can thus be used to create surrogates for rare or fragile originals as well as to improve access to this material. This means that by digitizing library collections information will be accessible to all instead of a group of researchers.

1.3.2 Digital preservation

Digital preservation can be defined by various authors as follows:

- As the planning, resource allocation and application of preservation methods and technologies necessary to ensure that digital information of continuing value remains accessible and usable (Hestrom, 1997);
- As combination of policies, strategies and actions to ensure that digital objects remain authentic and accessible to users and systems over a long period of time,

regardless the challenges of component and management failures, natural disasters or attacks (American Library Association (ALA), 2007); and

- As aiming to ensure protection of information of enduring value for access by present and future generations, and hence it comprises of planning, resource allocation and application of preservation methods and technologies necessary to ensure that digital information of continuing value remain accessible and usable (Das, Sharma & Gurey, 2009).

For the purpose of this study, digital preservation is thus perceived as a combination of plans, strategies, actions, policies, procedures, resource allocation, preservation methods and technologies aimed at prolonging the existence of and access to digital resources for as long as necessary by maintaining them either in their original format or in a more persistent format, while protecting their authenticity (Hedstrom, 1997; American Library Association (ALA), 2007; Das, Sharma & Gurey, 2009).

1.3.3 Digital resources

Digital resources are those resources that deal with both born digital and digitized materials which can be either accessible from the library's in-house database or from the world-wide-web. Digital resource is simply referring to any resource which is in digitized form, that is which can be read and scanned by means of electronic media. These resources can include books, journals, newspapers, and visual and audio materials stored as electronic media format. However, digital resources do not require separate space in a library as these can be stored in a computer locally or remotely. Digital Preservation Coalition (2002) distinguishes two forms of digital resources:

- Born digital, which refers to materials which were not intended to have an analogue equivalent; and
- Made digital, which connotes creating digital files by scanning or otherwise converting analogue materials to electronic formats.

1.3.4 Academic library

An academic library is one created to serve a college or university to disseminate and store information for the use of users, and its main group of users are students, faculty and staff at that institution. It is a nerve of the institution, and an academic environment without a library is thus tantamount to a person without a brain. As stated by Jama (1984) academic libraries in particular assume a focal point where users of diversified age groups, socio-political, economic backgrounds and cultural interests have to converge to utilize all the available resources that are relevant to their individual needs. It is a big repository of information and knowledge from all fields of learning to the academic community of students and it serves the reading and research interests of undergraduates, lecturers, researchers, and other users. According to Ogunsola (2005) academic libraries develop and maintain standard books, journals and audio-visual collections and services to fulfil their mission of supporting the educational objectives of their parent bodies, which include teaching, learning, research and cultural development.

Aina (2004) further describes an academic library as central to learning and research, and it therefore serves two complementary purposes: to support the school's curriculum and to support the research of the university faculty and students. It has always depended on relevant new technologies, which are driven by emerging trends in education and research. As noted by Odeh (2011) an academic library has to build a strong collection of information resources in physical and digital formats to cater for the knowledge requirements of students, faculty members and research scholars of the institution. Academic libraries must therefore fulfil some set of roles for serving their parent institutions to remain relevant in this digital era.

1.3.5 Digital library

The Digital Library Federation (2001:1) defines digital libraries as:

> Organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily available for use by a defined community or set of communities.

Candela, Athanasopoulos, Castelli, Raheb, Innocenti, Ioannidis, Katifori, Nika, Vullo & Ross(2007:16) describe a digital library as:

> A potentially virtual organization, that comprehensively collects, manages and preserves for the long depth of time rich digital content, and offers to its targeted user communities specialized functionality on that content, of defined quality and according to comprehensive codified policies

Krishnamurthy (2005:200) further describes digital libraries as:

> Electronic libraries in which large number of geographically distributed users can access the contents of large and diverse repositories of electronic objects (networked text, images, maps, sounds, videos, catalogues, data sets).It is a special library with a focused collection of digital objects that can include text, visual material, audio material, video material, stored as electronic media formats (as opposed to print, microform, or other media), along with means for organizing, storing, and retrieving the files and media contained in the library collection.

A digital library provides technology based information and services to enable learners to access relevant information and services anywhere anytime, as well as provides empowerment for innovative and life-long learning. It applies appropriate communication technologies to provide support to e-learning and e-research by providing seamless access to electronic resources and services. These range of electronic resources include online catalogues, databases, multimedia, online journals, digital repositories, electronic books, electronic archives, and online or electronic services (Barton, 2005). The use of cutting edge technologies by digital libraries to provide access to electronic resources and services in support of learning, teaching, and research has therefore benefited both learners, lecturers and researchers. They can undertake learning and research without being in the library.

According to Borgman, Bates, Cloonan, Efthimiadis, Gilliland-Swetland, Kafai & Leazer (1996:9) digital libraries is regarded as:

i. Set of electronic resources and associated technical capabilities for creating, searching and using information. In this sense, digital libraries are an extension and enhancement of information storage and retrieval systems that manipulate digital data in any medium (text, images, sounds; static or dynamic images) and exist in distributed networks. The content of digital libraries includes data, metadata that describe various aspects of the data (i.e. representation, creator, owner, reproduction rights) and metadata that consist of links or relationships to other data or metadata, whether internal or external to the digital library; and
ii. Constructed, collected and organized by a community of users, and their functional capabilities support the information needs and uses of that community. They are a component of communities in which individuals and

groups interact with each other, using data, information and knowledge resources and systems. Digital libraries in this sense are an extension, enhancement and integration of a variety of information institutions as physical places where resources are selected, collected, organized, preserved and accessed in support of a user community. These information institutions include, among others, libraries, museums, archives and schools, but digital libraries also extend and serve other community settings, including classrooms, laboratories, homes and public spaces.

1.3.6 Preservation strategy

A digital preservation strategy is an approach to the preservation of digital objects to ensure that access to the born-digital archives accessioned by a repository can be maintained indefinitely. It is a particular technical approach to the preservation of digital materials that outlines a policy framework applicable to the three main stages in the life cycle of a digital resource: creation, management or preservation, and use (Beagrie, 2006; Lavoie & Gartner, 2005). As stated by Beagrie (2006), digital preservation strategies and actions address content creation, content integrity and content maintenance:

- Content creation includes: clear and complete technical specifications, production of reliable master files, sufficient descriptive, administrative and structural metadata to ensure future access, detailed quality control of processes, and use of persistent identifiers;
- Content integrity includes: documentation of all policies, strategies and procedures, recorded provenance and change history for all objects, verification mechanisms, attention to security requirements and routine audits; and
- Content maintenance includes: a robust computing and networking infrastructure, storage and synchronization of files at multiple sites, continuous monitoring and management of files, programs for refreshing, migration and emulation, creation and testing of disaster prevention and recovery plans, periodic review and updating of policies and procedures.

1.4 Digital preservation initiatives in other parts of the world

The challenges of long-term preservation of digital information have been recognized by archival and academic institutions around the world. In 1996 the Task Force on Archiving

of Digital Information identified a need for trusted organizations capable of providing long-term digital preservation (Waters & Garret, 1996). The Task Force declared a critical component of digital archiving infrastructure as the trusted organizations capable of storing, migrating, and providing access to digital collections (Waters & Garrett, 1996). The Task Force further noted that, if we are effectively to preserve for future generations the portion of this rapidly expanding corpus of information in digital form that represents our cultural record, we need to understand the costs of doing so and we need to commit ourselves technically, legally, economically and organizationally to the full dimensions of the task (Waters & Garrett, 1996:3-4). The Task Force also developed an audit checklist for digital repositories that was published in 2007 as the Trustworthy Repositories Audit and Certification (TRAC) checklist (RLG/NARA, 2007). TRAC presents almost 90 organizational, technological and digital object management criteria for digital repositories.

The Consultative Committee for Space Data Systems (CCSDS) also developed Open Archival Information Systems (OAIS), a high level model accepted by digital preservation as the key standard for digital repositories (CCSDS, 2002). CCSDS (2002) describe an OAIS as an archive consisting of an organization of people and systems that has accepted responsibility to preserve information and make it available for a designated community. The OAIS Reference Model defines high level services and requirements that a trustworthy repository should provide to support long-term access (ISO, 14721), and it also defines the processes required for effective long term preservation and access to information objects and establishes a common language to describe them. This model also provides a standardized method to describe repository functionality by providing detailed models of archival information and archival functions. It also provides the framework to make a successful implementation possible through describing the basic functionality and types of information required for a preservation environment.

One of the first uptakes of the OAIS reference model was for establishing conventions for determining the trustworthiness of repositories to determine whether an archive or repository is following practices that will ensure long-term digital preservation required for community consensus. In establishing an institution-wide digital preservation programme, the organization can assess its efforts by mapping its achievements to the Open Archival Information System (OAIS) reference Model (CCSDS, 2002). According to Task Force (1996) a process for certification of digital archives was needed to create an overall climate of trust about the prospects of preserving digital information. Additional standards, ISO 16363, was also created to specify auditing criteria for the certification of trustworthy repositories (CCSDS, 2002).

In 2002, Research Libraries Group (RLG) and Online Computer Library Center (OCLC) jointly published Trusted Digital Repositories: Attributes and Responsibilities, which further articulated a framework of attributes and responsibilities for trusted, reliable,

sustainable digital repositories capable of handling the range of materials held by large and small cultural heritage and research institutions. The six attributes of the trusted digital repository (TDR) framework are: administrative responsibility, organizational viability, financial sustainability, technological and procedural suitability, system security, and procedural accountability. This framework was broad enough to accommodate different situations, technical architectures, and institutional responsibilities while providing a basis for the expectations of a trusted repository. The document outlining the framework has proven to be useful for institutions grappling with the long-term preservation of cultural heritage resources and has been used in combination with the OAIS as a digital preservation planning tool.

In February 2007 the Digital Preservation Europe (DPE) project and the UK Digital Curation Centre (DCC) published their joint work on digital repository assessment methods as the Digital Repository Audit Method Based on Risk Assessment (DRAMBORA) (Hofman et al., 2007). The DRAMBORA tool presents a methodology for repository self-assessment and characterizes digital curation as a risk management activity. The job of a digital curator is to rationalize the uncertainties and threats that inhibit efforts to maintain digital object authenticity and understandability, transforming them into manageable risks. OCLC/RLG Working Group on Preservation Metadata: Implementation Strategies (PREMIS) also published its first proposal for core preservation metadata elements in 2005 as the PREMIS Data Dictionary for Preservation Metadata (PREMIS, 2005).

In 2010, the chairs of the Repository Audit and Certification Working Group (RAC), the Data Seal of Approval (DSA) board and the DIN trusted archives certification working group signed a memorandum of understanding stating that they will work together to create standards for trusted digital repository certification, and this effort is known as the European Framework for Audit and Certification of Digital Repositories (CCSDS, 2010). The Network of Expertise in long-term SToRage (NESTOR) working group performed DIN 31644, which also articulated the principles of documentation, transparency, adequateness and measurability that should be used when applying any criteria to trusted digital repositories. OCLC/RLG (1995) developed a Dublin Core Metadata Initiative (DCMI), which is an organization supporting innovation in metadata design and best practices across the metadata ecology, and aimed at promoting widespread acceptance of metadata standards. The mission of the Dublin Core Metadata Initiative (DCMI) was to make it easier to find resources using the Internet through these activities.

1.4.1 Digital preservation initiatives in Africa and South Africa

Considerable efforts have also been made over the past few years to ensure that academic institutions in South Africa are able to access the growing quantities of digital resources. Many of the initiatives were aimed at creating collaborative efforts in digitization and preservation of digital resources, providing the necessary infrastructure and strengthening capacity for safeguarding digital resources in academic institutions in African countries. Association of African Universities initiated Database of African Theses and Dissertations (AAU-DATAD), aimed at creating capacity in African universities for the collection, management and dissemination of theses and dissertations (T&Ds) electronically and providing visibility through improving management and access to African scholarly work (AAU, 2000). The programme's long-term objectives include:

- Working with participating institutions to build a regional database of theses and dissertations providing visibility and accessibility to the work of African scholars;
- Facilitating the protection of intellectual property rights of African university communities; and
- Providing support for the Association of African Universities (AAU), which aims at capacity building of research, promotion of cooperation among member universities and networking of higher education institutions.

Another project is Digital Imaging South Africa (DISA), a non-profit making initiative for co-operation among research libraries and archives in Southern Africa, based at the University of Kwa-Zulu Natal and sponsored by the Andrew W. Mellon Foundation since 1997. The organization seeks to build meaningful international partnerships in providing access to academic and professional networks, and in building shared resources in South Africa and worldwide. The Research Information Services (SARIS) project was also initiated with the aim of providing a framework for e-research services to all South African researchers (Van Deventer & Pienaar, 2008).

The implementation of institutional repositories (IRs) was another emergent trend in preserving digital resources in academic libraries in South Africa. By 1998 an increasing number of academic institutions begun to grapple with building institutional repositories in order to collect, disseminate, manage, preserve and index the research output created by their communities. Institutional repository (IR) is regarded as a digital preservation strategy to increase the institution's visibility and prestige, and to preserve and manage the digital scholarship learning communities produce. As noted by Crow (2002) an IR provides an opportunity for institutions and faculty to collect and organize digital resources such as research journal articles (pre-prints and post prints), digital versions of theses and dissertations and other digital assets donated to institutions such as arts and other

image collections and conference papers and proceedings for long-term preservation. Institutional repositories (IRs) also offer the following benefits as outlined by Barwick and Pickton (2006):

- Provide a means of enhancing the prestige of an institution, and increase the visibility and marketability of such an institution;
- Support teaching and learning by providing links with the library catalogue and the virtual learning environment;
- Provide a central storage space for the intellectual output of an institution;
- Increase the dissemination and impact of research output of staff and researchers if the IR is accessible through open access;
- Ensure long-term availability and accessibility of information sources stored in the IR; and
- Enhance academic communication by allowing global users to comment on pre-prints stored in the IR.

Massachusetts Institute of Technology (MIT) also initiated a research project titled DSpace to build a stable and sustainable long-term digital storage repository that provides an opportunity to explore issues surrounding access control, rights management, visioning, retrieval, community feedback and flexible publishing capabilities (DSpace, 2000). Electronic Information for Libraries (eIFL) and the Mellon Foundation also helped to establish a number of university institutional repositories (IRs) in South Africa. eIFL aimed at enabling access to knowledge for education, learning, research and sustainable community development, working in collaboration with libraries in more than 60 developing and transition countries in Africa, Asia, Europe, and Latin America.

South Africa has 27 academic institutions at present, some of which built IRs and are very successful in making their research output available to the world. These include: University of Pretoria (UPSpace & UPeTD), University of Johannesburg (UJDigispace), Durban University of Technology IR, University of Western Cape (UWC Research Repository)University of South Africa (UnisaIR), University of North West (Boloka),University of Stellenbosch (SUN Scholar repository),University of Witwatersrand (WIReDSpace), University of Limpopo IR, University of Cape Town IR, Rhodes University(ReRR), University of Fort Hare IR, Tshwane University of Technology (TUT Digital Open Repository), Vaal University of Technology (VUT DigiResearch), University of Zululand (UZSpace), University of Free State (UFS ETD),University of Kwa-Zulu Natal (UKZN Research space), Cape Town Peninsula University of Technology IR, Walter Sisulu University, University of Venda, Nelson Mandela Metropolitan University, Central University of Technology(Bloemforntein), Mangosuthu University of Technology, University of Mpumalanga, Sol Plaatjie University, Midrand Graduate Institute, Monash University (OpenDOAR, 2017). This study was therefore done in the context of all South

African academic institutions with the aim to assess the current status of preservation practices and its capabilities by using all the models as mentioned at the beginning of Section 1.4.

1.5 Conceptual framework of the study

In this study, the conceptual framework was adopted in line with the positivist research paradigm; however, the research started with theory since it was a quantitative study. Ngulube, Mathipa and Gumbo (2015) are of the view that theory and research form the positivist paradigm (i.e. the deductive approach whereby research starts with a theory) and the interpretivist one (i.e. the inductive approach which starts with observations in order to build up theories and generalizations). Miles and Huberman (1994) and Ravitch and Riggan (2012) are also of the view that theories are part of the conceptual framework of a study. According to Ngulube, Mathipa and Gumbo (2015:48) a conceptual framework is a set of concepts and aspects of theories that assist in establishing coherence in research and are "less developed than theories". It is "a theory-based and evidence-driven argument that is developed to justify the significance of the problem, define relevant concepts, establish theoretical and empirical rationale, guide selection of appropriate methods, and scaffold data analysis and interpretation" (Antonenko, 2015:57). As stated by Nieswiadomy (2012:94-95) the conceptual framework links concepts from several theories, from previous research results, or from the researcher's own experience. It may also be defined as an end result of bringing together a number of related concepts to explain or predict a given event, or give a broader understanding of the phenomenon of interest or simply of a research problem (Imenda, 2014:189).

Many quantitative studies are mainly concerned with testing or verifying theories rather than developing them. In conducting this study, the first step was to review various models and frameworks, with specific reference to the identification of key concepts or elements that constitute the preservation framework applicable to academic libraries. This study therefore adopted a conceptual framework as it considers understanding key concepts or elements of digital preservation as vital for a successful digital preservation framework applicable to academic libraries in South Africa. It is of a view that when key players of academic libraries fully appreciate the contextual meanings of key concepts or elements from various theories and models, they are likely to be effective in the implementation of actions to provide long-term preservation and access to digital resources in academic libraries in South Africa. The study thus used a combination of theories, models and frameworks together with ideas from the literature review, survey results and document analysis to deductively guide the inquiry.

The theories and models used in this study are: Davies' (2000) Policy, Strategy and Resources (PSR) troika model, Kenney and McGovern's (2003) three legged stool preservation model, Corrado and Moulaison's (2014) preservation triad model, the Digital Preservation Capability Maturity (DPCM) model and a framework for realizing opportunities for adapting to the digital age by the Council of Canadian Academies (2015), and are also mapped with the function requirements of the Open Archival Information System (OAIS) model OCLC/RLG (2002) and Digital Curation Centre (DCC) Life Cycle Model DCC (2005). All these models were chosen because in literature they discuss closely the issues and variables pertinent to digital preservation and are therefore used to underpin this study. A brief overview of theories and models adopted in this study is presented in Chapter Two.

1.6 Research purpose

The purpose of the study was to determine the factors that influence digital preservation sustainability in academic libraries in South Africa, with a view to develop a preservation framework for these institutions.

1.7 Research objectives

The following research objectives guided the study:

- To establish the extent to which academic libraries have implemented preservation programmes;
- To establish the barriers to effective preservation of digital resources in academic libraries;
- To determine the preservation approaches or strategies that are used in safeguarding digital resources in academic libraries in South Africa;
- To determine the systems, software and tools used for preservation of digital resources in academic libraries in South Africa;
- To propose a framework for preservation of digital resources in academic libraries; and
- To make recommendations to management on digital preservation issues and best practices.

1.8 Research questions

The following research questions were formulated:

- To what extent have academic libraries implemented preservation programmes?
- What are the challenges or barriers hindering the successful preservation in academic libraries?
- What preservation strategies are used in safeguarding digital resources in academic libraries in South Africa?
- What are the systems, software and tools used for preservation of digital resources in academic libraries in South Africa?
- What is a framework to be proposed for preservation of digital resources in academic libraries?
- What recommendations can be made to management on preservation issues and best practices?

1.9 Significance of the study

The significance of the study "elaborates on the importance and implications of a study for researchers, practitioners and policy makers" (Creswell, 2003:149). This section thus discusses the significance or importance of this study. Creswell (2003) argues that the significance of the study should centre on how the study adds to scholarly research and literature in the field and how it can help improve practice and why it can improve policy. This study is therefore significant in terms of contributing to the growing scholarly literature on digital preservation practices and on the impact of policies on the preservation of digital resources in academic libraries in South Africa. Most academic institutions in South Africa are faced with the challenges of preserving their digital resources and among these challenges are lack of policies, standards and procedures; poor technological infrastructure; lack of funding; lack of adequate resources and lack of trained staff, as outlined in Section 1.2.

Another justification for this study emanates from the rapid advancement of technologies, and as newer digital technologies rapidly appear, older ones are outdated. In other words, technology becomes obsolete and information that relies on obsolete technologies soon becomes inaccessible. It has been observed from the literature that technology obsolescence makes long-term preservation of digital resources a highly complex and daunting task. On the back of these challenges, it is hoped that the study would make a significant contribution to the ongoing discourse on the best practices and preservation

strategies in ensuring long-term preservation of digital resources in academic institutions in South Africa. The following questions are specifically considered pertinent to how this study will contribute to scholarly research in digital preservation:

- How can preservation models, frameworks and other international standards be used to understand the preservation of digital resources in the context of academic libraries in South Africa?
- How can we develop a preservation framework applicable to academic libraries in South Africa?
- How can we apply a preservation framework to South African academic libraries?

The study thus identified success factors such as implementation of clear policy and procedures, adequate funding, proper allocation of resources and collaboration, partnership and participatory opportunities and staffing as part of the strategies for realizing the digital age and to ameliorate the digital preservation conundrum faced by academic institutions in South Africa (Corrado & Moulaison, 2014; Council of Canadian Academies, 2015:58). The adoption of these factors in this study could have come at a better time, particularly when academic institutions are confronted with the challenge of preserving digital records. This study thus proposed a framework that will provide a well-articulated roadmap and support digital preservation activities in academic libraries in South Africa. It is hoped that such a recommended preservation framework could pave the way for effective preservation of digital resources in academic libraries in South Africa. Undertaking this study is therefore important as it may serve as a worthwhile guide for academic libraries in South Africa that are faced with the challenges of preserving their digital resources.

1.10 Originality of the study

Originality can be described as making new discoveries or producing new theories. In research, originality starts with tools, techniques and procedures used. Social scientists more often mentioned originality in method whereas the literature tends to equate originality with substantive innovation (Guetzkow, Lamont & Mallard, 2004:3). Guetzkow, Lamont and Mallard (2004) identified the categories described as being original as the research topic, the theory used, the method used, the data on which it is based and the results of the research (i.e. what was discovered), new approach and the area under study. It was observed from literature that the academic institutions risks losing vital digital information if digital preservation is not a consideration and prioritized or if urgent measures are not taken to rescue deteriorating conditions. New models, policies, and framework are thus needed to cope with the digital preservation challenges (Sinclair et

al., 2009; Quistbert, 2008). Originality in this study was therefore premised on testing other authors' theories and models such as the Policy, Strategy and Resources (PSR) troika model by Davies (2000); the three leg stool by Kenney and McGovern (2003); the preservation triad by Corrado and Moulaison (2014) and Digital Preservation Capability Maturity (DPCM) model by Carnegie Mellon University (1990). Reviewing all these models in this study was thus important and necessary in order to identify the key concepts or elements that can be used to ensure long-term access to digital information and to provide a guide in developing a framework for preservation of digital resources within academic libraries.

A great amount of research has also been conducted but there have not been studies that are specifically targeted at identifying and understanding elements or factors of digital preservation for a digital preservation framework applicable to academic libraries in South Africa. Quite a number of studies undertaken in the field of preservation in South Africa have rather focused on the preservation of cultural heritage, use of metadata and preservation methods, and preservation of public digital information (Masakazi, 2009; Groenewald & Breytenbach, 2011; Ngulube, 2012). The major gap in literature reinforces the need to closely examine digital preservation practices in academic libraries in South Africa. The emergence of this study thus addresses the knowledge gap in the preservation of digital resources in academic libraries where little attention has been accorded to digital preservation. As an under studied area, this study brings new knowledge by investigating the digital preservation practices in the context of academic libraries in South Africa, and this makes a particular study original. It is therefore expected that the findings from this research will add to the existing literature on the best preservation practices in relation to enhancing access to digital resources.

Africa was observed as one of the countries that has made very little progress with regard to putting in place strategies study and guidelines in the preservation of digital resources as compared with other countries in the world as outlined in Section 2.12 of Chapter Two. International initiatives from countries whose academic institutions have been at the forefront of adapting to the digital landscape, which focused on developing preservation strategies, principles, infrastructure, models and frameworks, aiming to ensure the perpetual access to its digital materials and to minimize risks of digital obsolescence on their collection for foreseeable future, were also valuable. Among others are: OAIS, TDR, Dublin Core, PREMIS, DRAMBORA Canadian Memory Institution's project and Netherlands's Data Archiving and Networked Service (DANS) Institute project. It is of a view that the preservation frameworks and models that have been developed and adopted in these institutions may guide a researcher in developing a framework that will be applied by South African academic libraries. The study thus provides a framework to guide on digital preservation activities in academic libraries. However, the proposed

framework will not only be applicable to academic institutions in South Africa but could also be adopted by and validated in institutions in other countries as well.

1.11 Research methodology

Research methodology is the mapping out of an approach to solve a research problem. The choice of the research methodology is determined by the underlying theoretical paradigm, the purpose of the research and the research questions (Ngulube, 2015:128). The study employed a quantitative research method and this follows because the study was based on positivism philosophy. Positivism is associated with deductive reasoning which is usually linked to hypothesis testing. The deductive approach was applied in this study whereby a researcher starts with a theory about why a particular phenomenon is occurring and develops a hypothesis (prediction). The current study is therefore guided largely by a quantitative paradigm in the form of a survey, complemented by a secondary research in the form of a document analysis (methodological triangulation during data collection and data analysis).

1.11.1 Research philosophy

For any researcher to conduct a study there must be a philosophy that is based on given assumptions that enable the researcher to have a framework, and some guidelines when conducting the research (Denzil & Lincoln, 2005). According to Saunders et al. (2007:84) the particular philosophy that a researcher chooses is based on the researcher's thoughts on development of knowledge. Quantitative research uses philosophies such as post positivist, objective, positivist or empirical research (Henrickson & McKelvey, 2002). This study was therefore premised on a positivist paradigm, that is, the research was started by theory (as pointed out in the conceptual framework Section 1.3) since the quantitative approach was the predominant one. Positivist philosophy is mainly based on objective approaches and involves measurable properties, which rely on various variables that result in a given hypothesis (Creswell, 2007).

1.11.2. Research design

According to Ngulube (2015) the three major quantitative research designs are survey, case study and experimental approach. Qualitative designs include the case study, historical research, grounded theory, ethnography, content analysis, phenomenology, action research, hermeneutics and discourse analysis (Mills, 2014, as cited in Ngulube, 2015). In line with the quantitative positivist paradigm, the study selected a survey research design. Surveys are largely quantitative and have been a widely used method in records and information management research (Williamson & Bow, 2000; Ngulube, 2005). A survey questionnaire was used to extract relevant information through the use of close-ended questions, supplemented by information obtained from document analysis (triangulation method).

1.11.3 Population

As defined by Parahoo (1997:218), population is a total number of units from which data can be collected, such as individuals, artefacts, events or organizations. For example, a set of records, or an event, or an institution, or people could constitute a study population. The whole universe or subset of the population (sample) can be studied depending on the size of the population and the purpose of the study. The study was conducted in all 27 academic institutions and all these institutions therefore constituted the target population and no sampling was done. The study utilized an online survey with academic library directors and managers, institutional repository managers, librarians and archivists, digitization and preservation administrators as well as digital preservation practitioners and experts from all academic institutions in South Africa.

1.12 Ethical considerations

When conducting research, researchers must consider ethics in order that they work within professional guidelines and that they act morally. Kemoni (2007:38) citing Tong (1997:9) posits that “ethics provide a number of analytical tools and action guides with which to pursue individual and collective goals ‘rightly’, whether these goals were minimalist ones, such as personal survival, or maximalistic ones such as universal love”. According to Thomas (2004) ethics are used in order to direct the researcher's actions during the process of conducting a research and it prevents participants from getting hurt

when a particular study is carried out. Ethical standards and considerations should therefore be held throughout the entire research process and the research should be ethical at every stage of the research process (Ngulube, 2015:128). Ethical issues were addressed at each phase in this study. Like any other universities in the world, the University of South Africa (UNISA) has a clear code of ethics that researchers under its ambit should follow, available at http://www.unisa.ac.za/contents/rresearchethicspolicy.

The study thus adhered to the following general ethics principles of research as per the UNISA policy on research ethics:

- A written confirmation of authority to conduct a research was provided to the participating institutions, explaining the nature of the study;
- An informed consent form was developed for participants to sign before engaging in the research. Information consent is the mechanism for ensuring that people understand what it means to participate in a particular research study so that they can decide in a conscious, deliberate way whether they want to participate;
- The purpose and the procedure of the study was explained in the questionnaire and during survey; and
- An accurate account of the findings was presented during the interpretation of data.

Ethical issues were addressed as follows: firstly, the study was approved by the Department of Information Science at the University of South Africa (UNISA) and cleared by UNISA's research ethics committee before being undertaken. The researcher identified potential participants and sufficient information was given to all participants after approval was obtained. The function of the researcher and the university was described to participants in detail and participants were informed about the purpose of the research, what was expected of research participants, including the amount of time required for participation and the possible negative and positive effects of their involvement in the research. Participants were also well informed about the intended use of the data. The research was also based on four accepted moral principles as promoted by UNISA's policy research ethics (2007), which specifies that researchers must avoid undertaking secret or classified research, and these principles are: autonomy, beneficence, non-maleficence and justice.

- Autonomy/respect for human participants: Ngulube (2015) emphasized that participants should be treated with respect from the time they come into contact with the researcher up to the data collection, analysis and dissemination of the findings. The study ensured that the autonomy, rights and dignity of research participants were protected. The steps were also taken to protect and ensure the dignity of participants as well as those that could be affected by the results of the study;

- Beneficence: This research made a positive contribution towards the welfare of the people and those who took on the burdens of research participation. Therefore the people who were expected to benefit from the research were the ones who were asked to participate;
- Non-maleficence: This serves as a guarantee that no participants will be put in a situation where they might be harmed as a result of their participation, physical or psychological. Interviews were therefore conducted in safe environments; and
- Justice: This serves as a guarantee that the benefits and risks to individual research participant were fairly distributed among people.

As indicated in Section 3.5, the research instruments were pre-tested to ensure reliability and validity, and did not create any discomfiture when administered. As pointed out by Stilwell (2004:1-2) pre-testing of research questions ensured that they were specific, real, researchable, interesting to the researcher and that they encompassed the expected content and predicted the whole argument. All sources cited in the study were referenced and acknowledged to avoid plagiarism. According to Aitchison (1999:20) referencing enables a researcher to distinguish between the ideas and findings of the writer and those of other people and to locate information sources that had been cited as easily and quickly as possible.

1.13 Assumptions and limitations of the study

Although there are different types of libraries that all perform the same basic functions to effectively provide information and services to their users, this study focused mainly on academic libraries that serve a college or university, not public libraries, that serve the general public or school libraries that serve students from kindergarten to grade 12. This study investigated the elements or factors influencing digital preservation sustainability in academic libraries in South Africa as it considers understanding success factors for digital preservation as vital for effective digital preservation framework applicable within academic libraries in South Africa. The concepts such as preservation practices and challenges, preservation strategies, policies and procedures, theories and models, preservation systems and technologies as well as preservation skills were covered in this study. The study thus focused on digital preservation practices in academic libraries and did not discuss the issues outside the parameters of this study. The study was therefore narrowed to academic libraries in South Africa and the results of the study cannot be generally applied to public libraries or school libraries.

However, the study had assumptions and limitations which were addressed accordingly. Leedy and Ormrod(2010:62) posited that assumptions are so basic that, without them, the research problem itself could not exist. The study was of the assumptions that:

- Respondents will answer the questions in an honest and candid manner;
- Respondents are digital preservation practitioners and experts in the field therefore assures that they have all experienced the same or similar phenomenon of the study;and
- Respondents have a sincere interest in participating in the research and do not have any motives such as getting incentive or impressing their job supervisor or researcher because they agreed to participate in the study.

Limitations are usually areas over which you have no control(Wargo, 2015).The following were anticipated limitations encountered in this study:

- The process of obtaining ethical clearance tended to be laborious given the difficult administrative hurdles that currently exist. However, given the researcher's evident familiarity with the procedures and being an employee at the University of South Africa, this limitation was overcome; and

- Data collection took place over the festive season and that caused a delay in the process as most of the respondents were out of the office and already on vacation leave. However, the limitation was overcome through follow up with relevant information professionals in academic institutions.

1.14 Organization of thesis

This study comprises six chapters.

Chapter One is an introductory chapter giving a general background, definitions of key concepts, theoretical framework, research questions, and objectives of the study, statement of the problem, significance, scope and limitations of the study, research methodology, ethical considerations and the originality of the study.

Chapter Two provides a literature review that revealed what was being done and what had not been accomplished in this field. The main areas covered in this chapter are digital preservation practices, the changing library environment, development of digital libraries, conceptual framework, issues and challenges of digital preservation in academic libraries, digital preservation strategies and initiatives, factors influencing digital preservation

sustainability, digital preservation systems and technologies as well as digital preservation standards and models.

Chapter Three presents the research methodology of the study and it focuses on the research paradigm, research method used, research design, study population, data collection techniques, data analysis and the reliability and validity of the study. The study also discusses ethical considerations during the research process.

Chapter Four presents research findings on digital preservation practices in academic libraries in South Africa.

Chapter Five interprets and discusses the findings presented in Chapter Four, i.e. core elements or factors contributing to digital preservation framework are discussed.

Chapter Six summarizes the research findings and makes recommendations for the preservation of digital resources in academic libraries in South Africa. The chapter also proposes a preservation framework applicable to academic libraries in South Africa, based on the findings.

1.15 Chapter summary

Chapter One provides the background to the study and it discusses the rationale behind the study. It defines key concepts such as digitization, digital preservation, digital library and digital preservation. The purpose and objectives of the study, research questions, research methodology, justification and originality of the study are also presented in this chapter. The chapter further highlights the scope and limitations, and ethical issues of the thesis. The chapter also reviewed literature and revealed that, while there have been attempts to understand the digital preservation practices, there exists the challenges in preserving digital resources in academic libraries in South Africa. The chapter justified the need for sustainable digital preservation in academic libraries in view of the undercurrent changing digital information environment these institutions have plunged into. It further reviewed literature on factors influencing the digital preservation sustainability and narrows the research problem to the need to develop an integrated digital preservation framework that will enhance the longevity of digital resources in academic libraries in South Africa. Chapter One thus laid the foundation for the contextual and conceptual framework in Chapter Two in which literature was reviewed in much more detail. The detailed description of the research is discussed in the subsequent chapters.

CHAPTER TWO

LITERATURE REVIEW ON DIGITAL PRESERVATION IN ACADEMIC LIBRARIES

2.1 Introduction

The main purpose of this study was “to develop an integrated framework for preservation of digital resources within academic libraries in South Africa”. In order to achieve this, the study investigated the key elements or factors that contribute to the success of digital preservation in these institutions. Quisbert (2008) have had to call on the digital preservation community for new thinking, new models and frameworks in order to cope with digital preservation problems. A combination of models, theories and frameworks were thus used to give grounded coherence to the study. According to Ngulube (2017), if aspects of a theory or components of various theories are used to give coherence for the research design they constitute a conceptual framework rather than a theoretical framework. Chapter Two thus presents the conceptual framework of the key contending theories and models which are relevant to the current study. In this regard, the study used some aspects or elements of different theories and models that constitute a conceptual framework of the study, namely: McGovern’s (2003) three leg stool; Davies’ (2000) Policy, Strategy and Resources (PSR) troika model; Corrado and Moulaison’s (2014) preservation triad; Carnegie Mellon University’s (1990) Digital Preservation Capability Maturity (DPCM) model, a framework for realizing opportunities for adapting to the digital age by the Council of Canadian Academies (2015), the Open Archival Information System (OAIS) model by OCLC/RLG (2002) and the Digital Curation Centre (DCC) life-cycle Model by DCC (2005). The basic concepts or elements of each model were critically reviewed and analysed in order to understand the various factors that constitute the digital preservation framework that is appropriate to academic libraries in South Africa, followed by the discussion of the relevance of each model to this study.

This chapter also discusses the purpose of a literature review and how it was conducted. An overview and deeper understanding of digitization and digital preservation concepts as well as a need to digitize and preserve digital resources in academic libraries are also discussed in this chapter. The chapter further discusses the changing of the academic library environment and the development of digital libraries. The digital preservation challenges, the approaches or strategies adopted to address these challenges, various studies related to digital preservation, digital preservation initiatives and best practices in other jurisdictions are also reviewed and discussed in this chapter. Systems, tools and standards that have already been adopted for the design and implementation of digital

preservation programmes elsewhere, which will aid in developing a sustainable digital preservation applicable to academic libraries in South Africa, are also discussed.

2.2 Purpose of the literature review

A review of literature is crucial for any academic research project and demonstrates that the proposed research extends the existing body of knowledge (Levy & Ellis, 2006). A literature review has the capability to shed light on previous work that was done in order to provide answers to inform the studies (Olivier, 2009). Reviewing literature thus helps the researcher to establish how other scholars have investigated the same problem (Mouton, 2004). According to Bourner (1996), there are good reasons for spending time and effort on a review of the literature before embarking on a research project, and these reasons include to avoid reinventing the wheel, identify seminal works in your area, identify opposing views and to carry on from where others have already reached (reviewing the field allows you to build on the platform of existing knowledge and ideas). As pointed out by Webster and Watson (2002), a literature review should systematically analyse and synthesize quality literature, provide a solid foundation for particular research questions, present the concluding implications for researchers and practitioners and motivate future research. Hart (1998) defines a literature review as an objective, thorough summary and critical analysis of the relevant available research and non-research literature on the topic being studied. A literature review provides a theoretical background to the study and helps to establish the links between what researchers are proposing to examine and what has already been studied, and also enables a researcher to show how research findings have contributed to the existing body of knowledge.

Bless and Higson-Smith (1995:23) further described the purpose of a literature review as a way to sharpen and deepen the theoretical framework; to familiarize the researcher with the latest developments in the area of research; and to identify gaps in knowledge and weaknesses. Two other purposes of a literature review are to provide a theoretical background to the study and to enable a researcher to contextualize the findings in relation to the existing body of knowledge in addition to refining the methodology. The content of the literature review should therefore reflect these two purposes and, in order to fulfil the first purpose, a researcher should identify and describe various theories relevant to the field and specify gaps. In order to comply with the second function, a researcher should integrate the results from the study with specific and relevant findings from the existing literature by comparing the two for confirmation or contradiction. Boote and Beile (2005) have also summarized basic purposes of a literature review as follows:

- It provides a context for the research;

- It justifies the research;
- It ensures the research has not been done before (or that it is not just a replication study) or there are gaps in previous research;
- It shows where the research fits into the existing body of knowledge;
- It enables the researcher to learn from previous theory on the subject;
- It illustrates how the subject has been studied previously, and highlights any flaws in previous research;
- It outlines gaps in previous research, shows that the work is adding to the understanding and knowledge of the field; and
- It assists in refining, refocusing or even changing the topic.

Ngulube (2003) and Creswell (2003) concur that irrespective of whether a study pursues a deductive or inductive model, a literature review assists in identifying theories and ideas that are tested for the purpose of developing a theoretical or conceptual framework. In the context of this study, the purpose of the literature review was to establish the conceptual framework for preservation of digital resources in academic libraries. As noted by Ngulube (2017), the conceptualisation might be achieved thorough using personal experience or consulting the relevant scholarly literature. The conceptualization in this study was therefore achieved through conducting a literature review pertaining to digital preservation. According to Ngulube (2017) conducting a literature review can assist to:

- Develop a conceptual definition of a construct on the basis of shared meaning;
- Identify the key properties of a concept and assign priorities to them;
- Describe what theory or theories were used to explain relationships among concepts; and
- Establish how the concepts have been measured in an empirical investigation.

Addressing these questions may enable researchers to develop a conceptual system and check the coherence between the conceptual or theoretical framework and various elements of the research design (Ngulube, 2017). In this regard, a researcher was able to understand what theories or models were used to explain relationships among concepts, which helped in developing a conceptual digital preservation model for this study in Chapter Two and further developed an integrated preservation framework in Chapter Six.

2.2.1 Conducting a literature review

To carry out the review, the author searched the relevant databases from a number of institutions, organizations and websites as well as articles on previous studies reporting on digital preservation practices, challenges and strategies. The study thus started the whole process with a literature review in order to understand the factors that contributed in developing a proposed conceptual model presented in Chapter Two. By reviewing literature for this study, it was possible to evaluate information sources and use those that were most pertinent or relevant to digital preservation practice in academic libraries. The researcher also evaluated the knowledge that previous researchers have contributed. Several sources of published literature were consulted extensively to unravel the depth of the subject of digital preservation and the sources include academic papers, journals, books, the internet and other sources related to the study.

As observed by Cronin, Ryan and Coughlan (2008) a literature review can be narrative (traditional) or systematic and, in contrast to the traditional or narrative review, systematic reviews use a more rigorous and well-defined approach to reviewing the literature in a specific subject area. Cronin, Ryan and Coughlan (2008) describe the purpose of a systematic review as to provide as complete a list as possible of all the published and unpublished studies relating to a particular subject area unlike traditional reviews. While traditional reviews attempt to summarize results of a number of studies, systematic reviews use explicit and rigorous criteria to identify, critically evaluate and synthesize all the literature on a particular topic (Cronin, Ryan & Coughlan, 2008). Parahoo (2006) suggests that a systematic review should detail the timeframe within which the literature was selected, as well as the methods used to evaluate and synthesize findings of the studies in question.

The current study thus adopted a narrative (traditional) review as it attempted to critically review and summarize a body of existing literature and draw conclusions about the topic in question. The body of a traditional review is made up of the relevant studies and knowledge that addresses the subject area, and this type of review is useful in gathering together a volume of literature in a specific subject area and summarizing and synthesizing it (Cronin, Ryan & Coughlan, 2008). In this regard, this chapter reviews literature, theories and models on the factors that are influencing digital preservation sustainability within academic libraries. This is because understanding preservation theories and models forms the basis for first establishing the general picture, and the extent in terms of the challenges and enabling factors of the digital preservation in general. Secondly, they guided in developing a framework for the preservation of digital resources in academic libraries in South Africa. For the purpose of this study, the relevant literature reviewed was therefore developed based on specific issues relating to the digital

preservation practices, digital preservation challenges, digital preservation strategies and initiatives in developed as well as developing countries. The views of scholars such as Kanyengo (2006), Kalusopa and Zulu (2009), Li (2011), Mongaddam (2010), Groenewald and Breytenbach (2011), Sigauke and Nengomasha (2011), Njeze (2012), Asogwa (2012), Ngulube (2012), Suleman (2013), Owens (2013), Boamah (2014), Sawant (2014), Corrado and Moulaison (2014), Ilo (2015) and the Council of Canadian Academies (2015) make the research more significant and important in contributing to the body of knowledge. A hermeneutic circle was also used to conduct the literature review in this study, as discussed in the next section.

2.2.1.1 Hermeneutic circle

According to Boell and Dubvraka (2010) reviewing literature is an iterative process that can be described by moving from the whole of all (identified) relevant literature to particular texts and from there back to the whole body of relevant literature. This process is known as a hermeneutic circle. Boell and Dubvraka (2010) also describe the hermeneutic circle as the process of the formation of knowledge and it clarifies the way in which we understand and know things. In accordance with the hermeneutic circle, understanding of the meaning and importance of individual texts depend on the understanding of the whole body of relevant literature which in turn is built up through the understanding of individual texts. Undertaking a survey of relevant literature can therefore be described by the hermeneutic circle which can be broken down into more specific steps as depicted in Figure 2.1.

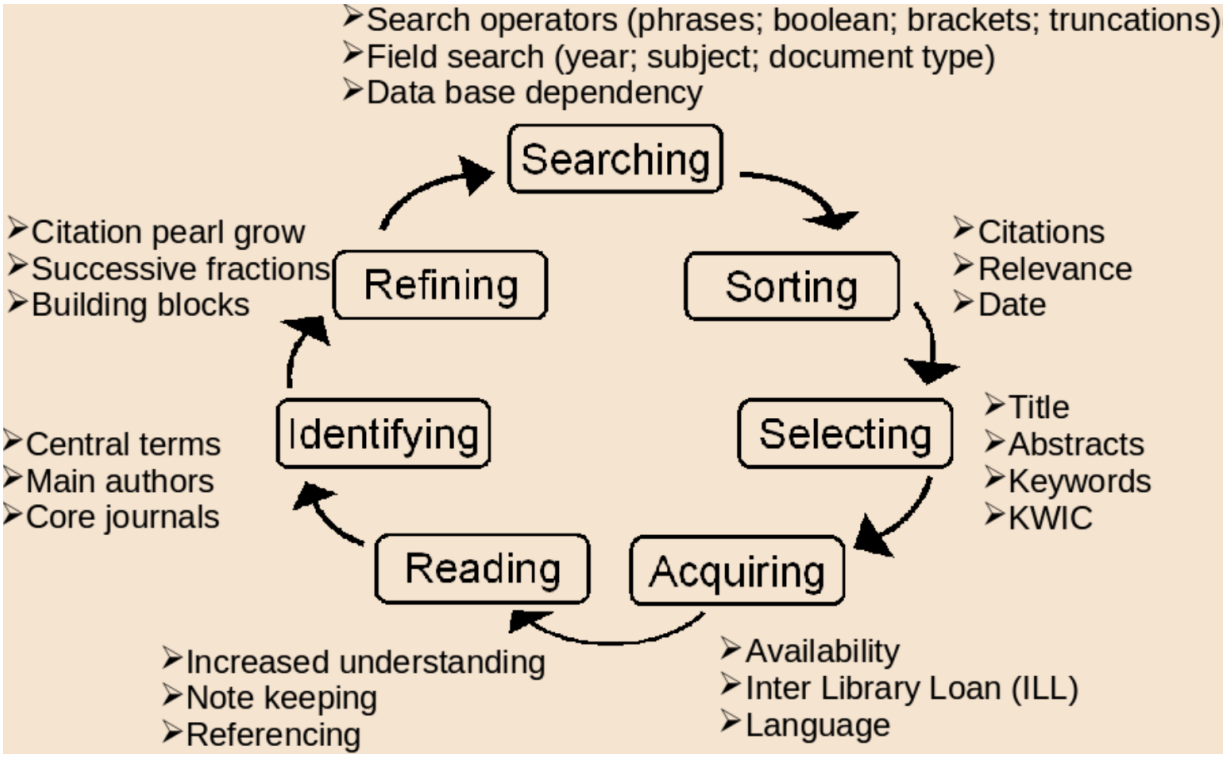

Figure 2.1: The hermeneutic circle of reviewing literature (Adapted from Boell & Dubvraka, 2010)

As shown in the diagram above, the researcher started by looking for literature by searching for documents, using search operators, and by looking up relevant entries by subject. Relevant documents (journals and articles) were acquired and sorted and selected by titles and abstracts. The researcher read the texts and selected central concepts, identified authors and relevant materials, and finally created a roadmap of literature in Chapter Two of the study.

For the purpose of this study, hermeneutic circle of reviewing literature was used to establish the success factors for sustainable digital preservation in academic libraries in South Africa. Literature review is therefore comprised of five steps based on the hermeneutic circle:

Step 1: Conducting or carrying out a literature search and reviewing theoretical models in Chapter Two of the study to establish the factors that influence digital preservation sustainability in academic libraries;

Step 2: Proposing a preliminary model based on the data collected from literature review and theoretical models used in this study;

Step 3: Collecting data using a questionnaire and document analysis to improve data collected from the literature review and theoretical models;

Step 4: Interpreting and discussing data collected from questionnaires and document analysis, and the findings from the questionnaire and document analysis were thus used to update the proposed preliminary conceptual model presented in Chapter Two, with a view to developing a framework for preservation of digital resources in academic libraries in South Africa;

Step 5: Making recommendations and proposing a preservation framework. A digital preservation framework is presented in Chapter Six of the study.The hermeneutic (iterative) process is shown in Figure 2.2.

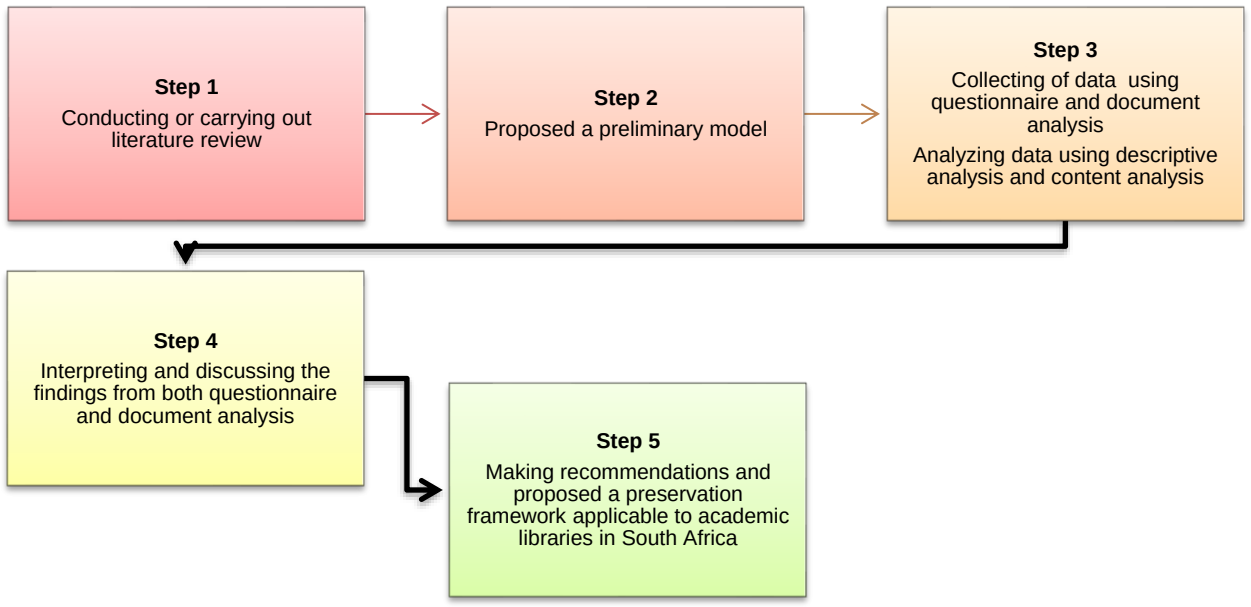

Figure 2.2 : Hermeneutic (iterative) process

In this study, the researcher referred back to the literature review after conducting a survey and document analysis to identify similarities or conflicting views to the research findings. According to Aronson (1994), referring back to the literature to interweave it with the findings makes the researcher's story robust. This iterative process thus enabled thorough familiarity with the questionnaire data and also ensured validity and reliability of the findings from the survey strategy and document analysis.

2.3 Overview of digitization and digital preservation

In order to effectively discuss digital preservation in the context of South African academic libraries, it is necessary to understand clearly what it means. A clear understanding of digitization and digital preservation is therefore considered as essential for this research as it should be able to assist in understanding the digital preservation practices in academic libraries in South Africa. This section thus discusses digitization and digital preservation concepts as well as the evolution of digital objects.

2.3.1 The concept of digitization

The concept of digitization is discussed in this section as the researcher considers that it is through the process of digitization that digital resources are generated. Many university libraries world-over have adopted the concept of digitization as a means of preserving information. Digitization has many concrete benefits in terms of access, support for preservation, collection development, institutional and strategic benefits, and research and publication (Hughes, 2004; Anderson & Maxwell, 2004). Digitization has also been useful to support preservation by storing rare original objects that can provide access to users while preserving the originals from damage. Digitization is rapidly becoming one of the standard forms of preservation for libraries, archives and information centres' analogue materials, and it is allowing preservation practitioners to ensure information contained within fragile organic materials will still be viewable to future generations (Perry, 2014).

In the context of this study, the term 'digitization' is used to refer to a process of converting analogue materials to machine-readable format for the purpose of providing electronic access and preservation (Lampert & Vaughan, 2009). Digitization of analogue material can thus be used to create surrogates for rare or fragile originals as well as to improve access to this material. This means that by digitizing library collections information will be accessible to all instead of a group of researchers. Pandey and Misra (2014) also described the aim of digitizing material as for preservation and easy access by end users or researchers and further outlined various reasons motivating organizations to digitize that include:

- Improve and widen access to participating libraries' collections;
- Increase longevity of information material;
- Encourage and facilitate resource sharing among libraries;
- Ensure standardization and conformity among libraries;

- Reduce duplication of work;
- Improve access to library resources;
- Preserve the age-old materials which are important and valuable for the future;
- Facilitate new forms of access and use;
- Better and enhanced access to a defined stock of research material;
- Create a single point of access to documentation from different institutions concerning a special subject;
- Support for democratic considerations by making public records more widely accessible;
- Better search and retrieval facilities for library types of materials; and
- Give the institution opportunities for the development of its technical infrastructure and staff skill capacity.

Best (2009) further described digitization as an important aspect of developing digital libraries as it opens up new avenues of access, use, research and preservation of valued information resources. Many countries in the world started digitizing their materials in the early 1990s, whereas, in Africa, the concepts of digitization and digital preservation were recognized in the digital library conference, which was organized by Society of Information Science in Bangalore in 1996. As observed by Liu (2004) most of the libraries involved in digitization projects in the United States were academic libraries. In 1998, the majority of universities in South Africa embarked on digitizing their library materials. Galloway (2009) argues that digitization has many useful benefits, but if professionals cannot devise useful storage and retrieval techniques, there is the fear that future historians may find the current period a Dark Age of information from which little has survived.

Chauhan and Chopra (2011) also argued that digitization is the only way to allow access to documents for the present as well as future users and by digitizing library collections, information will be accessible to all instead of a group of researchers. As noted by Liebetrau (2012) one could argue that digitization in itself is a form of preservation and by making a digitized surrogate, means the original physical form is less handled and better preserved. Also, by making resources available you are (in a way) preserving heritage by keeping it alive.

2.3.2 Digital preservation concept

The preservation of electronic records has been of concern to archivists since the early 1960s, when the Machine-Readable Records Branch was formed at the National Archives

(Hirtle, 2003). Preservation emerged with the establishment of the first central archives and the Archives Nationals were established in 1789 during the French Revolution and were transformed into a central archive later in 1794 (Posner, 1940). This was the first independent national archives and its goal was to preserve and store documents and records as they were. This trend gained popularity and soon other countries began establishing national archives for the same reasons, to maintain and preserve their records as they were created and received (Cloonan, 2010). In the late eighteenth century, many museums, national libraries, and national archives were established in Europe to ensure long-term preservation of their cultural heritage. Cultural and scientific change also helped to bring about the idea and practice of preservation.

The concept of digital preservation was originally developed in libraries as an aid to ongoing library analogue preservation efforts. The creation of the field of digital preservation as an activity of the library community has meant that some issues that are important to archivists may have initially received less attention. Early on, archivists realized that all electronic resources require proper management and long-term preservation. In addition to preserving the digital records, archivists have emphasized the need to maintain the ability of digital records to serve as evidence. Digital preservation action must be at the heart of any future digital library research agenda, given the core dependency of digital libraries on guaranteeing the authenticity, integrity, interpretability and context of the digital material across systems, time and context (Ross, 2007). A fundamental fact of digital preservation sustainability is that, without preservation, there is no access (BRTF, 2010). Therefore, acquisition of digital collections will be a complete failure if the materials acquired are not adequately preserved for accessibility.

For decade, libraries have managed their information in various analogue formats (hardcopy) including parchment, paper, videotape and photographic film and they now need to address the challenge of preserving their digital resources for the same length of time. It is therefore important to understand what digital preservation is and how it can be effectively used to preserve collective knowledge for future generations (Perry, 2014). The digital preservation concept is a relatively new one that has developed side by side with concepts like digital libraries (Chowdhury, 2010:209) and digital curation (Beagrie, 2006:4). Digital curation involves maintaining, preserving and adding value to digital data throughout its life-cycle and it is used in parallel with digital preservation (Askhoj, Nagamori & Sugimoto, 2011). Digital preservation interests different organizations and has been defined in various ways by various authors. The term ‘digital preservation’ is perceived from the following definitional perspectives:

- As the planning, resource allocation and application of preservation methods and technologies necessary to ensure that digital information of continuing value remains accessible and usable (Hestrom, 1998); and

- As a series of managed activities necessary to ensure continued access to digital materials for as long as necessary (Beagrie & Jones, 2008).

Corrado and Moulaison (2014) identified five key aspects of digital preservation derived from the above definition, as highlighted by the Joint Information System Committee (JISC), which are managed, activities, necessary, continued access and digital materials, and argued that these aspects should be kept in mind when planning any digital preservation initiative. As noted by May (2006) digital preservation involves planning, resource allocation and application of preservation methods and technologies, and it combines policies, strategies and actions to ensure access to reformatted and born digital content regardless of the challenges of media failure and technological change. Duranti (2010) also described digital preservation as the whole of the principles, policies, rules and strategies aimed at prolonging the existence of a digital object by maintaining it in a condition suitable for use, either in its original format or in a more persistent format, while protecting the object's identity and integrity, that is, its authenticity.

According to the American Library Association (ALA) (2007) digital preservation combines policies, strategies and actions to ensure that digital objects remain authentic and accessible to users and systems over a long period of time, regardless of the challenges of component and management failures, natural disasters or attacks. Additionally, Das, Sharma and Gurey (2009) mentioned the main rationale behind digital preservation as to ensure protection of information of enduring value for access by present and future generations and hence it comprises of planning, resource allocation and application of preservation methods and technologies necessary to ensure that digital information of continuing value remains accessible and usable. All definitions of digital preservation have therefore concentrated on the notion of long-term preservation of digital resources and, despite the diverse views, the main objective of digital preservation is to preserve and maintain the continued access to digital resources for as long as necessary.

For the purpose of this study, digital preservation is, therefore, perceived as a combination of plans, strategies, actions, policies, procedures, resource allocation, preservation methods and technologies aimed at prolonging the existence and access of digital objects for as long as necessary by maintaining it either in its original format or in a more persistent format, while protecting its authenticity (Hedstrom, 1997; May, 2006; American Library Association (ALA), 2007; Beagrie and Jones, 2008; Das, Sharma and Gurey, 2009; Duranti, 2010). All these activities and actions are essential to sustainable digital preservation. For example, digital preservation policies and procedures document an organization's commitment to preserve digital content for future use; specify file formats to be preserved and the level of preservation to be provided; and ensure compliance with standards and best practices for responsible stewardship of digital information.

Digital Preservation can be divided into the following levels of access as noted by Ruusalepp and Dobreva (2013):

- Long-term preservation: continued access to digital materials or at least to the information contained in them, indefinitely;
- Medium-term preservation: continued access to digital materials beyond changes in technology for a defined period of time but not indefinitely; and
- Short-term preservation: access to digital materials either for a defined period of time while use is predicted but which does not extend beyond the foreseeable future or until it becomes inaccessible because of changes in technology.

This study has, therefore, focused on long-term preservation of digital resources in the academic libraries. It is, then, useful to break down what is understood as effective preservation in order to understand the process necessary to achieve the long-term digital preservation of objects. According to Knight (2010) digital preservation implementation must be predicated on the requirements of the particular organization and he identified the following strategic drivers for digital preservation:

- Does your organization have a long-term preservation mandate?
- What is the nature of your digital collections?
- What is the extent or size of your digital collections now and in the future?
- What are your institutional policy requirements for digital preservation?
- What is the status of digital preservation within your institution?
- What is your available resourcing or staffing to implement or support digital preservation?
- What is your funding environment for digital preservation?

There are also a number of ways professionals can ensure that digitally preserved materials remain usable. Firstly, staff training and education are essential when digitizing or digitally preserving materials. The Society of American Archivists (SAA) (2013) has created a list of core competencies that a digital archivist should have which include:

- The ability to communicate the requirements related to digital archives;
- To formulate the strategies needed to best organize and preserve them;
- To integrate technologies, tools, software, and media within existing functions for appraising, capturing, preserving; and
- Providing access to digital collections.

Ruusalepp and Dobreva (2013) further describe preservation as a complex activity not only because of the increasing complexity of digital objects, but also because the context of use too needs to be re-created, which means sustaining not only the data, but also any specific software which was used to work with them and the technological infrastructure.

It is, therefore, also important not only to preserve the record itself, but also the hardware and software it was created on and designed to be used with. The selected preservation methodology must allow the preserved entities to continue to be readable and useable regardless of any technological changes to the underlying hardware or software environments. The preserving organization should account for these technological changes so that the entities may continue to be migrated to newer platforms as needed to avoid technological obsolescence. This means that institutions must create mechanisms that allow for the determination of authenticity based on the trustworthiness of the source of the digital entities and the chosen method of their transmission through time, and then adopt the necessary methods and strategies to preserve them in a sustainable way. The evolution of various types of digital objects addressed by digital preservation is presented in Figure 2.3.

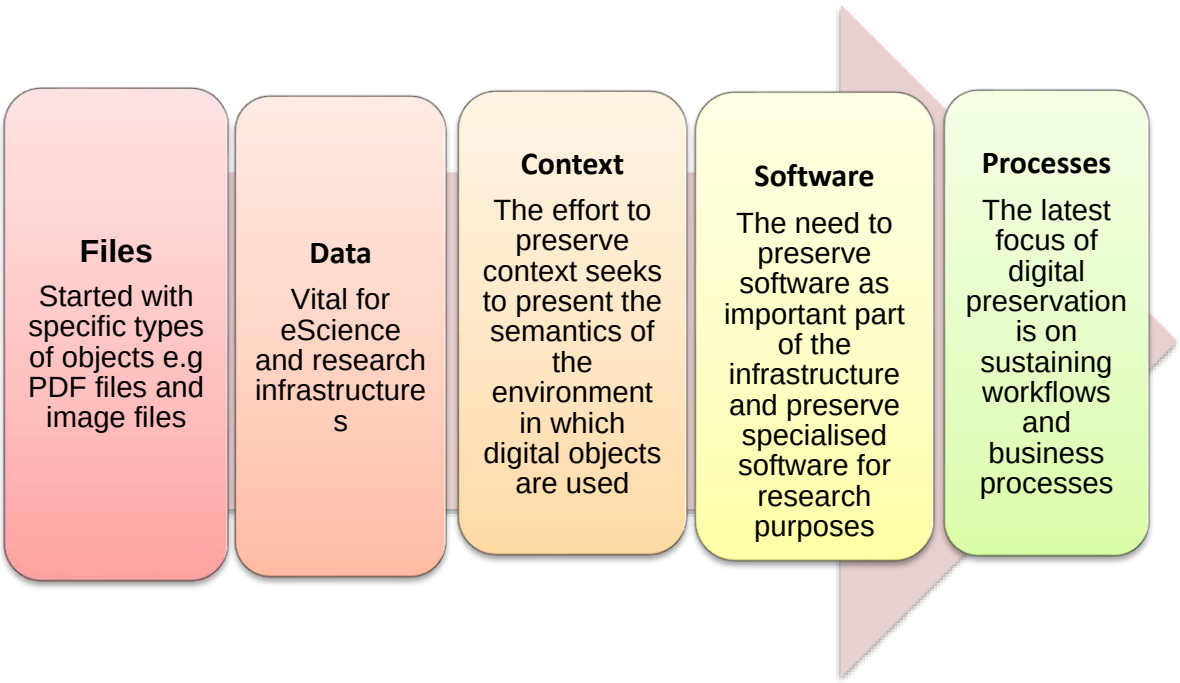

Figure 2.3: Evolution of digital objects addressed by digital preservation (Ruusalepp & Dobreva, 2013)

According to Ruusalepp and Dobreva (2013) all these types of digital objects are relevant for digital preservation in the humanities research and within research and academic institutions. Ruusalepp and Dobreva (2013) also noted that although in many cases the emphasis is on the preservation of digital files, it is important to analyse the need to preserve software, the context of digital objects which is necessary for their future use, and any processes which also need to be preserved.

Ross (2007) emphasized that in undertaking preservation planning and action, individuals and organizations must consider the following factors in both organizational and technical levels:

- For some materials held in digital libraries retaining the content will be a sufficient outcome;
- For other materials we must also retain the environment and context of creation and use; and
- For other materials we must be able to reproduce the experience of use if we are to ensure that the right semantic representation and information is passed on to the future.

2.4 Map of research literature

The literature reviewed in this chapter is discussed with the aid of a literature map. This section thus outlines the map of research literature. A literature research map allows the visualization of who is doing the same or similar type of research, what has been written or done, what is the consensus, or what discussions are happening as suggested in the Learning Light: Literature Road Map model (University of Sheffield, 2007; Ngulube, 2003; Creswell, 2003; Altinay & Paraskevas, 2008). The literature research map starts with the broad subject of the changing library environment at the top as it is important to understand the paradigm shift from the traditional library to the digital library and how this transition is affecting the information professionals operating in this environment.

It was also important to understand the development of digital libraries and their role in the digital age. Several viewpoints on implementation of digital preservation programmes in libraries were looked at, as well as the strategies, tools and technologies used in developing these programmes. The literature map is presented as a flow chart and it gives an overview of the existing literature (Creswell, 2002:33). The literature map, therefore, shows the core subjects that are placed in a way that represents their relative connection to each other. Subject headings are linked with the use of directional arrows that reflect the connections between subject headings as shown in Figure 2.4.

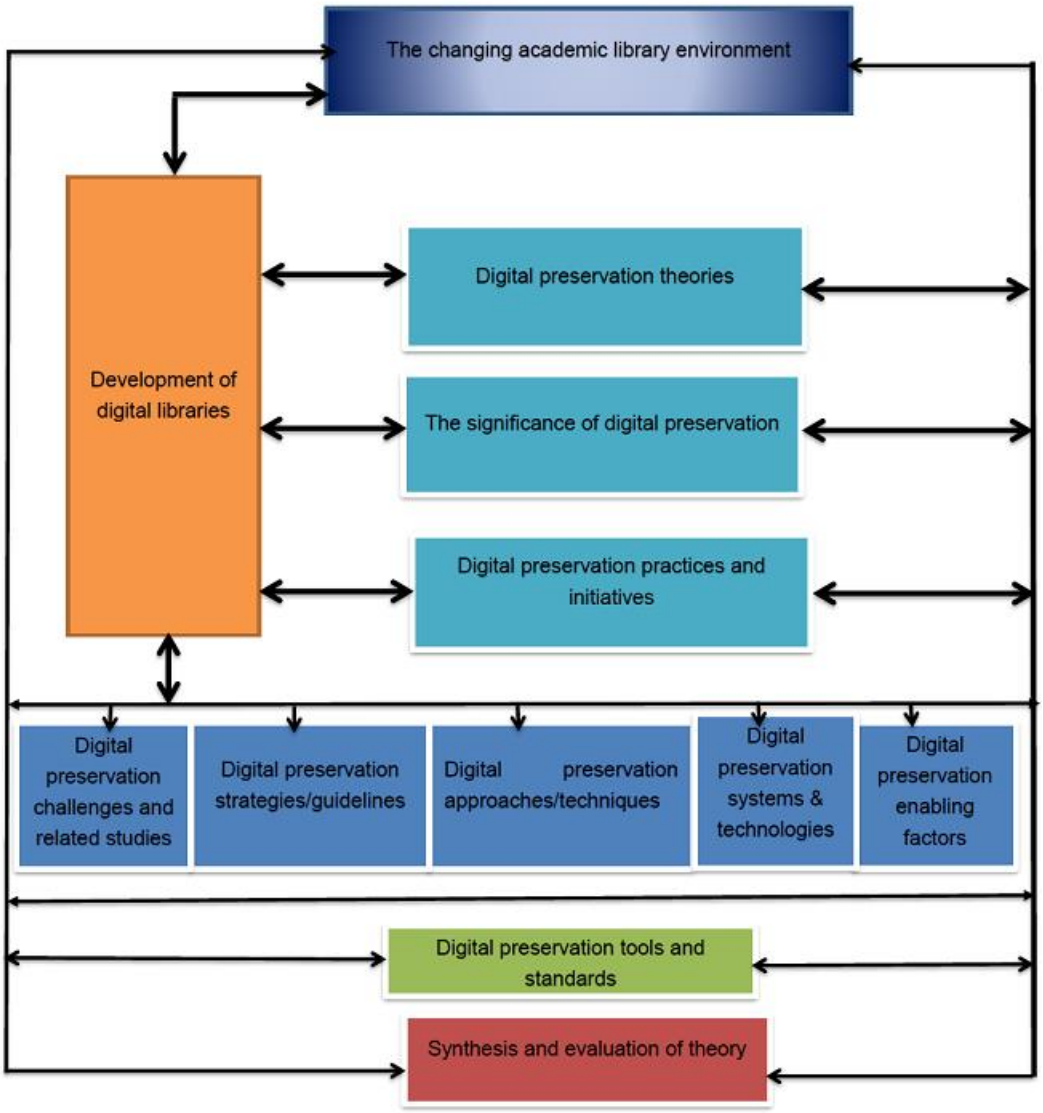

Figure 2.4: Map of research literature

2.5. The changing academic library environment

The emergence of information and communication technology (ICT) has repositioned the frontiers of academic library resources, operations, and services as well as expectations of user groups (Anunobi & Okoye, 2008). As observed by De-la-Fuente, Bueno, John & Boon (2012), nowadays academic libraries have been changed dramatically towards a new era of information services due to the advance of open educational resources and increased access to electronic resources. For many years, researchers had to physically

walk into the libraries to access services and this is changing as many libraries are now accessible online. The International Federation of Library Associations and Institutions (IFLA) (2003) stated that the university libraries' main objective is to capture and hold the interest of the academic community's reading; to produce intelligent users of all types of documents; and to cultivate in users an appreciation of libraries as academic institutions. Academic libraries should thus remain trusted institutions.

Wawrzaszek and Wedaman (2008) also describe the academic libraries' mission as to select, collect and preserve information, and to facilitate access to and the use of information. Wawrzaszek and Wedaman (2008) further mentioned one of the aims of academic library as to facilitate educational access and academic excellence through exceptional management of university operations and resources, innovative delivery systems and student services, and relevant programmes that are learner-centred, success-oriented, and responsive to technology. The academic library is therefore one of the important infrastructure components in the higher education system as it supports the educational and research goals, and it provides tools needed both for faculties, students, administrative staff and the community.

Academic libraries are changing dramatically by adopting new means of technology in all activities and have so far evolved from focusing on the management of physical resources and related services to transforming resources and services into digital formats (Choi & Rasmussen, 2009:457). The internet is widely used among the libraries and as of 31 December 2012, South Africa had 6.8 million internet users, just less than 5% of Africa's total internet users (Stassa, 2012). At 140 million estimated internet users in Africa, South Africa is the 5th largest user on the African continent (Statssa, 2012). As stated by Liebetrau (2012) low internet usage across the continent impacts on the ability of Africans to leverage this media to enhance the visibility of the African digital heritage and academic scholarly output. As noted by Tennant (1999:54):

> The game has changed and we face an array of possibilities and challenges that will leave no library untouched. We are, whether we want to or not, about to become much more than we are now or much less.

As pointed out by Wawrzaszek and Wedaman (2008), the success of the academic library in the digital world will, to a large extent, depend on higher education's response to this changing environment. Wawrzaszek and Wedaman (2008) emphasize that the libraries must actively embrace the changes in the information environment in order to fulfil their traditional mission and to stay relevant in the digital world. The National Universities Commission (2007) also emphasized that the academic libraries must provide access to both print and electronic resources to serve users and to increase the visibility of their institutions. As Lombardi (2000) notes, users prefer more computer content, computer indices, digitized finding aids, digital repositories of articles, online access to newspapers,

etc. As also observed by Campbell (2006:17), numerous creative and useful services have evolved within academic libraries in the digital age including providing quality learning spaces, creating metadata, offering virtual reference services, teaching information literacy, choosing resources and managing resource licences, collecting and digitizing archival materials and maintaining digital repositories.

Resources today occur in hybridized form (print and electronic) and therefore services provided and skills possessed by professionals in these libraries should reflect that trend (Anunobi & Okoye, 2008). The change to the digital world has also posed many challenges to information professionals in academic libraries and they are thus faced with managing hybrid resources (print and electronic) that require the necessary skills. As noted by Routray and Satpathy (2007) library and information science (LIS) professionals are exposed to stress due to several situations of changing technologies, library environment from manual to automate or digital and managing different types of collection. Rapid technological advancement is thus seen as a major cause of stress in LIS professionals since they have to develop ICT applications in the libraries (Routray & Satpathy, 2007).

Routray and Satpathy (2007) also pointed out that in this electronic digital era continuous learning and training of junior level professional staff and users is becoming mandatory even though this is an additional burden to libraries and library managers. Halder (2009) observed that LIS professionals are stressed because they are lacking information, clarity and knowledge, as handling the acquisition of electronic or digitized resources, data entry, data coordination and administration require specialized skills, experience, attitude, training and utmost attention. As a result, LIS professionals at various levels need to strive hard to implement the latest ICT advancements in their libraries, automation of in-house operations, computerization of catalogues, digitization of documents and also to handle electronic or digital documents to bring change in the environment as per the goals of parent organizations. The training modules developed in coordination with the Centre for Curriculum Development (UNISA) are currently under review by Nancy McGovern (Head of curation and preservation services at MIT libraries in Massachusetts Institute of Technology, US) to assist with the capacity building and skills development in digitization and preservation.

Bell and Shank (2004:373) suggested a new role called ‘blended librarian’, an academic librarian who combines the traditional skill-set of librarianship with the information technologist's hardware and software skills, and the instructional or educational designer's ability to apply technology appropriately in the teaching-learning process. In order to survive in this digital world, the academic libraries need more blended librarians to offer the best combination of skills and services, with the ability to use new learning and research management systems to become rich resources for staff and students. Academic libraries are presently faced with not only the decision on what books and

journals to acquire to satisfy faculty and students but also on how to remain relevant in the digital era (Anunobi & Okoye, 2008). The question is, how do the traditional library mission, structure, processes, and staffing transfer to this new environment?

The shift from print to digital collections has thus resulted in more innovations such as digital libraries as discussed in Section 2.6 in Chapter Two. The traditional academic library system has thus come to embrace the digital library model as technology continues to impact on the delivery of information service (Choi & Rasmussen, 2009). Guenther, (2000:35) also added that the demands of users for access to information have forced libraries increasingly to adopt a 24-hour facility for core services and to offer these through what is often called the digital, electronic, or virtual library. The next section discusses the development of digital libraries as well as their purpose.

2.6. The development of digital libraries

The evolution of digital technologies and the shift from print to digital collections has resulted in more innovations such as digital libraries. Digital libraries appeared as a new mechanism and a solution for managing scholarly production, dissemination and preservation of digital resources in academic institutions in South Africa. A substantial number of academic institutions as well as information centres have now implemented digital libraries in order to adapt with changing library environment. As pointed out by Ross (2007), if we think more carefully about digital libraries we easily observe that they may be libraries by name, but they are archives by nature and the content they hold does not really need to be held elsewhere because net-based services mean it can be provided from a single source wherever and whenever it is wanted. Strong, Lee and Wang (1997) stated that we are just coming to grips with archival science and diplomatics as components of a theory of information object management and a foundation for digital libraries. Modern archival science began in the 17th century with the development of diplomatic, the critical analysis of documents (Ross, 2007). As pointed out by Ross (2007:8):

> Digital library users might wish to know where the digital materials came from, who created them; why, where and how they were created, how they came to be deposited, how they were ingested (e.g. under what conditions, using what technology, how the success of the ingest was validated), and they may need information as to how the digital object was maintained after its acquisition by the digital library (e.g. if it was maintained in a secure environment and if changes in hardware and software had an impact on the digital object in question).

Diplomatics is a core tool in archival science that provides the theoretical framework to investigate such questions (Ross, 2007). Archival science with its principles of uniqueness, provenance, authenticity, trust, context, description and arrangement, repository design and management, appraisal, and its tool sets such as diplomatics, may therefore offer a framework for a theoretical foundation for digital libraries (Ross, 2007).

The foundation of modern archives (the internet, electronic libraries and archives) was laid in 1945 when Vanneva Bush envisioned an automated system that would store more information, known as a memex machine, which would allow a user to view stored information from several different access points and look at several items simultaneously, as reported by Hughes (2004). In 1950, Doughlas Engelbert hypothesized that computers could be used to handle tasks and help people think faster and better about more complex problems (Mutula & Ojedokun, 2008). Hughes (2004) also pointed out that since Bush anticipated the notion of scholars having access to infinite quantities of information at the desktop, it has led to a sea-change in the accessibility, affordability and ease of use of computing and networked digital information and, right from then, the evolution of digital libraries and archives was tied to hypertext searching and advances in computer technology.

Ross (2007) defines a digital library as the infrastructure, policies and procedures, and organizational, political and economic mechanisms necessary to enable access to and preservation of digital content. According to IFLA/UNESCO (2010) the mission of the digital library is to give direct access to information resources, both digital and non-digital, in a structured and authoritative manner and thus to link information technology, education and culture in a contemporary library service. The following goals are pursued to fulfil this mission (IFLA/UNESCO, 2010):

- Supporting digitization, access to and preservation of cultural and scientific heritage;
- Providing access for all users to the information resources collected by libraries, while respecting intellectual property rights;
- Creating interoperable digital library systems to promote open standards and access;
- Supporting the pivotal role of libraries and information services in the promotion of common standards and best practices;
- Creating awareness of the urgent need to ensure the permanent accessibility of digital material;
- Linking digital libraries to high-speed research and development networks; and
- Taking advantage of the increasing convergence of communications media and institutional roles to create and disseminate digital content.

However, one can assume that digital libraries have the same purposes, functions and goals as traditional libraries with the following specific characteristics (Cleveland, 1998:3; Deegan & Tanner, 2002):

- Digital libraries encompass both electronic and paper materials;
- Digital libraries also include digital materials that exist outside the library's physical and administrative boundaries;
- Digital libraries serve a particular clientele, as do traditional libraries, but with the difference that they might be widely dispersed throughout the network;
- Digital libraries require the services of both librarians as well as computer scientists;
- A digital library is a managed collection of digital objects;
- The digital objects are created or collected according to principles of collection development;
- The digital objects are made available in a cohesive manner, supported by services necessary to allow users to retrieve and exploit the resources just as they would any other library materials; and
- The digital objects are treated as long-term stable resources and appropriate processes are applied to them to ensure their quality and survivability.

The United States (US) dominates the world of digital libraries with some of the biggest projects concentrated in its university libraries including the University of Michigan digital library project, the University of Illinois at Urbana-Champaign digital library research project and the University of California at Berkeley digital library research project. In practice, the majority of African libraries, particularly in South Africa, have already digitized their scholarly output and established institutional repositories and digital libraries, and a few are at some intermediate stage. For the past few years, considerable efforts have been made to ensure that university communities in Africa are able to access the growing quantities of digital resources. In 2005, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Coalition of South African Consortia (COSALC) held a workshop known as Building Digital Library Collections using the green stone at the University of Cape Town (UCT), attended by delegates from Ethiopia, Lesotho, Namibia, New Zealand, Swaziland, Sudan and the host country, South Africa. The workshop aimed at:

- Raising awareness on open access models for information exchange;
- Building capacity of information and communication technologies (ICT) professionals in African institutions; and
- Supporting the creation of digital libraries and providing archivists and librarians in Africa with the skills to utilize electronic information tools and resources in their work and enhance access to online resources (UNESCO, 2005).

As observed by Juma, Wamukoya and Wekullo (2014) digital library initiatives in Africa largely revolved around university libraries whose efforts in this area were made possible by the need to transform and strengthen their print collections which were highly inadequate. Many digital library projects such as that of Association of Africa Universities (AAU), Rhodes University in South Africa, the University of Nigeria and the African Digital Library (ADL) are some of the digital library projects being implemented in Africa to ensure that university communities are able to access the growing quantities of digital resources.

However, the development of digital libraries has faced several challenges in terms of managing and preserving their digital resources. Ross (2004) pointed out that as institutions invest in developing digital libraries they come to recognize that the digital assets on which their libraries depend, their capital assets, are fragile and may require substantial continued investment of finance and effort if the holdings themselves are to remain accessible over the longer term. The academic institutions in Africa thus need to position themselves in the current society by putting in place the infrastructure to facilitate better knowledge gathering, processing, distribution, access and preservation of their digital resources. According to Rosenberg (2006) several stages must be followed in order for this transformation to succeed, including listing the contents, developing an electronic catalogue, digitizing locally produced information and establishing trusted repositories to provide access to the scholarly material produced by members of the university.

2.7 Models, theories and conceptual framework

As mentioned in subsequent sections, the question of understanding digital preservation in academic libraries is certainly a complex one. This study therefore required a conceptual or theoretical framework to give grounded coherence to such an inquiry. According to Ngulube (2017) conceptual or theoretical frameworks serve as the glue that holds the components of social research together, and it is therefore inconceivable to do research without either a conceptual or theoretical framework. However, many researchers, including heritage management professionals, find developing and using theoretical and conceptual frameworks challenging because there is limited guidance in the extant literature (Green, 2014; Ngulube, Mathipa & Gumbo, 2015). Some researchers use conceptual frameworks and theoretical frameworks interchangeably (Anfara, 2008; Kitchel & Ball, 2014; Maxwell, 2013; Ocholla & Le Roux, 2011) as cited in Ngulube (2017). Ngulube (2017) argues that a conceptual framework and theoretical framework are conceptually different, although they are both tools for conceptualising research. To some scholars the two notions are conceptually different as a theoretical framework is

considered an aspect of a conceptual framework (Imenda, 2014:187; Ngulube, Mathipa, & Gumbo, 2015:61; Ravitch & Riggan, 2012).

A conceptual framework links concepts from several theories, from previous research results or from the researcher's own experience (Nieswiadomy, 2012:94-95). Desjardins (2010) also describes a conceptual framework as a logically structured representation of the concepts, variables and relationships involved in a scientific study with the purpose of clearly identifying what will be explored, examined, measured or described. Ngulube, Mathipa and Gumbo (2015) further explained the conceptual framework as the golden thread running through good research and it should inform research questions methodologies and data analysis. On the other hand, a theoretical framework presents a broad, general explanation of the relationships between the concepts of interest in a research study; it is based on *one* existing theory (Nieswiadomy, 2012:87). Therefore, a conceptual framework comprises of concepts that inform a research project while a theoretical framework is derived from established theories that have already been tested and these theories cannot describe the entire phenomenon as they explain a phenomenon from a certain angle (Ngulube, 2017).

According to Ngulube (2017) a conceptual framework is inductively developed by the researcher through pulling together various components of theories, various concepts embedded in the extant literature, diverse theories, and sources and experiences. When a theory is used as a lens through which social reality may be investigated, understood or interpreted, the net result is a theoretical framework, but when various theories are used we end up with a conceptual framework (Ngulube, 2017). Ngulube (2017) also noted that when some parts of concepts that constitute a theory are used as conceptual tools to guide the research this should be regarded as a conceptual framework. However, a conceptual framework may be used if there is no theory that fits the concepts to be studied, or when various theories are used to guide a study in the absence of one theory that comprehensively addresses the research question (Ngulube, 2017). In this study, some of the components or elements from various theories and models were used to deductively and inductively guide the research, and as a result the study adopted a conceptual framework.

This section therefore provides a conceptual foundation for the current study. In this regard, a combination of models and theories was reviewed to give grounded coherence to the study and to understand the factors that constitute a framework for preservation of digital resources in academic libraries. The terms 'models' and 'theory' are inappropriately used interchangeably (Gunnell, 1969; Ngulube, Mathipa & Gumbo, 2015); as, a theory predicts or explains a phenomenon while a model merely describes it. Six and Bellamy (2012:35) describe a model as a formal representation of exactly how a theory might be realised, showing how the explanatory factors are to be measured, predicted to be linked with each other and how they relate to what is being described or explained. The common

appreciation of theories in the social sciences as in the natural sciences is that theories are made up of interrelated concepts and the relationships between the concepts (Nieswiadomy, 2012). Ngulube (2017) describes concepts and theories as the conceptual tools that provide direction, meaning and implications of a research enterprise. According to Frankfort-Nachmias and Nachmias (2008:24), scientists begin the process of research by forming concepts. Puttergill (2000:19) posits that theories are constituted through concepts and certain aspects of a theory may therefore be used as a conceptual framework. Therefore, in ascertaining the best framework for digital preservation within academic libraries, the researcher considered it appropriate to use Davies' (2000) Policy, Strategy and Resources (PSR) troika model, Kenney and McGovern's (2003) three leg stool, Corrado and Moulaison's (2014) preservation triad and the Carnegie Mellon University's (1990) Digital Preservation Capability Maturity (DPCM) model, Open Archival Information System (OAIS) model by OCLC (2002) and the Data Curation Centre's life-cycle model by DCC (2005), as they are the most dominant theories in the archival and digital preservation field. These theories and models were adopted because the issues and variables they raise are very critical and pertinent to the study. The centrality and influence of these models and frameworks are further discussed below.

2.7.1. Policy, Strategy and Resources (PSR) troika model

The Policy, Strategy and Resources (PSR) troika model was developed by Davies (2000) to assist in the understanding of strategy development for the running of organizations. It was used to identify the key elements of digital preservation in academic libraries of South Africa. Davies (2000:25) identifies that any effective understanding of strategy development and contextualization revolves around an understanding of policies and resources in that organization. According to Davies (2000), in order for organizations to achieve sustainable digital preservation, three key elements that require equal consideration must be considered and these include: policy, strategy and resources. These three elements of the PSR troika model are reviewed in this study as they are considered as enabling factors to successful preservation of digital resources in academic libraries in South Africa, as illustrated in Figure 2.5.

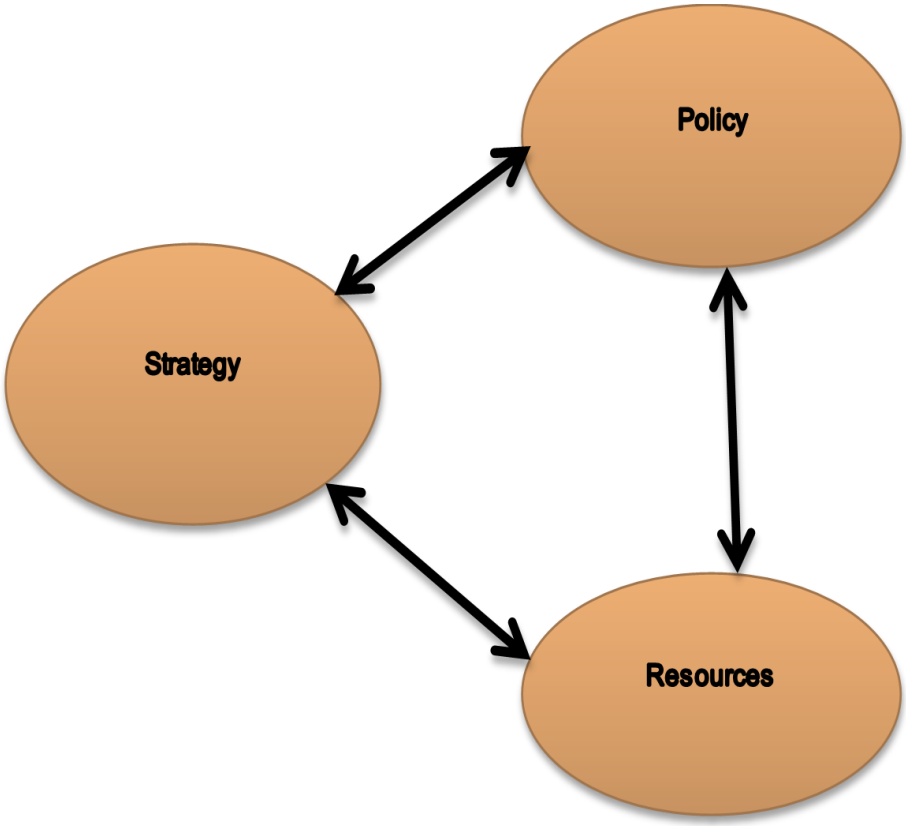

Figure 2.5: The PSR troika model (Davies, 2000)

2.7.1.1 Policy

Parsons (1995:13-14) defines a policy as the manifestation of considered judgment, plan, role, action, tactics and strategy adopted by a government, a party or an organization. It prioritizes the planned course of actions adopted and pursued by an organization or a government. As observed by Davies (2000:9), the goals and objectives set by policy cannot be achieved without the strategy. Deenapantay (2005) also used the PSR troika model in developing a template for running a business by including a fourth element to extend PSR into the Policy, Strategy, Resources and Tactics (PSRT) model to ensure the ecological sustainability of business. According to Deeenapanray (2005), policies outline the organization's objectives and prescribe its operational domain.

2.7.1.2 Strategy

Academic institutions in South Africa are now challenged by the way of new digital technologies and, in order not to lose their digital content forever, ICT experts, policy developers, decision makers and key players need to design and coordinate contextual strategies to effectively manage how these technologies are affecting preservation of their digital resources. Strategy refers to the plan of how the goals will be achieved and it is articulated by policy, but without resources strategy cannot be implemented. The troika suggests multiple-option, multiple paths and multiple-outcome aspects of strategy as an enabler to get around insurmountable obstacles, avoid unacceptable consequences and be tolerant to changes in conditions (Davies, 2000:28). The essence of the strategy is to provide a plan that employs multiple inputs, options and outputs to achieve policy goals and objectives. Strategy can be seen as the pattern or plan that integrates the organization's major goals, policies and action sequences into a cohesive whole (Davies, 2000). A well-formulated strategy helps to properly allocate the organization's resources into a unique and viable situation based on its relative internal competencies and weaknesses, anticipated changes in environment, and contingent moves by intelligent opponents (Chakravarthy et al., 2003:2).

The PSR troika model by Davies (2000:25) thus proposes that the nature and purpose of strategy as well as how it is applied in practice are best understood when viewed as one element in a troika that also includes policy and resources. This reveals the primary characteristic of strategy as having a causal relationship with policy and resources in a troika. As mentioned by Chakravarthy et al. (2003:1), strategy is about creativity and innovation, and this means that information professionals in the academic libraries can look at their own circumstances and create strategies to meet their needs. Chakravarthy et al. (2003) further pointed out that strategy formulation and implementation has long been seen as an active, goal-oriented process, with a sequence of clearly defined phases and decisions as the relevant objects of analysis.

2.7.1.3 Resources

According to Davies (2000) without resources, strategy cannot be implemented and resources are needed to make strategies effective in order for strategies to contribute to the achievement of goals set by policy. Resources refer to the materials, knowledge, skills and capabilities that can serve as a source of supply, providing the means which can be drawn upon to support, aid or facilitate the execution of a planned action (Zlotin & Zusman, 2005). The researcher is of the view that, for any country to effectively manage

its digital resources, other resources such as financial, infrastructure, equipment, human and adequate time are imperative. Resources are needed to make strategies effective in order for strategies to contribute to the achievement of goals set by policy (Davies, 2000). Resources also supply the materials and methods needed to make strategy functional and effective. Table 2.1 provides a list of types of resources for effective digital preservation and their descriptions as outlined by Zlotin and Zusman (2005:30).

Table 2.1: Resources for effective digital preservation

Types of resources	Description
Financial Resources	The ability of a country to provide funds for the undertaking of projects and programs such as digitization and digital preservation initiatives
Human Resources	Refers to the availability of a skilled labor force and knowledgeable personnel to handle the development and implementation of strategies, development of policies for the effective management activities and these include ICT. Experts, strategy development experts, librarians, archivists, records managers, policy makers and so on
Time Resources	Refers to any time before, after and between the cycle of a process or procedure within the period allotted for a project such as digitization initiative or digital preservation program
ICT Resources	Refers to any information material or institutions such as libraries, archives, museums and ICT facilities such as broad-band, computers, internet etc., that enable easy access to current and relevant information within the organizational or country levels

Adapted from Zlotin & Zuzman (2005:30)

2.7.1.4 Relevance of the PSR troika model to this study

Academic institutions in South Africa are challenged by the ways of new digital technologies and, in order not to lose their information in digital forms forever, these institutions need to design policies and strategies to effectively preserve their digital resources. As reported by the Institute of Museum and Library Services survey (IMLS, 2001), one third of academic libraries and a quarter of public libraries are involved in

digitization efforts; however, many of these libraries do not have policies to guide them in the execution of such efforts. The report suggests that libraries need to implement policies regarding the standards, preservation, and selection of digitized material. Dollar and Ashley (2014) stated that a written digital preservation policy should include the purpose, scope, accountability and approach to the transfer of records and the operational management and sustainability of trustworthy preservation repositories. This study is therefore of a view that implementing a sustainable digital preservation for academic institutions in South Africa requires the effective development of policies and strategies as well as proper allocation of resources.

Arms (2000) also observed that careful management of the human and financial resources related to all aspects of the digitization life-cycle enables successful implementation of digital preservation programme. The PSR troika model considers the development of policies, the implementation of strategies and allocation of resources as key aspects to sustainable digital preservation. The researcher is also of view that without resources, strategy cannot be implemented, and policy priorities the planned course of actions adopted and pursued by an organization or institution. Adequate resources and implementation of policies and strategies are therefore fundamental to sustainable digital preservation in academic libraries. Davies' (2000) PSR troika model was therefore able to assist in understanding the issues surrounding the enactment of preservation policies, the basic principles of strategy development and the allocation of resources to sustain digital preservation programmes. This study suggests that the understanding of key concepts like 'policies', 'strategies' and 'resources' within the context of academic libraries in South Africa is vital for a successful digital preservation programme. Therefore, key players in academic libraries are likely to be successful if they fully appreciate the contextual meanings of these three key concepts in the implementation of sustainable digital preservation.

2.7.2 Three leg stool

Kenney and McGovern's (2003) three leg stool model was also used as a guide to understand the various elements contributing to the digital preservation framework in the academic libraries. The three leg stool developed by Kenney and McGovern (2003) is comprised of three elements: organizational leg, technological leg and resources leg; they are interrelated and influence one another. According to Kenney and McGovern (2003), for a programme to be viable and sustainable, the three legs must be equally strong and balanced to sustain data over time. These three elements - organization, technology and resources - represent core components of a sustainable digital preservation programme (Kenney & McGovern, 2003). The researcher is therefore of the view that organizational

infrastructure, technological infrastructure and adequate resource allocation outlined in this model are key enabling elements for sustainable preservation of digital resources.

Kenney and McGovern's (2003) model is therefore relevant to this study as it identifies three elements (organizational infrastructure, technological infrastructure and adequate resources) which are perceived in this study as some of the factors that can be used to sustain digital preservation in the academic libraries. The three leg stool model is shown in Figure 2.6:

Figure 2.6: The three leg stool by Kenney & McGovern (2003)

2.7.2.1 Organizational leg

A real key in assessing digital preservation is to understand the organizational impediments to digital preservation practice. The organizational leg determines the “what” of digital preservation: the mandate, the scope, the objectives, and the staffing of an organization for engaging in digital preservation. This leg is expressed in a comprehensive policy framework, providing the rationale and mandate for a programme as well as detailing the requisite policies, procedures, practices, people and plans (Kenney & McGovern, 2003). The organizational leg includes policies, procedures, practices and people, the elements that any programme needs to thrive but specialized to address digital preservation requirements. The organizational leg is best framed by the community document, Attributes of a Trusted Digital Repository: Roles and Responsibilities (TDR). These seven attributes are: OAIS compliance, administrative responsibility, organizational viability, financial sustainability, technological and procedural suitability, system security and procedural accountability.

2.7.2.2. Technological leg

This technological leg entails preservation planning to provide ongoing support for a robust, flexible, and cost-effective technological platform. Components of requisite technological infrastructure for digital preservation include hardware and software, file formats and storage media, tools and workflows, a secure environment, platforms and networks and the skills to establish and maintain the digital programme (Kenney & McGovern, 2003). This technology leg is best framed by the OAIS Reference model, an ISO standard approved more than a decade ago that encompasses the roles, functions, and states of digital content as managed over time and that has informed technical developments for most major digital preservation programmes since. Technology forecasting identifies and incorporates relevant developments and solutions over time.

2.7.2.3 Resource leg

The resource leg addresses the requisite start-up, ongoing, contingency funding, staffing and skills to enable and sustain digital preservation programmes. It is best framed by the Final Report of the Blue Ribbon Task Force on Sustainable Digital Preservation and Access, which is being supplemented by the development of an economic sustainability

reference model. A sustainable resources framework, covering staffing, technological, operational and other costs, is necessary to undergird the organizational and technology infrastructures.

2.7.2.4 Relevance of three leg stool to this study

With more and more libraries digitizing their collections, policy concerns and technology problems are becoming increasingly paramount. Kenney and McGovern's (2003) three leg stool comprises of the organizational leg, technological leg and resource leg as three elements for successful digital preservation. For a programme to be viable and sustainable, the three legs must be equally strong and balanced to sustain data over time (Kenney & McGovern, 2003). Kenney and McGovern (2003) also stated that a sustainable preservation programme should address organizational issues, technological concerns and resources issues. The best indicators of the development of the organizational leg are implementation of policies and procedures, appropriate strategies and staffing of an organization for engaging in digital preservation. The technology leg combines hardware, software, formats, storage media, networks, security measures, workflows, procedures, protocols, documentations, and skills, both technical and archival. The lessons from the past decade have demonstrated to the community that a balanced three-legged stool with a sturdy technology leg will be more effective in establishing a sustainable digital preservation programme (Kenney & McGovern, 2003). In practice, the organizational leg is represented by policies, the technological leg is represented by digital repositories and the resource leg is represented by both human and financial resources. The study therefore considers that the use of the three elements of three leg stool requires equal consideration for a successful preservation of digital resources in academic libraries.

2.7.3 Preservation triad

Corrado and Moulaison (2014) also identified three aspects that constitute a sustainable digital preservation and these are: management related activities, technological related activities and content centred activities. Corrado and Moulaison's (2014) model included the content as they believe that it is the core to digital preservation and that without content there is nothing to preserve. The three elements that make up the digital preservation block are depicted in Figure 2.7:

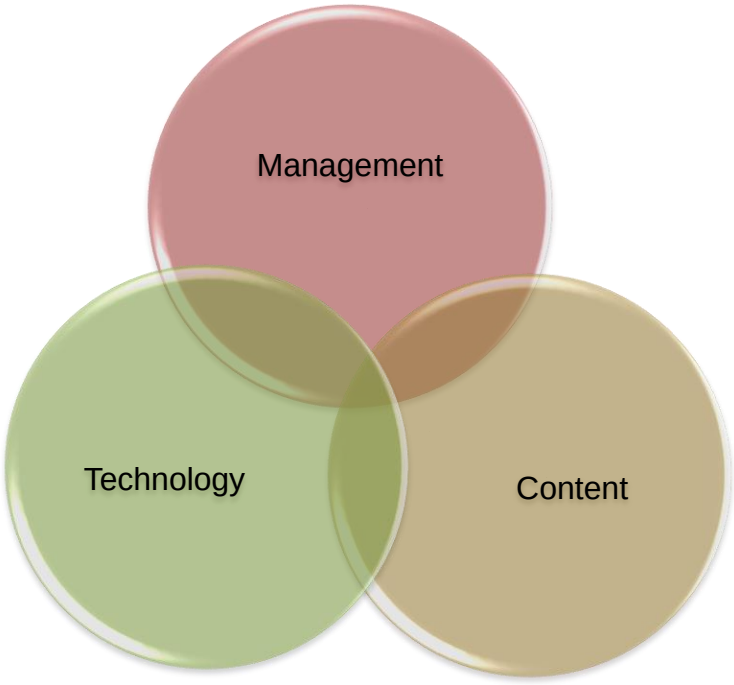

Figure 2.7: Preservation triad (Corrado & Moulaison, 2014)

2.7.3.1 Management

Management is at the top of the triad model and it is vital to preservation as without management in the form of resources and policies there is no impetus to preserve digital objects (Corrado & Moulaison, 2014). Management aspects include planning for the technology and content and making sure they are able to work successfully. It requires the creation of policies and documentation as well as the oversight of resource issues, i.e. human resources and financial resources (Corrado & Moulaison, 2014:21).

2.7.3.1.1 Policies and planning for digital preservation

Policies are high level documents reflecting the mission of the institution and they guide in the creation of action plans or guidelines and best practices. Williams (2006) describes a policy as a set of coherent decisions with a common long term aim that relate to a specific organizational goal.

2.7.3.1.2 Resource issues (human and financial resources)

Institutions are now facing new access and preservation issues, as personal documentation is being donated to them in digital format without the personnel at the deposit institution having the necessary skills to handle and store such information (Groenewald & Breytenbach, 2011). Academic librarians are knowledge workers and they need to constantly update or acquire new skills and knowledge to remain relevant and drive the organization forward. In this regard, human assets will remain the library's greatest asset and collective knowledge of staff is the key and therefore the steps are needed to help develop staff to their fullest potential. Corrado and Moulaison (2014) mentioned the main skills required for digital preservation as technical (systems), metadata creation (cataloguing) and involve selection and appraisal (collection). It will thus be necessary to provide metadata and digitization training to people working on the project before digitization and descriptive metadata creation can begin.

The cost of long-term digital preservation can be a difficult task to identify and define. According to Corrado and Moulaison (2014) good digital preservation practice and planning can support processes to maintain digital content collection and ensure they remain accessible and trustworthy over the required lifespan in a cost efficient way. All stakeholders in digital preservation should therefore be aware of the financial implications their activities have on the costs of digital preservation and follow guidelines and policies accordingly. There are limited numbers of long term digital preservation cost models for ongoing storage of digital content (Corrado & Moulaison, 2014). Lifecycle Information for e-literature (LIFE) project, in collaborative effort with the London library and the British library, developed a cost model and predictive costing tool that can be used to estimate the preservation costs of digital objects across the object's life cycle. The six stages in the LIFE model, including creation or purchase, acquisition, ingest, bit-stream preservation, content preservation and access (Corrado & Moulaison, 2014). California Digital Library has also undertaken investigations into cost models of long term preservation and developed a formula for the total cost of digital preservation, and that was applied to two specific pricing models (Corrado & Moulaison, 2014) and the first pricing model is pay as you go and the second pricing model is the paid up model where long term digital preservation costs are funded upfront.

2.7.3.2 Technology

More new software and hardware is being designed as the demand for digital technology in libraries increases and the trend for digital hardware and software to be integrated into

library systems is increasing. According to Corrado and Moulaison (2014:30), digital preservation is not all about technology; however, it is not possible to undertake digital preservation without the use of complex technology. Arguably, technology has been viewed as both the problem and solution for digital preservation. Therefore, digital preservation systems such as trustworthy digital repository (TDR) and metadata have to be in place in order to make use of resources and implement the policies as described in the management section (Corrado & Moulaison, 2014:30). According to Day (2005) metadata aids in the long-term management of digital material and needs to be embedded in the planning processes. As pointed out by NISO (2004) a metadata is the best way of minimizing the risk of digital resources becoming inaccessible and to be most valuable for all and needs to be consistently maintained throughout the process. Groenewald and Breytenbach (2011) also observed that the methods to minimize the loss of digital data are often ignored so the use of metadata structures embedded in digital objects from the outset thereof are recommended as a starting point towards good preservation principles. Metadata is also identified as one of the elements for a successful digital preservation programme and should comply with prevailing metadata standards such as Dublin Core and Preservation Metadata Implementation Strategies (PREMIS) to facilitate preservation decisions, detect preservation threats and provide measures for minimizing risks to long-term access.

2.7.3.3 Content

Content is a core to digital preservation as without content there is nothing to preserve, no matter how well thought-out your management and how good your policy and plans; the best preservation systems are worth nothing without content (Corrado & Moulaison, 2014). Another way to encourage preservation sustainability is through formal agreements with content providers and therefore securing ongoing access to valuable content is one strategy for pleasing consumers. Copyright issues should also be investigated to makes sure proper intellectual property rights have been granted that are legally required to perform the actions necessary for long term preservation (Corrado & Moulaison, 2014:35). Specific challenges relating to the content may pertain to aspects of management and these include developing the collection**,** ensuring its usefulness and providing for its long-term preservation.

2.7.3.4 Relevance of preservation triad to this study

An increasing number of academic institutions are making efforts to preserve their library materials through digitalization and implementation of institutional repositories. However, these efforts are being hampered by limited or complete lack of human, financial and technological resources by the institutions with statutory responsibility for digital preservation. As pointed out by Manaf (2007), well established infrastructures play a role to ensure that the essential digital records are archived and stored so as to generate accessibility over a long period of time. Corrado and Moulaison (2014) identified three aspects that constitute a sustainable digital preservation as management related activities, technological related activities and content centred activities. Management activities include human factors related to staff ability to perform roles in digitization and content management activities bordered on management functions such as organizing, categorizing and structuring information resources. The technological element entails the implementation of digital preservation systems such as trustworthy digital repository and metadata systems that need to be in place in order to make use of resources and implementation of the policies described in the management section (Corrado & Moulaison, 2014). Resources, policies, content management and planning of technology are also part of the management function. It is therefore clear that the sustainability of digital preservation in academic libraries is influenced by the three key aspects or elements of the preservation triad, i.e. management, technology and content management related activities.

2.7.4 Digital Preservation Capability Maturity (DPCM) model

The Digital Preservation Capability Maturity (DPCM) model was also used in this study as a guide to identify the components of digital preservation programmes and to measure their preservation capabilities. This model is based on the functional specifications of ISO 14721, the auditing criteria of TRAC and ISO16363. It accepted best practices in operational digital preservation repositories and it organizes the digital preservation requirements of the ISO Standards into fifteen components with metrics to assess maturity. According to the Carnegie Mellon University (1990) the objective of the model is to provide a process and performance framework (benchmark) against best practice standards and foundational principles of records management, information governance, and archival science. The DPCM model is designed to help identify, protect and provide access to long-term and permanent digital assets and to enable organizations to assess

the maturity of their software development process and identify key practices necessary to improve the capability of those processes (Carnegie Mellon University, 1990).

Dollar and Ashley (2014) described the goal of the DPCM model as to identify a high level where an electronic records management programme is in relation to optimal digital preservation capabilities; report gaps, capability levels, and preservation performance metrics to resource allocators and other stakeholders; and establish priorities for achieving enhanced capabilities to preserve and ensure access to long-term electronic records. The DPCM model identifies additional elements of digital preservation consisting of three interdependent domains: digital preservation infrastructure (that includes policies, strategies, governance, collaboration, and technical expertise and designated community), trustworthy digital preservation repositories and digital preservation services (that include electronic records survey, ingest, archival storage, media/device renewal, integrity, security, preservation metadata and access) (Carnegie Mellon University,1990). The DPCMM model also includes two major stakeholder groups, records producers (or donors) and users who seek access to the contents of the digital preservation repository. In identifying factors for sustainable digital preservation, this model helped in establishing the requirements and necessary elements for the development of a preservation framework applicable to academic libraries in South Africa. Figure 2.8 illustrates the Digital Preservation Capability Maturity (DPCM) model by Carnegie Mellon University (1990).

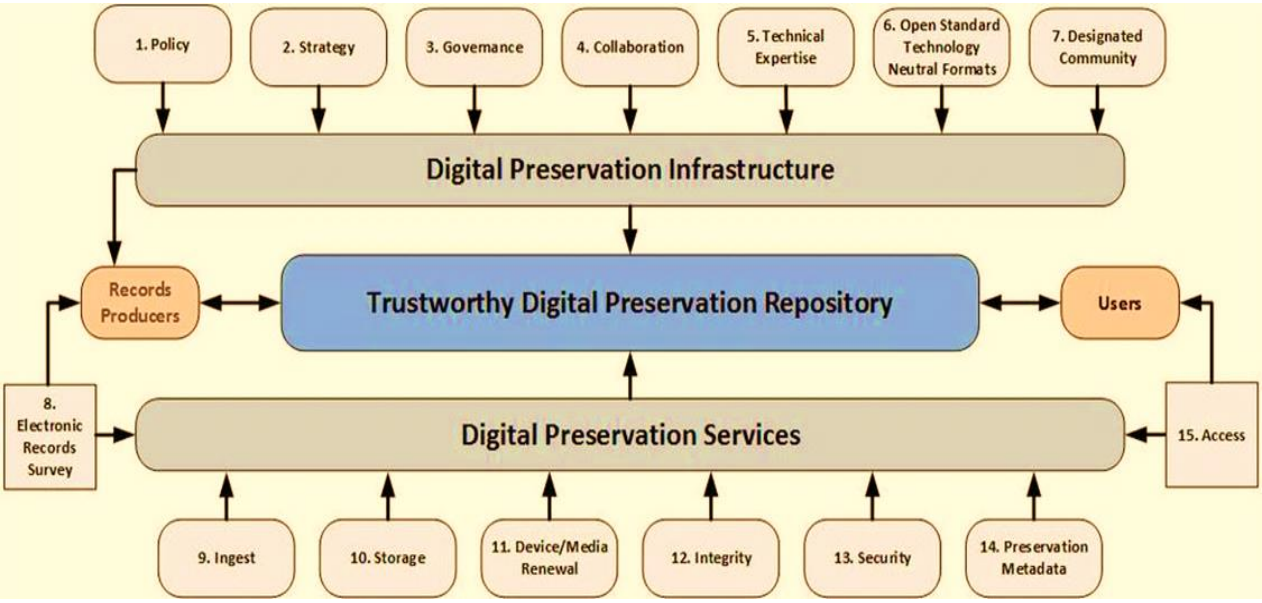

Figure 2.8: Digital Preservation Capability Maturity (DPCM) model (Carnegie Mellon University, 1990)

2.7.4.1 Digital preservation infrastructure

Digital preservation infrastructure consists of seven infrastructure components that are essential to ensure a sustained commitment, including allocation of adequate resources to the long-term preservation of electronic records. The seven digital preservation infrastructure components are the Digital preservation policy, digital preservation strategy, governance, collaboration, technical expertise, Open Standard Technology Neutral (OSTN), formats and designated community (Carnegie Mellon University, 1990). These components focus on what an organization as a distinct entity does to enable a preservation repository to execute the appropriate digital preservation services or how a trusted preservation repository executes services within the constraints of the organization's digital preservation infrastructure (Dollar & Ashley, 2014).

2.7.4.2 Digital preservation repository

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

2.7.4.3 Digital preservation services

Digital preservation services consist of eight key business process areas needed for continuous monitoring of external and internal environments in order to plan and take actions to sustain the integrity, security, usability and accessibility of electronic records stored in trustworthy preservation repositories (Dollar & Ashley, 2014).These include electronic records survey, ingest, archival storage, media or device renewal, integrity, security, preservation metadata and access (Carnegie Mellon University, 1990). All these digital preservation services focus on a range of actions required to ingest and sustain

long term and permanent electronic records and continuously monitor the technical environment upon which they depend.

According to Dollar and Ashley (2014) the ability to plan actions to sustain the integrity, security, usability and accessibility of the records stored in the repository relies on the record producing organization systematically identifying and transferring electronic records of long-term value and providing sufficient strategic direction and resources. The electronic records survey component is a critical interface between records producers, the repository and the digital services domain, and it addresses the need for an informed estimate of the volume, file formats, and types (i.e. images, text, and databases) of digital content that will be transferred to the digital repository or safeguarded by record producers in their own technology environments (Dollar & Ashley, 2014).

However, not all aspects from the DPCM model by Carnegie Mellon University (1990) were applied in this study. The study focused only on digital preservation infrastructure (that includes policies, strategies, governance, collaboration, and technical expertise and designated community), trustworthy digital preservation repository and digital preservation services (ingest, storage, integrity, security, media renewal, preservation metadata and access) to guide in the implementation of sustainable digital preservation in academic libraries. In this context it was, therefore, considered appropriate that all these factors inform the current study.

2.7.4.4 Relevance of the Digital Preservation Capability Maturity (DPCM) model to this study

This section discusses some of the key elements from the DPCM model and their relevance to this study, namely: governance, collaboration, technical expertise, designated community and security.

- **Governance**

An organization with a digital preservation mandate should have a formal decision-making process aligned to its enterprise information governance framework that assigns accountability and authority for the preservation of electronic records with permanent value, and articulates approaches and practices for preservation repositories sufficient to meet stakeholder needs (Dollar & Ashley, 2014). Gartner (2014) defines information governance as the specification of decision rights and an accountability framework to

encourage desirable behaviour in the valuation, creation, storage, use, archival and deletion of information. It includes the processes, roles, standards and metrics that ensure the effective and efficient use of information in enabling an organization to achieve its goals. The governance framework enables compliance of the preservation repository with applicable laws, regulations, record retention schedules, disposition authorities, and standards. Therefore, this study acknowledged governance as one of key elements of successful digital preservation

- **Collaboration**

As mentioned by Dollar and Ashley (2014), an organization with a mandate to preserve electronic records is well served by maintaining and promoting collaboration among its many stakeholders. As noted by Corrado and Moulaison (2014), library, archives and museum (LAM) institutions use collaboration strategies to assemble groups with necessary expertise to advance digital preservation work and take advantage of resources in the larger library and digital preservation community. The collaborative initiative seeks to leverage financial, human, and technical resources, promote stewardship, and exchange knowledge about the current and future state of digital initiatives (Dollar & Ashley, 2014). Council of Canadian Academies' (2015:58) framework also identified the external opportunities for realizing the digital age as participatory opportunities and collaborative opportunities.

IFLA also encourages libraries to collaborate with other cultural and scientific heritage institutions to provide rich and diverse digital resources that support education and research, tourism and the creative industries (UNESCO, 2010). According to the Council of Canadian Academies (2015:82) collaboration with private companies and academia may allow memory institutions to become involved in exciting activities that enhance their visibility and to undertake large projects that they could not otherwise resource on their own. Collaboration initiatives are thus essential as they will provide an opportunity for academic institutions to increase their exposure and also assist in developing and maintaining relationships between these institutions and various communities.

- **Technical expertise**

Digital preservation is an extremely complex area, an evolving field that requires a great deal of knowledge and technical expertise. For academic institutions to practice an efficient digital preservation system, it should have competent information professionals

and staff that have knowledge, skills and technical expertise in digital preservation. Anunobi and Okoye (2008) also noted that resources today occur in hybridized form (print and electronic) and therefore services provided and skills possessed by professionals in academic libraries should reflect that trend. A viable digital preservation capability also requires organizations to have sufficient technical expertise in electronic records management and digital preservation to support all of the infrastructure and requisite key processes. Technical expertise may exist within internal or contracted staff, may be provided by a centralized service bureau, or by external service providers (Dollar & Ashley, 2014). The Society of American Archivists (SAA) (2013) has also created a list of core competencies that a digital archivist should have, which includes the ability:

- To communicate the requirements related to digital archives;
- To formulate the strategies needed to best organize and preserve them, and
- To integrate technologies, tools, software, and media within existing functions for appraising, capturing, preserving, and providing access to digital collections.

The study agrees with the DPCM model that technical expertise is required to help information professionals in managing digital preservation systems.

- **Designated community**

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

- **Security**

While this study concedes that repositories and archives containing digital materials are useful to institutions and user communities, they can pose a threat if proper security protections are not put in place. As observed by Dollar and Ashley (2014), digital preservation requires processes that restrict access to the physical repository where digital content is stored, ensure the security of electronic records through techniques that block unauthorized access, protect the confidentiality and privacy of records and intellectual property rights, support periodic backup of electronic records that are stored at offsite storage repositories, and support disaster recovery and business continuity. Again, **a** digital preservation system should also include and apply controls on access to ensure that the integrity of records is not compromised. Copyright issues should be well managed, and therefore academic institutions must identify all content that is part of the project as there may be content in the public domain and acquire permission to use copyright-protected content.

2.7.5 Open Archival Information System (OAIS) model

According to Quist (2008), the Open Archival Information System (OAIS) model is the most widely used reference in the development of digital libraries, digital archives, digital repositories and record keeping. The OAIS model was proposed by the Consultative Committee for Space Data Systems (CCSDS) to standardize digital preservation practice and provide a set of recommendations for preservation programme implementation (CCSDS, 2002). CCSDS (2002) also describes the OAIS model as an archive consisting of an organization of people and systems that has accepted the responsibility to preserve information and make it available for a designated community. It is simply a set of standardized guidelines intended to aid the people and systems behind a repository that has been designated with the responsibility of maintaining documents for archival purposes over a long period of time (CCSDS, 2002). The model has been adopted as an ISO standard for guiding the long-term preservation of digital data and documents (ISO 14721 2003).

As noted by Hockx-Yu (2006:238) the OAIS model provides a complete functional and information specification of a repository and establishes mandatory responsibilities that an organization must discharge in order to operate an OAIS archive. The model therefore describes a way that institutional repositories intended for preservation purposes can be run to ensure long-term preservation of digital objects they contain. According to Hockx-

Yu (2006:239) the repository managers should apply the OAIS principles which focus on the implementation of open access archives in accordance with OAIS functional and information model. The following are some of the reasons why the OAIS model is so helpful to the digital preservation process and community (CCSDS, 2002): It has:

- Standardized the terminology associated with digital preservation;
- Outlined the duties and services of a preservation repository;
- Outlined a way that information should be attributed and managed within a repository;
- Mobilized community discussions about repository standards and certification;
- Included preservation metadata as an important part of the preservation process; and
- Focused on long-term preservation.

This model is also concerned with all technical aspects of a digital object's life cycle including ingest, archival storage, data management, administration, access and preservation planning (CCSDS, 2002). Figure 2.9 shows a summarized version of the OAIS reference model.

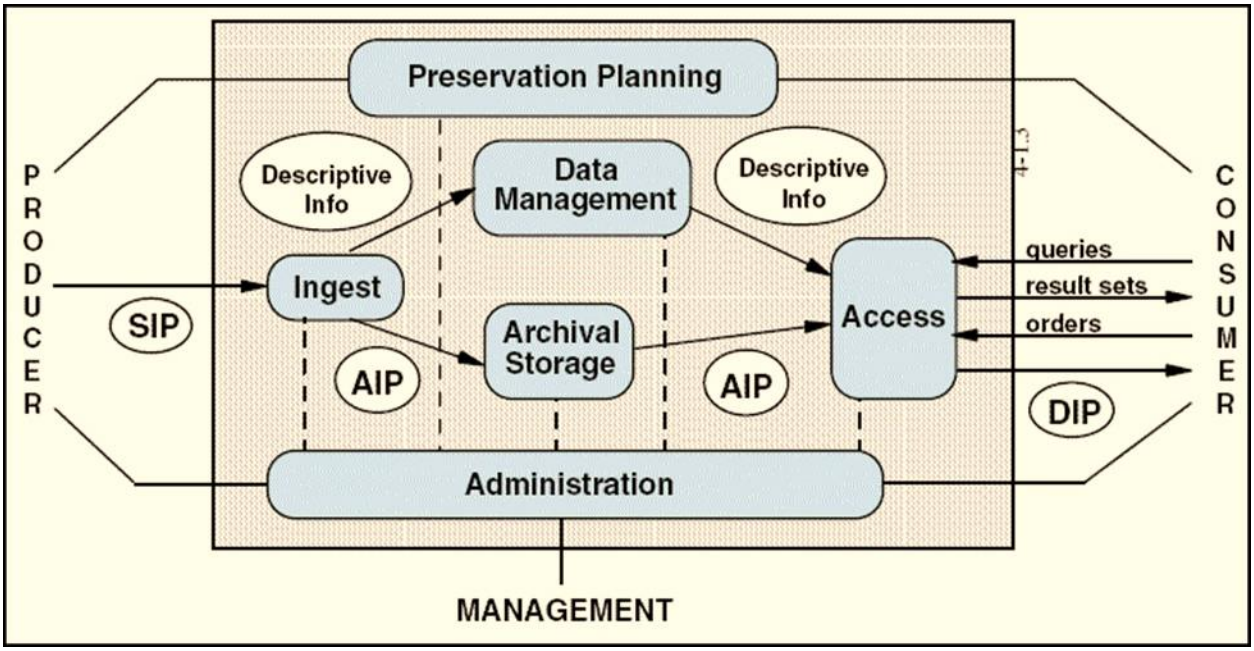

Figure 2.9: The OAIS reference model (Lavoie, Henry & Dempsey, 2006)

The OAIS functional entities (ingest, archival storage, data management, administration, access and preservation planning) manage the flow of information from information

producers to the archive, and from the archive to consumers. Therefore, any system built according to this model should contain all six functional entities.

- **Ingest**

Ingest represents the incorporation of submitted information into the archive and its functions are: to receive submission information packages (SIPs) from the producer and subject them to quality assurance; to generate appropriate archival information packages (AIPs) and descriptive information; and to co-ordinate the requisite updates to the archival storage and data management entities. According to Bantin (2016) the ingest function includes receiving and accepting digital objects as SIPs from producers (creators) and preparing and managing the contents for archival storage and management. This includes verifying the SIP, generating an AIP that complies with the archive's standards, extracting descriptive information from the AIP for inclusion in the database and transferring the AIP to archival storage and data management (Bantin, 2016). The SIP is the information package that is transferred from the producer to the OAIS, while the AIP is the information package that is stored and preserved by the OAIS.

The SIPs and AIPs are variants of an information package defined by OAIS as a conceptual container of two types of information: content information or the digital object that is to be preserved and preservation description information (PDI) or preservation metadata which can include context, fixity and access rights (Bantin, 2016). Digital objects are wrapped in rich contextual and descriptive metadata which allows users to understand them. Users accessing digital objects within an OAIS model do not interact directly with the preserved objects themselves; instead the system translates their request into orders which then create dissemination information packets (DIPs) containing not only the requested object but pieces of metadata that match the user's needs. This makes the desired information easier to find for users and the digital object is protected from damage or loss due to manipulation (Bantin, 2016). For academic libraries to preserve digital information for the long-term, producers of digital information ingest data into the institutional repository and the system appraises the data to enable quality assurance and to render the submitted data to generate the digital information.

- **Archival storage**

This functional entity covers the storage of the AIPs, and its functions are therefore to receive AIPs from the ingest entity; to manage the storage hierarchy (i.e. put the AIP on the appropriate storage medium); to replace media as necessary (which may involve repackaging the content data and PDI); error checking; disaster recovery; and providing copies of AIPs to the access entity on request.

- **Data management**

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

- **Administration**

This entity covers the activities needed to run the OAIS smoothly and its functions are: negotiating a submission policy with producers; managing the system configuration; performing archival information updates (by retrieving DIPs from Access, modifying them, and submitting them back to Ingest as SIPs); physical access control; establishing archive system policies and standards; auditing submissions to ensure at least minimum standards are maintained; activating requests (automatically generating dissemination requests from saved searches); and customer service.

- **Preservation planning**

This entity ensures that the policies and procedures are in place at the OAIS to adequately protect it from issues arising from technological changes. Its functions are monitoring the designated community for changes in requirements; monitoring technology, standards and platforms to track the emergence of new ones and the decline

of older ones; developing preservation strategies and standards; and developing packaging designs and migration plans.

- **Access**

This entity covers the search and retrieval of archived information and its functions are: co-ordination of access activities into a single user interface, including methods for search queries, report requests and orders for DIPs; generation of DIPs from AIPs; and delivery of result sets, reports, DIPs and assistance to consumers.

The current study found it appropriate to use the OAIS model as it highlights the various roles and functions of the active participants of the designated community. A major purpose of this reference model is to facilitates a broader understanding of the preservation requirements and access to digital information for a long-term which concurs with the study. As has been stated in Chapter One of this study, one of the key objectives is to establish the extent to which digital preservation practices have been implemented in academic libraries by mapping them with international preservation standards such as the OAIS model and TDR. Despite the proliferation of digital information in academic libraries, technological obsolescence has posed many challenges that hinders long-term preservation of their digital information. The OAIS model can facilitate the implementation of effective digital preservation in academic libraries because it has the capacity to reliably store information, migrate it and provide access to digital information.The model also has a number of benefits as summarised by OCLC(2002) that include:

- Providing both an information and functional reference model that can be used as a guide when developing digital preservation systems and functionality within other systems;
- Providing the discipline necessary to maintain the accessibility of packages and interpretes the information they contatin, even accros changes technology and in representation of data;
- Defining the roles of the stakeholders clearly (i.e. creators, users and managers of digital records) who interact with the archive;
- Identifying the necessary controls needed to maintain reliable archive management;
- Identifying the documentation required to communicate the archive’s purpose and interactions to interested parties; and
- Carefully documenting the chain of custody of archived packages to ensure that documents are not inappropriately tampered with.

2.7.6 Digital Curation Centre (DCC) life- cycle model

The Data Curation Centre (DCC) preservation life-cycle model provides a graphical high level overview of the stages required for successful curation and preservation of data from initial conceptualization or receipt (DCC, 2005). This model can be used to plan activities within an organization or consortium to ensure that all necessary stages are undertaken, each in the correct sequence. The model can also help with the process of identifying additional steps, which may be required, or actions, which are not required by certain situations or disciplines, and ensuring that processes and policies are adequately documented (DCC, 2005). All the stages of DCC life-cycle models are summarized in Table 2.2.

Table 2. 2: The stages in the DCC life-cycle model

Data (Digital objects or databases)	
Data, any information in binary digital form, is at the Centre of the Curation Lifecycle. This includes:	
Digital objects	Simple Digital Objects are discrete digital items; such as textual files, images or sound files, along with their related identifiers and metadata. Complex Digital Objects are discrete digital objects, made by combining a number of other digital objects, such as websites
Databases	Structured collections of records or data stored in a computer system

Full Lifecycle Actions	
Description and Representation Information	Assign administrative, descriptive, technical, structural and preservation metadata, using appropriate standards, to ensure adequate description and control over the long-term. Collect and assign representation information required to understand and render both the digital material and the associated metadata.
Preservation Planning	Plan for preservation throughout the curation lifecycle of digital material. This would include plans for management and administration of all curation lifecycle actions.
Community Watch and Participation	Maintain a watch on appropriate community activities, and participate in the development of shared standards, tools and suitable software.
Curate and Preserve	Be aware of, and undertake management and administrative actions planned to promote curation and preservation throughout the curation lifecycle.

Sequential actions	
Conceptualize	Conceive and plan the creation of data, including capture method and storage options.
Create and receive	Create data including administrative, descriptive, structural and technical metadata. Receive data, in accordance with documented collecting policies, from data creators, other archives, repositories or data centers, and if required assign appropriate metadata.
Appraise and select	Evaluate data and select for long-term curation and preservation. Adhere to documented guidance, policies or legal requirements
Ingest	Transfer data to an archive, repository, data centre or other custodian. Adhere to documented guidance, policies or legal requirements.
Preservation actions	Undertake actions to ensure long-term preservation and retention of the authoritative nature of data. Preservation actions should ensure that data remains authentic, reliable and usable while maintaining its integrity. Actions include data cleaning, validation, assigning preservation metadata, assigning representation information and ensuring acceptable data structures or file formats.
Store	Store the data in a secure manner adhering to relevant standards.
Access, use and reuse	Ensure that data is accessible to both designated users and re-users, on a day-to-day basis. This may be in the form of publicly available published information. Robust access controls and authentication procedures may be applicable.
Transform	Create new data from the original, for example By migration into a different format. By creating a subset, by selection or query, to create newly derived results, perhaps for publication.

Occasional Actions	
Dispose of data	Dispose of data, which has not been selected for long-term curation and preservation in accordance with documented policies, guidance or legal requirements. Typically, data may be transferred to another archive, repository, data centre or other custodian. In some instances, data is destroyed. The data's nature may, for legal reasons, necessitate secure destruction
Reappraise	Return data which fails validation procedures for further appraisal and reselection.
Migrate	Migrate data to a different format may be done to ensure the data's immunity from hardware or software obsolescence.

Adapted from Higgins (2008)

The DCC life-cycle model also describes sequential activities to ensure that all necessary stages are preserved. Sequential actions are related to the ingest functions which include conceptualize, conceive and plan the creation, capture and storage of digital objects, create or receive, creation of receipt of digital objects and metadata; appraise and select and ingest the actual transfer to a repository. Full life-cycle actions in the model related to preservation planning functions include description and representation information, preservation planning, community watch and participation, and curate and preserve.

2.8 Summary of theories and models used in this study

This study used the PSR troika model (Davies, 2000), three leg stool (Kenney & McGovern, 2003), preservation triad (Corrado & Moulaison, 2014) and DPCM model (Carnegie Mellon University, 1990), in understanding the factors that influence digital preservation sustainability in academic libraries. All these theories and models were considered in this study, as they combine policies, strategies, plans, proper allocation of resources and application of preservation methods and technologies to ensure long-term

preservation of digital resources. Table 2.3 shows a summary of the elements of preservation models and their linkage to the research questions**.**

Table 2. 3: Summary of the elements of preservation models and their linkage to the research questions

Research questions	PSR Troika Model by Davies (2000)	Three leg stool by Kenney & McGovern(2003)	Preservation triad by Corrado & Moulaison (2014)	DPCM model by Carnegie Mellon University (1990)
What are the factors that influence digital preservation sustainability in academic libraries in South Africa?	• Policy • Strategy; and • Resources.	**Organizational infrastructure including:** • Policies and procedures ; and • Resource allocation.	**Management including:** • Resources and policies; and • Content.	• Policy • Governance • Collaboration • Technical expertise; and • Designated community.
What are the systems, software and tools used for preservation of digital resources in academic libraries in South Africa?		• Technological infrastructure.	• Proper technology.	• Digital preservation repositories; • Metadata systems; • Technology; and • Media/device renewal.

Adapted from Davies (2000); Kenney & McGovern (2003); Corrado & Moulaison (2014); Lavoie, Henry & Dempsey (2006)

Based on the above summary of theories and models, the PSR troika model (Davies, 2000), three leg stool (Kenney & McGovern, 2003), preservation triad (Corrado & Moulaison, 2014) and the DPCM model (Carnegie Mellon University, 1990), it is clear that these models represent almost the same views with regard to elements or success factors in relation to digital preservation. All the theories and models used in this study were therefore able to address the following research questions as outlined in Section 1.9 of Chapter One:

- What are the factors that influence digital preservation sustainability in academic libraries?

- What are the systems, technologies and tools used for preservation of digital resources in academic libraries in South Africa?

The authors of these theories and models thus seem to agree that the success of digital preservation is determined by the implementation of organizational infrastructure, proper resources and proper technology infrastructure. The understanding of all factors from these models together with factors from the literature review was useful to provide guidance in developing a priliminary model of factors influencing digital preservation sustainability in academic libraries in South Africa, presented in Figure 2.15 of the study.

2.9 The significance of digital preservation

As pointed out by the Library of Congress (2010), traditional information sources such as books, photos and sculptures can easily survive for years, decades or even centuries but digital items are fragile and require special care to keep them usable. Ensuring the ongoing and efficient allocation of resources to digital preservation is thus an urgent societal problem because digital information is inherently fragile, prone to information loss and degradation (Ruusalepp & Dobreva, 2013). Corrado and Moulaison (2014) also added that because of rapid rate of technological change, electronic documents may be inaccessible just a few years after they were created. Ross (2007) also observed that digital objects break and occur in a rich array of types and representations; they are bound to varying degrees to the specific application packages (or hardware) that were used to create or manage them, are prone to corruption, are easily misidentified and generally poorly described or annotated. Hardware and media obsolescence, lack of support for older computer formats, human error as well as malicious software all can also lead to loss of digital objects. Electronic documents may thus be inaccessible just a few years after they were created due to rapid rate of technological change and content may not be accessible using new software.

Scientists and publishers could also not access research data and gain visibility for their own publications and they are unable to decode the formats used. Embedded objects are no longer accessible, programmes do not run, information in digital format is lost, and there is physical deterioration; and the medium is vulnerable to deterioration and catastrophic loss (The Library of Congress, 2003; Ross, 2007; Corrado & Moulaison, 2014). Some of the factors that lead to the need for preservation of digital resources in various organizations include: vast amount of born digital data, digital environment is not stable, and digital items are fragile and require special care to keep them usable. Digital resources thus require a specific environment to be accessible as they are vulnerable to loss and destruction and are stored on fragile magnetic and optical media that deteriorate

rapidly. Digital preservation comprises planning, resource allocation and application of preservation methods and technologies necessary to ensure that digital information of continuing value remains accessible and usable. It is about more than keeping the bits, those streams of 1s and 0s that are used to represent information (Ross, 2004), and maintaining the semantic meaning of the digital object and its content. It is also about maintaining its provenance and authenticity, about retaining its interrelatedness and about securing information about the context of its creation and use. As noted by Williams (2006) international standards require digital resources to have the qualities of authenticity, integrity, reliability and usability, and it is these characteristics that set them apart from other forms of information. Duranti (1998, 2005) noted that authentic documents are those which attest to events that actually took place or information that is true. In upholding the authenticity of a digital record, the creation, maintenance and receipt of the record must be deemed to have come from sources that are verifiable and should speak nothing but the truth (Sharon, 2010). Authenticity helps to prevent unauthorized addition, alteration, deletion, use and concealment of records by unknown people (ISO 15489-1, 2001). Integrity in digital preservation is the condition where a record is said to be whole, complete, consistent, correct, and accurate and unaltered (Kiltz, Lang & Dittman, 2007). The integrity of a digital object is established when measures such as prevention, tracking and verifying changes of archived objects are pursued. Such methods will eventually ensure the sustenance, maintenance, and preservation of storage media if (a) users use existing programmes, (b) programmers test their programmes on a non-productive machine, (c) control processes are audited, and d) system managers and auditors have access to the system (Bishop, 2004).

On the other hand, reliability are those resources that are trusted to be full and accurate representations of the business transactions in hand (Williams, 2006). As a result, the digital record must reflect transactions that are accurate, factual (ISO 15489-1, 2001) and dependable in any administrative and business setting. Within the context of long-term preservation of digital records, usability refers to the extent to which future end users can view and interact with the preserved data (Doyle, Viktor & Paquet, 2007) by way of retrieving, presenting, and interpreting the data correctly (Mason, 2007). To be usable, users must be able to locate, retrieve, present and interpret digital records. All these characteristics, together, lay the foundation for the authenticity of a document in digital format and they need to be considered in the process of preserving digital resources over a long period of time. According to Ruusalepp and Dobreva (2013) digital preservation ensures against multiple risks to information assets over time and such assets must be actively managed for sustained periods of time, using best practices for data stewardship across the full life-cycle of creation, description and curation, deposit in secure storage, use and reuse. The importance of digital preservation has also been emphasized in many publications, and even in the new definition of digital libraries provided in the Digital

Library Reference Model (2007) which describes a digital library as an organization which might be virtual, that comprehensively collects, manages, and preserves for the long term. This definition includes preservation as the main function of a digital library, along with the provision of a specified set of functionality for the user to access and use quality information within a set of agreed policies.

2.10 Digitization and digital preservation practices in academic libraries in South Africa

The underlying assumption was that academic institutions in South Africa, like any other organizations, may be grappling with the preservation of both paper and electronic resources, hence there is a need to understand the extent of their preservation of such resources. Many library organizations are digitizing materials which are in danger of being lost in the future, such as old manuscripts, photo images, non-commercial live musical recordings, theses, and other pieces of history. This study therefore found it appropriate to investigate the extent to which academic institutions in South Africa have implemented digital preservation practices to ensure permanent storage of their electronic resources. Literature revealed that the increasing number of academic institutions in South Africa have so far taken up the challenge of making available their internally stored research output to the global market, and are considering or are already digitizing their own unique resources such as those housed in university archives and special collections (Macha & De Jager, 2011). For example, as far back as 1999, the Campbell collection of the University of KwaZulu-Natal was initiated as a centre of research excellence with an archive, a museum and a library of rich holdings reflecting the social and cultural heritage of KwaZulu-Natal. Several thousand early 20th century historic photographs from this collection have been digitized and made available online to researchers around the world.

Another project started in 2003 by the computer science department was to digitize theses and dissertations by the students in their department, followed by the law space department that also digitized their theses and dissertations in 2005. Macha and De Jager (2011) also reported that the staff in the Department of Manuscripts and Archives followed international guidelines and benchmarks regarding capturing parameters and type of metadata during the project. Staff members also attended workshops given by Digital Imaging South Africa (DISA) which they regarded as being helpful in giving them an overview of the processes and of the practical implications of undertaking a digital project. However, most of the libraries involved in digitization projects in the US were academic libraries and this is primarily because academic libraries have access to more resources and historic artefacts or documents. Additionally, they receive federal funds and foundation assistance to contribute to large scale preservation of materials.

2.10.1 The development of institutional repositories

Digital preservation has been regarded as an important motivation for building institutional repositories (IRs) and to ensure digital materials are available and accessible in the long-term. Memory institutions such as libraries, archives and museums are actively building institutional repositories and participate in national and international digital preservation initiatives in an attempt to preserve their digital resources for future access. Ngulube (2012), UBC Project (1997) and NLA (2007) also suggested that developing institutional repositories in academic libraries will preserve and sustain digital information for the present and future generations. As noted by Lynch and Lippincott (2005), institutional repositories have emerged in North America and Western Europe primarily because they are regarded by the university communities as a means of having access to products of scholarship and research and as a locus for preserving such resources and maintaining access to them over the long-term.

As stated by the American Council of Learned Society (2006), an IR sits firmly within the digital scholarship landscape, which includes building digital collections, and creating tools for collecting, analysing and authorizing digital information and analytical tools to generate new intellectual products. The IRs have accumulated not only preprints and post-prints of articles, books, theses and dissertations, but also raw data files resulting from research, working papers, course syllabi, class notes, handouts, students' papers, committee meetings agendas and minutes, unpublished conference presentations and several other types of documentation that fall under the category of personal and university records, as noted by Duranti (2010). Johnson (2002) further describes an IR as a digital archive of the intellectual product created by the faculty, research staff and students of an institution and accessible to end-users both within and outside of the institution with few if any barriers to access. Gibbons (2004) also identifies the functions of institutional repositories to include access control, preservation, discovery support metadata application and materials submission.

Many academic libraries are playing a leadership role in their institutional repository projects (Anunobi & Okoye, 2008). Such projects include:

- The Academic Research in the Netherlands Online (ARNO) project initiated in September, 2000 and implemented by the library staff of the University of Twente, the University of Amsterdam and Tilburg University;
- DSpace which is a collaborative project of the MIT libraries and Hewlett-Packard;
- Ohio State University's Knowledge Bank; and
- Utrecht University institutional repository.

In South Africa, the majority of academic institutions also developed institutional repositories (IRs) in an attempt to manage and preserve scholarly outputs in their libraries (Pienaar & Van De Venter, 2008). Macha and De Jager (2011) stated some of the reasons for the establishment of institutional repositories in South African academic institutions are to help to preserve the institution's intellectual property and increase the institution's visibility and prestige. As reported by Macha and De Jager (2011), the University of Cape Town (UCT) implemented institutional repositories in four different departments, namely: UCT Law Space (Department of Law), UCT Computer Science Research Document Archive, Department of Manuscripts and of Archives in the library and open educational resources. In 2005, the Carnegie Corporation of New York has awarded the UCT library, together with the libraries at the universities of the Witwatersrand and Kwa-Zulu-Natal, a grant amount of $2.5 million for a three-year project directed at supporting research and library staff development at these institutions (Macha & De Jager, 2011). According to Macha and De Jager (2011) this grant also provides funds to develop a new digital initiative unit with up-to-date equipment and expert staffing. This digital initiative unit is in charge of spearheading the establishment of an IR with the following strategic plans and priorities:

> Attract, preserve, digitize and make available via a sophisticated web portal, key African archival and other resources. Digitize these resources as a contribution to African scholarship, as an incentive for digital collaboration on the continent and as a showcase for UCT's research presence (Rapp, 2009:2).

The Carnegie thus played a major role in establishing the IR at UCT and also enabling the purchase of equipment such as scanners, cameras and the DigiTool software (Macha & De Jager, 2011). The contents in this repository are divided into three categories: digital collections, finding aids and theses and dissertations. Another example is the University of Pretoria (UP) that also started a project of making theses available online in 2000 (UPeTD website) and established an institutional repository (IR) using an open access ETD-db software. UP established another IR in 2006, known as UPSpace, for the management and dissemination of digital research materials donated to or created by the community publications (Pienaar & Van De Venter, 2008). According to Olivier (2010) this institution has the total of two repositories, UPeTD and UPSpace and these repositories offer open access to the full text of research articles published by staff, students and affiliates of the University of Pretoria. As noted by Macha and De Jager (2011), UP became a member of the international body the Networked Library of Theses and Dissertations (NDLTD), which provides access to all the world's theses and dissertations and which holds annual conferences. UP has also contributed to nine workshops in South Africa, Botswana, Lesotho, Ghana and Ethiopia, sharing expertise and enthusiasm and helping colleagues to start their own operations, and also assisted the Council of Scientific

and Industrial Research (CSIR) to develop a digital repository (Pienaar & Van De Venter, 2007). As a result, various types of digital materials have been digitized and made publicly accessible. Digital scholarly outputs such as scholarly publications, pre-prints, post-prints and digital versions of theses and dissertation are now managed and preserved in the IRs with the use the open-source software such as DSpace, ETD-db and Eprints. According to Prosser (2003:168) an IR also provides a central archive for a researcher's work and increases its dissemination and potentially its impact on the research community, and can act as a researchers 'curriculum vitae' as all their output is gathered in one place. The IRs have therefore become a vehicle through which South African collections could be made accessible to the rest of Africa and ultimately to the rest of the world. Table 2.4 shows the list of academic institutions with institutional repositories in South Africa as well as the content and application software they use (OpenDoar, 2015).

Table 2. 4: List of institutional repositories in South Africa

Institutions	Typical content	Application
University of Pretoria(UP)	Electronic theses and dissertation	ETD-db.
University of Johannesburg(UJ)	Electronic theses and dissertation	ETD-db.
University of Western Cape (UWC)	Electronic theses and dissertation	ETD-db.
University Of Cape Town(UCT)	Electronic theses and dissertation	E-Prints
Stellenbosch University(SUN)	Theses and dissertations but also contains maps and items from the university's special and manuscript collections.	DSPace
University of Pretoria(UP)	Publication output of the university as well as digitized historical and archival materials donated to the university.	DSPace
University of Western Cape(UWC)	Materials related to the study, practice and governance of higher education in South Africa.	AHERO
University of North West(UNW)	Articles and Theses	DSpace
Central University of Technology(CUT)	Electronic Theses and dissertation	DSpace
University of Kwa Zulu Natal(UKZN)	Theses and Multimedia	DSpace
University of Free State(UFS)	Articles and Theses	Apache
Tshwane University of Technology(TUT)	Article and theses	ContentPro
UNISA	Articles; Theses; Unpublished; Special	DSpace
University of Fort Hare	Theses	DSpace
University of Limpopo	Theses	DSpace
University of Free state	Theses	ETD-db
University of Zululand	Theses	DSpace
Vaal University of Technology	Theses	DSpace
Nelson Mandela Metropolitan University	Theses	ETD-db
Walter Sisulu University	Theses	ETD-db
Rhodes University	Articles; Conferences; Theses	E-prints
Durban University of Technology(DUT)	Electronic theses and dissertation	DSpace

Adapted from OpenDoar (2015)

The growth of open access IRs has therefore been remarkable in South Africa and it shows that South African academic libraries are currently the leader among African universities in terms of the development of IRs, growing from a total of 14 registered and active repositories to the current 23 repositories. However, efforts by many African

institutions to establish digital repositories to facilitate the capture, storage, preservation, and dissemination of an institution's intellectual outputs are very often faced with challenges (Lor, 2005; Ezema, 2011), eventually rendering the repositories unsustainable (Ngulube, 2012). In many African countries the digitization of materials and the setting up of institutional repositories has faced serious problems ranging from low internet connectivity; software and hardware challenges; lack of highly skilled personnel; inadequate power supply; low bandwidth; legal copyright laws; poor funding; lack of organizational infrastructure and policies; project sustainability and many others (Ezeani & Ezema, 2011; Rosenberg, 2006). Hughes (2004) also noted that despite all the efforts to create digitization programmes, roadblocks such as copyright issues, funding, institutional support, technical drawbacks and conservation of originals have always hampered meaningful progress in building digital libraries and institutional repositories.

However, OECD (2017) recommended the actions needed to develop a successful research data repository business model that should be revisited regularly during a repository's life-cycle that include:

- Understanding the life-cycle phase of the repository's development (i.e. the need for operational funding);
- Identifying who the stakeholders are (i.e. data depositors, research funders and policy makers);
- Developing the product/service mix (i.e. value-added data and services);
- Understanding the cost drivers and matching revenue sources (i.e. scaling with demand fordata ingest and use);
- Identifying revenue sources (i.e. structural funding and value-added services); and
- Making the value proposition to stakeholders (i.e. measuring impacts and value).

2.11 The challenges to digital preservation in academic libraries

The phenomenal growth of digital content poses a number of challenges for preservation of digital resources in academic libraries. The major challenge faced by academic libraries is to make sure that users can access the content that has been ingested in their institutional repositories. One of the objectives of this study was to establish the barriers or the challenges of preservation of digital resources in academic libraries. The study thus investigated the existing preservation challenges in order to identify preservation requirements in academic libraries, as this will enable the provision of tailored solutions for the domain context. This section also presents literature and findings from studies conducted by other researchers on preservation practices in selected parts of the world

including Africa and South Africa. It identified digital preservation challenges that need to be addressed in order to ensure long-term preservation of digital resources. One of the major challenges is that preservation has not been considered as a priority by various organizations. Corrado and Moulaison (2014) concur that many libraries and other cultural organizations have not been able to make digital preservation a high priority. Corrado and Moulaison (2014:6) further elaborated that even big and well-funded projects can go awry if digital preservation is not a primary concern at the outset. Lack of awareness about the historical value and significance of digital documentary heritage among corporate and policy makers has also been taken for granted for far too long. ERPANET (2003) revealed that:

- Awareness of the issues surrounding digital preservation is perceived differently across organisations, and even across different divisions of the same organisation;
- Few organisations took a long-term perspective of digital preservation and those that did were either national information curating institutions (e.g. archives) or institutions from telecommunications, pharmaceuticals and transportation sectors;
- Most sectors failed to adopt best practices to create higher levels of the regulatory risk exposure than in other sectors; and
- An organisational strategic approach to preservation was rare.

The call by the Library of Congress in 2005 under the National Digital Information Infrastructure and Preservation Programme inviting heads of state libraries, archives and other corporate institutions for a workshop to develop strategies for the preservation of significant state and local government information in digital form (NDIIPP, 2008) is one form of awareness creation that could be replicated in academic libraries in South Africa. Many information professionals view digital preservation as a conceptually simplistic exercise and fail to recognize that digital preservation is an extremely complex, evolving field that requires a great deal of knowledge to understand (Duff, Limkilde & Van Ballegooie, 2006).

Literature also reveals numerous issues and challenges concerning preservation of digital resources among various organizations and institutions, including South Africa (Kanyengo, 2006; Sigauke & Nengomasha, 2011; Ngulube, 2012), as summarized as follows: lack of human capacity and skills, absence of established standards, policies, procedures, protocols and proven methods for preserving digital information, lack of knowledge and adequately trained personnel in managing digital resources, technological obsolescence due to constantly changing software and hardware, weakness or absence of information technology policies and strategies in digital preservation, costs related to preservation management, authenticity and context of the creation of the records, use of

proprietary software with expensive licensing requirements, legal issues regarding intellectual property rights, access and security, lack of collaboration efforts and partnerships, lack of ICT infrastructure, management and poor ICT infrastructure in digital preservation management, insufficient commitment to long term preservation, failure to properly assess critical risks related to digital preservation, inadequate administrative metadata, failure to provide archivists and librarians with the necessary standards and guidelines to enable them to effectively collect, describe and preserve digital information and inconsistent or inappropriate use of international industry standards.

As stated by Chowdhury (2009), a number of challenges are also associated with the current digital preservation systems that range from increasingly large volumes of data to the underlying hardware, data formats, metadata and the various management practices used by these systems. Online Computer Library Centre (OCLC) and Research Library Group (RLG) (2002) highlighted in their joint report on digital preservation that the majority of organizations creating digital materials or designing digital content management systems do not take great interest in their long-term preservation. It is therefore clear that many systems still do not take long-term preservation into account. Hardware and software obsolescence and other factors such as lack of commitment by relevant stakeholders make long-term preservation of digital resources a highly complex and diverse matter. Lee et al. (2002) seem to agree that digital resources present more complex problems than conventional analogue media as newer digital technologies rapidly appear and older ones are outdated, and information that relies on obsolete technologies soon becomes inaccessible. Rahman and Mohammed-ul-Islam (2012) emphasize that any library in this digital environment has to cope with the new technology for preserving the digital information for its users and to sustain itself.

As noted by Styblinska (2006) ensuring ongoing access, therefore, requires currency with technology changes, and moving digital objects from obsolete to current file formats, storage media, operating systems and so on. However, this is difficult to do for the following reasons as summarised by Bullock (1999):

- The rapidly increasing number of digital objects and proliferation of document standards and formats;
- The increasing complexity of digital objects (incorporating text, images, audio, video in various formats) and their increasing software dependence (i.e. storage in databases);
- The lack of planning to incorporate preservation needs in systems and lack of availability of off-the-shelf products supporting preservation needs;
- The lack of consideration of long-term access requirements when creating digital products;
- The absence of widely accepted standards which will assure access over time;

- Copyright/intellectual property rights that may interfere with the ability to preserve digital objects through systematic copying;
- Unstable storage media (i.e. diskettes) whose life span is limited;
- A lack of technical expertise in collections managers and preservation experts; and
- An emphasis on the creation and/or acquisition of digital material in an era of diminishing resources, rather than ongoing preservation and access to existing electronic holdings.

The Council of Canadian Academies (2015) also added that many of the challenges that memory institutions (libraries, archives and museums) face as they attempt to adapt to the digital age are rooted in the technical issues associated with managing digital content, the sheer volume of digital information and the struggle to remain relevant. These challenges are outlined as follows (Council of Canadian Academies, 2015):

- Technology obsolescence: Hardware and software obsolescence is regarded as a major issue with digital preservation as it poses challenges of maintenance as well as safeguarding the digital resources for keeping long term. Technology becomes obsolete quickly, and as a result memory institutions are challenged with preserving files in formats that will remain accessible over the long-term;
- Sheer volume of digital information: The growing amount of materials to appraise makes it difficult to decide which records to preserve; and
- Relevance: The copyright that memory institutions must follow in their daily activities are not always relevant for the digital age.

The Blue-Ribbon Task Force on sustainable Digital Preservation and Access (2008) further published a report highlighting five major problems of building a sustainable digital preservation programme, namely:

- Inadequacy of funding models to address long-term access and preservation needs;
- Confusion or lack of alignment between stakeholders, roles and responsibilities with respect to digital access and preservation;
- Inadequate institutional, enterprise and community incentives to support the collaboration needed to reinforce sustainable economic models;
- Complacency that current practices are good enough; and
- Fear that digital access and preservation is too big to take on.

As pointed out by Kalusopa and Zulu (2009), for most countries in the ESARBICA region preservation challenges include, among others, the lack of support and recognition for quality records management; lack of understanding by public officials and decision makers about the importance of records management; the absence of or weaknesses in

legislation, policies and guidelines; technological obsolescence of both hardware and software; inadequate education and training; and poor preservation of electronic records. Electronic records are being created in public institutions and some are being mismanaged or lost, and in Botswana, for example, a lot of electronic records are being generated within government and other agencies in several forms such as word-processed documents, spreadsheets, databases and e-mail (Kalusopa & Zulu, 2009). However, most organizations do not seem to have a framework for managing e-records, resulting in the danger that the e-records generated may not be retained and preserved as e-archives. In most of the cases, poor records management has resulted in information gaps, leading to incomplete public records and documentary heritage (Kalusopa & Zulu, 2009).

2.12 Studies related to digital preservation practices in academic libraries

Several digitization and digital preservation studies have been reported in Africa. Ezeani and Ezema (2011) reported on the digitization efforts at the University of Nigeria, which revealed that personnel involved in digitization initiatives did not possess the required digitization skills such as book marking, digital signature, web linking and internet skills. The study found that hardware and software facilities for the project were adequate and reliable except the server which was identified as being unreliable in the project. Research by Olatokun (2008) of 15 universities in Nigeria found that digitization projects were rarely reported basically because of lack of awareness. Masakazi (2009) in the study of digitization of South Africa's arts, culture and heritage observed that South Africa was way ahead of other African countries in the digitization of heritage materials.

Mbambo-Thata (2007) in Zimbabwe during the implementation of Database for African Theses (DATAD), Electronic Theses and Dissertations (ETD) and the Institutional Repository also identified a number of challenges faced by the University of Zimbabwe. These challenges include: lack of clearly documented set policy on copyright and no clearly stated theses submission policy as every department followed different channels with some theses lacking abstracts. The biggest challenge on copyright was that the academic staff were not aware whether their copyright agreements with publishers allowed them to deposit content in the University of Zimbabwe repository or not. Rosenberg (2006) also captured challenges of universities in Africa as regards collecting materials published locally and outside but related to their particular countries such as theses and dissertations, research reports, papers presented at conferences and journal articles. Rosenberg (2006) further mentioned that the majority of the universities at that time lacked funding as the projects were heavily dependent on external funding. The projects also lacked ICT trained staff, continuing education for library staff, and new

graduates from library schools with knowledge and skills to assist in the sustainability of in-country projects.

With regard to policy issues, Gbaje and Zakari (2013) in their research in Nigeria noted that institutional repository and preservation policies were entirely optional and scarcely developed. Lack of such policies has affected the level of commitment in terms of institutional financing, staff capacity building, skilled manpower, equipment and the general preservation issues (Gbaje & Zakari, 2013). Ezema and Ugwu (2013) noted that the management, preservation and dissemination of theses and dissertations in Africa fall below expectations. This is despite the fact that with the advent of ICT librarians have opportunities of preserving and disseminating theses and dissertations in electronic form through the Electronic Theses and Dissertations movement (ETD). As reported by Ezema and Ugwu (2013), within Southern Africa, out of 15 member states of the Southern African Development Community (SADC), only three countries, namely Namibia, South Africa and Zimbabwe, have discoverable institutional repositories. A study by Li (2001) examined the current practices of digital preservation of institutional repository (IR) materials using an online survey. The study revealed challenges impeding the ability of IR to collect and preserve content and these include copyright issues, lack of collection policies, lack of sustainable funding and inadequate staffing.

A study by Kanyengo (2006) also investigated the management of digital resources focusing on the permanent access and storage of information resources which have been the cornerstones of libraries for centuries. The study revealed that most African countries had no information policies on the handling of information be it in print or electronic form. The study thus emphasized the need for the development and improvement of the policy framework that will deal with permanent access and availability of digital information resources both at institution, country, regional and continental levels. The study by Kanyengo (2006) also indicated infrastructure, financial resources, technical knowledge and copyright issues as among the issues that affect management of digital resources in Africa. The study thus suggested several strategies for permanent access to digital scholarly resources. These strategies include: enabling policy environment, standardized archiving policies, training in modern methods of metadata preservation and funding.

Kalusopa and Zulu (2009) also presented an overview of the state of digital heritage material preservation in Botswana. The study was part of a three-country, United Nations Educational, Scientific and Cultural Organization (UNESCO) digital heritage preservation project on the state of digital material preservation in Africa involving Botswana, Ethiopia and South Africa. Survey strategy, document research, observation as data collection techniques as well as holding of a national consultative seminar as an additional data input tool were used in the study. The study revealed challenges such as a weak policy formulation on digitization both at the institutional and national levels; weak legislative framework for digital preservation; ill-defined national digitization co-ordination for

digitization activities at institutional level; lack of awareness about the potential of digital preservation by national heritage institutions; a dearth of human resources for digitization; and lack of common standards on digital heritage material preservation.

In his paper, Moghaddam (2010) reviews the issues and challenge imposed on libraries by the presence of digital resources in Iran. The study identified factors influencing digital preservation that include technical issues (print and digital media), organizational issues (costs of preservation, expertise in digital preservation and selection of digital materials) and legal issues (copyright, intellectual rights management and business models and licensing) as well as cooperation and collaboration among different organizations. In his thesis, Luyombya (2010) also examined the framework for effective management of digital records in Uganda by surveying 23 ministries that form the Uganda Public Service (UPS). The study sought to establish the current state of digital records in the UPS and determine the factors hindering the managing of digital records. Primary data was collected using questionnaires and semi-structured interviews that provided insight and illuminated personal experiences of those involved in the management of records and of digital systems in Uganda. The findings of the study revealed that the problems with Digital Records Management (DRM) were due to the absence of ICT facilities with recordkeeping functionality, a lack of clear policies, guidelines and procedures, and to the fact that the Uganda Records and Archives legislation is not fully implemented and not properly enforced. The study posits that failure to fully implement the National Records and Archives Act has led to a lack of appropriate institutional and managerial structures.

The study by Luyombya (2010) also cited similar problems like the other studies such as the lack of a reliable power supply and of sufficient financial resources and human capacity. The recommendations of the study are in four key areas: the need for formal legal infrastructure; the need to establish formal instruments, in particular a national archives agency with appropriate policies, procedures and guidelines; and the development of both robust DRM infrastructure and of appropriately skilled human resource capacity. It underscores the fact that these factors are necessary and needed to be addressed urgently in order to assure government that it is accountable to its citizens in the digital world. Although this study was not specifically on the readiness of e-records, it provided insights into the methodology and understanding of the depth of electronic records management in the public sector in general and particularly in Uganda.

Groenewald and Breytenbach (2011) also conducted a research on the use of metadata and preservation methods for continuous access to digital data. The study revealed that negligence with regard to format specifications and standardization can cause huge electronic information losses in the future. It therefore suggested that there is a need for a study on a more simplified implementation of preservation strategies and commended the use of metadata structures embedded in digital objects from the outset as a starting point towards good preservation principles. The study indicated that storage and

preservation of digital resources needs more attention in South Africa, meaning that training in the preservation of electronic content and the actual delivery of plans and policies need to receive more attention in the corporate environment especially with regard to electronic content stored on personal computers.

Sigauke and Nengomasha (2011) investigated the challenges hindering digitization and preservation of historical records in the National Archive of Zimbabwe (NAZ). The study identified some of the challenges that hinder NAZ's efforts to see long-term digitization and preservation of their historical records and these include undervalued staff establishment which requires further training and exposure to modern digitization technologies, the absence of a digitization policy programme, inadequate funding and lack of collaboration efforts. In Nigeria, Njeze (2012) also conducted a study about investigating preservation and conservation issues in selected Nigerian universities. The study identified some of the major preservation challenges affecting all the universities including lack of comprehensive preservation policy, lack of trained and competent manpower, lack of infrastructure, lack of funding and obsolete hardware and software.

Asogwa (2012) also investigated the challenges of preservation of archives and records in the electronic age at Nigerian universities. The key findings cited several challenges that include copyright issues, technological obsolescence, lack of technical expertise in preserving digital resources, inadequate funding, increasing cost of payment for electronic databases and inadequate ICT infrastructures. The study by Ngulube (2012) about preserving public digital information for the sustenance of electronic government also identified a number of key factors impeding digital preservation. Among others are: the failure by national libraries and national archival institutions to collaborate; limited initiatives at the national libraries and national archives to identify, collect, store and preserve online publications and organizational records; the failure to provide archivists and librarians with the necessary standards and guidelines to enable them to effectively collect, describe and preserve digital information; the prevalence of limited infrastructure, policies, procedures and staff skills for collecting and preserving online information; the limited risk assessment of digital collections by librarians and archivists; the prohibitive costs associated with ensuring long-term access to digital information as compared to paper-based materials has not been adequately assessed; the fact that no additional funding has been provided to undertake collection preservation of online records and publications; the lack of a sustainable repositories project; the failure to properly assess critical risks related to digital preservation; and an acute shortage of staff with the awareness and skills to develop and implement strategies for preserving the national heritage online.

Suleman (2013) also conducted a study about an African perspective on digital preservation and reveals that archivists in African institutions are not as technically skilled as their counterparts in other parts of the world, the level of education of the general

population hinders preservation, lack of funding for preservation projects and many of the projects are funded by external agencies. The digital divide is still a major hindrance and internet bandwidth is non-existent in some places and that causes a digital divide. The study suggested that all online solutions must be bandwidth-friendly and that novel solutions are needed to make digital archives more effective. The study conducted by Owens (2013) was also aimed at investigating how various institutions are preserving their digital materials. A web-based survey and follow-up phone interviews with 12 institutions was used. The study reveals that people are dealing with a wide range of technical issues including storage cost and capacity, the complexities of web archiving and video preservation, the need for technical infrastructure to support long-term preservation, the complexity of preserving a wide variety of formats and keeping up with standards, trends and technology. The management issues are mainly centred around staffing levels, staff skills sets and funding. Most of institutions have implemented institutional repositories (IRs) to manage and provide access to the scholarly output of the university and also wrote digital preservation policies to guide them in their path forward.

In his recent thesis, Boamah (2014) also investigated the contextual factors influencing management and preservation of digital cultural heritage resources in Ghana. The study used Diffusion of Innovation (DOI) theory by Rogers (2003) and the Policy Strategy and Resources (PSR) troika model by Davies (2000) as the theoretical framework, and identified four main clusters of contextual factors as: attitudinal, resource related, policy related and managerial related factors. Sawant (2014) also conducted a study on preservation and conservation practices in academic libraries in Mumbai using a survey consisting of a structured questionnaire. The study revealed that there was no written policy on preservation and conservation in nearly all libraries in Mumbai. Lack of trained manpower and lack of funding were also main constraints to preservation practices. The study suggested that higher authorities and policy makers need to be convinced to make provision of staff and budget not just for preservation but also for the long-term survival of libraries. In Nigeria, Ilo (2015) also examined the factors that inhibit the use of ICT in the acquisition, preservation and accessibility of indigenous knowledge in the academic libraries and these include lack of adequate funding and ICT skills and attitude of indigenous communities. For the purpose of improvement, the paper recommended that librarians should develop ICT skills so as to be conversant with best practices, collaboration with multinational organizations and donor agencies for fund generation and respect for indigenous copyright issues.

Another study by the Council of Canadian Academies (2015) sought to investigate how memory institutions are addressing issues and challenges posed by the changing ways in which Canadians are communicating and working in the digital age and remain relevant as a trusted source of continuing information. The research revealed that many of the

challenges that memory institutions face are rooted in technical issues associated with managing digital content, the sheer volume of digital information and the struggle to remain relevant. The research article documented the key factors that contribute to the success of memory institutions in the digital age, and these include digital policies, resource sharing, institutional risk-taking, participatory and collaborative culture, volunteers, effective leadership in both institutional and national levels, human resource capabilities, management support, technical standards, managing copyright and intellectual property, innovation and reallocation of resources.

From the studies above, it is evident that developing countries are grappling with the challenging issues of managing and preserving digital resources for continued access and posterity. Library practitioners, archivists, researchers, ICT experts, policy developers, decision makers and key players in academic libraries should, therefore, develop new measures, methods, approaches or strategies to effectively preserve their digital resources (Wright 2012).

2.13 Strategies and guidelines in the preservation of digital resources in developed countries

It was evident from literature review that Africa is said to have made very little progress with regard to putting in place strategies and guidelines in the preservation of digital resources as compared with other countries in the world. Another objective that was sought in this study was to determine the preservation strategies that are used in safeguarding digital resources in academic libraries in South Africa. As noted by Wright (2012) any long-term access and future benefit may be heavily dependent on digital preservation strategies being in place and underpinned by relevant policy and procedures. However, there is an observable trend that most of the strategies and practices adopted in the preservation of digital resources have had considerable influence from developed countries such as Europe, New Zealand, United Kingdom, the United State of America, Netherlands and Australia while it is acknowledged that there have been a lot of efforts elsewhere in the world.

Concerns about digital preservation initiatives and strategies in various organizations in both developing and developed countries have concentrated on how to address the challenges that hinder successful preservation of digital resources. As observed by Beagrie (2003) the preservation initiatives in the developed countries were also triggered by the recognition that digital materials were proliferating, but digital media are fragile and depend on rapidly evolving software that becomes obsolete. Therefore, digital preservation initiatives were developed to ensure long-term preservation of digital

resources that were proliferating. Reviewed literature therefore shows a progress and common impetus for digital preservation initiatives in the developed countries and these countries have developed some strategies and guidelines that are useful and relevant to this study. The study is of the view that what is successfully in operation at their institutions may be learned by other countries' institutions.

Beagrie (2003) surveyed the national digital preservation initiatives in the United Kingdom, Australia, Netherlands and the United State of America and made some useful observations that are also relevant to this study. The observation by Beagrie (2003) shows the need for collaboration and involvement of all institutions in such national projects. Therefore, understanding the digital preservation initiatives and strategies taken in these countries provided the current study with some necessary guidelines and strategies for developing a preservation framework applicable to academic libraries in South Africa. The next sections thus reviewed strategies and initiatives taken by the developed countries such as Europe, New Zealand, United Kingdom (UK), the United State of America (USA), Netherlands and Australia as well as the challenges faced by these countries.

2.13.1 Europe

Several EU member states have been involved in projects in Europe through the European Commission, and have developed strategies aimed at addressing the challenges of preserving digital resources. One of the notable projects has been the Digital Preservation Europe (DPE), Preservation and Long Term Access through Network Services (PLANETS) and ERPANETS. Digital Preservation Europe (DPE) is a European project which ran from 2006-2009 that fostered collaboration between many national and international initiatives across the European research area and it worked to pool the expertise of many in order to secure effective preservation of digital materials (DPE 2006). The DPE network had a number of objectives that included:

- Improving coordination of activities and avoiding duplication efforts;
- Sharing knowledge and practical experiences with digital repositories by offering workshops and seminars;
- Encouraging software providers to make their software more suited to long term preservation;
- Promoting cooperation in practice and research (concerning tools and methods for digital preservation);
- Developing guidelines, methods and assistance; and
- Raising awareness within the organizations and in key political areas.

DPE produced deliverables in the following areas:

- A toolkit for audit and certification of digital repositories, including a tool and guidelines for self-certification;
- A checklist and guidance for planning and setting up digital repositories;
- A unique identifier service;
- A shared research agenda and exchange programme;
- Analysis of technological developments; and
- A model for national competency centres to support systematic development and delivery of desk-based research and services in the field of digital preservation.

PLANETS is another European project that started in 2006 and was co-funded by the European Union under the Sixth Framework Programme to address core digital preservation challenges (OPF, 2010). PLANETS was aimed at providing a solid framework and infrastructure that can be used to develop and test a coherent set of instruments and tools for the management of digital objects. This infrastructure and tools are to make it possible to systematically perform preservation planning and keep digital objects accessible and readable into the future. PLANETS consortium also brought together expertise across Europe from national libraries and archives, leading research universities and technology companies, and these included the British Library, The National Library of Netherlands, Australian National Library, The National Archive of Netherlands, The Austrian Institute of Technology, IBM Netherlands, The National Archive of England, Wales and United Kingdom and Tesella.

ERPANET is another European project which was initiated with the aim to address the digital preservation question of how widespread is the appreciation of the digital preservation problem. To address this question, ERPANET conducted seventy-eight case studies that provide insights into current preservation practices in different European institutional, juridical and business contexts as well as across the public and private sectors. The case studies and results are complemented by research conducted elsewhere, including a survey of fifteen national libraries; the DPE survey of archives and libraries in the EU member states; the AIIM surveys in 2004 and 2005; the 2006 Digital Preservation Coalition UK survey ‘Mind the Gap’; and surveys of national and local archives which were reported on in Enabling Persistent and Sustainable Digital Cultural Heritage in Europe. The results show that:

- Awareness of the issues surrounding digital preservation varied markedly across organizations, and even across different divisions of the same organization;
- Few organizations took a long-term perspective and those that did were either national information curating institutions (i.e. archives) or institutions from telecommunications, pharmaceuticals and transportation sectors where failure to

adopt best practices creates higher levels of the regulatory risk exposure than in other sectors;

- An organizational strategic approach to preservation was rare;
- The lack of preservation policies and procedures within organizations was ‘an issue that still needs a lot of attention’;
- Retention policies were not often noted but, where they were, they too were not necessarily implemented across the entire organization;
- There was a general recognition that preservation and storage problems were aggravated by the complexity, diversity of types or formats, and size of the digital entities;
- Costs were poorly understood;
- Benefits to be derived from long-term preservation have proved elusive and arguments which might convince commercially-minded business leaders of the benefits are restricted;
- The value placed on the digital materials by organizations depended on how much the organization relied on the material for business activity, with the highest value placed on information by organizations that either saw or depended on exploiting the potential re-use of information or identified the risks associated with its not being available; and
- Organizations were waiting for solutions to be delivered by technology developers, researchers and service providers.

2.13.2 United Kingdom (UK)

In the United Kingdom (UK), digital preservation came to the fore in the mid-1990s with a series of high level activities to examine the organizational challenges involved in maintaining access to digital materials, and concentrated on building a sustainable collaborative support infrastructure. The UK has so far made much progress in the development of digital preservation tools and practices through the projects such as Digital preservation Coalition (DPC), CURL Exemplars in Digital Archives (CEDARS), the Electronic Records in Office Systems (EROS) and the National Digital Archive of Datasets (NDAD). DPC was launched in 2001 aiming to develop and pursue a UK digital preservation agenda within an international context (Beagrie, 2001). DPC developed the new strategy with the following objectives for digital preservation and access: influencing an effective collaboration, sharing and disseminating knowledge, enriching members’ experience, empowering and developing members’ workforces and assuring the sustainability and the effectiveness of the coalition.

CEDARS is another UK project funded by the Joint Information Systems Committee (JISC) run by the Consortium of University Research Libraries (CURL). This project aimed to address strategic, methodological and practical issues and provide guidance in best practice for digital preservation. It also tested the recently published OAIS Reference Model (ISO 14721, 2003) to establish its applicability as a common framework for digital preservation applications, and created the first coherent metadata set specifically for digital preservation activities. The Electronic Records in Office Systems (EROS) and the National Digital Archive of Datasets (NDAD) were also initiated by the National Archives (TNA) in 1998, as part of the e-government reforms to modernize government and to secure the preservation and provision of access to electronic records (National Archive, 2002).

The National Archives provided a framework in the form of a route map and milestones to guide the agencies and help them meet the set targets including development of policies, strategies, identifying requirements for electronic records management appraisal and preservation plans. EROS started as a specialized programme to ensure that electronic records of long-term value, created across government, are available for future access (Irvine & Baron, 2000:12; National Archive, 2002). TNA project has successfully developed generic functional requirements for the management of electronic records: MoReq and Requirements for Electronic Records Management systems. The TNA's toolkits give guidance on practical implementation of the functional requirements to help match the agencies' particular needs (National Archives, 2002).

The University of Manchester (UML) in UK has also been spearheading efforts in the development of a digital preservation strategy. The plan for the development of the UML strategy began in 2012, aiming at ensuring perpetual access to its digital materials in accordance with their content and collection management policies (UML, 2012), and it also aims to minimize the risks of digital obsolescence on our collections for the foreseeable future. The Digital Preservation Strategy group identified a number of policies which were either enacted or under development that related to the formation of a digital preservation strategy for UML. The existing policies include content development and collection management policies, digitization policy and escolar preservation policy. The group believed a sustainable digital preservation strategy was more likely to succeed if it was aligned well with the existing policies and the enactment of policies was identified as one of the factors enabling digital preservation in the academic libraries.

2.13.3 Australia

Australian practice in digital preservation is often at the forefront of world best practice for library record keeping, audio-visual archiving, data archiving and geo-science factors (Gatenby, 2002; Beagrie, 2003). One example is a report by Beagrie (2003) on a national Digital Preservation Initiative written to advise Library of Congress about developing its National Digital Information Infrastructure and Preservation Program (NDIIP). Beagrie (2003:14) noted that Australia has a relatively large number of leading-edge online projects across all sectors and archiving these online materials has become a significant area of effort for Australia's memory institutions and both the National Library of Australia (NLA)and the National Archive activities and guidelines are frequently cited internationally as exemplars in this area.

There is also an active electronic records management system or archive sector in Australia and the work of Monash University, The Public Record Office (PRO) of Victoria and the National Archive of Australia has earned an international reputation. National Library of Australia (NLA) has also been active in digital preservation since 1994 and founded one of the world's first library digital preservation sections in 1995 and currently houses its digital collections on Pandora, the web archive they developed for the preservation of their digital content that uses the PANDAS archiving system (NLA, 1996). NLA also drafted the Digital Preservation Direction Statement 2008 to 2011, supported by the Library's Digital Preservation Policy and emphasizes the importance of incorporating preservation planning in all aspects of digitization.

The VERS project was also initiated by the Public Record Office Victoria (PROV) in 1995 to assist agencies in developing systems for managing electronic records, archiving systems and policies that fit their existing business processes and records management structures (Smith, 2004:3). The overall aim of the project was to ensure the capture of accurate, reliable and authentic electronic records to support good governance and preservation of digital heritage. According to Smith (2004:3), the project had three broad key stages, namely: preliminary investigation into potential solutions, building and testing a demonstrator system (prototype), and implementation of the system. The first stage of the VERS project involved an investigation of how digital records could be safeguarded against obsolescence caused by changes and developments in computer software, hardware and storage media (Smith, 2004:3). The key goals were to understand the government processes which led to records creation, and the ways in which these records were used, managed and archived. It is important to note that the strength of this project has largely depended on the collaboration between Monash University (Australia) and the National Archives and Record Administration (USA).

2.13.4 New Zealand

As observed by Knight (2008), the National Library of New Zealand (NLNZ) has been a leading organization in digital preservation and its experiences will be of relevance to many other libraries throughout the world. The NLNZ's working mandate is to preserve New Zealand's digital heritage in perpetuity. In his 2008 International Federation of Library Associations and Institutions (IFLA) paper, Knight (2008) described the following key issues relating to digital preservation at NLNZ:

- Digital preservation and the legislative and strategic context: the NLNZ Act 2003 provided the legislative mandate to incorporate digital preservation as a core component of its business activities and requires the National Library to collect and preserve digital content in ways that ensure current and future access to New Zealand's documentary heritage (Public Act, 2003). NLNZ's digital preservation activities also underpin the four strategic priorities identified in the Library's strategic plan to 2017, i.e. accessing New Zealand's digital memory, sharing our nation's stories, inspiring knowledge creation and economic transformation and enriching the user's experience;
- Business change: it is organizational readiness for digital preservation management and the following seven discrete work streams were developed to enable the introduction of the National Digital Heritage Archive (NDHA): business process, capacity and capability, performance measures, internal training, producer management, business and technical support and business change communications (Knight, 2010);
- Integration of the digital preservation systems into the organization's infrastructure: NDHA is being integrated with the NLNZ's existing collection management systems and software to deliver digital library services to users (Knight, 2010);
- Migration of current digital content to a preservation environment: NLNZ has met its legal deposit for digital objects through the implementation of an Object Management System(OMS) which included published material deposited through legal deposit, digitized materials from NLNZ's digitization programme and web archiving sites (Knight, 2010); and
- Performance measures for a digital preservation system: sixty key performance measures covering key performance indicators, reporting, audit and internal ingest have been developed for the NDHA.

The National Library of New Zealand also developed a proactive approach to digital preservation in creating the first national digital preservation plan, the Digital Continuity Action Plan, partnering with Archives New Zealand, and the plan is an all-of-government approach to preservation. The National Digital Heritage Archive (NHDA) was developed

in 2004 with help from ExLibris and marketed as Rosetta (NHDA, 2009) and this project was divided into two phases: Phase 1 of the NDHA project concentrated on issues related to provenance, context, authenticity and integrity and Phase 2 developed and implemented risk management and preservation planning.

2.13.5 United State of America (USA)

In the USA, the National Digital Information Infrastructure and Preservation Program (NDIIPP), University of British Columbia's (UBC) School of Library, Archival and Information Studies and the International Research on Permanent Authentic Records in Electronic Systems (InterPARES) projects provide useful insights on the preservation of digital resources. The National Digital Information Infrastructure and Preservation Program (NDIIPP) is a USA initiative led by the Library of Congress and its mission was to develop a national strategy to collect, preserve and make available significant digital content, especially information that is created in digital form only, for current and future generations (Library of Congress, 2003). The Library of Congress has built a preservation network of over 130 partners from across the nation and is working with them on a variety of initiatives and also hosts a website listing tools for preservation metadata implementation. The Library of Congress's NDIIPP has also developed a national stewardship network for sustainable preservation and the focus is on four goals: stewardship; building a national digital collection plan to preserve at-risk content; building a shared technical platform for preservation; and developing a public policy to encourage preservation (Library of Congress, 2003).

A tool for digital preservation called BagIT, a specification for the packaging of digital content for the purpose of automating the content's receipt, storage, and retrieval, was developed by the Library of California Digital Library and Stanford University as an NIDPP effort (Oehlerts & Liu, 2012). The University of British Columbia's (UBC) School of Library, Archival and Information Studies is another USA project run from 1994-1997, aiming at identifying the best methods and define requirements for creating, handling and preserving the reliability and authenticity of electronic records during their active and semi-active life (UBC, 2006).The first phase of the project was to articulate a conceptual framework, namely: reliability and authenticity of records and these specific goals have been stated as to:

- Establish what a record was in principle and how it could be recognized in the electronic environment;
- Determine electronic systems that generated records;

- Formulate criteria that allowed for the segregation of records from all other types of information in electronic systems;
- Define the conceptual requirements for guaranteeing the reliability and authenticity of records in electronic systems; and
- Assess these requirements against different administrative, judicial, cultural, and disciplinary points of view (MacNeill, 2000).

International Research on Permanent Authentic Records in Electronic Systems (InterPARES) is another USA based project that began in 1999 as a major international research initiative bringing together archival scholars, computer engineering scholars, national archival institutions and the private industry collaborating to formulate international, national and organizational policies, strategies and standards for long-term preservation of authentic records created in electronic systems (Duranti,1996:159). This project is composed of national research teams mainly from Canada, America and Australia; however, there are multi-national contributions from Europe, Asia and Africa.

InterPARES arose out of the need to determine conditions for preserving records no longer needed for current business and the project pooled multi-disciplinary expertise on the challenges of guaranteeing the authenticity of the electronic record over time (Hunter, 2000:271). InterPARES underwent three phases, namely InterPARES 1, InterPARES 2 and InterPARES 3. InterPARES 1, which was the first phase of the project, ran from1999-2001 aimed to address the long-term preservation of electronic records that were no longer needed in the day-to-day business; and that had to be preserved for future operational, legal or historical use (Hunter, 2000:271). The InterPARES 1 focused on four main objectives:

- Identifying requirements that are necessary for preserving and maintaining the authenticity of electronic records over time;
- Investigating and establishing the effect/influence of digital technologies on the methodology of appraisal and whether there is a need to change these methodologies;
- Developing methods, procedures and rules for preservation of electronic records according to requirements identified in domain one and defining responsibilities for implementing them; and
- Developing a framework for the formulation of principles that will guide the development of international, national and organizational strategies, policies and standards for the long-term preservation of authentic electronic records.

InterPARES 2 began in 2002 and was concluded in 2007 and aimed to develop theory and methods capable of ensuring the reliability, accuracy, and authenticity of electronic records from their inception and throughout their preservation. The research focused on records created in dynamic, experiential and interactive systems in the course of artistic,

scientific and governmental activities. InterPARES 3 began in September 2007 following InterPares 2 and continued until August 2012, with the goal of implementation of the findings of the first two phases of the project in archival organization or units with limited resources (InterPARES Project, 2010). Duranti (2010:158) reported on the third stage, InterPares 3 case study called cIRcle, at the University of British Columbia (UBC). cIRcle is a digital repository for the management, dissemination and preservation of the intellectual output of a university and its community members (Duranti, 2010:158). cIRcle's retrospective theses project involves the deposit of digitized theses and dissertations originally archived in print.

According to Duranti (2010) there were 14,073 items in cIRcle totaling 130GB as of November 2009, and this material is stored in DSpace. DSpace is a database with a set of services to capture, store, index, maintain and make accessible a variety of entities in a digital format over the internet utilizing a controlled set of workflows and access permissions. cIRcle's operational goal is to be able to accept, preserve indefinitely and provide continued readability and accessibility to virtually all published and unpublished digital objects created in any file format by or on behalf of the University, its faculty, staff or students (Duranti, 2010). The digital materials ingested into cIRcle include pre-prints and post-prints of academic journal articles, other items such as theses, dissertations, departmental publications, technical reports, bulletins, conference proceedings, course notes and other learning objects, and raw research data. The cIRcle case study is very relevant to this study as the majority of digital scholarly output in academic libraries in South Africa are managed and preserved in institutional repositories (IRs).

cIRcle also developed a preservation strategy for IRs that is sensitive to intellectual rights issues and for the testing of such strategy. Authenticity and intellectual rights were identified as the paramount factors for digital preservation success (Duranti, 2010). Duranti (2005) defines the authenticity of digital material as dependent upon the maintenance through time of its identity and of its integrity. Intellectual rights comprise several types of rights as stated by Duranti (2010), but among them the ones that are affected by long-term preservation by means of constant transformative migration or emulation are the two major groups of intellectual rights and these are economic rights and moral rights. O'Hare (1982) describes the economic rights as those rights that enable the copyright owner (not necessarily the author or creator) of a work to make commercial gain from the exploitation of that work. Rajan (2004) describe the moral rights as those rights that the author or creator retains (regardless of whether the author still retains the economic rights) over the integrity of a work (rights of reputation) such that no one, even the copyright owner, is allowed to distort, mutilate or otherwise modify the work in a way that is prejudicial to the author's honour or reputation. cIRcle began to separate the protection of the moral rights and that of the economic rights.

The InterPARES Project has also made a submission to the Commission of Industry Canada and the Department of Canadian Heritage responsible for updating the Canadian copyright act, requesting that specific attention be given to the problems presented by the long term preservation of authentic digital entities (Davies, 2002). This project further conducted an inventory of all the items in cIRcle to identify their nature and characteristics, content, current licence, attached digital rights management, etc., in order to develop an intellectual property policy and a preservation plan consistent with it (Duranti, 2010). The Colorado State University Libraries in USA began digitization activities, including participating in collaborative digitization projects and creating digital collections in the early 2000s, with assistance from the University's Academic Computing and Network Services (ACNS).

There are several research projects and initiatives at California State University in Los Angeles CSUL) initiating investigations into data management and curation. University publications, faculty papers, theses and dissertations, student research posters, archival images and documents are also available online with the inauguration of the CSUL Digital Repository. CSUL experienced a major flood disaster in 1997 and so it is particularly aware of disaster recovery and risk management issues (Lunde and Smith, 2009), and the institution now incorporates disaster planning, recovery, and preservation in all aspects of project planning, including digitization. The University of Minnesota and Old Dominion Universities (ODU) in USA are also committed to long-term preservation of its digital resources and both implemented a digital preservation framework that provides a broad set of guidelines for digital preservation, from which procedures can be developed that will meet accepted standards, make effective use of resources and support the mission and goals of the library (ODU, 2012; University of Minnesota, 2014). ODU established a Digital Services Center (digital repository) and a digital initiatives team to perform digital practice. The University of Minnesota is committed to developing its digital preservation policies, repository, and strategies in accordance with the Open Archival Information System (OAIS) Reference Model and intends to align its policy, procedures, and practices with the Trustworthy Repositories Audit & Certification (TRAC), ISO 16363 standard (University of Minnesota, 2014). The primary objectives of the digital preservation programme as summarized by University of Minnesota (2014) are to:

- Protect the Libraries' investment through a fully implemented digital preservation program;
- Demonstrate organizational commitment through identification of sustainable funding for the program;
- Comply with preservation community standards and best practices;
- Seek, expand, and develop digital preservation methods that are appropriate for the Libraries and the University community;
- Identify, through systematic selection, classes of digital resources to be preserved;

- Assess the risks for loss of content posed by technology variables such as proprietary file formats, applications and obsolescence;
- Evaluate the digital content to determine what type and level of format conversion (migration) or other preservation actions may be required;
- Determine the appropriate type and level of metadata needed for each content type and the relationship to the object(s); and
- Include materials that originated in digital form (born digital) and those converted to digital form.

Both the University of Minnesota libraries and the Old Dominion University are guided by the same principles and actions in the development, implementation, and management of the university libraries' digital preservation programme (ODU, 2012; University of Minnesota, 2014). These include:

- Access: Long-term access to selected digital content is the primary goal of all preservation activities;
- Authenticity: Establish procedures to meet archival requirements pertaining to the provenance, chain of custody, authenticity, and integrity (bit-level and content) of institutional records and assets;
- Collaboration: Partnerships and collaborative agreements will be investigated and established when deemed to be an appropriate use of library resources;
- Intellectual Property: Define policies and procedures for the preservation of and access to digital resources that are in accordance with all applicable intellectual property ownership and rights laws;
- Standards and Best Practices: 1) Align its policy, procedures, and practices with the Trustworthy Repositories Audit & Certification (TRAC). 2) Comply with the Open Archival Information System (OAIS) reference model standard in the development of digital archives. 3) Adhere to prevailing community-based standards in developing and maintaining its organizational and technological context. 4) Participate in the development of digital preservation standards and their promulgation;
- Sustainability: Define a sustainability plan for the digital archive that is cost-effective and transparent, and that can be audited over time;
- Technology: 1) Develop the digital archive to maximize scalability, flexibility, and reliability. 2) Employ appropriate storage management technologies for digital resources, utilizing on-line, near-line, and off-line storage as appropriate. 3) Ensure that hardware, software, and storage media containing archival copies of digital content are managed in accordance with environmental, quality control, security, and other standards and requirements;
- Training: Provide appropriate training and development for staff in areas related to digital preservation, as well as raise awareness about digital preservation issues

and developments for both additional staff and the broader community of digital content producers, archivists, and users; and
- Transparency: Create consistent, documented policies, procedures, and practices for the program and the operation of the digital archive.

The University of Minnesota recognized challenges in implementing an effective and enduring digital preservation programme, including:

- Rapid growth and evolution: Technology that enables the variety of formats and dissemination mechanisms changes rapidly. Establishing a program that is responsive to change is a large challenge;
- Sustainability: The need for effective cost models and an affordable program is widely acknowledged. The scale is based on the level of commitment. The program should promise more than can be delivered;
- Content provider partnerships: Working with creators and providers of valued content to employ appropriate provisions prior to deposit will better facilitate future preservation;
- Enabling full preservation: Moving from well-managed digital collections to preserved collections in the true sense of the term requires ongoing institutional effort, partnership development, and financial commitment;
- Flexibility: To respond to evolving technological capabilities and changing user expectations, the digital archive must revise continually the definition of the dissemination information package (DIP) that will allow for the delivery of information to an expanding array of content delivery platforms; and
- Education: Training and awareness will be provided for all staff since they contribute directly and indirectly to the digital preservation function, although the majority of staff members do not have digital preservation as an explicit or significant portion of their responsibilities. The libraries are committed to providing appropriate training for, and raising awareness about, digital preservation issues and developments both for its internal staff and for the broader community of digital content producers, archivists and users.

2.13.6 Netherlands

In the Netherlands, Data Archiving and Networked Services (DANS) promotes sustained access to digital research data files and encourages researchers to archive and reuse data, for example, through the online archiving system EASY (DANS, 2011). The EASY repository system can also be used for the online depositing of data of completed research. DANS also created a Data Seal of Approval and Dutch Data Verse Network

(DDN) system. Data Seal of Approval has been created for giving an indication of quality, preservation and accessibility of data and the Dutch Data Verse Network (DDN) was created to support researchers from Dutch universities and other scientific organizations (DANS, 2011).

Another project is a Scalable Preservation Environments (SCAPE), an EU-funded project, led by the National Library of Netherlands, which directs towards long-term digital preservation of large scale and heterogeneous collections of digital objects (National Library of Netherlands, 2011). The SCAPE consortium brings together experts from memory institutions, data centres, research labs, universities and industrial firms in order to research and develop scalable preservation systems that can be practically deployed within the next three to five years (SCAPE, 2014). It has developed scalable services for preservation planning and execution of institutional preservation strategies on an open source platform that orchestrates semi-automated workflows for large-scale, heterogeneous collections of complex digital objects. SCAPE also developed infrastructure and tools for scalable preservation actions, provided a framework for automated, quality-assured preservation workflows and integrated these components with a policy-based preservation planning and watch system (SCAPE, 2014). It is also dedicated towards producing open source software solutions available to the entire digital preservation community.

SCAPE preservation components are to:

- Identify the need to act to preserve all or parts of a repository through characterization and trend analysis;
- Define responses to those needs using formal descriptions of preservation policies and preservation plans;
- Allow a high degree of automation and scalable processing; and
- Monitor the quality of preservation processes (SCAPE, 2014).

The United Nations Educational Scientific and Cultural Organization (UNESCO) also implemented a memory of the world (MoW) programme aimed at preserving the world's documentary heritage by making it permanently accessible to all without hindrance. According to Swan (2012) the memory's mission was to facilitate preservation by the most appropriate techniques of the world's documentary heritage and to assist universal access to documentary heritage. It aimed at also increasing awareness worldwide of the existence and significance of documentary heritage (Swan, 2012).

2.14 Digital preservation initiatives in Africa and South Africa

Literature revealed growing evidence of awareness in Africa and Southern Africa regarding preservation of their digital resources. Several projects have been initiated to address the issues of digital preservation in academic institutions in Africa and South Africa. Many of the initiatives were aimed at strengthening capacity for safeguarding digital resources and creating collaborative efforts in digitization and preservation of digital resources.

2.14.1 Digital preservation initiatives in Africa

Reports on specific digital preservation projects in different parts of Africa provided a useful lead to the investigation of factors influencing digital preservation sustainability in academic libraries in South Africa. For instance, Ryan (2010) reports a case study that describes experiences in a collaborative initiative project to digitize a wide range of scholarly materials in Africa. Ryan (2010) describes the Aluka project highlighting the creation of computer laboratories where cultural heritage materials were digitized in Mali and oral histories, maps and audio-visual recordings were also digitized in Mozambique. The collaborative nature of the Aluka project revealed that digital preservation initiatives can thrive on collaboration as an enabling factor. Other factors that were identified to have enabled the Aluka project are skill personnel, adequate funding, and adequate infrastructure.

Ryan (2010:29) also identified factors hindering the operational efficiency of technical projects such as lack of access to high-end equipment, complicated custom processes and limited control over environment, as was seen with the case of Aluka. In the context of academic institutions, Wordofa (2011) reported that the Institute of Ethiopian Studies Museum of the Addis Ababa University (AAU) embarked on mass digitization of its historical and archival collections, especially the Islamic and Geez manuscripts, archives and photographs with funding from the British Library. The Geez manuscripts are found in various monasteries and churches throughout the country with no access to such valuable resources. The Ethiopian Languages and Culture Academy of the AAU is responsible for digitizing the manuscripts to enhance wider access and long-term preservation. Wordofa (2011) also observes that the AAU-Electronic Theses and Dissertations (ETD) repository system built on DSpace technology and managed by the library and the repository contains documents from all faculties.

2.14.2 South African initiatives

As observed by Liebetrau (2012) South Africa does not currently enjoy widespread national funding and extensive governmental support for digitization initiatives such as that provided by JISC in the United Kingdom. Liebetrau (2012) noted that universities are largely funding their own individual digitization projects, often supplemented by foreign funding, to support e-research and provide global access to their own scholarly resources by building Institutional Repositories (IRs). As far back as 1999, the Campbell Collections of the University of KwaZulu-Natal was initiated as a centre of research excellence with an archive, a museum and a library of rich holdings reflecting the social and cultural heritage of KwaZulu-Natal. This project was made possible with funding from the Andrew Mellon Foundation and several thousand early 20th century historic photographs from this collection have been digitized and made available online to researchers around the world. This project provides online access to important South African heritage, which would otherwise be little known outside the country.

Another innovative project is Digital Imaging South Africa (DISA) based at the University of KwaZulu-Natal and funded by the Andrew Mellon Foundation in 1999, aiming at making Southern African material of high socio-political interest, such as anti-apartheid material, accessible to scholars and researchers worldwide. This innovative project developed an extensive online digital repository of open access resources around South African heritage that assisted new curriculum development and contributed to e-learning and e-research initiatives. DISA's vision was to digitize and create a freely accessible online scholarly resource focusing on the socio-political history of South Africa, particularly the struggle for freedom during the period from 1950 to 1994. It was a national collaborative project partnered by several South African universities, the National Archives and the National Library. DISA encourages self-determination for developing important historical resources and building capacity, knowledge and expertise in digital imaging technology in the library and archival community in the region.

South African Rock Art Digital Archive (SARADA) is another project, the largest of its kind in the world, and based at Wits University in Johannesburg funded by the Ringing Rocks Foundation and the Andrew Mellon Foundation. This project is referred to as a milestone in the digital preservation of Africa and the world's cultural heritage and a good example of a national collaborative project which brings together scattered collections into one "virtual" space (SARADA, 2012). Images from museums, universities and private collections around the country and a significant contribution to the sum of African heritage have been scanned and made available online through this project. It is precisely these kinds of projects that are able to drive cutting edge technological developments and define digital information management boundaries but widespread skills deployment is

urgently required to push digitization initiatives forward in South Africa. Valuable skills remain within the project, often invested in short-term contract staff and student assistants until project insecurity drives them further afield, taking their skills with them, often outside the country. The South African Rock Art Digital Archive (SARADA) and the collaborative nature of the Aluka project thus reveal that digital preservation initiatives can thrive on collaboration as an enabling factor. The SARIS project also started inter alia because of the extremely high costs to South African research institutions and university libraries to access the global research literature. A new research paradigm called e-Research was emerging and it was therefore recommended that a framework for e-Research services for the entire South African research community be created, as depicted in Figure 2.10.

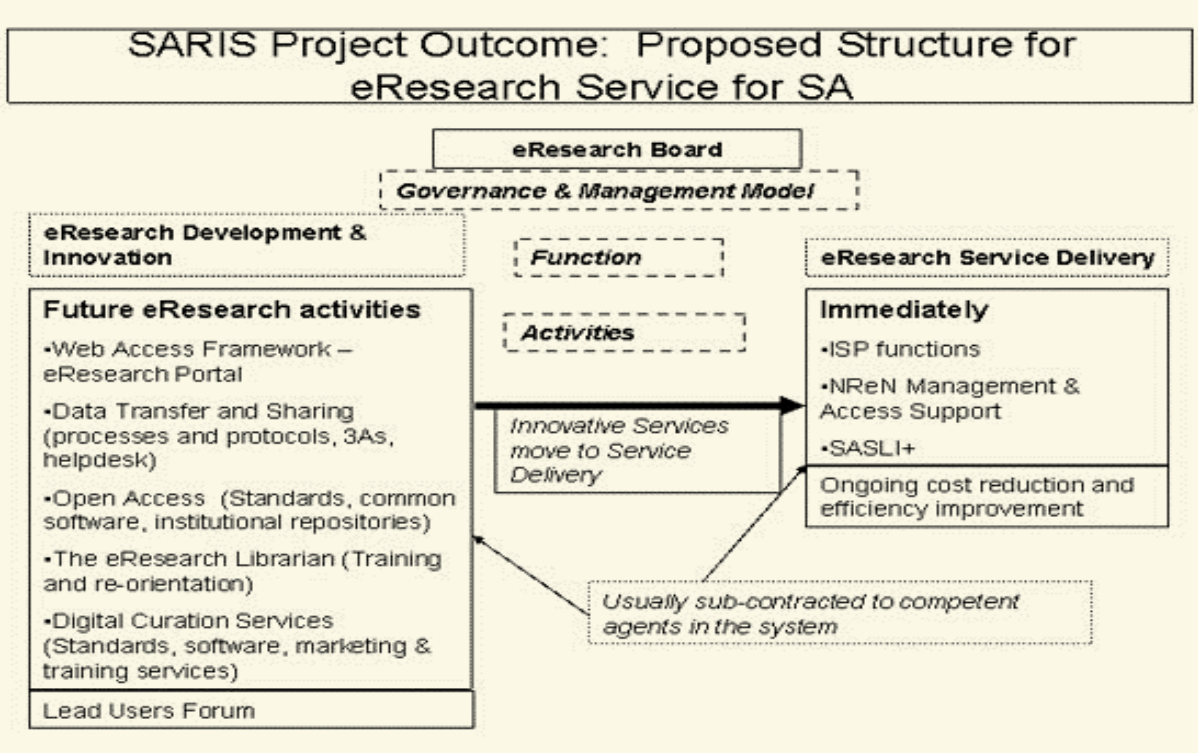

Figure 2.10: A proposed e-Research framework for South African research community (Shipp et al., 2005)

Again, in 2009, the Carnegie Corporation of New York provided the National Research Foundation (NRF) with a grant to assist previously disadvantaged universities with training and hosting of their ETDs (open source software) on a server housed at the NRF (NRF, 2009). The aim of the project was to:

- Determine the state of digitization in South Africa;

- Identify digitization initiatives nationwide;
- Establish a national portal or database;
- Produce a digitization manual, templates, standards and policies; and
- Establish a digitization and preservation centre (technical support, training and knowledge sharing).

The digitization and digital data preservation centre is another collaborative South African initiative by NRF (2010), aimed to:

- Provide technical digitization support and services to those institutions that are not able to wholly and partially do it themselves;
- Provide or mobilize experts to conduct training and support for persons and institutions that would like to embark on digitization and digital preservation exercises;
- Coordinate collaborative digitization and digital data preservation initiatives among HEIs and as much as possible NGOs and other organizations that are keen to collaborate and/or provide digitization support to others; and
- Facilitate the sharing of knowledge through this portal.

The National Research Foundation (NRF) has also created a National Electronic Theses and Dissertations (NETD) portal for searching, browsing and accessing South African theses and dissertations from South African universities that have their repositories open for harvesting. A collaborative initiative on the South African Framework, called Managing Digital Collections, was also published by the NRF in 2010 under its auspices as an introductory guide intended to supplement a series of regional training workshops (NRF, 2010). It aimed at assisting universities and heritage organizations gain valuable skills. Managing the digital collections framework provides high-level principles for planning and managing the full digital collection life-cycle aimed to:

- Identify the components and activities involved in creating good digital collections;
- Identify existing sources in support of the development of sound local practices;
- Encourage community participation in best practices for digital collection building;
- Contribute to the benefits of sound data management practices, data sharing and long term access;
- Assist cultural heritage organizations to create and manage complex digital collections;
- Assist funding organizations who wish to support and encourage the development of good digital collections;
- Advocate the use of open standards to ensure quality and to increase global interoperability for better exchange and re-use of data and digital content; and

- Establish a national portal consisting of heritage repository, training modules, digital initiatives register and publications.

Another initiative is Electronic Information for Libraries (eIFL) sponsored by the Mellon Foundation, aimed at enabling access to knowledge for education, learning, research and sustainable community development, working in collaboration with libraries in more than 60 developing and transition countries in Africa, Asia, Europe, and Latin America. eIFL in particular has been very supportive of open access and the development of repositories in South Africa, especially at the academic institutions. The implementation of institutional repositories became an emergent trend in academic libraries and digital collections that capture and preserve the intellectual output of university communities (Crow, 2002).

2.15 Digital preservation approaches and strategies used in academic libraries

The discussion in the previous section has so far established the challenges and key barriers to digital preservation. Although it is difficult to address these challenges, the researcher is of a view that academic libraries can overcome these problems if the proper policies and strategies are put in place. The PLANET project in 2009 concluded that more work ought to be done on policies and budgets of digital preservation and those component-based solutions to digital preservation are needed (Sinclair et al., 2009). One of the major challenges is the proliferation of digital information in the face of technological changes that poses challenges to academic libraries, and this, therefore, calls for approaches and strategies for managing and preserving these vast digital collections. A number of approaches and strategies have thus been proposed to address these challenges and they need to be considered to ensure long-term access to digital information. Beagrie et al. (2002) describe a digital preservation strategy as a particular technical approach to advance continued access to archived digital materials. This study reviewed some of the preservation approaches applied by various organizations in ensuring long-term access to their digital information. The next section discusses the MoSCow approach, technological preservation approach, risk management approach and cloud computing.

2.15.1 The MoSCoW approach

The PoWR Handbook, funded by JISC for web preservation, concentrates on strategies for the preservation of web material and encourages the MoSCoW approach to the

selection of digital archival materials (University of London Computer Centre, 2008). The MoSCoW approach is summarized as follows (University of London Computer Centre, 2008):

M: Things you or institution must preserve;

S: Things you should preserve, if at all possible;

C: Things you could preserve, if it does not affect anything else; and

W: Things you won't preserve.

This MoSCoW approach can be applied in the selection of all digital materials for long-term storage and archival purposes by individuals and organizations (University of London Computer Centre, 2008). The next section discusses some of the preservation strategies used to address the challenge posed by technological obsolescence.

2.15.2 Technological preservation approaches

According to Lee et al. (2002) technological digital approaches are classified into two main approaches, namely: preserve the technological environment and overcome technological obsolescence as depicted in Figure 2.11.

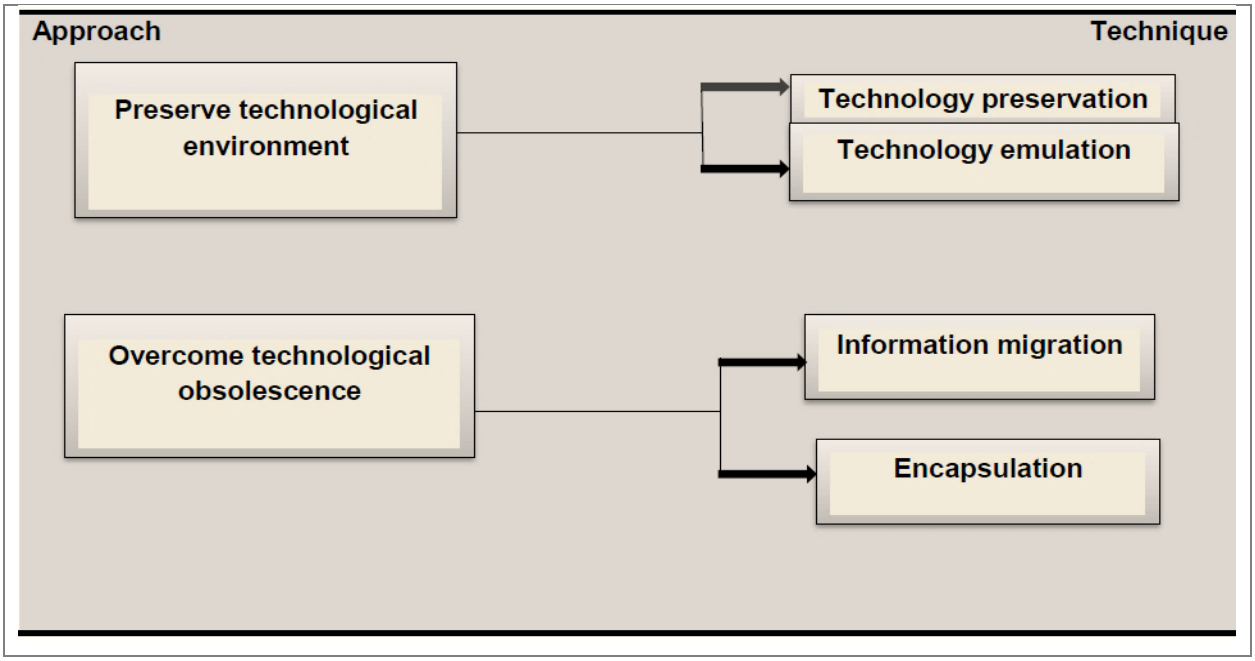

Figure 2.11: Technological preservation approaches (Source: Lee et al., 2002)

2.15.2.1 Preserve technological environment

The first is the more conservative approach where the original technological environment is fully preserved for decoding the digital information in the future. This approach can be further divided into two preservation techniques: technology preservation approach and technology emulation approach.

- Technology preservation approach: is to preserve the working replicas of all computer hardware and software platforms for future use and operates on the principle that if digital material relies on the technical environment used to create it in order to preserve the functionality and "look and feel" of the product, then the most obvious approach is to preserve the original technology (Beagrie et al., 2002; Cornell University Library, 2007); and
- Technology emulation approach: is to programme the newer computer systems to emulate on demand the older obsolete platforms and operating systems. This approach also combines software and hardware to reproduce in all essential characteristics the performance of another computer of a different design, allowing programmes or media designed for a particular environment to operate in a different, usually newer environment (Cornell University Library 2007; UKOLN 2006). Emulation strives to maintain the ability to execute the software needed to process data stored in its original encodings, whereas migration changes the encodings over time so that we can access the preserved objects using state-of-the-art software in the future.

2.15.2.2 Overcome technological obsolescence

The second approach is to overcome the technical obsolescence of file formats and it may also be classified into two techniques: information migration strategy and encapsulation.

- Information migration strategy: is to transform or convert the old digital resource to a format that is independent of the particular hardware and software that were applied to create them; and
- Encapsulation: is where a digital object and anything else necessary to provide access to that object are grouped together and preserved.

However, these approaches have the advantages and disadvantages of digital approaches as outlined by Lee et al. (2002). Table 2.5 illustrates the advantages and disadvantages of preservation approaches.

Table 2. 5: Advantages and disadvantages of preservation approaches

Techniques	Disadvantages	Advantages	Domain
Emulation	Maintain the look and feel.	The complexity of creating emulator specifications; The large amount of information that must be preserved; and Archaic software required to access information.	Application software; Complex digital resources such as those that contain executable files; Resources for which there is lack of sufficient. knowledge, and for which future use is unlikely.
Migration	Does not need to retain original applications; and Support active access and management.	Significant cost for long-term; Information Degradation; Lack of Metadata; and Need for continued diligence on the part of archivists.	Resources that are actively accessed and managed such as scientific data or database; and Resources whose formats are sufficiently known.
Encapsulation	Maintain preservation information.	Knowledge about the format must be preserved; and Systems required for capturing digital information.	Resources that are unlikely to be accessed and managed actively; and Resources whose formats are sufficiently known.

Adapted from Lee et al. (2002)

2.15.3 Risk management approach

Barateiro, Antunes and Borbinha (2009) proposed a risk management based approach to design and assess digital preservation environments, enclosing the definition of context and requirements, and the identification of threats and vulnerabilities, to be used as the basis of the definition of actions to deal with the risks associated with those threats and vulnerabilities. Risk management is a continuously developing arena whose ultimate goal is to define prevention and control mechanisms to address the risk attached to specific activities and valuable assets, where risk is defined as the combination of the probability of an event and its consequences (Barateiro, Antunes & Borbinha, 2009). Digital preservation stresses the time dimension of interoperability and focusing on the requirement that digital objects must remain authentic and accessible to users and systems over a long period of time, thus maintaining their value. It aims at maintaining digital objects accessible over long periods of time, ensuring the authenticity and integrity of these digital objects. In order to achieve the goals of digital preservation, repositories must protect digital objects against several threats that can affect their future interpretation (Barateiro, Antunes & Borbinha, 2009), and protecting digital objects against threats is equivalent to reducing the risk of those threats, which is the main goal of the broad area of risk management.

As noted by Barateiro, Antunes and Borbinha (2009), firstly, defining the context is crucial to identify strategic objectives and define criteria to determine which consequences are acceptable to this specific context. Secondly, today's organizations are continuously exposed to several threats and vulnerabilities that may affect their normal behaviour. The identification, analysis and evaluation of these threats and vulnerabilities are the only way to decide on the appropriate techniques to handle them (Barateiro, Antunes & Borbinha, 2009), and the identification of threats, vulnerabilities and risks is based on events that may affect the achievement of goals identified in the first phase. Finally, the risk analysis and evaluation estimates the likelihood and impact of risks to the strategic goals, in order to be able to decide on the appropriate techniques to handle these risks. Figure 2. 12 shows the risk management process by Barateiro, Antunes and Borbinha (2009).

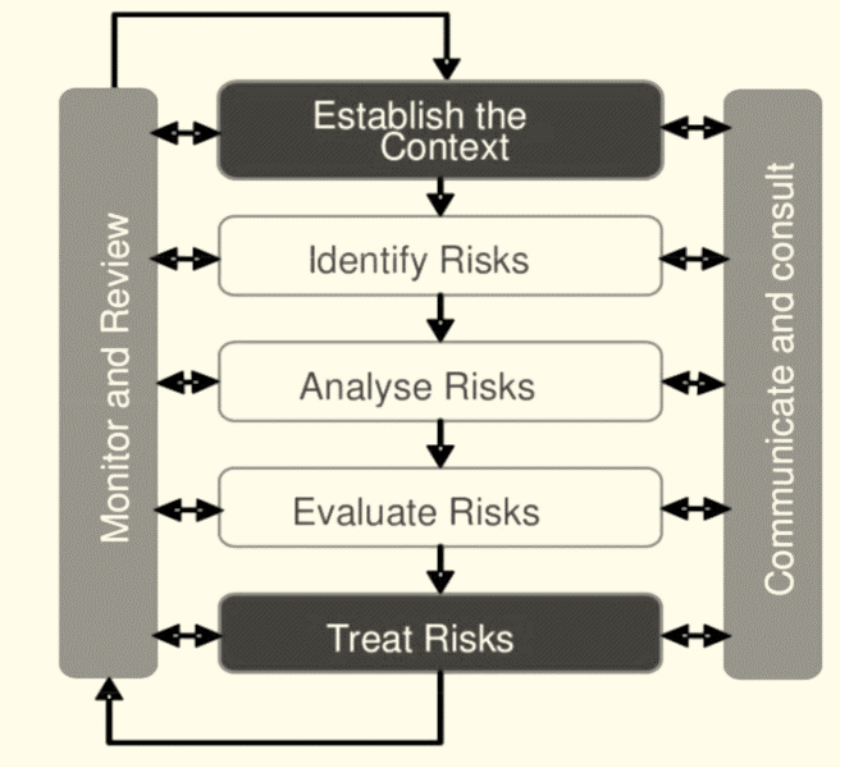

Figure 2. 12: Risk management process (Barateiro, Antunes & Borbinha, 2009)

As pointed out by Oehlerts and Liu (2012), digital preservation assessment programmes such as DRAMBORA and TRAC can assist with mitigating risks by guiding organizations through the preservation planning process. The Trustworthy Repositories Audit and Certification (TRAC) Criteria and Checklist is meant to identify potential risks to digital content held in repositories and it takes OAIS as its intellectual foundation, and as the benchmark for measuring success in terms of trustworthiness. It also establishes appropriate methodologies for determining the soundness and sustainability of digital repositories. The Digital Repository Audit Method Based on Risk Assessment (DRAMBORA) process also focuses on risks, and their classification and evaluation according to individual repositories' activities, assets and contextual constraints (McHugh, Ruusalepp, Ross, & Hofman, 2007). These risk management tools are discussed in detail in Sections 2.15.4 and 2.15.5. Several large cultural heritage institutions have implemented risk management programmes and some of these are the British Library, the Library of Congress, the National Library of Australia and the National Library of New Zealand (Oehlerts & Liu, 2012). Many organizations and institutions use a life-cycle approach to risk management, with an emphasis on treating all digital content

in a consistent fashion and identifying actions needed to reduce the risk of loss or degradation of digital content.

Corrado and Moulaison (2014:12) also identified risk management as an essential aspect of digital preservation and mentioned the following key strategies for ensuring access across the long-term:

- Involvement in the creation process: Digital preservationists should be involved as early in the creation of digital content as possible. If content is created with long term preservation in mind, it will be less complicated and therefore less expensive to preserve the content over time;
- Open and well-documented standards and systems: Digital preservationists should plan to use open and well documented standards for file formats and within the digital preservation systems and software;
- Documentation divisions: Those working to mitigate risks should take care to make documentation a priority. Digital preservation policies, procedures and processes should be documented;
- Accepted standards for metadata systems: Digital preservationists should use widely accepted standards for technical and descriptive metadata schemas. Technical metadata is necessary to ensure that the files do not suffer from bit or other technological failures. Descriptive metadata is important for making digital objects discoverable;
- Needs of the user: Digital preservationists should be aware of current and anticipated needs of the user for preservation and must ensure that the needs of the user are met;
- Exit strategy: Having an exit strategy from any digital preservation function upfront will reduce risk in the long run; and
- Succession planning: It can be described as a process for identifying and developing internal people with the potential to fill key business leadership positions. There is therefore a need for people who can maintain technology, ingest materials, and create descriptive metadata and so on. Organizational knowledge should be openly shared and documented wherever possible. Therefore, measured planning and the recognition that digital curation and preservation as a risk management activity at all stages of the longevity pathway are critical aspects of the preservation process (Ross & McHugh, 2005).

2.15.4 Cloud computing

Memory institutions are facing numerous challenges as they attempt to preserve and sustain their digital resources including dealing with rapid obsolescence of the technology used and making accessible mass quantities of digital data (Council of Canadian Academies, 2015). These institutions are constantly in search for low-cost, best solutions and a strategy that may enable preservation of their digital resources. Cloud computing, a technology that delivers on demand provisioning of information technology (IT) resources, is also seen as one of suitable preservation strategies to offer a solution to the problem of digital preservation. According to Dale Prince (2011) cloud computing promises better delivery of IT services as well as availability whenever and wherever needed at reduced costs with users paying only as much as they consume through the services of cloud service providers. As pointed out by JISC (2011) cloud-based services are set to transform the way libraries work, unleashing librarians from the admin burden to focus on services for students and researchers. These technologies have made significant progress in libraries and archival communities as many services offered by libraries and archives have migrated to the cloud without much difficulty. Thus, the prospect of using this technology to preserve digital materials has become an option in most academic institutions the world over.

Cloud computing is currently delivered in three main service models known as Software as a Service (SaaS), development platforms known as Platform as a Service (PaaS), and computing resources for storage and processing commonly referred to as Infrastructure as a Service(IaaS) (Yuvaraj, 2015).

- **Cloud Software as a Service (SaaS)**

In Cloud Software as a Service (SaaS), applications are delivered as a service to end-users over the internet and are accessible from various client devices through a thin client interface such as a web browser (i.e. web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings (Yuvaraj, 2015).

- **Cloud Platform as a Service (PaaS)**

In Cloud Platform as a Service (PaaS), application development and deployment platform are delivered as a service and the capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations (Yuvaraj, 2015).

- **Cloud Infrastructure as a Service (IaaS)**

In Cloud Infrastructure as a Service (IaaS), server, storage and network hardware and associated software are delivered as a service and the capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g. host firewalls) (Yuvaraj, 2015).

The following are some of the benefits of cloud computing as noted by Dale Prince (2011):

- Reduced cost: vendors supply storage, software and processing power as there is no need to purchase dedicated storage or servers;
- Scalability: in this instance, a cloud service responds to the fluctuating needs of its clients with respect to storage or server load, distributing the load across the linked servers in its system;
- Pay only for what you need: an organization making use of cloud services pays only for the space it uses and pays for extra space only as its data grows;
- Remote access: cloud computing allows users to access data from any location via any device that can be connected to the internet; and
- Physical storage centre/servers have become obsolete: information centres no longer need to have server rooms or maintain storage systems. The cloud service vendor provides storage and pays for the maintenance of these systems so that the user does not have to or the user pays on a by-use basis.

Cloud computing has a great potential for memory institutions as many libraries and archives are getting their business files into cloud-based document-management

solutions. Clearly, the success of digital preservation in academic libraries is inherently rooted in strategies such as risk management and technological strategies such as migration and cloud computing.

2.16 Preservation systems, software and tools used in academic libraries

The preceding section of the current study discussed the various strategies for digital preservation. However, a range of systems and software tools exist to support the variety of preservation strategies. This section sought to address one of the research questions: What are systems and technologies used to support digital preservation practices in academic libraries? The International Council on Systems Engineering (INCOSE, 1998) defines 'system' as an integrated set of elements to consummate a specific objective. These elements may include hardware, software, firmware, people, information, techniques, facilities, services, and other elements to support the above mentioned components. Digital preservation in practice means provisioning secure storage systems, refreshing aging media, fixity checks, and replication in multiple systems or locations, format migration, emulation and other techniques to keep information safe and accessible over time (Ruusalepp & Dobreva, 2013). Digital preservation can therefore be seen as a specific case of system engineering which is all about integration or federation of multiple systems that must interoperate in order to achieve a common goal (Valerdi, 2009). A digital preservation system requires the integration or interoperability of information entities, processes and technological infrastructure, as summarized by Barateiro, Antunes and Borbinha (2009) as follows:

- Information entities: a future system must be able to interpret the representation of the preserved information entities, so that this information can be rendered as the original creator intended to;
- Processes: the alignment and traceability of processes manipulating digital objects during its entire life-cycle is crucial to be able to make assertions about provenance, integrity and authenticity; and
- Technological infrastructure: the addition of new components into the preservation environment is required to support the growth of dynamic collections (incrementing the storage space) or to reduce the costs of digital preservation, refreshing components by newly created ones with fewer administration and/or maintenance costs.

Considering that a digital preservation system is a sort of information system that must be able to communicate (interoperate) with some unknown system in the future, the ability

to interoperate in the above mentioned dimensions are key factors for digital preservation (Barateiro, Antunes & Borbinha, 2009).

Digital preservation systems should therefore be inteoperable, which refers to the capability of a computer hardware or software system to communicate and work effectively with other systems in the exchange of data, usually a system of a different type, designed and produced by a different vendor (Reitz, 2006). According to Westel (2006), interoperability indicates openness on behalf of the institution or the library which is willing to contribute to national and international schorlaship**.** Interopearbility can be achieved by being OAIS compatible and this means that digital reservation systems must be accepted by standards provided by the OAIS model. OAIS standards create interoperability and connecting distant digital repositories content through search engines capabilities. OAIS enables compliant sites to be interoperable and making digital content to be visible and more accessible (Carpenter, 2008). According to Nabe (2010:30) metadata also plays a role in the systems operability and for digital repositories to achieve interoperability and to exchange digital objects between them, they firstly need to provide metadata to their partners which they can understand.

Nordland (2007) also proposed the digital preservation management architecture as the system and processes for managing the digital material that is submitted for long-term digital preservation. This system is determined by several factors including the diversity of content, format types and media, storage and cost. The digital preservation architecture supports the digital collection from acquisition to storage and finally to dissemination, which includes integrated access to digital and print resources (Nordland, 2007), and in order to do so, persistent and unique identifiers, metadata registry and a hierarchical data storage system or model are necessary for filing, organizing and retrieving digital material. According to Nordland (2007) these components should be interoperable and based upon standards such as ISO 15489 and at the core of the digital preservation architecture is an established repository that is reliable and has sufficient storage. Nordland (2007) also noted that the preservation management architecture must also incorporate a means of ensuring that the records are searchable, thus metadata should at least be properly indexed for use by public search engines such as Google. For example, the National Library of Australia's architecture called Metadata Repository and Search System was created, allowing for increased search ability and retrieval through several interoperable systems.

As discussed in Section 2.8.5 of Chapter Two, the majority of academic institutions in South Africa and the world over have implemented institutional repositories to manage and store a wide variety of their digital resource. These institutional repositories are using different open source software for preservation of their digital resources. Open source software includes the source code for the programme so that it can be changed and shared (in modified and unmodified form) by people in any field for any endeavour (OSI,

2014). Carden (2012) states that if the software is freely available and modifiable, other memory institutions are more likely to use it and subsequently collaborate with the original developers to help improve it. Examples of repository software systems mostly used by digital repositories around the world are: Rossetta, Tessella, DAITSS (Dark Archive in the Sunshine State), Archivematica, DSpace, Eprints, ETD-db, Greenstone, AHERO and MyCore, the Flexible Extensible Digital Object and Repository Architecture (Fedora), Greenstone digital library software and the Berkeley Electronic Press (Bepress).

Even with these examples of available repository software, organizations need to decide how to select an appropriate repository option by considering the capabilities and limitations of each and the extent to which the repository software meets archival requirements and suits the digital content to be preserved. For example, University of Stellenbosch, University of Pretoria, Durban University of Technology and the Council for Scientific Research use open source software called DSpace for preservation of their digital resources while Rhodes University and University of Cape Town use the E-Prints open source software system. The DSpace open-source software provides tools for managing digital assets and as of May 2008 there have been 324 installations of DSpace in 54 countries (DSpace, 2008). However, other software packages, such as Eprints and Fedora also provide alternative software choices for institutional repository (IR) implementations. The IRs can also include special materials such as digital assets generated by and donated to an institution such as art and a wide range of other image collections (Macha & De Jager, 2011).

As noted by Knight (2010) the National Library of New Zealand (NLNZ) has also worked with the ExLibris Group to develop a digital preservation system now available in the market place called Rosetta. According to Knight (2010) the NLNZ has made a very considered decision to enter into this commercial development partnership and recognized that it was important to approach the digital preservation system as enterprise class software. Rosetta is embedded in the business and comprises the key features such as producers, depositor 1, depositor 2, validation stack, IE data model, SIP submission or SIP processing, set management, directory structure transformer, GO API, audit trail, workflow process automation, staff management, user management, permanent repository, delivery and reports (Knight, 2010). Organizations may opt to build their own repository, such as the National Library of the Netherlands, or to subscribe to a digital preservation service provider, such as Bpress or the OCLC Digital Archive.

Repository software may integrate digital preservation systems and tools (or equivalent functionality) or an organization may define for itself a digital preservation workflow that integrates tools at appropriate points in the process. Recent examples of systems and tools used for digital preservation include those that identify and evaluate file formats (e.g., JHOVE, DROID), that normalize files to preservable formats (i.e. XENA), that generate and capture metadata (i.e. the NLNZ metadata extractor), and that produce a

unique identifier and aid in detecting changes to files (e.g., checksums). Colorado State University Libraries (CSUL) operates two digital asset management systems, CONTENTdm by OCLC and DigiTool by ExLibris. CONTENTdm is the legacy system that hosts around 5000 digital objects and provides online access to quite a number of digital collections (Oehlerts & Liu, 2013).

DigiTool was developed and maintained by the libraries in May 2007 as the system for the University's institutional repository and it supports the submission, ingest, management and delivery of digital content, including images, documents, videos and audios of various formats (Oehlerts & Liu, 2013). DigiTool incorporates available open-source standards and utilities such as JHOVE, and records the important checksum information, as noted by Oehlerts and Liu (2013). California State University of Los Angeles (CSUL) has begun exploring collaborative opportunities for digital preservation, such as participation in MetaArchive, LOCKSS, and Dura Cloud systems. However, there are many advantages and disadvantages of systems and open source software, and therefore digital preservationists should evaluate these technologies and determine whether they meet their needs, what resources (human and financial) will be necessary to implement them and what their limitations might be (Corrado & Moulaison, 2014).

JSTOR Harvard object validation environment (JHOVE) is another open source software that provides the function to perform format specific identification validation and characterization of digital objects. JHOVE2 is being developed in a collaborative effort between California Digital Library and PORTICO which tries to address some of the perceived shortcomings of JHOVE by providing answers to four questions about a file:

- What format is the file (identification)?
- What about it (feature extraction)?
- What is the file (validation)?
- So what does this mean (assessment)?

University libraries are also using various archival file formats for long-term preservation of their digital resources. For example, CSUL archival file formats are given the greatest level of preservation support, including assigning persistent identifiers and preservation metadata to support files' access and management over time, providing secure storage and backup, periodic refreshment to new media as necessary, performing regular fixity checks using the proven checksum method, strategic monitoring of format changes and developments using automated services such as listserv and RSS, and migrating to succeeding formats upon format obsolescence (Oehlerts & Liu, 2013). Corrado and Moulaison (2014) pointed out that every record stored in the repository should have its own persistent and unique identifier so that the database application can locate, retrieve and disseminate the requested record. For example, the National Library of Australia and Library Archives use the persistent web address for their records. Persistent and unique

identifiers ensure that every record in the collection is citable in a persistent manner and that the identifier will resolve to the location of the record.

According to Corrado and Moulaison (2014) the preferred text document format for most digital repositories is either PDF or PDF/A and other formats that are commonly accepted for long-term preservation include rich text format (RTF), extensible mark-up language (XML) and hypertext mark-up language (HTML). There is software that helps to identify file formats as identified by Corrado and Moulaison (2014), and these are Digital Record Object Identification (DROID) and Format Identification for Digital Objects (FIDO). Digital record object identification (DROID) is another tool that can be used to identify file formats automatically, and it was developed by National Archives, designed to meet the fundamental requirements of any digital repository to be able to identify the precise format of all stored digital objects and to link that format identification to a central registry of technical information about that format and dependencies. As Li and Banach (2011) pointed out, assuring quality of content and collecting content in formats that can more easily be preserved is another area of consideration. Libraries and digital repositories should t have a preservation and format support policy that is readily available to staff and end users to address this concern as suggested by Oehlerts & Liu (2013).

2.16.1 Digital preservation assessment and certification tools

Another objective for this study is to recommend best practice and standards for digital preservation to management in academic libraries. The study aims to achieve this by investigating assessment and certification tools as well as standards that are used or associated with digital preservation practices in academic libraries. Several assessment toolkits and metadata standards are thus being used as best practices to address the challenges and assess the capacity of digital preservation in academic libraries. Metadata standards and guidelines are commonly sought when planning digitization and digital preservation projects. Becker and Rauber (2011) noted that sustaining digital preservation components over time requires an audit process or an accountability review; as a result, they advocate continuous auditing of the entire preservation process, including preservation planning to guarantee effective long-term preservation.

This section of the current study therefore elaborates on issues regarding assessment and certification toolkits for digital preservation and focuses on digital preservation toolkits such as Trusted Digital Repositories (TDR), Trustworthy Repositories Audit and Certification: Criteria and Checklist (TRAC), Digital Repository Audit Method Based on Risk Assessment (DRAMBORA), European Framework for Audit and Certification of Digital Repositories, Preservation Metadata: Implementation Strategies(PREMIS) and

Dublin Core metadata. These standards and tools are reviewed in this study to determine whether the South African academic libraries have followed these international standards in implementing and maintaining their digital preservation, if not to recommend some guidelines based on these standards and tools. The next section discusses the preservation standards and tools.

2.16.1.1 Trusted Digital Repositories

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

- Compliance with OAIS model, to ensuring that the implementation complies with the model;
- Administrative responsibility, to advise on the adoption of appropriate standards, respond to the demands of evolving standards and requirements, and document decisions and actions as needed in support of organizational objectives;
- Organizational viability to define feasible technical requirements for depositor agreements and advising on and providing text to address the technical aspects of policies, procedures and practices;
- Financial sustainability, to provide sound recommendations on the technical infrastructure to support the program, the cycle of replacement for hardware and software, the appropriate technical solutions for preservation strategies and supporting technologies for archival storage with associate cost information for these aspects;
- Technological and procedural suitability to develop plans that will meet each requirement for the infrastructure or the necessary preservation strategies and to ensure that the plans are executed successfully and fully with complete documentation and in compliance with established policies and standards, including the organization’s responsibility to actively seek and evaluate appropriate preservation solutions and provide the means to implement them;

- System security that requires technical solutions, ongoing upgrades and enhancements and means for auditing processes; and
- Procedural accountability to respond to ongoing managerial needs, to anticipate those needs when possible and to develop mechanisms for automatically generating and capturing the necessary documentation.

These attributes work together to retain the trusted digital repository's status as being OAIS compliant. According to Nordland (2007) long-term digital preservation management requires organizational infrastructure, technological infrastructure and a resources framework in order to build a trusted digital repository.

- The organizational infrastructure is expressed in a comprehensive policy framework;
- The technological infrastructure entails a flexible preservation plan that can incorporate changing technological platforms over time; and
- A resources framework focuses on the staffing, technological, operational and other costs associated with maintaining the organizationl.

Nordland (2007) regarded these elements as the core requirements necessary for the long-term preservation of digital information. However, Rosenthal, Robertson, Lipkis, Reich and Morabito (2005) identified various threats to digital repositories and these include media failure, hardware failure, software failure, communication errors, failure of network services, media and hardware obsolescence, software obsolescence, operator error, natural disasters, external attacks, internal attacks, economic failure and organizational failure. Ngulube (2012) suggested that these factors should be considered and monitored when creating trusted repositories.

To be considered trustworthy, a digital repository must be able to maintain the integrity of its research documentation and material for both the potential stakeholders, for example, its depositors and funding agencies, and its designated user community. As such, a trusted digital repository must be sustainable and identify essential organizational, curatorial and operational responsibilities, address high-level agenda recommendations such as certification, requisite tools, cooperative models, comprehensive archival system design and development, intellectual property rights, preservation strategies and metadata, and be mapped to the OAIS model to ensure OAIS compliance (OCLC & RLG 2002). Ngulube (2012) also mentioned that in order to determine the trustworthiness of a digital repository, the following elements need to be considered:

- Its means of governance, which should be "explicit, tangible, and based on a long-term commitment to comply with prevailing standards, policies, and practices;
- The organizational structure required to support the various functions;

- The creation of staffing policies to ensure trained staff capable of sustaining the digital repository;
- The development of policies and procedures: current written policies should be reviewed at regular intervals;
- Its financial fitness and sustainability: business planning processes should be in place to sustain the repository over time;
- Data security issues: security needs should be assessed and implemented; and
- The necessary technological infrastructure: adequate hardware and software should be provided and these systems must conform to ISO 17799.

The Alliance for Permanent Access to the Records of Science in Europe Network (APARSEN) also produced a brochure on trust to help answer this question, “What does it mean to be trustworthy in terms of digital preservation?” APARSEN also identified the following key questions related to the trust that need to be addressed as mentioned by Corrado and Moulaison (2014):

- Has the data been preserved properly?
- Is it of high quality?
- Has it been changed in some way?
- Does the pointer get me to the right object?

Corrado and Moulaison (2014) emphasized that it is worthwhile to reflect on these four questions in turn when thinking about the importance of demonstrating the trustworthiness of a digital repository.

2.16.1.2 Trustworthy Repositories Audit and Certification: Criteria and Checklist (TRAC)

In 2003, RLG and the US’s (NARA) Task Force on digital repository took on the challenge of creating one of the first sets of criteria and checklists for long-term digital preservation. The criteria and checklist document created by this Task Force is known as the Trustworthy Repository Audit and Certification: Criteria and Checklist (TRAC), which is the basis of the current international standard, ISO 16363 (TRAC 2003), and it allows digital repositories to assess their capability to reliably store, migrate, and provide access to digital content. TRAC provides tools for the audit, assessment, and potential certification of digital repositories, establishes the documentation requirements required for an audit, delineates a process for certification, and establishes appropriate methodologies for determining the soundness and sustainability of digital repositories

(TRAC 2003). It is a revised version of the RLG/NARA document, Audit Checklist for Certifying Digital Repositories, and the compilers of these criteria and checklist encouraged repositories to use the checklist as an audit tool for objective evaluation.

The TRAC checklist is based on two frameworks: the OAIS model and the RLG/OCLC Trusted Digital Repositories: Attributes and Responsibilities document, of which the latter focused on high level, non-prescriptive organizational and technical attributes as well as the matter of digital repository certification. It is based upon existing standards and best practices for trustworthy digital repositories and incorporates a set of 84 audit and certification criteria arranged in three sections: Organizational Infrastructure; Digital Object Management and Technologies, Technical Infrastructure, and Security (OCLC & CRL 2007). The digital object management section includes the sub-sections ingest: acquisition of content and ingest: creation of the AIP, containing criteria related to the ingest function along with explanations, examples of supporting evidence and discussion points.

In 2007, Trustworthy Repositories Audit and Certification: Criteria and Checklist (TRAC) report was published and dealt with the organisational and technical infrastructure for trustworthy repositories and covers capabilities of certification for repositories (TRAC 2007). It defines criteria in several aspects that are of specific interest for preservation planning, which, among others, include:

- Procedures, policies and their evolvement;
- Review and assessment;
- Documented history of changes;
- Transparency and accountability; and
- Monitoring and notification.

Organizations may use the resulting checklist of audit and certification criteria and supporting evidence to prove the effectiveness of their digital repositories and to support the development of preservation improvement plans.

2.16.1.3 Digital Repository Audit Method Based on Risk Assessment (DRAMBORA)

Digital Repository Audit Method Based on Risk Assessment (DRAMBORA) was another assessment toolkit introduced by the Digital Curation Centre (DCC) and Digital Preservation Europe (DPE) in 2007. DRAMBORA offers a methodology and a toolkit for

digital repository self-assessment by identifying assets, activities and potential impact of risks on the repository. It is designed to facilitate an internal audit that assists organizations in identifying their capabilities, strengths and weaknesses of their digital repositories. Ball (2010) added that the auditing tool is required to describe and document the repository's role, objectives, policies, activities and assets in order to identify and assess the risks associated with these activities and assets and define appropriate measures to manage them. This toolkit can thus be used as a means of guiding repository administrators and other staff to identify the risks that are associated with the organization's business continuity and to anticipate, avoid, mitigate and maintain appropriate evidential documentation (DCC & DPE, 2007).

2.16.1.4 European Framework for Audit and Certification of Digital Repositories

Again in 2010 the chairs of the Consultative Committee for Space Data Systems (CCSDS), Repository Audit and Certification working group (RAC), the Data Seal for Approval (DSA) board and the DIN trusted archives certification working group signed a memorandum of understanding, stating that they would work together to create standards for trusted digital repository certification. This effort is known as the European Framework for Audit and Certification of Digital Repositories, and it is intended to help organizations in obtaining appropriate certification as a trusted digital repository and establishes three increasingly demanding levels of assessment. As also observed by Corrado and Moulaison (2014:10) digital preservation is a relatively new field and much of technology is still evolving and, therefore, one needs to look no further than the international guidelines for trusted institutional repositories to see most of what is required to becoming certified or receiving a Seal of Approval.

The framework designates three levels to represent increasing degrees of trustworthiness and these levels are: basic certification, extended certification and formal certification.

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

However, the concept behind the different levels is that some repositories may not be able or may not desire to perform a full external audit and certification of their digital preservation system due to the time, expenses or other considerations (Corrado &

Moulaison, 2014). The subsequent section elaborates on the preservation metadata standards for digital preservation.

2.16.2 Digital preservation metadata standards

Corrado and Moulaison (2014:25) pointed out that no matter how well a digital file is protected, it cannot be found and retrieved if is not well preserved. For this reason, it is important to have descriptive metadata that provide attributes of the content being preserved, including information such as author, title and subject. Each library or consortium preparing to digitize typically must develop rules and standards specifically for the processes they intend to use. California State University (CSU, 2004) provides a good example of specific, measurable standards in their principles of acceptable digitization practices for a digital resource provider:

> If the e-resource has a print equivalent, the online version should contain the same content as the print version, including any book reviews, editorials, graphs, charts, and illustrations. The illustrations should retain original colors and have a minimum resolution of 600 dpi so that they can be accurately displayed and printed. The online version should be made available concurrently with the print format. CSU also recommends and requires that information providers provide metadata that includes USMARC records, OCLC numbers, and URLs.

Literature revealed metadata as the best way of minimizing the risk of digital resources becoming inaccessible and it needs to be consistently maintained throughout the process (NISO, 2004). According to Day (2005) metadata aids in the long-term management of digital material and needs to be embedded in the planning processes. However, the methods to minimize the loss of digital data often ignore the use of metadata structures embedded in digital objects from the outset which are recommended as a starting point towards good preservation principles, as observed by Groenewald and Breytenbach (2011).

NISO (2004) describes metadata as the key resource in order to facilitate resource discovery, to organize electronic resources, to facilitate interoperability and legacy resource integration, to provide digital identification and support archiving and preservation of digital objects. Preservation metadata has been defined as the information a repository uses to support the digital preservation processes that are necessary to ensure that a digital object remains viable, able, understandable, authentic, and identifiable (PREMIS, 2005). Bantin (2002:4) further describes a metadata is a set of data elements used to describe, represent, and manage information objects over time.

National Information Standards Organization (NISO) (2004) also defines metadata as structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use or manage an information resource. Preservation metadata also contains archival information which is needed for the long-term preservation of the object and the migration to other digital formats as software and hardware changes continuously (Groenewald & Breytenbach, 2011).

Various international organizations and agencies like the National Library of Australia (NLA), CEDARS Project and a joint working group of OCLC (Online Computer Library Center) and RLG (Research Libraries Group) have worked on defining metadata schemas for digital preservation. Many of these initiatives are based on or are incompatible with the standard reference model for an Open Archival Information System (OAIS) (ISO 14721, 2003). As noted by Lee et al. (2002) these high-level preservation metadata initiatives provide much needed information required to manage the long-term preservation of digital resources. For the current study, the issue of preservation metadata is critical in understanding the extent to which information systems in academic libraries captured digital resources to provide evidence. The next section outlines types of metadata standards guided this study.

2.16.2.1 Dublin Core metadata

Dublin Core and Preservation Metadata: Implementation Strategies (PREMIS) are some of the common metadata standards used to ensure preservation of digital information and accessibility for future generations. Dublin Core is an initiative to create a digital library card catalogue for the Web and it is made up of 15 metadata (data that describes data) elements that offer expanded cataloguing information and improved document indexing for search engine programmes (DCMI, 2009). The 15 metadata elements include: title (the name given the resource), creator (the person or organization responsible for the content), subject (the topic covered), description (a textual outline of the content), publisher (those responsible for making the resource available), contributor (those who added to the content), date (when the resource was made available), type (a category for the content), format (how the resource is presented), identifier (numerical identifier for the content such as a URL), source (where the content originally derived from), language (in what language the content is written), relation (how the content relates to other resources, for instance, if it is a chapter in a book), coverage (where the resource is physically located), and rights (a link to a copyright notice) (DCMI, 2009).

The Dublin Core standard includes two levels, namely: Simple Dublin Core and Qualified Dublin Core. Simple Dublin Core comprises fifteen elements and expresses elements as

attribute-value pairs using just the 15 metadata elements from the Dublin Core Metadata Element Set. Qualified Dublin Core includes three additional elements (Audience, Provenance and Rights Holder), as well as a group of element refinements (also called qualifiers) that refine the semantics of the elements in ways that may be useful in resource discovery (DCMI, 2009). It increases the specificity of metadata by adding information about encoding schemes, enumerated lists of values, or other processing clues.

2.16.2.2 Preservation Metadata: Implementation Strategies (PREMIS)

Digital information requires detailed metadata perhaps more than any other media to ensure its preservation and accessibility for future generations. OCLC and RLG jointly developed a metadata framework called Preservation Metadata: Implementation Strategies (PREMIS), which is outlining types of presentation metadata and developing a set of core elements and strategies for the encoding, storage, and management of preservation metadata within a digital preservation system (OCLC/RLG 2001). As noted by Alemneh, Hastings and Hartman (2002) PREMIS plays a significant role in facilitating preservation decisions, detects preservation threats and provides measures for minimizing risks to long-term access to digital information. This type of metadata is one of the vital building blocks essential in order to establish and document the authenticity, integrity and trustworthiness of digital objects as they pass through successive technology evolutions during their lifecycle (PREMIS, 2005). The PREMIS data model describes five elements associated with digital preservation processes: intellectual entity, objects, rights, agents and events. The research conducted by other cultural heritage institutions such as the National Libraries of Australia, New Zealand, Great Britain and the Netherlands greatly inform the development of the PREMIS model, and currently, the PREMIS data dictionary influences the world to be an international de facto standard for preservation metadata (Caplan, 2006).

The principles and best practices identified in the TDR, TRAC and the aforementioned auditing tools and metadata standards could form the basis for a benchmark standard to which academic institutions in South Africa could be assessed. Therefore, this may be a suitable guide for digital repositories in these institutions and can assist in identifying their capabilities, strengths and weaknesses of their digital repositories. Self-assessment tools like DRAMBORA could also be used by academic libraries to identify and assess risks associated with digital preservation activities.

2.17 Factors influencing digital preservation sustainability in academic libraries

Ensuring sustainable preservation of digital resources can be challenging and it is therefore appropriate to review and discuss various factors influencing digital preservation in academic libraries. The main objective of the current study was to develop a framework to ensure sustainable digital preservation in academic libraries in South Africa. This study thus considers that the understanding of the factors or elements influencing digital preservation sustainability can lead to the establishment of a preservation framework applicable to academic libraries in South Africa. This was done by reviewing literature on previous studies reporting on digital preservation challenges, strategies and best practices. This methodology was used to apply and increase knowledge in a particular area of research, thereby showing proficiency in reviewing, synthesizing and critically analysing the relevant research literature (University of Washington, 2011).

Further understanding of the factors contributing to digital preservation sustainability was also premised on preservation theories and models discussed in Section 2.6. An understanding of success factors may also assist academic libraries to develop multiple-option, multiple-path strategies to achieve future goals and to progress in effective digital preservation. According to Nabe (2009), the following items should be kept in mind before proceeding for digital preservation.

- Necessary resources to preserve the information;
- Necessary manpower, institutional commitment and involvement of every staff member in the library;
- Technical staff for maintenance of server, programming, to create metadata, standards and implement the project;
- Budget provision by the parent organization;
- Recommended platform;
- Selection of software (open source or commercial);
- Copyright issues and proper guidelines; and
- Selection of file formats.

Literature review reveals various essential factors which contribute to the sustainability of digital preservation (Alemna, 1999; Granger, 1999; Council of Canadian Academies, 2015; Corrado & Moulsaion, 2014; Buchanan et al., 2012) including, human resources and education; effective implementation of policies and strategies; proper allocation of resources; collaboration and partnerships, understanding intellectual property issues and outreach and sustainability.

2.17.1 Human resources and education

According to Raju (2014:1) dramatic changes, largely the result of rapidly evolving digital technologies, have impacted significantly on the knowledge and skills requirements for information professionals practicing on e-environment. This transformation from traditional library to digital library requires a new generation of information professionals to be equipped with knowledge and skills to effectively and efficiently operate in this e-environment. Raju (2014) also suggested that new knowledge and skills are required to mediate. Corrado and Moulaison (2014:55) concur that working with digital preservation requires actively learning new skills, researching and understanding trends and being part of an open community that supports long-term access for consumers. Information professionals in the e-environment must have knowledge of technologies used to present, analyse, and create digital information. However, literature has revealed that many librarians are not comfortable with the digital world they find themselves in (Raju, 2014:2). Many librarians and archivists are technophobic and they struggle with how to be stewards of both print and digital information.

Academic library management needs to actively encourage and value continuous learning and to invest heavily in staff development across all areas of the organization in order to support changes and developments in the tertiary environment (Lewis, 2007). This continuous learning requires innovative and creative thinking, along with the capacity to plan and operate in novel situations (Neal, 2006). An increasing number of technologists are therefore required to develop, customize and maintain sophisticated library technologies and infrastructure. It will also be necessary to provide metadata and digitization training to people working on the project before digitization and descriptive metadata creation can begin (Corrado & Moulsaion, 2014:20).

2.17.2 Implementation of relevant policies and strategies

A clearly documented and realistic preservation policy is an essential foundation for any sustainable digital preservation programme. Preservation policy will chart the path and outline the roadmap to achieving any long-term access and future benefits of digital preservation.However, literature reveals that most of academic libraries do not have policies that guide the digital preservation practices. Policies and procedures should thus be implemented to guide the digital preservation process in academic libraries. Such policies should also guide the use of digital technologies and preservation systems in these institutions and should include:

- Digitization policy;
- Preservation policy;
- Content development and management policy;
- Institutional repository policy;
- Disaster recovery plan policy;
- Security policy;
- Storage policy;
- Copyrights and intellectual rights policy;
- Open access to digital information policy; and
- Metadata policy.

The study also used the preservation policy model by Beagrie (2008) as a practical guide for developing an institutional digital preservation policy. The preservation policy is divided into two phases: a policy level and an implementation level. The policy level highlights some of the key points of consideration needed at the beginning of a digital preservation policy, while the implementation level indicates the resources and the infrastructure that ought to be in place to get the policies executed. Table 2.6 shows a summary of the preservation policy model by Beagrie (2008).

Table 2.6: **Digital preservation policy model**

Policy level	
Clause	**Description**
Principle statement	Highlights the role of digital content and collections to be preserved
Contextual links	Links to other internal strategies web or e-learning, storage standards.
Preservation objectives	States that the policy will deliver a reliable and authentic version to its user community.
Identify contents	Lists materials in urgent need for preservation.
Procedural accountability	Identify high level responsibilities for the policy and terms of reference for the policy should be made clear
Guidance and implementation	Outline the implementation plan and the technical steps to be taken for preservation purposes.
Version control .	The policy should be dated, the author identified and the version tracked

Implementation level	
Clause	**Description**
Financial and staff responsibility	This covers staff training, technical infrastructure, storage media and costing projection.
Intellectual property	Legal context, access, copyright issues and deposit agreements should be considered.
Distributed services	Institutions should use third parties or partnering with collaborative institutions (eg. Digital Preservation Network(DPN), InterPares, Deutche Initiative for Networked Information etc.
Standards compliance	Compliance with OAIS model or Trusted Digital Repositories: Attributes and Responsibilities,(RLG-OCLC,2002), ISO 16363:Audit and certification of trustworthy digital repositories(TDR).
Review and certification	Policy should be reviewed more often and be aligned with European Framework for Audit and Certification and Digital Repository Audit Method Based on Risk Assessment (DRAMBORA) (DCC & DPE,2007), which follows a self-audit process for certifying a repository. Data Seal of Approval(DSA,2013) and DIN 31644:criteria for trustworthy digital archives may also be necessary.
Auditing and risk assessment	Audit trails should be performed. Risk assessment for file formats and protection of data should also be stated.
Stakeholders	Departments, sections and identifiable parties involved in the policy should be indicated.
Preservation strategies	This includes metadata, trustworthy repositories, migration, risk management and cloud computing.

Source (Beagrie, 2008)

The researcher is of the view that the adoption of the Beagrie (2008) preservation policy model within academic libraries in South Africa will provide guidance in the implementation of sustainable digital preservation. It is clear that any long-term access to digital records rests heavily on preservation strategies underpinned by digital preservation policies.

2.17.3 Proper allocation of resources

One of the most important components of institutional commitment to any project is financial support. According to Corrado and Moulaison (2014), there needs to be institutional commitment for digital preservation to be successful and this includes ensuring that enough financial resources are available to sustain the initiative. Ensuring sustainable preservation of digital resources thus requires substantial and ongoing financial commitments over time. Lavoie (2003) mentions that although there has been much discussion about the problem of ensuring access to files over time, there has been relatively little discussion of how we can ensure that digital preservation activities survive beyond the current availability of soft money funding. The questions such as who will pay for preservation costs need to be addressed before the implementation process commences. The funding for preservation applications could come from the government, NGOs, the private sector or the users in South Africa. Thus, factors that should be addressed include cost effectiveness of the preservation solutions as well as sustainability issues. Digital preservation activities may include several different ongoing costs:

- Technical infrastructure (storage media, equipment purchases, ongoing maintenance, technological obsolescence monitoring and network connectivity);
- Staffing (hiring, general and specialized training);
- Financial planning (securing ongoing budget commitments, seeking project grants); and
- Outsourcing (preservation methods undertaken by outside vendors).

Many institutions also do not have procedures in place that allow them to document how much they spend on digital preservation and this may be due to the technology and the potentially unlimited length of time digital preservation services will be needed.

As suggested by Corrado and Moulaison (2014), the following financial factors should also be considered:

- Capital expenditure;
- Evaluation of Return on Investment(ROI) for issues such as costs and cost saving results; and
- Operational expenditure for training.

2.17.4 Legal issues

The lack of a single international copyright protocol and the variations in copyright laws from country to country present a big challenge for online distribution (Council of Canadian Academies, 2015:50). Copyright issues should also be investigated to make sure proper intellectual property rights have been granted that are legally required to perform the actions necessary for long-term preservation (Corrado & Moulaison, 2014:35). The copyright issue relates to acquiring permission to use copyright-protected content. Memory institutions must identify all content that is part of the project as there may be content in the public domain or protected content and may undertake a search to identify copyright holders, locate the holders and obtain required permission from them (Council of Canadian Academies, 2015:51). Memory institutions may be reluctant to preserve these collective works because identifying the copyright owners, locating them, obtaining licence agreements and keeping records of each agreement will undoubtedly be a resource-intensive process (Muir, 2004). However, the Canadian Copyright Act established a fair dealing, a provision that is available to all users of content and allows one to reproduce copyright material without permission for specific purposes such as research, private study, education, review and news reporting (Council of Canadian Academies, 2015:54).

2.17.5 Outreach and sustainability

Outreach for digital preservation can be defined as a set of organized activities of digital programmes and their value (Corrado & Moulaison, 2015). Digital preservationists should be able to communicate in multiple ways in which digital preservation brings value to the organization. Digital preservation implies a serious financial commitment and adequate resources and funding is necessary to ensure the digital preservation's sustainability.

2.17.6 Collaboration and partnerships

Literature reveals that memory institutions are working to establish partnerships and collaboration in addressing the challenges posed by the digital environment (Council of Canadian Academies, 2015:58). According to Corrado and Moulaison (2014), Libraries, Archives and Museums (LAM) institutions use collaboration strategies to assemble groups with necessary expertise to advance digital preservation work and take advantage

of resources in the larger library and digital preservation community. The Council of Canadian Academies (2015:58) also identified the external opportunities for realizing the digital age as participatory opportunities and collaborative opportunities. Additionally, the Council of Canadian Academies (2015:58) identified two types of factors; those at the national level, which include policies and infrastructure, and those at the institutional level, such as effective management of partnerships and new business mode considerations.

However, Africa faces many challenges which are often unknown to their partners in the developed countries when it comes to collaborative digital preservation projects and these include intermittent and unreliable power supply, lack of access to high-end equipment, complicated customs processes and limited control over the environment (Ryan, 2010:29). Figure 2. 13 shows a basic framework profiling two opportunities, namely: participatory and collaborative opportunities as well as the supporting factors for adapting to the digital age by the Council of Canadian Academies (2015:58).

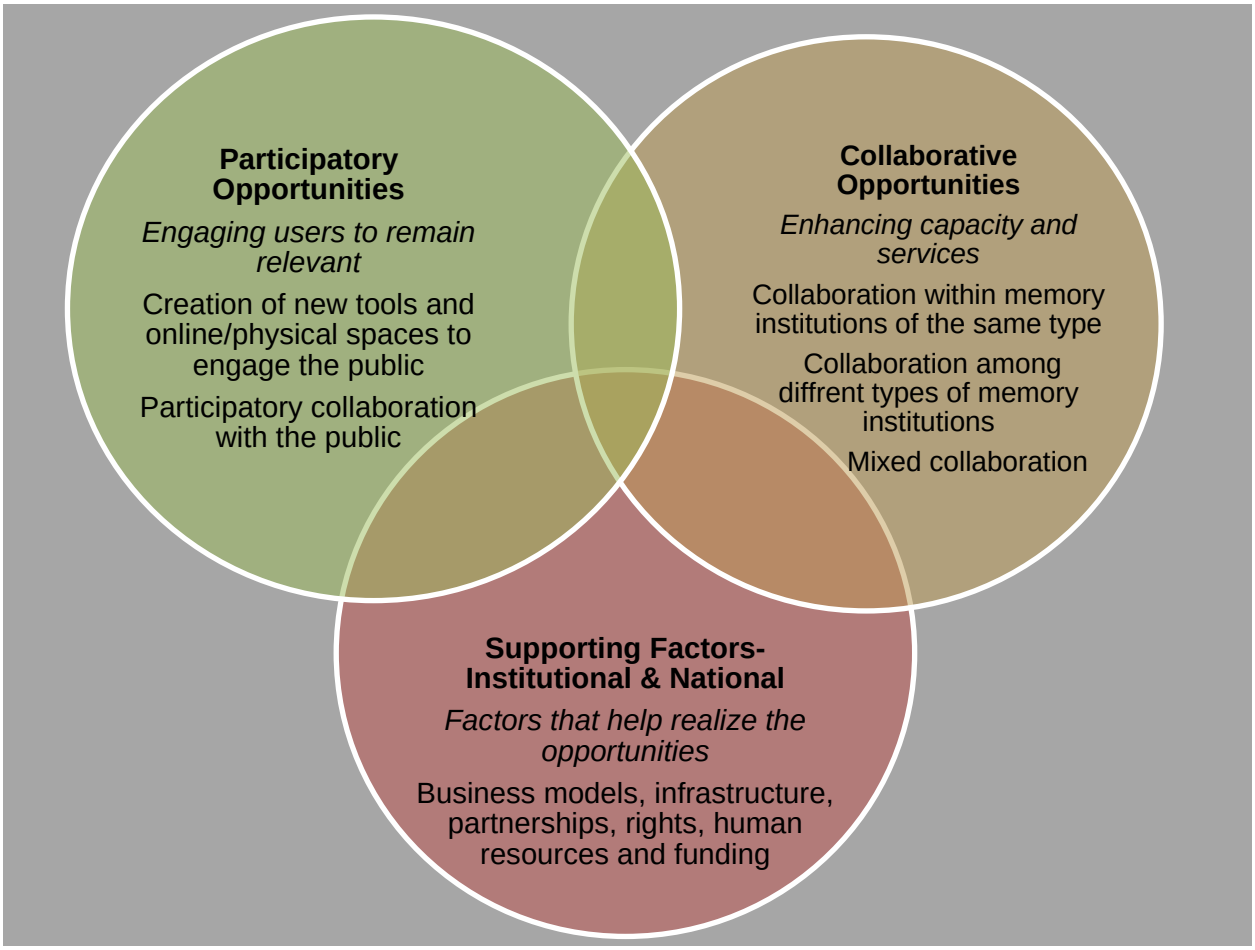

Figure 2. 13: A framework for realizing opportunities for adapting to the digital age (Council of Canadian Academies, 2015:58)

- **Participatory opportunities**

Memory institutions are working to establish meaningful relationships with a diverse set of communities so that people are aware and trusting of opportunities awaiting them. These institutions are seeking new ways to retain their relevance by encouraging a participatory culture; contributions from the public range from simple tagging activities to sharing of historical knowledge to design of software by expert volunteers (Council of Canadian Academies, 2015:61). Therefore, by reaching out to the public, memory institutions are not only maintaining relevance and satisfying the expectations of their visitors, but they are also forging connections and taking advantage of volunteers who can help them adapt to the digital age.

Memory institutions are also creating more visitor-centric services as an approach for engaging users and volunteers by inviting them to participate in online activities that enrich collections. For example, the Library of Congress began a pilot project to enable the public to enhance contextual information for photos in the Library's collection and most of the information is provided by regular contributors who have been described as history detectives (Council of Canadian Academies, 2015:62). As also observed by the Council of Canadian Academies (2015:62), other volunteers use their personal histories such as memories of the lives of their relatives and may even be able to link the information they provide to sources such as newspapers or other websites. The most committed volunteers may help to engineer software programmes that enable memory institutions to offer unique services to their users.

- **Collaborative opportunities**

According to the Council of Canadian Academies (2015:82) collaboration with private companies and academia may allow memory institutions to become involved in exciting activities that enhance their visibility and to undertake large projects that they could not otherwise resource on their own. Collaboration can make core services more convenient for users, reduce the workload for individual institutions, increase standardization of policies and digital platforms and facilitate further collaboration. Collaborative initiatives provide an opportunity for smaller memory institutions to increase their exposure and are essential for developing and maintaining relationships between memory institutions and various communities. For example, in Canada, aboriginal communities are collaborating with museums to create culturally sensitive content management systems to support access to their cultural heritage and facilitate self-representation (Council of Canadian

Academies, 2015:84). Collaboration also enables memory institutions to work at higher capacities while incurring fewer costs which helps to facilitate networking and outreach.

- **National and institutional supporting factors**

Corrado and Moulaison (2014) pointed out that in order to sustain digital preservation initiatives it is important to align these initiatives with the organization's goals and mission. Digital preservationists need to be able to convince management and other decision makers that digital preservation is important to the overall mission of the organization and not just an experimental technology project (Corrado & Moulaison, 2014). Digital preservation goals should therefore be based on an institution's business needs and aligned with organizational mission and priorities. One of the keys to getting sufficient management buy-in for sustainable digital preservation is to have a communication plan that clearly describes the benefits of digital preservation to management and other stakeholders of the organization.

Further, the Council of Canadian Academies (2015:114) provides the organizational factors as being relevant to supporting the realization of digital opportunities and these include the prioritization of digital opportunities by senior management, developing new business models for these opportunities, the promotion of standardized and generic information and communications technologies' (ICTs) infrastructure, managing partnerships, managing outsourcing, managing the cloud, managing the various copyrights, developing human resources and funding. As stated by the Council of Canadian Academies (2015:114), these factors, in combination, can support change and help realize digital opportunities. The above framework as well as other elements mentioned above are thus to be considered as enabling factors of digital preservation in academic libraries in South Africa.

2.18 Synthesis and evaluation of theory

As it applies to digital preservation, theory is still developing. However, it is still important to synthesize and evaluate the existing digital preservation theory to understand it further, as well as to create inroads into the development of that which is relevant to academic institutions in South Africa. There are characteristics to look out for in evaluating theory and these include an outline of the theory, who its proponents are, where and how it can be applied, whether or not it promises prediction, how global it is, whether or not the concepts used in it are understood with ease in the context of the discipline, how easy it

is to apply, and its applicability to one's research. The essence of Chapter Two was therefore to present the theoretical backbone of the research. This chapter laid out the foundations of the inquiry by carefully reviewing existing literature and previous studies to inform the conceptualization of the study. This study was about investigating success factors to digital preservation with a view to developing a framework applicable to academic libraries in South Africa. Accordingly, Chapter Two examined literature, theories and models to establish factors contributing to a digital preservation framework. The theories and models gave an insight into what work has been happening in archival science and they are important to the success of digital preservation in the context of academic libraries. Therefore, some of the components or elements from various theories and models were used to guide the research and, as a result, the study adopted a conceptual framework. Figure 2.14 illustrates initial factors from theoretical models and the literature review (Davies, 2000; Kenney & McGovern, 2003; Corrado & Moulaison, 2014; Carnegie Mellon University, 1990).

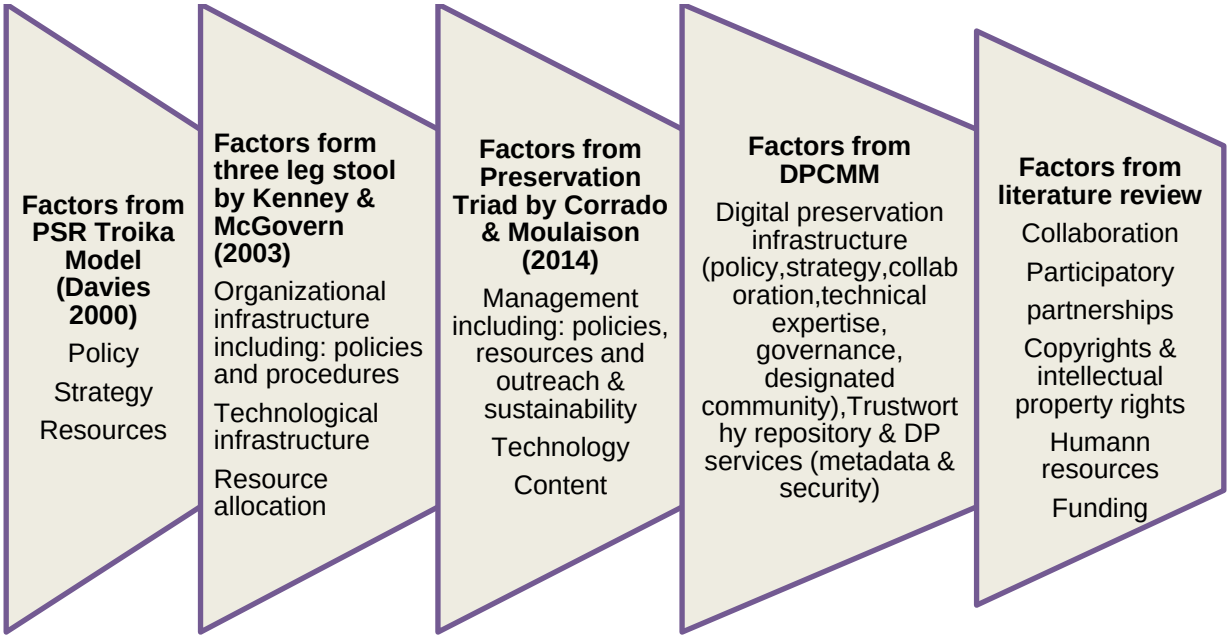

Figure 2. 14: Factors from literature review and theoretical models

Based on factors from theoretical models and the literature review in Figure 2.14, it is clear that the elements of digital preservation by various authors represent the same views on the composition of digital preservation components. These authors: Davies (2000), Kenney and McGovern (2003), Corrado and Moulaison (2014), Council of

Canadian Academies (2015:58) and Carnegie Mellon University (1990) seems to all agree that the success of digital preservation is determined by preservation policies, adequate resources and trustworthy technology. In view of this, and also of the fact that in South Africa preservation systems are still prevailing, all these models perhaps remain more relevant to this study as they outline various essential factors that contribute to the sustainability of digital preservation, including policies, procedures, strategies, collaboration, participatory partnerships, human resources and education, financial resources, technology infrastructure, outreach and sustainability, content management, copyrights and intellectual property rights. Copyright Act 98 of 1978 of South Africa provide the limitations and general exceptions regarding protection of copyright work for libraries, archives, museums and galleries with regard to preservation of digital content and making that information available when is needed. Below are some of the points outlined in the Copyright Amendment Bill (Copyright Amendment Bill, 2017) regarding protection of copyright work for libraries, archives, museums and galleries. A library, archive, museum and gallery:

- May make a copy of any work in its collection for the purposes of back up and preservation;
- May make copies of publicly accessible websites for the purposes of preservation;and
- May without the consent of the author engage in format-shifting or conversion of works from ageing or obsolete technologies to new technologies in order to preserve the works for perpetuity and to make the resulting copies accessible.

The next section presents a preliminary conceptual model of digital preservation success developed based on theories, models and literature review.

2.19 A preliminary conceptual model of factors influencing digital preservation

Based on evaluation of the theories and models presented in Section 2.15 above, a model of factors was developed to assist in the implementation of a digital preservation framework applicable to academic libraries in South Africa. This was developed after investigating the preservation needs and requirements that are vital to effective digital preservation as well as analysing the elements or success factors to sustainable digital preservation. This model draws its themes from Davies' (2000) PSR troika model, Kenney and McGovern's (2003) three leg stool, Corrado and Moulaison's (2014) preservation

triad model and Carnegie Mellon University's (1990) DPCM model as well as success factors identified from the literature review. The aim is to answer the fourth research question which was presented in Chapter One: What is digital preservation framework that should be proposed for South African academic libraries? The factors from the models, theories and literature review are therefore used in this section to develop a preliminary conceptual model to guide the understanding of the factors contributing to the digital preservation framework for academic libraries in South Africa. Figure 2.15 shows a proposed preliminary conceptual model, as summarized into three major areas, namely: management-related factors, resource-related factors and technology-related factors.

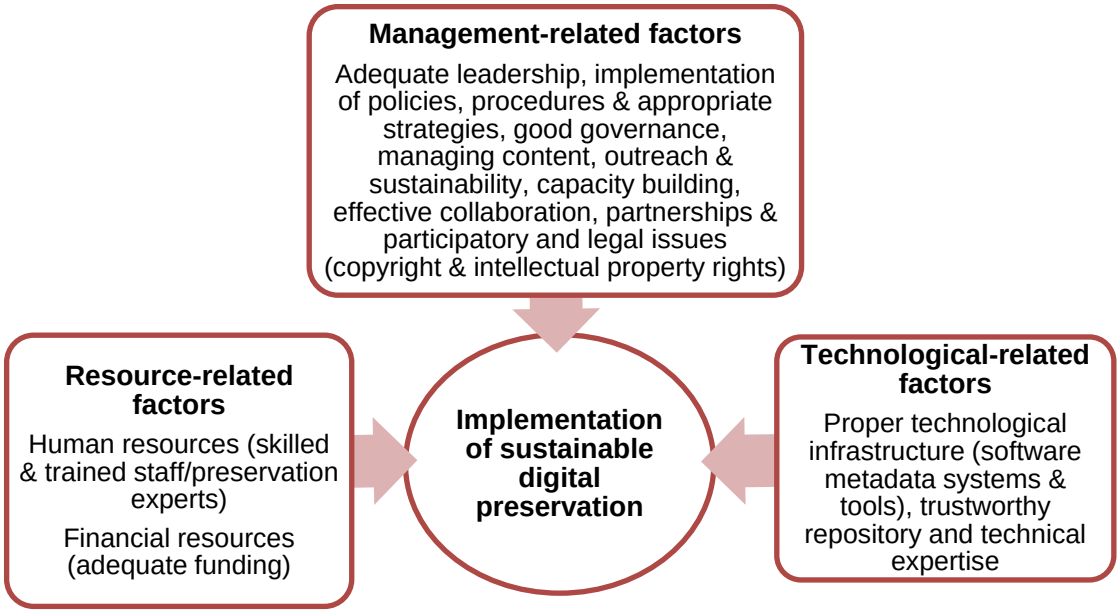

Figure 2.15: A preliminary conceptual model

The proposed preliminary conceptual model above was based on the elements or factors of digital preservation as identified in the PSR troika model by Davies (2000), three leg stool by Kenney and McGovern (2003), preservation triad by Corrado and Moulaison (2014) and DPCM model by Carnegie Mellon University (1990) as well as the factors from literature review. All the factors identified from these models and literature review therefore constitute a proposed priliminary conceptual model for preservation of digital resources in academic libraries. As has been stated in Chapter One of this study, one of the key objectives is to establish the factors that influence digital preservation sustainability by mapping them with international preservation standards such as the OAIS model and TDR.The current study found it appropriate to use the OAIS model as it highlights the various roles and functions of the active participants of the designated

community. A major purpose of this reference model is to facilitate a broader understanding of the preservation requirements and access to digital information for a long-term which concurs with the study. OAIS model establish a minimum level of funcitionality for archival repositories. Despite the proliferation of digital information in academic libraries, technological obsolescence has posed many challenges that hinders long-term preservation of their digital information.The OAIS model can, therefore, facilitate the implementation of effective digital preservation in academic libraries because it has the capacity to reliably store information, migrate it and provide access to digital information.

The missing requirements that were not included under a proposed priliminary model were therefore sought from survey questionnaire responses from library directors and managers, librarians, archivists, digitization and digital preservation administrators, experts and practitioners in academic institutions, as well as information obtained from document analysis. This contribution was used to inform and improve a proposed framework for preservation of digital resources applicable to academic libraries in South Africa. A digital preservation framework is presented and discussed in Chapter Six, based on the findings from the literature review and the theoretical models as well as the survey and document analysis findings that are provided in Chapter Four (presentation of results) of this study.

2.20 Chapter summary

This chapter reviewed literature pertaining to various aspects of digital preservation and discussed the purpose of a literature review, the changing academic library environment, the significance of digital preservation and theoretical models. Emphasis was placed on the following areas, which were part of this study's objectives: digital preservation practices, digital preservation initiatives, strategies and guidelines, factors influencing digital preservation sustainability, digital preservation systems and technologies, digital preservation standards and tools, and other empirical studies done in selected parts of the world including African organizations. The review showed that academic institutions in South Africa need proper plans and strategies to enable the effective preservation of their digital resources.

Digital preservation would also be possible if the factors such as policies, resources and strategies are put in place in academic libraries in South Africa. This study was supported by the four models, namely: PSR troika model by Davies (2000), three leg stool by Kenney and McGovern (2003), preservation triad by Corrado and Moulaison (2014) and DPCM model by the Carnegie Mellon University (1990) which outlined the elements contributing

to the successful preservation of digital resources in academic libraries. The literature reviews also helped in finding out the procedures, tools and standards used by international organizations for effective preservation of digital resources in various organizations and institutions.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Chapter Three focuses on the research methodology that was used to answer the research questions and objectives. As discussed in Chapter One, the main objective of the research study was to provide a framework for preservation of digital resources in academic libraries in South Africa. The aim is to promote and improve accessibility and preservation of digital resources in the context of academic libraries in South Africa. In order to guide the research process, this chapter discusses the research paradigm, research method, research design, study population, the data collection methods, data analysis, validity and reliability of the instruments and the type of triangulation method used as well as the form of ethics that were applied in this study.

3.2 Research methodology and design process

Hickson (2008:3) defines a research as the systematic investigation of a specific question in order to establish new facts and draw a new conclusion, and that it involves the interpretation and revision of current knowledge and the discovery of new knowledge. Trochim (2006) noted that when conducting a research it is important to first indicate that the study followed a scientific approach as it aims to build knowledge obtained by use of a particular methodology to prove certain variables beyond reasonable doubt. Bless and Higson-Smith (1995) defines a scientific research as a systematic investigation of a question, a phenomenon, or a problem using principles. A scientific research always involves a method that can be understood in the research process as a single complete sub-process, which includes choosing and following a particular research strategy, data collection method and data analysis method (Trochim, 2006).

The appropriate research methods are therefore required to conceptualize research problems and describe the phenomena that are being investigated (Ngulube, 2015), and it is therefore important to provide a roadmap showing the research methods followed in the research. Research method mapping is designed to be an introduction to researchers to the processes of research and the significance of research ethics (Trochim, 2006), and it focuses on showing how key features of a research project are linked to one another

within the philosophy of science. Figure 3.1 shows the research methodology roadmap as proposed by Ngulube (2015).

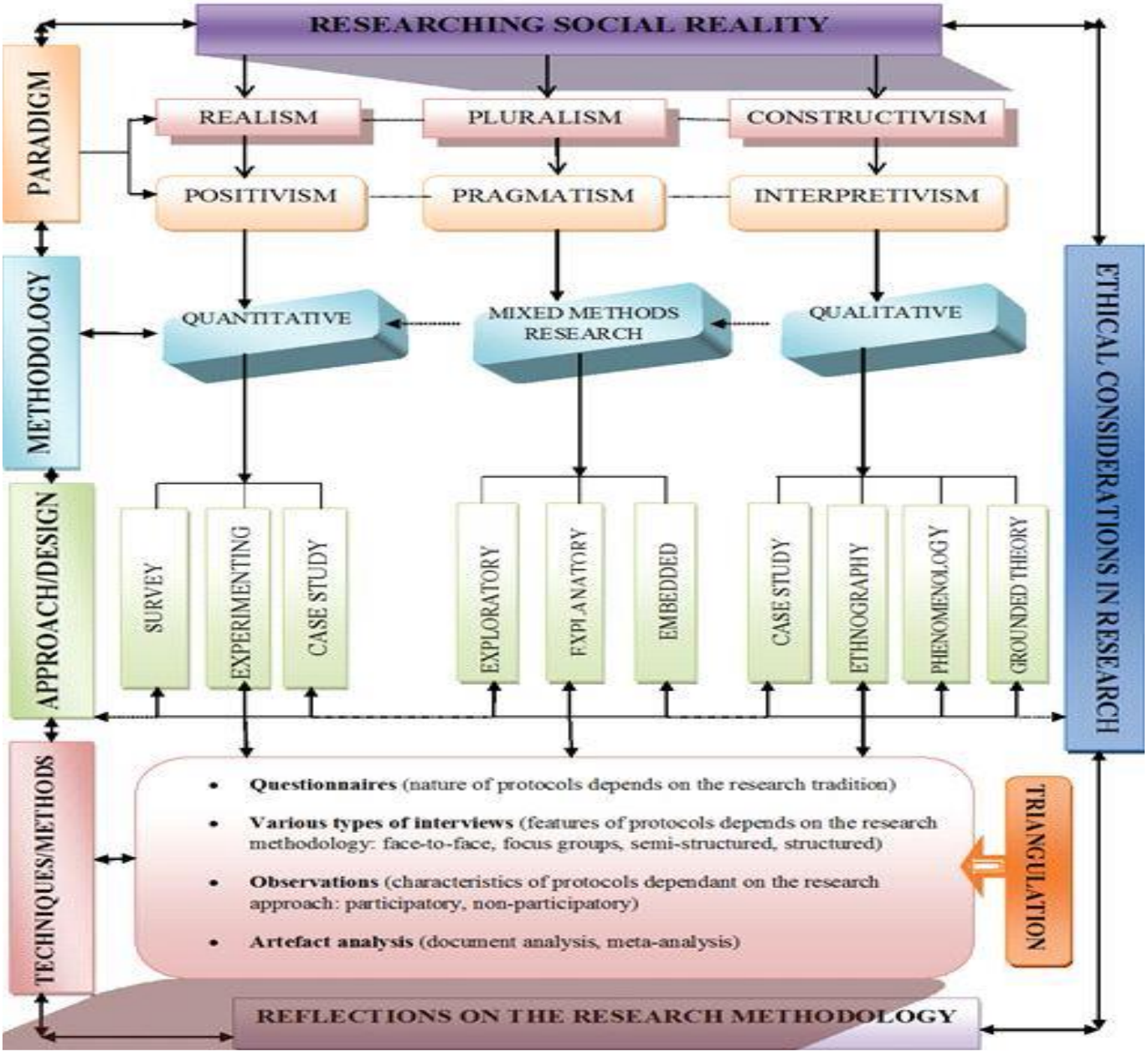

Figure 3.1: Research methodology roadmap (Ngulube, 2015)

Ngulube (2015) 's roadmap illustrates different types of paradigms for quantitative, qualitative and mixed methods research, the research designs and data collection

techniques as well as ethical considerations in the research. Trochim (2006) pointed out that ethical points of view are essential at all stages of the research process from planning to report and that a researcher need to consider ethics throughout the research process as it is essentially means following and obeying the practices as accepted by the scientific community of good scientific research. The research topic, strategies and methodological choices all influence the kinds of ethical questions a researcher need to take into account in the research process. Trochim (2006) further mention that a researcher must know and obey the common good scientific practices which are collegially accepted by the science community, regardless of research topic or methods. Figure 3.2 shows the roadmap adopted in this study, based on Ngulube (2015)'s research methodology roadmap.

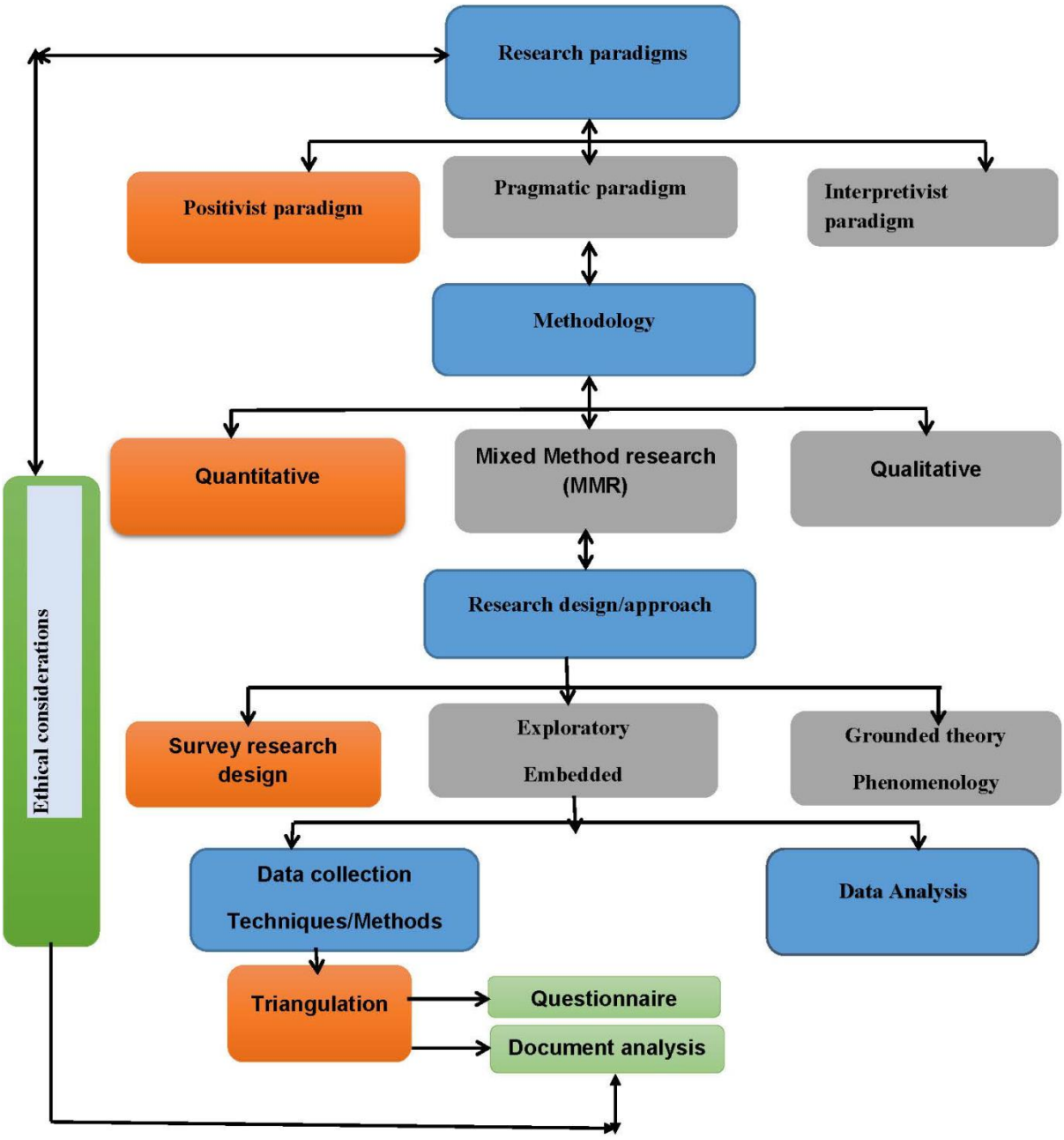

Figure 3. 2: **Research methodology road map for the study**

In pursuit of the roadmap that was adopted in the study, as shown in Figure 3.1, the study employed a quantitative research approach and it is therefore largely guided by a positivism paradigm. The survey research strategy was adopted, complemented by document analysis (data triangulation during data collection). Quantitative data(questionnaire) was analysed statistically using Statistical Package for the Social Sciences (SPSS) to measure and summarise the variables in the study while content

analysis was used to analyse qualitative data. The next section presents a discussion on the research philosophy or paradigms, methodology, research design, data collection techniques and data analysis adopted in this study.

3.2.1 Research philosophy

According to Denzil and Lincoln (2005), there must be a philosophy that is based on given assumptions that enable the researcher to have a framework and some guidelines when conducting the research. Philosophical assumptions assist researchers in choosing the problems to study, the questions to ask and the theories to utilize in their production of valid knowledge (Cecez-Kecmannovic and Kennan, 2013; Creswell, 2013; Saunders, Lewis and Thornhill, 2009) as cited in Ngulube (2015). According to Trochim (2006) the philosophy of science forms the background to the choices of methods, research strategies, data collection and data analysis methods, and thus an essential part of methodological and scientific thinking is to understand the position of the research in the tradition of the philosophy of science. Chalmers (1982) defines the term 'philosophy' to include factors that a particular scientific community adopts, and these include the techniques, laws and theoretical assumptions that are applied in various studies. The philosophical assumptions are referred to as worldviews (Creswell, 2014) and are also called paradigms, following Guba and Lincoln (2005). Killam (2013) summarized the quantitative paradigm as follows:

- It is founded on relativist ontology;
- Research maintains an etic (outside's point of view) perspective through objectivity and distance from subject;
- It allows nature to answer research questions and discover the truth using experiments;
- Methodologies are typically experimental in nature and involve measurable tests and questionnaires;
- A randomized control trial is the gold standard within quantitative research;
- It is used for proving cause and effect relationships among variables under study;
- Quazi-experimental and descriptive methods are also used;
- The aim of quantitative research is to develop explanation for phenomena
- Discover truth using experiment;
- Results are considered factual and universally applicable;
- They can be generalized because they are considered context-free; and
- Reliability measured as reliability of results and validity as accuracy of measurement are essential tools (Golafshani, 2003).

Guba and Lincoln (1994: 107) define paradigms as basic belief systems based on ontological, epistemological and methodological assumptions, and they presented various kinds of quantitative and qualitative paradigm assumptions including: ontological, epistemological, axiology and methodological assumptions. The paradigm assumptions are summarized below based on the current the study:

- Ontology: The study investigated participants' perspectives based on their experience of digital preservation practices in academic libraries in South Africa;
- Epistemological: The researcher lessened the distance between the researcher and the participants during data collection by using the online survey method;
- Axiological: Existing biases and interpretations which may exist as well as ethical considerations in the conduct of research were discussed by the researcher; and
- Methodological: Triangulation method was used to collect and analyse data while it sought to answer the research questions, before making any generalizations.

Saunders, Lewis and Thornhill (2007:84) pointed out that the particular philosophy or paradigm that a researcher chooses is based on the researcher's thoughts on development of knowledge. Quantitative research uses philosophies such as post-positivist, objective, positivist or empirical research while qualitative research is based on philosophies such as interpretive studies, postmodern research and critical studies (Creswell, 2011). This study was thus premised on a quantitative positivist paradigm, that is, the research starts with theory (as pointed out in the theoretical framework, Section 1.3 of Chapter One) since a quantitative method was the predominant one. Positivism research involves measurable properties which rely on various variables that result in a given hypothesis as mentioned by Creswell (2003), while interpretive research seeks to investigate the meanings of words or texts as they are expressed within their respective social contexts by various participants (Carr & Kemmis, 1986). Positivist paradigms view the world as objective and employs statistical methods in its investigation (Fitzgerald & Howcroft, 1998; Myers, 2010). The positivist approach was applied in this study in order to investigate the factors contributing to a digital preservation framework applicable to academic libraries in South Africa. These factors were also validated by the experts within South Africa academic libraries.

As mentioned by Ngulube (2015) the research instruments may be either inductive or deductive. The deductive approaches are concerned with testing of existing theories while the inductive approaches are most commonly used to generate theories (Saunders, Lewis & Thornhill, 2007). Ngulube (2015:127) further mentioned that qualitative research is inductive and exploratory in nature while quantitative research is hypothetic-deductive, since it is theory-led and tends to be confirmatory. Babbie (2010) added that positivism is associated with deductive reasoning which is usually linked to hypothesis testing while interpretivism is associated with inductive reasoning which is usually linked to generation

of theory from data. The attributes of the deductive approach were therefore applied in this study as it is positivism, quantitative research and uses a top-down approach and involves measurable properties which rely on various variables that result in a given hypothesis.

3.2.2 Research methodology

Ngulube (2015:127) describes methodology as central to the research process, because it is the lens through which a researcher looks when making decisions on acquiring knowledge about social phenomenon and getting answers to research questions. According to Creswell (2003:5) the methodology is the strategy or plan of action that links the methods to outcomes. Research methodology and design constitute a plan that provides the overall framework for collecting data and that also allows the researcher to draw conclusions between variables (Bless & Higson-Smith, 2000). There are various research methodologies commonly used by various authors in conducting their research and these are qualitative, quantitative and mixed methodologies (Creswell, 2011; Ngulube. 2015). The methodology of positivism is quantitative while that of interpretivism is qualitative (Ngulube, 2015:127).

The quantitative research method focuses on hypotheses testing with the aim of testing existing theories (Welman & Kruger, 2001:178) and it is the one in which the investigator primarily uses post-positivist claims for developing knowledge. Quantitative research employs strategies such as experiments and surveys and collects data on predetermined instruments that yield statistical data. On the other hand, qualitative research uses a naturalistic approach to study and understand context-specific settings such as the “real world setting where the researcher does not attempt to manipulate the phenomenon of interest” (Patton, 2002:39). In quantitative research, the questionnaire is the main data collection tool while qualitative research involves the use of qualitative data collection methods such as in-depth interviews, document analysis and participant observation, and ethnography to understand and explain social and cultural phenomena (Myers, 1997).

Another rapidly emerging alternative research method is mixed methods research (MMR). MMR is defined by Johnson, Onwuegbuzie and Tuner (2007) as a class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or languages into a single study or set of related studies. MMR is in the realm of multi-paradigms since it employs both the positivist and the interpretivist paradigms and, according to Romm and Ngulube (2015), it is important to note that MMR goes beyond the boundaries of triangulation which utilizes a number of research techniques in the same research design. MMR combines the

strengths of the qualitative and quantitative methodologies to produce a comprehensive and broad-based research (Creswell & Clark, 2007:5). MMR is thus a combination of the qualitative and quantitative research methods used to collect and analyses data in a particular study.

As noted by (Ngulube, 2015:128) the choice of the research methodology is determined by the underlying theoretical paradigm, the purpose of the research and the research questions. The quantitative research method was appropriate for this study as its main purpose is to find out how much, how many, how often, to what extent do digital resources are preserved in academic libraries in South Africa. The reasons for adopting a largely quantitative approach is that the study is a descriptive survey and used questionnaires to collect data on identifying the factors influencing digital preservation sustainability with a view to proposing a preservation framework applicable to academic libraries in South Africa. Creswell (2003) suggests that, if the problem is identifying the factors that influence an outcome, the utility of an intervention or understanding the best predictors of outcomes, then a quantitative approach is the best. Thus, the selection of the approach was influenced by the research problem of this study.

3.2.3 Research design

A research design is a programme that guides a researcher in collecting, analysing and interpreting data and giving meaning to it (Ngulube, 2010). Johnson and Christensen (2004) define a research design as an outline, plan or strategy used to arrive at findings for a research question. According to Mashall and Rossman (2006) the research design assists the researcher by providing a guideline that equips the researcher with a roadmap indicating how the particular study is to be conducted. Hider and Pymn (2008) labelled research designs as research strategies as cited in Ngulube (2015). The research design or strategy determines and controls data collection and analysis procedure, and it directs the researcher to the necessary information needed for a chosen study, thereby making research as efficient as possible as noted by Kothari (1990) and Ngulube (2005). Ngulube (2015) suggested several research designs that can be used when applying qualitative or quantitative methodologies, as shown in Figure 3.1, and these include survey, case study, exploratory, explanatory, embedded, ethnography and phenomenology. The three major quantitative research designs are survey, case study and experimental approach. The research design or strategy of this study was informed by the choice of the research paradigm discussed in Section 3.2.1.

In line with the quantitative positivist paradigm, the study therefore selected a survey research design whereby a researcher starts with a theory about why a particular

phenomenon occurs and develops a hypothesis (prediction) based on the theory (Johnson & Christensen, 2008). The survey strategy was found appropriate in this study, in order to investigate the preservation challenges, strategies and the factors contributing to effective digital preservation in academic libraries in South Africa. Surveys are largely quantitative and have been a widely used method in records and information management research (Williamson & Bow, 2000; Ngulube, 2005). The survey method could be used in different data collection techniques, for example, questionnaires (print or electronic), interviews (face-to-face or telephone), and observation techniques (Tanner, 2002:89; Sincero, 2012). A survey questionnaire was therefore used in this study to extract relevant information through the use of closed-ended questions. The research process followed in this study is presented in Table 3.1.

Table 3.1: Survey research process

Steps undertaken	Application in this study
Step 1: Identify research questions.	The main research questions and sub-questions were identified as presented in Section 1.5 and 1.6 of the study.
Step 2: Identifying the target population.	The target population is all 27 academic institutions in South Africa.
Step 3: Choosing a survey method.	Online survey method(cross- sectional) was used.
Step 4: Creating a survey questionnaire.	Closed-ended questionnaire was created and emailed to digital preservation experts in academic libraries in South Africa.
Step 5: Conducting a pretest.	Survey questionnaire was pre-tested by supervisor and preservation experts and practitioners from selected academic institutions. Questionnaire was revised after it has been pre-tested and modified accordingly.
Step 6: Collecting data from the target population.	Data was collected from information professionals in the academic libraries, using online questionnaire.
Step 7: Analyzing and interpreting the data gathered.	Data analysis was done by the use of descriptive and content analysis.
Step 8: Communicating the results and findings.	The findings and interpretations are presented in Chapter 4 and 5 of the study. Chapter 6 provides the recommendations and a proposed preservation framework.

Adapted from Sincero (2012)

Surveys can use two types of time horizon for collecting data, namely: longitudinal time horizon and cross-sectional time horizon. Time horizon is the time framework within which the project is intended for completion (Saunders, Lewis & Thornhill, 2007). Longitudinal time horizon is conducted over an extended period of time, usually years, and cross-sectional time horizon focuses on the state of the population in single

dimension or just at one point (Ngulube, 2005:200; Tanner, 2000:81). Therefore, longitudinal surveys are used when the researcher attempts to gather information over a period of time or from one point in time up to another, while cross-sectional surveys usually utilize questionnaires to ask about a particular topic at one point in time (Sincero, 2012). Cross-sectional studies use a shorter time frame to examine a particular phenomenon and are suitable for exploratory or descriptive studies (Babbie, 2005; Saunders, Lewis & Thornhill, 2007), and they are used when the investigation is concerned with the study of a particular phenomenon at a specific time. Therefore, a cross-sectional time horizon was employed in this study due to the fact that this choice supports the time limitations that exist in this study and it is also a descriptive study.

3.3 Study population

Population of the study refers to the body of people or collection of items under consideration for research (Babbie, 2004; Collis & Hussey, 2003; Powell, 1997). Parahoo (1997:218) defines population as a total number of units from which data, such as individuals, artefacts, events or organizations can be collected. For example, a set of records, or an event, or an institution, or people could constitute a study population. The whole universe or subset of the population (sample) can be studied depending on the size of the population and the purpose of the study. For most small populations, however, it is preferred that the whole population is studied and many scholars affirm that there is no point in sampling a population of less than 100 units of analysis. A unit of analysis may be an individual, groups, an event, an entity, a geographical unit or social interactions (Trochim, 2006).

In South Africa, there are 27 academic institutions and therefore all these institutions constituted the target population for the study. An online questionnaire was emailed to the directors or managers of academic libraries in South Africa. Participants from academic institutions involved the library staff members responsible for preservation and this included library directors or managers, librarians, archivists, ICT managers, institutional repository managers and digital preservation administrators, practitioners and experts. The study deemed the views of digital preservation experts in the subject area as very relevant and those who can influence digital preservation in any way in order to get a better understanding of the factors contributing to the development of a framework for preservation of digital resources in academic libraries in South Africa. In each of the 27 academic institutions, the digitization and preservation directorate office received an online questionnaire, and facilitated the process to ensure that the online questionnaire was also answered by relevant colleagues who are responsible for digital preservation practices in academic libraries.

3.4 Data collection methods

Data collection refers to the systematic approach, techniques and tools used in data collection, and the type of techniques and instruments that are influenced by the choice of research design and methodology (Voce, 2005). In order to collect data, a researcher used instruments that made it possible to obtain information that is required to address the existing research questions. It was also pointed out earlier that a quantitative paradigm is the dominant data collection strategy in this study with a small component of the overall study being drawn from the qualitative paradigm. For the purpose of this study, two data collection techniques were employed to triangulate and verify data, namely, a questionnaire as the primary data collection method, complemented by document analysis. As noted by Mason (2002:33), by using different data collection methods, the researcher sought to "corroborate one source and method with another to enhance the quality of the data". Bowen (2009) also described the purpose of triangulating as to provide a confluence of evidence that breeds credibility.

As noted by Rothbauer (2008), the basic idea underpinning the concept of triangulation is that the phenomena under study can be understood best when approached with a variety or combination of data collection methods. The effectiveness of triangulation also rests on the premise that the weakness in a single method would be compensated for by the counter-balancing strength of the other (Easterby-Smith et al., 1991; Yin, 1994). Therefore, the combination of these two instruments enabled the strengths of one method to counteract the weaknesses of the other and it also helped to check the validity of the findings and generate a rich profile on digital preservation practices within academic libraries. The use of triangulation was also motivated by the type of questions and the nature of the data desired for this study. The next section discusses types of data collection methods adopted in this study, namely: survey questionnaire and document analysis.

3.4.1 Questionnaire

An online questionnaire was employed in this study as a technique to allow participants to provide rich, contextual descriptions of events and practices that enhanced the

understanding of the contributing factors in the academic libraries. As mentioned by Williamson and Bow (2002:217) questionnaires are the most common instruments used in survey research designs and they are frequently used in the library and information science discipline, especially for understanding users and evaluating information services, users' information requirements, user satisfaction and usage patterns. Sincero (2012) described a questionnaire as an instrument that is comprised of a set of questions to be asked to the participants of the survey. It is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents. Oates (2008) further defines a questionnaire as a set of pre-defined set of questions (or items), arranged in a pre-determined order, whereby respondents are requested to answer those questions, thus providing the researcher with data that can be analysed and interpreted. Several studies in records and information management such as those of Kalusopa (2006) and Ngulube (2003) all used a questionnaire in their studies. The major reason for using a questionnaire was that it was able to quickly collect information on wider geographical spread specifically on academic institutions in South Africa.

However, there are advantages and disadvantages of using questionnaires as outlined by Collis and Hussey (2003), Oates (2008), and Sincero (2012). The advantages of using questionnaires include:

- Ideal for asking closed-ended questions and it is effective for market or consumer research;
- Ability to collect data from a large number of people within a relatively short period of time;
- Ability to encourage frankness and completion without the researcher being present;
- Obtaining fixed standardized types of answers (with pre-defined range of answers) thus eliminating too much variation of answers; and
- Cheap and less time consuming.

Disadvantages of using questionnaires include:

- Limit the researcher's understanding of the respondents' answers and requires budget for reproduction of survey questionnaires;
- Failure of some respondents to get clarification on ambiguous questions when the researcher is not there; and
- Costs of printing or photocopying to meet the desired population may be considerably high.

According to William, Burstein and McKemmish (2002) questionnaires are of different categories which are open-ended (or structured) or closed-ended questions

(unstructured) or contingency questions, the most common being the Likert type scale or there may be a combination of both in other cases. The current study used closed-ended questions whereby respondents are provided with alternative answers in which they are required to select one or more answers depending on the way the question has been structured. The type of data collected was that which addresses the objectives of this study as stipulated under Sections 1.5 and 1.6 of Chapter One.

3.4.1.1 Administering the questionnaire

According to Sincero (2012) the questionnaires may be online or postal; however, an online survey questionnaire is one of the most widely utilized survey methods, since the response rates related to mail surveys have gone low. In this current study, the 27 questionnaires were emailed to 27 academic institutions, and therefore the questionnaires were administered and completed online. An online survey is the systematic gathering of data from the target audience characterized by the invitation of the respondents and the completion of the questionnaire over the World Wide Web (Sincero, 2012). Powell and Connaway (2004) suggest that the administration of online questionnaires facilitates the gathering of data and the reason is that data would be relatively easy to collect and analyse in a short space of time. According to Fowler (2002) and Connaway (2004) this type of questionnaire (online) is inexpensive to administer.

Sincero (2012) lists the advantages of online surveys to include the ease of data gathering, and it facilitates low-cost and fast data collection from the target population. Therefore, sending email questionnaires and other online questionnaires are more affordable than the face-to-face method as the respondents are able to answer the questionnaire by means of inputting their answers while connected to the internet and the responses are automatically stored in a survey database, providing hassle-free handling of data and a smaller possibility of data errors. It also provides the highest level of convenience for the respondents because they can answer the questionnaire according to their own pace, chosen time and preferences, so complex types of surveys can be easily conducted through the internet. The questionnaire may also include more than one type of response format in such a way that the respondents would not get discouraged from the changes in the manner they answer the questions.

Sincero (2012) also listed disadvantages of using an online questionnaire by stating that an online survey is not suitable for surveys which ask open-ended questions because there is no trained interviewer to explore the answers of the respondents, and inability to reach challenging population, that this method is not applicable for surveys that require respondents who do not have access to the internet. Some examples of these

respondents include the elderly and people who reside in remote areas. Survey fraud is probably the heaviest disadvantage of an online survey as there are people who answer online surveys for the sake of getting the incentive (usually in the form of money) after they have completed the survey, not with a desire to contribute to the advancement of the study (Sincero, 2012). Another disadvantages of using an online survey, as noted by Powell and Connaway (2004), is the absence of explanations to ambiguous questions, as well as a certain degree of non-responsiveness of respondents. Slater (1990) is also concerned with questionnaire design as a possible hindrance to questionnaire effectiveness and this would be due to complicated questions, or questions that are excessively long.

3.4.2 Document review and analysis

Document review was also used as another source of data collection to supplement the use of the questionnaire. According to Blaxter, Hughes and Tight (2008:1660), “all or virtually all research projects involve to a greater or lesser extent the use and analysis of documents”. Merriam (1988:118) argued that documents of all types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problem. Documentary review refers to the study on documents that detail procedures, policies, acts and standards as requirements for proper functioning of an organisation (Patton, 2002). The purpose of conducting a document review in this study was to examine and understand the nature of the implementation of digital preservation practices, digital preservation policies, procedures and standards enabling academic institutions to manage and preserve their digital resources, and if they are also in compliance with prevailing standards. Atkinson and Coffey (1997:47) emphasized that:

> We should not use documentary sources as surrogates for other kinds of data. We cannot, for instance, learn through records alone how an organization actually operates day-by-day. Equally, we cannot treat records as firm evidence of what they report. That strong preservation does not mean that we should ignore or downgrade documentary data. On the contrary, our recognition of their existence as social facts alerts us to the necessity to treat them very seriously indeed. We have to approach them for what they are and what they are used to accomplish.

For this current study, document analysis begun with researcher identifying and selecting documents on the basis of their usefulness and relevance to the study. Documents that were collected for analysis in this study included:

- Library guides;

- Library reports;
- Digital preservation policy;
- Right to information law;
- Copyright and intellectual properties law;
- Security risks to digital preservation;
- Digital preservation planning and implementation;
- Open access to information; and
- Digital preservation strategies.

All these documents were requested from academic institutions of South Africa while some of the information were obtained from institutional websites and relevant databases. Document analysis was therefore meant to complement answering research questions numbers 1, 3 and 5 as outlined in Section 1.9 in Chapter One. This implied a critical review of policies, procedures, strategies, guidelines, systems and tools concerning digital preservation. This information was also meant to collaborate and augment evidence from other sources on digital preservation. Document analysis was thus useful in developing an understanding of the nature of the implementation of digital preservation practices as well as the aspects of digital preservation policies in academic libraries in South Africa. The institutional documents were qualitatively analysed using content analysis and evaluated against the survey questionnaire, the primary data collection instrument.

3.5 Reliability and validity

Reliability and validity are concepts that have evolved and are rooted in the positivist tradition and quantitative research. Reliability and validity must be addressed in all quantitative studies and are therefore central to this study. In qualitative research, the main issues of concern under reliability and validity relate to credibility, transferability, dependability, and conformity (Hernon & Schwartz, 2009; Golafshani, 2003; Lincoln & Guba, 1985). For quantitative research, reliability seeks to determine the extent to which data or measurement is consistent and this means that one should be able to get similar results from a different sample of the same population or determine to what degree an instrument measures the same way each time it is used under similar conditions with the same subjects (Hernon & Schwartz, 2009:73). Reliability is a matter of whether a particular technique, applied repeatedly to the same object, would yield the same result each time (Babbie & Mouton, 2001:119). Reliability has to do with whether the result is replicable, whereas validity determines whether the study and the research instruments measure that which it was intended or purported to measure (Hernon & Schwartz, 2009;

Golafshani, 2003). Validity simply refers to the extent to which a research instrument is designed to measure what it is intended to and reliability refers to the ability of research instrument to obtain consistent and stable results with replication (William, Burstein & McKemmish, 2002). Hernon and Schwartz (2009:73) have listed three ways to estimate reliability in a quantitative study, namely:

- Internal consistency: it is where researchers write a few sets of questions that measure the same concept. Then, after collecting responses, they might use correlation between both groups of questions to determine whether the instrument reliably measures the concept;
- Pre-test: it is where researchers might ask some individuals not appearing in the actual study to review the wording on the questions and ensure their meanings are well understood; and
- Test and re-test: in this case, the researchers want to determine whether similar results are obtained when the same participants respond to the same test a second time and nothing has been done between testing that would affect their knowledge, learning or skills.

Pre-testing was used to ensure reliability and validity of the study. Powell and Connaway (2004) noted that it is necessary to pre-test a questionnaire after it has been informally evaluated in order to refine the questions. The data collection instrument used in this research (questionnaire) was therefore pre-tested before collecting data in academic libraries in South Africa. Some questions were edited in language that was well understood, so as to allow respondents to answer at ease without ambiguity. Firstly, the questionnaire was verified by the research supervisor. In order to ensure reliability and validity of the study, the questionnaire was sent to the lecturers of the University of South Africa (UNISA) and the digital preservation experts at the University of Pretoria (UP) to review and offer their input on the first draft of the questionnaire. The adoption of the Total Design Method, which thrives on continuous follow-up, covering letters, pre-tested instruments and several reminders to respondents, yielded some level of positive results as questionnaires were completed and returned within the scheduled time. This process was done also to check and see if the questions were appropriate, necessary and sufficient. This method yielded some level of positive results as they enabled a researcher to obtain valuable data through a continuous follow-up and several reminders to respondents.

There are various approaches a researcher can use to address validity in quantitative study and the most popular method includes triangulation of information among different sources of data. This study employed the triangulation method to ensure validity of the study. The triangulation method in social sciences is conceptualized as mixing of multiple theories, methods, data sources or researchers with the aim of enhancing the validity of

research findings (Modell, 2009). Yin (2003) also added that the triangulation method arose from an ethical need to confirm the validity of the processes. According to Patton (2002) the triangulation method can be achieved by using multiple data sources, multiple informants and multiple methods (i.e. interviews, participant observation, focus groups and so on) in order to gather multiple perspectives on the same issues so as to gain a more complete understanding of a phenomenon and to increase confidence in the research findings.

As noted by Ngulube (2015:137), triangulation is one of the ways of enhancing rigor and trustworthiness in qualitative studies and the validity and reliability of quantitative studies. The use of the triangulation method in this study thus enabled one data collection method to harmonize limitations and weaknesses of the other research techniques, and this enhanced the validity and reliability of the research results. Perone and Tucker (2003:1) argued that both quantitative and qualitative research designs seek reliable and valid results as such “combining methods, advantages of each methodology, complements the other, making a stronger research design, resulting in more valid and reliable findings”. In this study, therefore, the questionnaire was pre-tested to enhance the reliability of the results while data collection methods (questionnaire and document analysis) were triangulated to further enhance the validity of the results. The next section discusses the triangulation method used in this study.

3.5.1 Triangulation method employed in this study

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Triangulation is the combination of two or more data sources, investigators, methodological approaches, theoretical perspectives or analytical methods (Denzin 1970; Kimchi, Poliva & Stevenson, 1981). Cohen, Manion and Morrison (2007) outlined different types of triangulation methods and these include:

- Time triangulation employs cross-sectional and longitudinal designs;
- Space triangulation uses comparative or cross cultural approaches instead of researching one culture;
- Combined levels of triangulation involve more than one level of analysis (individual level, group level and organizational level);
- Investigator triangulation utilizes more than one observer independent of the other;
- Multiple triangulation: where the researcher combines in one investigation multiple observers, theoretical perspectives, sources of data, and methodologies;
- Theoretical triangulation uses multiple theories to explain research findings; and
- Methodological triangulation entails multiple methods (Ngulube, 2015:137).

This study used methodological triangulation that is implemented by using multiple sources of data collection, a questionnaire and document analysis. The researcher therefore used multiple sources of data which are primary data collected from the participants through a survey questionnaire and secondary data collected during an analysis of institutional documents, which worked together to make the study more valid. The document analysis method was thus used to counter the weaknesses of the quantitative survey, and it revealed meaningful information that might not have been discovered if only one approach or data collection technique had been used. Jack and Raturi (2006:346) summarize some useful reasons as to why methodological triangulation is often used:

- Completeness: there is recognition that any single research method chosen will have inherent flaws or weaknesses; and the choice of the method will correspondingly limit the conclusions that would be drawn. It is therefore essential to obtain corroborating evidence using both quantitative or qualitative methods so as to enrich the study or provide more detail that would not be obtainable from one method;
- Contingency: it is driven by the need to explain why a particular strategy was chosen and this could be based on the need to illuminate a phenomenon which a particular method may fall short of explaining. For example, though data has been collected quantitatively, interviews, document review and other interpretative methods could shed more light on the 'why' and 'how' of such a phenomenon under study; and
- Confirmation*:* it is where triangulation improves the researcher's ability to draw conclusions from his/her study and might result in a more robust and generalizable set of findings. Thus, traditional criteria like reliability and validity are replaced by the level of symmetry between alternative methods used. This implies that by combining multiple data sources, alternate observers, distinctively different theories, alternate methods, and varying empirics, the researcher hopes to overcome the intrinsic biases arising from single-method, single-observer, and single-theory studies (Jack & Raturi, 2006).

By triangulating data, the researcher attempts to provide a confluence of evidence that breeds credibility (Eisner, 1991:10). The next section discusses the data analysis techniques that were employed in this study.

3.6 Data analysis techniques

An essential component of ensuring data integrity is the accurate and appropriate analysis of research findings. Analysis of data is a crucial part of a research project and it is about organizing data and breaking it into easily understood parts which can be ordered and presented in a form that allows the researcher to answer the initial research questions (Oates, 2006). Oates (2006) further described data analysis as a key aspect of any research that helps in drawing conclusions and generalizations of findings to a problem statement. As noted by Bala (2005) data analysis procedures help a researcher to arrive at the data analysis and therefore understanding of the data analysis will help a researcher to:

- Appreciate the meaning of the scientific method, hypotheses testing and statistical significance in relation to research questions;
- Realize the importance of good research design when investigating research questions;
- Have knowledge of a range of inferential statistics and their applicability and limitations in the context of your research;
- Be able to devise, implement and report accurately a small quantitative research project;
- Be capable of identifying the data analysis procedures relevant to your research project;
- Show an understanding of the strengths and limitations of the selected quantitative or qualitative research project;
- Demonstrate the ability to use word processing, project planning and statistical computer packages in the context of a quantitative research project and report; and
- Be adept at working effectively alone or with others to solve a research question/ problem quantitatively.

Some of the ways in which data can be analysed include the use of thematic analysis, descriptive statistics, hermeneutics analysis, narrative and performance analysis, discourse analysis, grounded theory analysis and content analysis (Miles & Huberman, 2005). In this current study, the analyses and interpretations of research findings are in line with the study objectives and research questions presented. The data analysis triangulation method was employed in this study, that is the combination of two or more methods of analysing data. This method was used to analyse quantitative data obtained from the survey questionnaire and the qualitative data obtained from documents analysis. The quantitative analytical approach allows the reporting of summary results in numerical terms to be given with a specified degree of confidence and uses a statistical technique

for collecting, organizing, analysing and interpreting data (Ajiferuke, 2002). According to Kombo and Tromp (2006), analysing quantitative data varies from simple descriptive analysis to more elaborate reduction and multivariate associating techniques. In this current study, quantitative data was collected and analysed to produce a set of descriptive results, while the institutional documents were qualitatively analysed using content analysis. This study therefore used the following data analysis techniques, namely: descriptive analysis and content analysis, as discussed in the next section.

3.6.1 Descriptive analysis

McHugh and Villarrvel (2003) define a descriptive analysis as a technique that can assist in the scrutiny of data, data arrangement and summarizing data using graphs and tables. Descriptive analysis provides simple summaries about the sample and the measures and it also describes what is or what the data shows (Trochim, 2006). In this study, the results from the survey were analysed through descriptive statistics and this was done by the use of graphs and tables. Wilkinson (2000: 78) pointed out that before analysing data, it must be classified or coded in some way, and in doing this we are preparing the data for analysis. Some people refer to this as cleaning or organising data. In other words, it is an “organized, compressed assembly of information that permits conclusion drawing or action taking” (Miles & Huberman 1994: 429). In this current study, quantitative data were collected and analysed to produce a set of descriptive results; and qualitative data were collected and analysed for another set of thematic results. The two sets of results were compared and contrasted to produce a single interpretation and the conclusion was drawn from the results. The analyses and interpretations of research findings were in line with the study objectives and research questions presented.

Although there are a number of software packages available to facilitate data analysis such as Statistical Tool for Analysis (STATA), Microsoft Excel, etc., in this study, quantitative data was analysed stastically using Statistical Package for the Social Sciences (SPSS) software. SPSS is a software package used in statistical analysis of data, developed by SPSS Inc. and acquired by IBM in 2009, and was officially renamed IBM SPSS. This software was originally meant for the social sciences, but has become popular in other fields such as health sciences, marketing, market research and data mining. Like other reputable statistical packages such as STATA, SPSS has a versatile full range of capabilities that includes data management, statistical analysis, graphics, simulations and custom programming. SPSS can perform basic statistic functions such as descriptive statistics to determine variance and frequency.This software can be used for entering, editing, tabulating, mapping, and disseminating census and survey data.The collected data was therefore converted into meaningful information by grouping all the

responses, tables and charts to determine the findings using SPSS software, and the results were presented through written descriptions, numerical summarizations and figures.

3.6.2 Content analysis

Content analysis has long historical roots and it was first used as a method for analysing hymns, newspaper and magazine articles, advertisements and political speeches in the 19th century (Harwood & Garry, 2003). However, as observed by Bates (1999) the flexibility and objectives of the content analysis process make it particularly suitable for Information Science research, given that the domain is the study of gathering, organizing, storing, retrieving and dissemination of information. Cole (1988) defined content analysis as a method of analysing written, verbal or visual communication messages. It is also described as a research method which is a systematic and objective means of describing and quantifying phenomena (Krippendorff, 1980; Downe-Wamboldt, 1992; Sandelowski, 1995). As suggested by Los and Kyngas (2008) content analysis is a method that may be used with either qualitative or quantitative data; furthermore, it may be used in an inductive or deductive way. An approach based on inductive data moves from the specific to the general, so that particular instances are observed and then combined into a larger whole or general statement (Chinn & Kramer, 1999) while a deductive approach is based on an earlier theory or model and therefore it moves from the general to the specific (Burns & Grove, 2005).

Inductive content analysis is used in cases where there are no previous studies dealing with the phenomenon or when it is fragmented. As noted by Kynga and Vanhanen (1999) deductive content analysis is used when the structure of analysis is operationalized on the basis of previous knowledge and the purpose of the study is theory testing. Catanzaro (1988) also added that deductive content analysis is often used in cases where the researcher wishes to retest existing data in a new context. This may also involve testing categories, concepts, models or hypotheses (Marshall & Rossman, 1995). The deductive content analysis approach is therefore useful if the general aim is to test a previous theory in a different situation or to compare categories at different time periods. For the purpose of this study, deductive content analysis was used to analyse data obtained from institutional documents pertaining to digital preservation practices in academic libraries with the aim to corroborate and augment evidence from the survey and other related sources. The content of the institutional documents was qualitatively examined and evaluated against the main data collection instrument, namely the survey questionnaire.

In this study, qualitative data obtained from institutional documents pertaining to digital preservation practices, digital preservation policies, procedures and standards was analysed. All these institutional documents were requested from academic institutions in South Africa while some of the information was obtained from institutional websites and relevant databases. The information was drawn from the institutions's stakeholders for digital preservation including library directors and managers, librarians, archivists, Institutional Repositories (IRs) managers, content managers, IT managers, policy makers and digital preservation practitioners and experts within academic libraries. The study took into account that these information professionals are in charge of digital preservation practices in academic libraries and are playing strategic role in the implementation of digital preservation programmes. The study is also in view that large part of the questionnaire requires decision makers and policy developers to respond to. A researcher thus relied on these information professionals to represent all of the elements of the population of interest and considering that their knowledge and experience in the field were very much critical to the current study.

3.7 Evaluation of research methodology

Ngulube (2005:139) observes that research methods need to be evaluated in order to explain what information was required, how it was collected accurately and how it was analysed. It is thus important to evaluate the research methodology in terms of the research design, its limitations, and shortcomings in the execution of the study as well as ethical issues that would have arisen in the process. In this current study, emphasis on evaluation of the research methodology was placed on the research paradigm, research design, and appropriateness of the data collection instrument employed and whether the study achieved its intended purpose. The study used quantitative research methods based upon the positivism paradigm, and adopted a survey research design where quantitative data collected was supplemented by document analysis to triangulate data. The rationale for using this methodology was that information from any single source would not provide sufficient data or explanations. The study thus blended data collection methods to provide a broader and deeper perspective through data triangulation. Bogdan and Biklen (2006) describe triangulation as a powerful technique that facilitates validation of data through cross verification from more than two sources.By using triangulation method, the researcher was able to collect data from different sources and provided explanations and meanings which would not have been possible with a single source being relied upon. Thus, the use of triangulation in data collection was ideal to help the researcher to understand the extent to which preservation practices are implemented in academic libraries in South Africa.

The study thus recommend the future researchers to use triangulation methods to investigate digital preservation practices in academic libraries.

However, the whole research process was not without challenges. A key strategy that ensured the reliability and validity of the questionnaire was the request sent to librarians of University of Pretoria and lecturers of the University of South Africa to voluntarily review and offer their input on the first draft of the questionnaire. In spite of this effort, the content of the questionnaire appeared to be bit technical to some of the respondents and also too long, and thus required a lot of time to complete. As a result, some of the sections in the questionnaire were left unanswered. In that regard, direct engagement with some of the respondents to explain the issues and guide them to fill the questionnaire became necessary.The reason as to why the questionnaire was too long was that it should efficiently cover all the elements that are important to the study.It was also not easy to obtain the cooperation of academic institutions employees to fill the questionnaire because they were often very busy, and this was also complicated by the fact that data collection started at the end of the year, in December 2016, a time when employees in academic institutions prefer taking vacation leave. Data collection was therefore extended to a period of four months instead of the initial two months, as most of the employees were out of the office until end of January 2017.The researcher therefore was faced with the challenge of having to deliver another questionnaire because the previous questionnaire was not attended to, while reminding other employees in other academic institutions to complete the questionnaire. As a result, the timeliness in getting the questionnaire to respondents did not translate into the timeliness that were expected for obtaining the results.

Again, initial responses on the questionnaire from some of academic institutions were evasive as some of the library directors and managers raised security concerns and requested for official permission letters from Unisa. Notwithstanding the above limitations, the researcher did manage to obtain some useful data from the willing participants that enabled the objectives of the study to be realized. Most of respondents in academic libraries were eager to know their digital preservation status and they were therefore very cooperative partly because the study was very relevant to the challenges they face in terms of preserving their digital resources. The respondents felt that the research findings will guide them in developing a sustainable digital preservation programme.

3.8 Chapter summary

This chapter discussed the research methodology that was used to answer the research questions and objectives of this study. The philosophy or paradigm upon which the study

was based as well as the research approach (i.e. the deductive approach) was discussed. The study population was clearly presented in this chapter. The current study was guided largely by a quantitative paradigm in the form of a survey, complemented by a qualitative preliminary inquiry in the form of triangulation during data collection. A methodological triangulation was used to collect and analyse data for this study. The survey questionnaire was the main data collection method, complemented by document analysis. SPSS software was thus used to analyse quantitative data and content analysis was employed to analyse qualitative data obtained from institutional documents.The chapter also looked at issues of ensuring reliability and validity within the context of the approach used. The researcher explained how ethical issues were considered in this study and the evaluation of the research methodology was also discussed in the chapter.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF DATA

4.1 Introduction

The current chapter presents the analysis of the empirical data that were collected by the use of a survey questionnaire, complemented by document analysis, in order to answer the research questions that were presented in Chapter One. For the purpose of this study, digital preservation is perceived as a combination of plans, strategies, actions, policies, procedures, resource allocation, preservation methods and technologies aimed at prolonging the existence and access of digital objects for as long as necessary by maintaining them either in their original format or in a more persistent format, while protecting their authenticity (Hedstrom, 1997; American Library Association (ALA), 2007; Das, Sharma & Gurey, 2009). The study investigated digital preservation practices across academic libraries in South Africa with a view to provide an integrated framework to guide digital preservation practices in these institutions. To accomplish this task, the study conducted an online survey that looked into preservation challenges, strategies and best practices, systems and tools that were being used for digital preservation, preservation policy and procedures, collaborative efforts and factors influencing digital preservation sustainability as well as staffing and organizational models to support digital preservation programmes.

The survey was also complemented by document analysis that was used to critically review the policies, procedures, strategies, guidelines, systems, standards and tools concerning digital preservation in academic libraries. The information from institutional documents was therefore meant to collaborate and augment evidence from the survey and other sources on digital preservation. However, the researcher was particularly interested in patterns of data that were addressing the research questions. Two data collection techniques, namely: a questionnaire and document analysis were thus used in this study to answer the following research objectives:

1. To establish the extent to which digital preservation practices were implemented in academic libraries in South Africa;
2. To establish the barriers for effective preservation of digital resources in academic libraries in South Africa;

3. To determine the preservation strategies that are used in safeguarding digital resources in academic libraries in South Africa;
4. To determine the systems, tools and technologies used for preservation of digital resources in academic libraries in South Africa; and
5. To establish the factors influencing digital preservation sustainability in academic libraries in South Africa.

Research questions 6 and 7 are dealt with as research outcomes in Chapter Six of the current study. All usable responses based on the above research objectives were analysed by using the Statistical Package for the Social Sciences (SPSS) to measure and summarize the variables in the study. This software package was chosen because it offers the most comprehensive solution for reporting, modelling and analysis of data (Powell & Silipigni, 2004). The software also offers a variety of data formats and programmes that make it easy to edit and transfer data from one programme to another. For that reason, descriptive statistics such as frequencies, percentages, cross-tabulation, pie charts and bar graph were produced for analysis.

Content analysis was also used in this study to enable the researcher to discover patterns in the data that helps in understanding digital preservation practices in academic libraries. Content analysis looks for the presence of words, phrases or concepts in a text and endeavours to understand their meanings and relationships to each other (Matthews & Ross, 2010:395). This study analysed institutional documents in order to understand the nature of the implementation of digital preservation and established internal policies, standards and procedures to enable academic institutions to manage and preserve their digital resources. The content of the institutional documents was therefore qualitatively examined and scored against the questionnaire survey. The data presented in this study is not associated with any other institution and this is so owing to the fact that, in order to encourage full participation, respondents were assured that their institutional data would not be identifiable. The results are presented in the same order that the questions were asked in the questionnaire.

4.1.1 Response rate and characteristics of the respondents

The survey was conducted in all (27) academic institutions in South Africa and out of the 27 questionnaires emailed to these institutions, 22 completed questionnaires were returned, representing a response rate of 81.5%. This response rate was considered as very good and considered valid for data analysis judging by the benchmarks of Bailey (1987); Babbie (1998) and Hager et al. (2003). The main reason for this high response rate was largely due to the fact that most of academic institutions were enthusiastic about

the results of the study as they were eager to know their digital preservation status. The survey respondents included the directors, managers, archivists, librarians, digitization officers, institutional repository officers and digital preservation practitioners from academic libraries. All surveyed employees were full time employees in academic libraries in the year 2016 and they all had email addresses and access to the internet at the time of this study. Only a few institutions stated that they did not have established digital preservation programmes in place. However, they expressed their desire and interest in developing a programme for preserving their digital materials. The following section presents the key findings which are discussed under the broad themes as contained in the questionnaire pertinent to digital preservation practice in academic libraries.

4.2 Current digital preservation practices in academic libraries

It is part of library and archives' mission to prevent the loss of cultural and historical material, important scientific and research data and institutional records. Secondly, these memory institutions need to protect the significant investment of time and their digital resources. It was pointed out in Chapter Two that, as the basis for understanding the depth and breadth of digital resources in academic libraries, one of the key issues was to examine the current digital preservation practices in these institutions. Therefore, the need to understand the institutional and legislative environment was fundamental to understanding the current digital preservation practices in academic libraries. This entails the whole institutional environment comprising policies, procedures, challenges, strategies, responsibilities, accountabilities, standards, systems and tools that need to be in place to enable the institution to meet effective digital preservation practices. These also consist of best practices, guidelines and ethics governing the business environment that relates to digital preservation. It is therefore important to investigate and understand digital preservation practices in academic libraries in South Africa. The findings were presented under the following themes within the context of digital preservation practices (derived from questions 5 - 49), and these include:

- Implementation of digital preservation programmes;
- Digital preservation challenges;
- Digital preservation strategies;
- Preservation software and tools;
- Factors influencing digital preservation sustainability; and
- Training needs in digital preservation.

4.2.1 Extent of implementation of digital preservation programmes in academic libraries

To fully appreciate the state of the art of digital preservation practices, it was considered necessary to first investigate the extent of implementation of digital preservation programmes in academic libraries. The first objective of the study was therefore to establish the extent to which academic libraries implemented digital preservation programmes. The respondents were asked to indicate as to whether they have formal digital preservation programmes in place. The majority of respondents (68.2%) indicated that they have a formal digital preservation programme in place in their institutions and 31.8% of institutions stated that they did not have a formal digital preservation programmes in place. However, they expressed their desire and interest in developing a formal programme for preserving their digital materials. As a result, the respondents were further asked to indicate whether they had undertaken any efforts to preserve digital materials at their institutions. The majority (95.5%) of respondents stated that they have undertaken efforts to preserve digital materials in their institutions and only 4.5% of respondents indicated that they have still not undertaken any efforts to preserve their digital materials. As to whether they had a dedicated budget for digital preservation practices, the majority (63.6%) of the institutions stated that they have a budget for preservation of their digital resources and only 36.4% indicated that they did not have a digital preservation budget. As a result of the complexity of digital preservation, effective digital preservation can only result from collaboration across multiple streams, expertise, agents and institutions.

The institutional documents were also analysed in an attempt to corroborate responses from the questionnaire, and to investigate the extent to which digital preservation programmes have been implemented across academic libraries in South Africa. Interestingly, the evidence from the documents shows that academic libraries recognize the changing library environment and the global reach of digital assets. As a result, most of academic institutions noted that they had formal digital preservation programmes in place. These institutions have developed digitization units and institutional repositories (IRs) to collect, preserve, manage and disseminate institutionally produced scholarly materials and research outputs. Digital preservation is an extensive process which requires collaboration and team effort amongst different stakeholders. In this regard, analysis of documents indicated that many academic libraries are participating in library consortia and joining peer institutions regionally, nationally and internationally in building their IRs. The role of IRs is to provide adequate and appropriate conditions for storage, protection and preservation of archival records and other collections and promote research by making it available worldwide. An increasing amount of digital material is thus made available to a wide range of users through IRs, and these institutions identify,

acquire and evaluate digital records of long-term historical, administrative and evidential value in order to serve as an institutional memory.

Preservation activities require the development of policies, standards and best practices as well as models for sustainable funding to guarantee long-term commitment to these materials. In this regard, library policy documents were also reviewed to establish the implementation of policies and standards to guide in digital preservation practices. Document review revealed that these institutions have developed policies, standards and procedures specially to enable them to digitize and preserve their records for future access. In most institutions, the IRs have been developed in line with international interoperability, metadata standards and policies, and the collection in IR is harvested on an international level by other major repositories using the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH). Library policy documents also outline the institutional goals, guiding principles, selection criteria, management and access to digital collections, digital standards and guidelines, governance of digitization and preservation initiatives, intellectual property rights, digital preservation and digital curation, facilitating the long-term access, use, management and long term preservation and sustainability. Therefore, the effective preservation of their digital resources include established policies and procedures, standards and codes of conduct that are conducive to fostering a strong ethical climate.

Digitisation and preservation activities were also performed within a framework of standards defined within established international standards, and most of the institutions comply with the Promotion of Access to Information Act (No. 2 of 2000) (PAIA) and the broad principles of records management that are required by the National Archives and Records Service Act (No. 43 of 1996), the International Standard for Records Management (ISO15489) and the South African National Standard for Records Management (SANS 15489). IRs thus provide access in compliance with legal requirements and standards. The majority of institutions have also expressed their commitment to openness and have signed the Berlin Declaration on Openness to Knowledge in the Sciences and Humanities, a mechanism to commit institutions to promote an open access approach to institutional research outputs and knowledge. This declaration asserted that scholarly research outputs and cultural heritage be freely accessible and usable for scientists and the public. As a result, most IRs follow the principles of the Berlin Declaration on Openness to Knowledge in the Sciences and Humanities.

Although an increasing number of institutions have undertaken efforts to preserve their library collections, only two institutions indicated that they do not have a formal preservation programme in place. However, these institutions have a digital preservation project plan in place, outlining the preservation approach, objectives and actions that are considered necessary for long-term preservation, as noted in their library documents. The

document review also revealed that some of the institutions had a budget for preservation practices and the costs were thus managed to make optimal use of resources, including training of staff members. Funding and costing is, however, recorded as one of the compelling problems in digital preservation practices because long-term sustainability of digital preservation infrastructure depends on it. Some of the institutions did not have a specific budget for preservation practices and depended on donor funding in implementing and maintaining their institutional repositories.

Reading the historical development of the institutions brought out the fact that the academic libraries started as traditional libraries by providing access to more physical resources housed in it. For many years, researchers had to physically walk into the libraries to access services and this is changing as many libraries are now accessible online. In response to this new transition, academic libraries have so far evolved from focusing on the management of physical resources and other services to transforming these services into digital formats. To remain relevant and up to date with the digital trend, the services provided and skills possessed by information professionals in academic libraries should also reflect this trend and, as a result, continuous learning and training of staff are necessary. However, institutional annual reports emphasized that all staff members should receive additional training or professional development throughout the year as part of the institution's strategies and plans. Library documents also confirmed that generic and specific training and workshops in digital preservation are offered in some institutions. As a result, identified staff in most of the institutions attended training in digital preservation as provided by their institutions, and this practice enhanced the knowledge and skills of information professionals. However, there is no evidence of succession planning, even if the institutional documents noted that there were career development practices.

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

It was also expected in the survey questionnaire that the respondents who had previously indicated in question 5.1 that their institutions are preserving their digital materials should

indicate in the appropriate box those who are responsible for digital preservation in their institutions, or make a suggestion in the “other” category. The purpose of this research question was to identify the persons, departments or unit responsible for implementing and facilitating digital preservation practices in academic libraries in South Africa. The results are shown in Table 4.1.

Table 4.1: Responsibility for digital preservation in the institutions

Those responsible for digital preservation	Responses	
	Total	Percent
Library management	8	16.7%
Digital preservation unit	9	18.8%
Information technology department	5	10.4%
Librarian or archivist	10	20.8%
Repository manager	16	33.3%
Total	48	100.0%

Of those indicating that they are preserving their digital materials, the highest score of Respondents 16(33.3%) stated that repository managers were responsible for digital preservation in their institutions followed by librarians or archivists 10(20.8%), digital preservation unit 9(18.8%), library management 8(16.7%), and only few noted information technology department with the lowest score of 5 (10.4%).

The respondents were pressed further to state what motivated them to preserve digital materials in their institutions. Possible factors that may motivate an institution to preserve their digital materials were listed in question 8 of the research questionnaire as identified from the literature review. The respondents were asked to rate these factors in a five-point scale, a Likert scale of strongly agree, agree, neutral, disagree and strongly disagree. For purposes of analysis, the responses for “strongly agree” and “agree” were considered as “agree,” or favourable or positive, while the results of “strongly disagree” and “disagree” were considered as “disagree” or negative. An “other” option was provided

for respondents to indicate any other factors that may motivate them to preserve their digital materials. The results from the research questionnaire are presented in Table 4.2.

Table 4.2: Motivation to preserve digital materials in academic libraries

Reasons for preservation	Strongly Agree (1)%	Agree(2) %	Neutral (3)%	Disagree (4)%	Strongly Disagree(5) %
Pressure from library users	22.7	36.4	22.7	18.2	-
Increase application of digital technologies	40.9	36.4	22.7	-	-
Pressure from other institutions in the developed countries	18.2	50.0	22.7	9.1	-
Ensuring long term access to digital resources	72.7	27.3	-	-	-
Competition among academic institutions	31.8	31.8	27.3	9.1	-
Managing digital content	54.5	41.0	4.5	-	-
The desire to promote library services	59.1	36.4	4.5	-	-
Interest in digital technologies	31.8	50.0	4.5	9.1	4.5
Pressure from researchers	18.2	45.5	31.8	4.5	-

The following are the major motivating factors for preservation of digital materials in academic libraries ranked in order of the highest percentage score: ensuring long term access to digital resources with the combined score of 100%, the desire to promote library services with the combined score of 95.5% and managing digital content with a combined score of 95.5%, interest in digital technologies with a combined score of 81.9% and increase application of digital technologies with a combined score of 77.3%. Other motivating factors for the adoption of digital preservation were pressure from other institutions in the developed countries with a combined score of 68.2%, competition among academic institutions with a combined score of 63.6%, pressure from researchers 63.7% and pressure from library users with a combined score of 59.1%, recording an average percentage score within the 50%-69% range. With regard to pressure from library users 22.7% were neutral and 18.2% disagreed. As regards pressure from other

institutions in the developed countries, 22.7% were neutral and 9.1% disagreed. Regarding pressure from researchers, 31.8% were neutral and only 4.5% disagreed. Respondents generally responded positively and the overall responses show that academic libraries acknowledged the need for digital preservation practices.

4.2.2 Types of materials in digital form

The study established that academic libraries have different types of materials in digital form. As a result, research question 9 of the research questionnaire sought to understand types of materials the institutions have in digital form. A list of types of digital materials were presented to the respondents and the majority of 19 (14.0%) indicated that theses and dissertation are in digital form while 17 (12.5%) of the respondents had journal articles in digital form followed by conference papers with the score of 15 (11.0%), research data 14 (10.3%), images 13 (9.6%), and institutional records 12 (8.8%), while annual reports 10 (7.4%), audio 9 (6.6%) and video 8(5.9%) were the least significant materials that were in digital form. The results are presented in Table 4.3.

Table 4.3: Types of materials in digital form

Types of materials in digital forms	Responses	
	Total	Percent
Theses	19	14.0%
Dissertations	19	14.2%
Research data	14	10.3%
Annual reports	10	7.4%
Journal articles	17	12.5%
Conference papers	15	11.0%
Images	13	9.6%
Audio	9	6.6%
Video	8	5.9%
Institutional records	12	8.8%
Total	136	100.0%

An understanding of the different types of materials that were preserved in academic libraries is crucial for the development of any effective digital preservation strategy that will reflect the business value of the institution because each type of digital material has

a different strategic value. Using a multi-response list, respondents were to further indicate the type of materials they are preserving. Digital materials such as theses 19 (15.1%) were the most common types of digital information received to be preserved, followed by dissertations 17 (13.5%) and textual documents 16 (12.7%) while institutional records 13 (10.3%), images 12 (9.5%) and audios 11 (8.7%) were also reported as type of materials they preserved. Only few respondents 2 (1.6%) cited emails. The results are presented in Table 4.4.

Table 4.4: Types of digital materials institutions are preserving

Types of digital materials institutions are preserving	Responses	
	Total	Percent
Textual documents	16	12.7%
Research data	11	8.7%
Theses	19	15.1%
Dissertations	17	13.5%
Images	12	9.5%
Emails	2	1.6%
Audio	11	8.7%
Video	9	7.1%
Journal articles	16	12.7%
Institutional records	13	10.3%
Total	126	100.0%

4.2.3 Factors ensuring successful implementation of preservation practices

Despite the challenges faced by academic libraries, practical steps can be taken now to ensure that digital collections will remain accessible in the future. In order to understand the state of the art of digital preservation, it was necessary to also establish how the institutions ensure successful implementation of their preservation practices. The different factors of ensuring successful digital preservation of materials identified from the literature review were listed in question 11 of the research questionnaire.The respondents were asked to indicate by ticking the applicable box as to the factors applicable in their institutions. The results are presented in Table 4.5.

Table 4.5: Factors ensuring successful implementation of digital preservation practices

Factors that ensure successful implementation of digital preservation practices	Responses	
	Total	Percent
Institution has developed preservation policy and procedures	16	16.5%
Institution has dedicated budget for preservation practices	14	14.4%
Institution has built collaboration with other institutions	12	12.4%
Institution has sufficient skilled staff	17	17.5%
Institution has technology infrastructure and resources	17	17.5%
Institution developed training programmes	7	7.2%
Preservation strategies are in place	14	14.4%
Total	97	100.0%

There was an overwhelming positive response from the respondents acknowledging that their institutions have sufficient skilled staff 17 (17.5%), and institutions have technology infrastructure and resources 17 (17.5%) and the institution has developed a preservation policy and procedures 16 (16.5%). This was followed by the acknowledgment that the institution has a dedicated budget for preservation practices 14 (14.4%), preservation strategies are in place 14 (14.4%) and that their institutions has built collaboration with other institutions 12 (12.4%). The development of training programmes 7 (7.2%) by institution was the least factor to ensure successful implementation of digital practices. Other factors for ensuring a successful implementation of preservation as mentioned in the “other” category included: thesis and dissertation policy in place and attending digital preservation training at other institutions such as NRF. The respondents were also asked to indicate the current level of digital preservation their institutions are providing. As shown in Figure 4.1, most of the institutions (81.8%) are taking a long-term perspective (as long as they are needed) of digital preservation and only 2 respondents (9.0%) take a medium term and 1 (4.5%) a short term perspective while only 1 (4.5%) does not know the level of digital preservation his/her institution is currently providing.

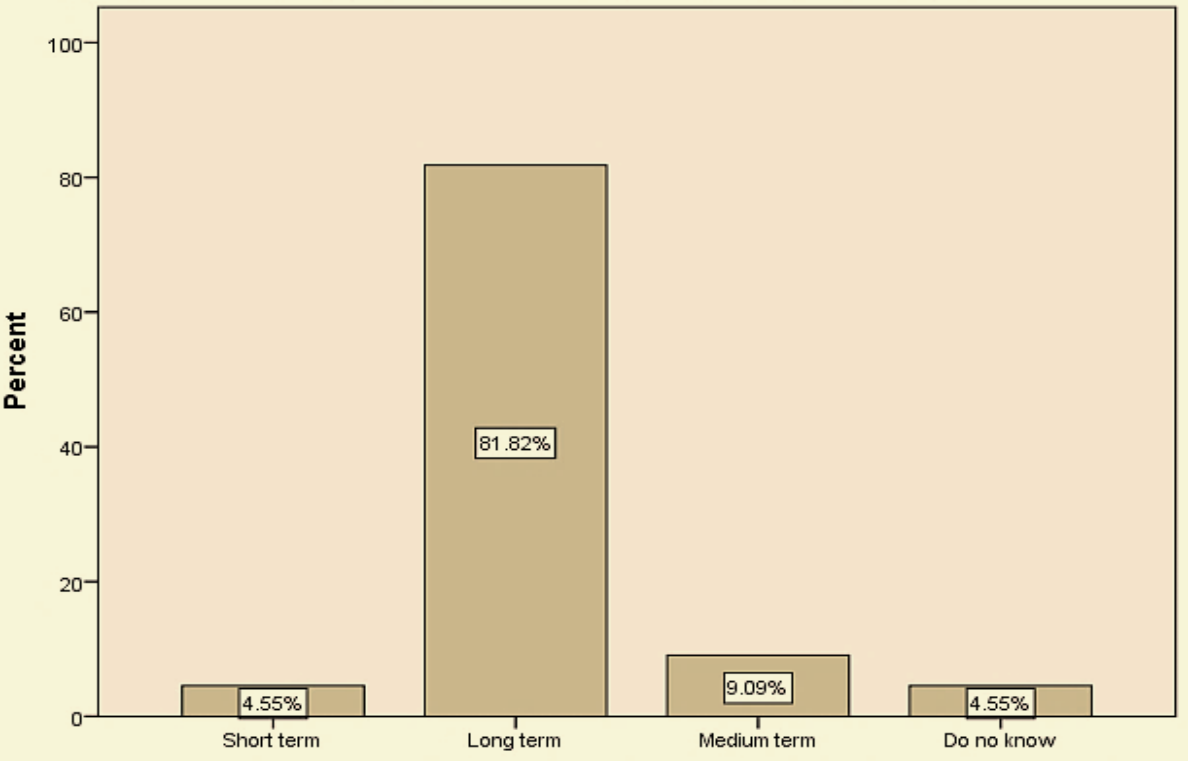

Figure 4.1: Level of digital preservation institution is currently providing

As described by Wawrzaszek and Wedaman (2008), the mission of academic libraries is to select, collect and preserve information, and to facilitate access to and the use of information. It is therefore very important to understand types of digital materials users normally seek. Question 13 of the questionnaire listed types of digital materials users normally seek, as identified from the literature review. The respondents were therefore asked to indicate by ticking the applicable box as to the types of materials users normally seek in their institutions.

Table 4.6: Types of digital materials users normally seek

Types of digital materials	Responses	
	Total	Percent
Theses	20	20.6%
Dissertations	18	18.6%
Research data	14	14.4%
Annual reports	9	9.3%
Journal articles	19	19.6%
Conference papers	17	17.5%
Total	97	100.0%

Theses 20 (20.6%), journal articles 19 (19.6%), dissertations 18 (18.6%), conference papers 17 17.5%) and research data 14 (14.4%) were recorded as the most frequent type of materials users normally seek while only 9 (9.3%) of the participants indicated that users normally seek annual reports, as shown in Table 4.6.

As indicated in previous chapters, this study has focused on long-term preservation of digital resources in academic libraries and it is therefore useful to break down what is understood as effective preservation in order to understand the process necessary to achieve the long-term digital preservation of objects. In this regard, the respondents were asked what they regarded as effective digital preservation rated by using a five-point scale, a Likert scale as a measure of the level of agreement and disagreement. The results are presented in 4.7.

Table 4.7: Phrases that best describes effective digital preservation in academic libraries

Effective digital preservation	Strongly Agree (1) %	Agree (2) %	Neutral (3)%	Disagree (4) %	Strongly Disagree (5) %
Data is maintained in the repository without being damaged, lost or maliciously altered	81.8	13.6	-	4.5	-
Data can be found, extracted and served to a user	72.7	22.7	4.5	-	-
Data can be interpreted and understood by a user	40.9	40.9	18.2	-	-
Data can be preserved over a long period of time	86.4	13.6	-	-	-

The following are descriptions of effective digital preservation in academic institutions ranked in order of the highest percentage score: data can be preserved over a long period of time (100%) data can be found, extracted and served to a user (95.4%), data is maintained in the repository without being damaged, lost or maliciously altered (95.4%) and data can be interpreted and understood by a user (81.8%). When asked about the level of the importance of long-term preservation in their institutions, a combined score of (95.4%) by the respondents indicated that long-term preservation of digital resources is very important or extremely important, with only (4.5%) saying it is somewhat important. Figure 4.2 summarizes the results.

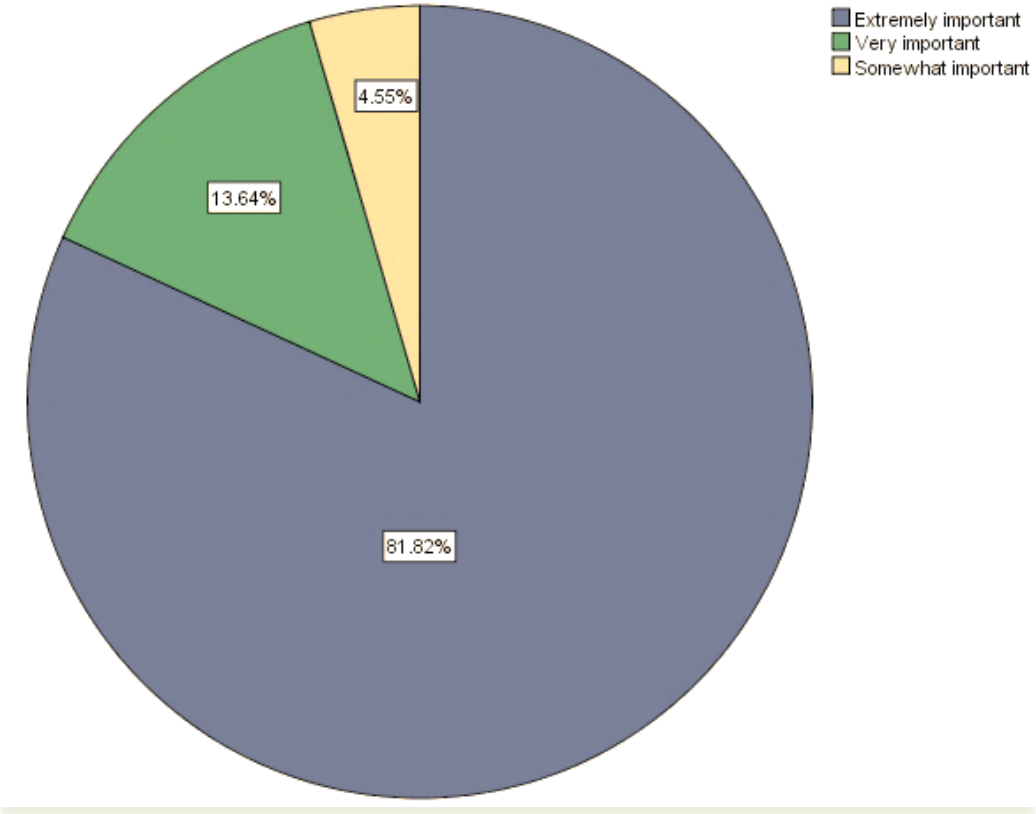

Figure 4.2: Level of the importance of long-term preservation in academic libraries

While this study concedes that preservation systems and databases containing digital materials are useful to institutions and individuals, they can however pose a threat if proper security protections are not put in place. As stated in UNESCO's charter on the preservation of digital heritage:

> The purpose of preserving the digital heritage is to ensure that it remains accessible to the public, and thus access to digital heritage materials, especially those in the public domain, should be free of unreasonable restrictions while at the same time, sensitive and personal information should be protected from any form of intrusion (UNESCO, 2003).

In this regard, the respondents were asked whether they had any measures to protect their digital materials with the majority of institutions 19 (86.4%) indicating that they do have measures to protect their digital resources. Only a few respondents 3 (13.6%) indicated that they do not have any measures to protect their digital materials. The respondents who stated in question 16 that they do have measures to protect

unauthorized access to digital materials were further asked to indicate by ticking in the applicable box the measures taken in their institutions.

Table 4.8: Protection of digital records from unauthorized access

Protection of digital records from unauthorized access	Responses	
	Total	Percent
Access and use policy	18	24.7%
Secure password authentication	13	17.8%
Network security	15	20.5%
Data Security	11	15.1%
Request for access approval	13	17.8%
Using audit trail	3	4.1%
Total	73	100.0%

As shown in Table 4.8, access and use policy 18 (24.7%) was widely implemented as a protection to unauthorized access to digital materials, followed by network security 15 (20.5%), security password authentication 13 (17.8%), request for access approval 13 (17.8%) and data security 11 (15.1%). Only a few institutions were using an audit trail 3 (4.1%).

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

4.2.4 Digital preservation policy

The development of content policies as a clearly documented, realistic and achievable preservation policy is a critical part of the pursuit of digital preservation and it is an essential foundation for any sustainable digital preservation programme. Without the development of policies to ensure the longevity of digital resources, academic libraries cannot be said to be undertaking digital preservation. Developing preservation policies is thus the first step to achieving preservation actions as short, medium, or long-term preservation of digital records are driven by policies. The study thus examined whether or not academic libraries have official digital preservation policies in place to ensure longevity of digital materials. The majority, 17 (77.3%), of respondents reported that their institutions had a written digital preservation policy in place while only 5 (22.7%) indicated that they do not have a policy for digital preservation at all that guides the preservation of data. These indicated that more attention has been paid to digital preservation policies.

The respondents were also asked to indicate the persons who are involved in the development of digital preservation policy and in most institutions respondents indicated that repository managers 16 (27.6%) were involved in the development of preservation policy, followed by university librarians 14 (24.1%) and systems librarian 14 (24.1%). Only a few institutions indicated that collection managers 8 (13.8%) and information technologists 6 (10.3%) were involved in digital preservation policy. Other respondents reported from the “other” category that NRF stakeholders are developing preservation policy in their institutions. The results are presented in 4.9.

Table 4.9: Those involved in the development of preservation policy

Those involved in the development of policy	Responses	
	Total	Percent
University librarian	14	24.1%
Systems librarian	14	24.1%
Collection manager	8	13.8%
Information technologist	6	10.3%
Repository manager	16	27.6%
Total	58	100.0%

In examining the content of digital preservation policy for best practices in other jurisdictions, the survey also sought to find out from respondents the key aspects covered by the preservation policy in their institutions. Question 20 of the research questionnaire listed different aspects of digital preservation policy identified from the literature review, namely: collection development, collection disaster plan, content management, access to digital resources, intellectual property rights, exhibition and loan, selection of materials, preservation ethics, retention and storage. The respondents were asked to indicate applicable aspects of policy covered in their institutions. The entire group of respondents 22 (100%) indicated that all aspects of policies were covered in their institutions. When asked whether the development of preservation policy was important in their institutions, the entire group 22 (100%) of respondents further stated that the development of preservation policy is very important.

The library policy documents were further reviewed to determine which aspects of policy and procedures were in place. The aspects of policy that were documented to be in place included selection, open access to materials, copyright and intellectual rights, preservation policy, metadata policy, collection development and management policy, storage policy; and institutional repositories, research policy, intellectual property policy, metadata policy, digitization policy, digital curation policy and preservation policy. Management and preservation of IRs and other archives in many institutions are thus aligned with these policies. To ensure compliance with policies, some of the institutions

mentioned that they perform a compliance audit with the guidance of an internal audit in order to ensure risk abatement. As a result, annual performance and quality management of the digital preservation programme transpired in some of the institutions to ensure the quality and integrity of the programme. Analysis of the documents also indicated that most of the institutions are reviewing their preservation policies every five years while some are reviewing them every two years. Library digitisation and preservation working groups comprise of IR manager, IT support manager, digitisation specialist, metadata specialist, open access specialist, copyright officer, special collections and representatives (information specialists) from faculty libraries, are responsible for developing and reviewing the policies.

4.2.5 Development of institutional repository

Memory institutions such as libraries, archives and museums are responsible for national digital preservation initiatives and these memory institutions are actively building institutional repositories in an attempt to preserve their digital resources for future access. Literature reveals that in South Africa the majority of academic institutions developed institutional repositories (IRs) in an attempt to manage and preserve scholarly outputs in their libraries (Pienaar & Van De Venter, 2008). The evidence from the survey results and document analysis also shows that most of the academic institutions developed institutional repositories in their institutions. As also observed by Ngulube (2012), the UBC Project (1997) and NLA (2007), developing institutional repositories in academic libraries will preserve and sustain digital information for the present and future generations. The IRs have become a vehicle through which South African collections could be made accessible to the rest of Africa and ultimately to the rest of the world. As a result, the respondents were also asked whether they have institutional repositories in their institutions, and almost all of the respondents 22(100%) reported that their institutions implemented institutional repositories. Furthermore, those that agreed that they do have institutional repositories were also asked to state the purpose of the institutional repository in their institutions. Question 23 was therefore to determine whether institutional repositories serve their purpose and some of the purposes of the institutional repository (IR) were listed in the questionnaire as examined in the literature. Each list was ranked in the usual five-point scale, a Likert scale.

The following are percentage ranking of the perceived purposes of IRs from highest to the lowest: increasing the dissemination of research output by researchers and ensuring long-term accessibility of digital resources both with the same score of 100%; providing a central storage space for intellectual output of an institution and improving visibility to

research output both with the same score of 95.4%, and enhancing academic communication by allowing global users to comment on pre-prints it stored 86.4%. In a nutshell, almost all the respondents acknowledged the importance of digital preservation to their institutions. The findings from document analysis also show that all 22 academic institutions implemented IRs in an attempt to manage and preserve their digital resources for future access. As a result, various types of digital materials have been digitized and made publicly accessible through institutional repositories. The purpose of an IR of digital materials would be to improve the accessibility, resource discovery, preservation and promotion of academic institutions' digital information. The survey results are presented in Table 4.10.

Table 4.10: The purpose of institutional repositories in academic libraries

IR purpose	Strongly Agree (1)%	Agree (2)%	Neutral (3)%	Disagree (4)%	Strongly Disagree (5)%
Increasing the dissemination of research output by researchers	72.7	27.3	-	-	-
Ensuring long-term accessibility of digital resources	63.6	36.4	-	-	-
Enhancing academic communication by allowing global users to comment on pre-prints it stored	45.5	40.9	13.6	-	-
Providing a central storage space for intellectual output of an institution	63.6	31.8	4.5	-	-
Improving visibility to research output	72.7	22.7	4.5	-	-

The respondents were further asked about types of digital materials kept in institutional repositories. As indicated in Table 4.11, theses and journal articles both had the same score of 20 (18.9%) and dissertations 19 (17.9%) were the dominating digital materials kept in IRs in most academic libraries. Annual reports and research notes with the same score of 10 (9.4%), research data 7 (6.6%) and artwork 4 (3.8%) were the least types of

digital materials kept in IRs. Other types of materials kept in their IRs reported by respondents in the “other” category were audios, images and inaugural lecturers.

Table 4.11: Types of materials kept in the institutional repository

Types of materials kept in the institutional repository (IR)	Responses	
	Total	Percent
Theses	20	18.9%
Dissertations	19	17.9%
Annual reports	10	9.4%
Journal articles	20	18.9%
Conference papers	16	15.1%
Research notes	10	9.4%
Research data	7	6.6%
Artwork	4	3.8%
Total	106	100.0%

Digital preservation has been regarded as an important motivation for building IRs and to ensure digital research materials are available and accessible in the long-term. In terms of longevity of digital materials kept in IRs, the majority of the respondents 77.2% indicated that their digital materials are kept for over 15 years, while 9.09% of respondents indicated that they are kept over five years. Only a few respondents with the same score of 4.5% indicated that their digital materials are kept for over 20 years, over 10 years and as long as they needed.

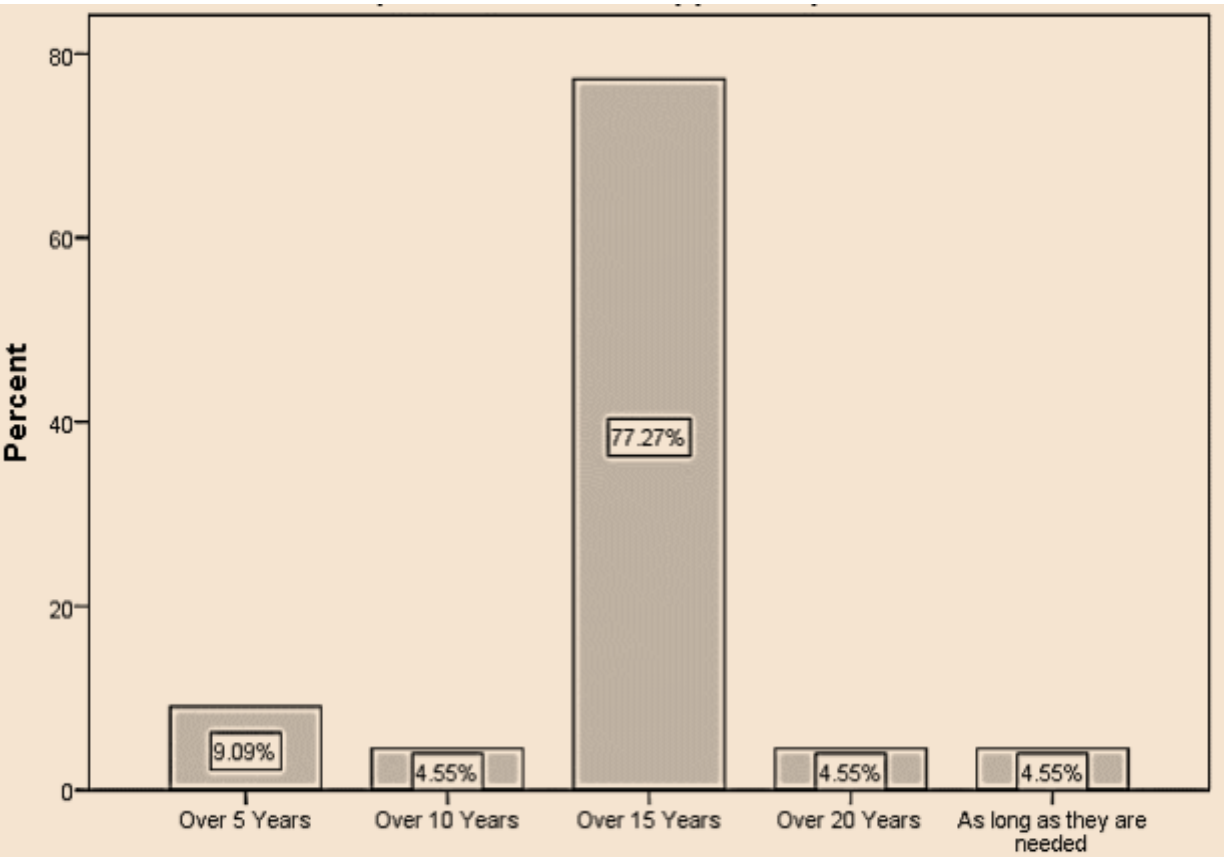

Figure 4.3: Longevity of digital materials kept in the institutional repository

In terms of preservation services offered by their institutions, long-term preservation of digital materials created by faculty, staff, students or others and preservation of institutional records were both rated the same high score of 22(19.1%), and were noted as the most offered services followed by educational materials on digital preservation such as websites, brochures etc. 18(15.7%), and collaborative agreements with other institutions 16(13.9%). Consulting on digital creation best practices and educational workshops on digital preservation, both at 11(9.6%), were noted as the least offered services. The results are shown in Table 4.12.

Table 4.12: Preservation services offered to the user community

Services offered	Responses	
	Total	Percent
Research data curation	15	13.0%
Consulting on digital creation best practices	11	9.6%
Educational workshops on digital preservation	11	9.6%
Educational materials on digital preservation such as websites, brochures etc	18	15.7%
Long-term preservation of digital materials created by faculty, staff, students or others	22	19.1%
Preservation of institutional records	22	19.1%
Collaborative agreements with other institutions	16	13.9%
Total	115	100.0%

With regard to how their digital materials are being preserved, the majority of institutions 59.0% indicated that they are preserving their digital materials collaboratively, while 36.3% of institutions are preserving them both locally and collaboratively and only a few 4.5% are preserving their materials locally, as shown in Figure 4.4.

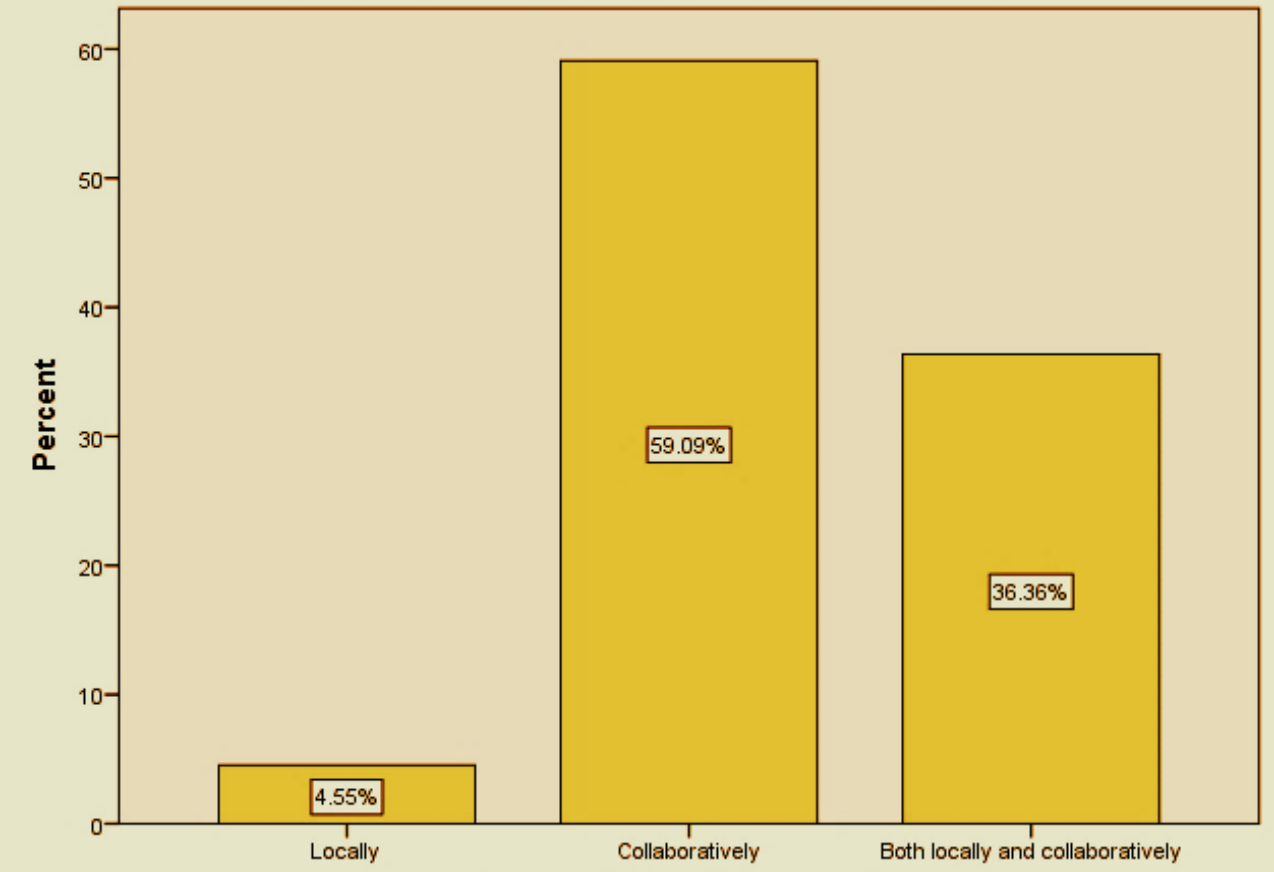

Figure 4.4: The extent to which digital materials are being preserved

Surprisingly, none of the respondents reported outsourcing digital preservation practices in their institutions. However, institutional documents revealed that outsourced services were only considered where material is deemed suitable, again if cost-saving justifies outsourcing and if there is a need for specialised equipment or skills that are not available in-house. One of the institutions noted that the digitisation and preservation unit established a list of suitable service providers for preservation services and established a protocol for requests for estimates, metadata recording and quality assurance to be used when outsourcing.

As noted by the Council of Canadian Academies (2015:82), collaboration with private companies and academia may allow memory institutions to become involved in exciting activities that enhance their visibility and enable them to undertake large projects that they could not otherwise resource on their own. Chapter Two of the current study brought to the fore the enormous benefits of collaborating with other institutions to share resources, knowledge and operate on the same technical standards. Collaboration can make core services more convenient for users, reduce the workload for individual

institutions and increase standardization of policies and digital platforms, facilitating further collaboration. Chapter Two of this study also underscored how the collaborative efforts such as Digital Preservation Coalition (DPC) from the UK, the National Digital Information Infrastructure and Preservation Program (NDIIPP), the International Research on Permanent Authentic Records in Electronic Systems (InterPARES) from the USA, the Data Archiving and Networked Services (DANS) from Netherlands and Scalable Preservation Environments (SCAPE) brought together archival scholars, computer engineering scholars, national archival institutions and the private industry collaborating to formulate international, national and organizational policies, strategies and standards for long-term preservation of authentic records created in electronic systems. Accordingly, the respondents were asked to indicate any collaborative preservation efforts they are involved with. The results are presented in Table 4.13.

Table 4.13: Possible collaborative efforts to preserve digital resources in academic libraries

Collaborative efforts	Responses	
	Total	Percent
Digital preservation Network	10	43.5%
Archive-IT	4	17.4%
OCLC Digital Archive	7	30.4%
DINI	2	8.7%
Total	23	100.0%

Those surveyed reported involvement in a wide array of digital preservation collaborative efforts including Digital Preservation Network (DPN) Archive-IT, OCLC Digital Archive, and Deutsche Initiative for networked Information (DINI). Some of the respondents 10 (43.5%) indicated that their institutions are being involved with Digital Preservation Network (DIN), whilst 7 (30.4%) of the respondents indicated that they have been involved with OCLC Digital Archive and only 4 (17.4%) were involved with Archive-IT and 2 (8.7%) with Deutsche Initiative for Networked Information (DINI). Other interesting collaborative projects the respondents reported being involved with from the “other” category in the questionnaire include COAR, CODATA, Smithsonian Folksway, Alexander Street Press,

DATACITE, CALICO Project Plan, SEALS Consortium, DCC, Archivematica, ATO developers, Digitization and Digital Data Centre. In general, these results are positive as collaborative opportunities drive memory institutions to be relevant. Review of institutional documents further revealed that academic libraries recognise that its role within its communities will mean that it will share its experience and expertise of digitisation with others. This implies that these institutions aim at increasing the quantity and diversity of digital content available to users at the national level by working collaboratively with other national and international institutions. This will also include: providing expertise to other institutions in the development of digitisation and preservation capacity, partnering in order to develop digital collections in areas of common interest, providing a centre for learning, research and skills development, and involvement in outreach for the preservation of ‘at risk’ heritage material. However, only a few of the institutions are partnering with international institutions or organizations to explore the long-term effectiveness of digital preservation. One of these institutions reported engaging with the British Library, which involves collaboration in terms of staff exchange and research.

As highlighted in previous chapters, management support is a key to meeting the challenges of digital preservation. Developing clear policies and processes requires effective leadership or library management that also makes recommendations to staff about preservation standards, technology options, feasibility and training of staff. The respondents were therefore requested to state whether management is supporting digital preservation practices in their institutions by using a Likert scale. The results are presented in Table 4.14.

Table 4.14: Management support on preservation of digital resources

Management support	Strongly Agree (1)%	Agree (2)%	Neutral (3)%	Disagree (4)%	Strongly Disagree (5)%
Supportive for preservation practices	72.7	22.7	4.5	-	-
Willing to collaborate with other organizations	63.6	31.8	4.5	-	-
Willing to benchmark with other institutions	68.2	-	13.6	18.2	-
Do not support the initiative	63.6	22.7	4.5	9.1	-

The following are percentage ranking of the perceived management support from highest to the lowest: supportive for preservation practices (95.4%), willing to collaborate with other organizations (95.4%), and willing to benchmark with other institutions (68.2%) while 86.3% of respondents indicated that management do not support the initiative. In a nutshell, although management in some of the academic libraries is supporting digital preservation in their institutions, management in most of the institutions is not fully supporting the preservation practices.

Analysis of documents indicated that, in some of the institutions, management is supporting digital preservation practices by raising awareness and promoting their digitization and preservation services as well as the use of IRs. These institutions are using tools such as pamphlets, brochures, events, research week, library week, open access week, presentation at conferences, organizing workshops, using university mailing lists and university blogs. Only one institution is using social media such as Facebook and Twitter to promote their digital preservation services.

4.3 Challenges hindering the effective preservation of digital materials in academic libraries

The phenomenal growth of digital content poses a number of challenges for preservation of digital resources in academic libraries. The major challenge faced by academic libraries is to make sure that users can access the content that has been ingested in their institutional repositories and other institutional archives. Thus, the challenges for effective preservation of digital resources in academic libraries are one of the key issues to be addressed. A survey of the literature on digital preservation reveals many challenges involved in preserving digital materials for the long term. These include inadequate staff with expertise in digital preservation, technical obsolescence, intellectual property rights issues, organizational issues, poor technology infrastructure and inadequate funding. The purpose of question 30 of the research questionnaire was thus to investigate the factors hindering the effective digital preservation in academic libraries. It consisted of a list of the different possible factors that inhibit digital preservation in academic libraries identified in the literature.

In order to identify a practical and sustainable solution to digital preservation problems, respondents were asked a multiple set of questions on challenges to digital preservation. Using a Likert scale, respondents were asked to state the problems that hinder the effective preservation of digital materials. The results are summarized in Table 4.15.

Table 4.15: Challenges hindering the effective preservation of digital materials in academic libraries

Digital preservation challenges	Agree (1)%	Agree (2)%	Neutral (3)%	Disagree (4)%	Strongly Disagree (5)%
Inadequate staff with expertise in digitizing resources	59.1	22.7	4.5	13.6	-
Inadequate funding to purchase enough infrastructure	45.5	31.8	4.5	18.2	-
Lack of relevant training	36.4	31.8	9.1	22.7	-
Software obsolescence	36.4	31.8	13.6	18.2	-
Low awareness on preservation issues	27.3	40.9	22.7	9.1	-
Intellectual property and copyright issues	63.6	18.2	4.5	13.6	-
Lack of human resources	40.9	31.8	13.6	13.6	-
Poor technology infrastructure	31.8	45.5	13.6	9.1	-

The majority of respondents considered inadequate staff with expertise in digitizing resources and intellectual property and copyright issues as the main challenges with the same score of 81.8%, and inadequate funding to purchase enough infrastructure and poor technology infrastructure scored with the same score of 77.3%, followed by lack of human resources (72.7%) as the other major challenges inhibiting the effective preservation of digital resources. Other preservation challenges included software obsolescence, lack of relevant training and low awareness on preservation issues with the same score of 68.2%. However, it was surprising to note that respondents did not perceive low awareness on preservation issues on preservation as a challenge as 20.8% of respondents were neutral.

One of the objectives of this study was to establish the barriers for ensuring long-term access to digital materials in academic libraries. The purpose of question 31 of the research questionnaire was therefore to investigate the existing preservation challenges in order to identify preservation requirements in academic libraries, as this will enable the provision of tailored solutions for the domain context. It consisted of a list of the different possible barriers that inhibit long-term access to digital materials in academic libraries as identified from the literature. These were ranked into the usual five point coded scale. The

respondents were asked to tick the category of the column that best described their degree of agreement or disagreement with the barriers to ensuring long-term access to digital materials in their institutions. The results are presented in the Table 4.16.

Table 4.16: Barriers to ensuring long-term access to digital materials

Digital preservation barriers	Strongly Agree (1) %	Agree (2)%	Neutral (3) %	Disagree (4) %	Strongly Disagree (5) %
Lack of practical capacity to preserve digital records	31.8	40.9	13.6	13.6	-
Inappropriate preservation policy	31.8	36.4	18.2	13.6	-
Poor ICT infrastructure	50.0	36.4	4.5	9.1	-
Inadequate resources	50.0	27.3	9.1	13.6	-
Lack of funding	40.9	40.9	9.1	9.1	-
Lack of skills in digital preservation	50.0	36.4	9.1	4.5	-
Lack of knowledge in digital preservation	36.4	27.3	13.6	22.7	-

A large proportion (86.4%) of respondents identified lack of skills in digital preservation, poor ICT infrastructure (86.4%), lack of funding (81.8%), inadequate resources (77.3%) and lack of practical capacity to preserve digital records (72.7%) as the biggest barriers to ensure long-term access to digital materials. The following are other barriers to long-term access that recorded a percentage score within the 60%-69% range: inappropriate preservation policy (68.2%) and lack of knowledge in digital preservation (63.7%).

Again, respondents were given other possible options and asked to rank the general problems faced by their institutions in preserving their digital resources. These were also ranked using the Likert scale. The results are summarized in Table 4.17.

Table 4.17: Challenges faced by academic libraries in preserving digital resources

Digital preservation challenges	Strongly Agree (1)%	Agree (2)%	Neutral (3)%	Disagree (4)%	Strongly Disagree (5)%
Inadequate resources	36.4	13.6	9.1	40.9	-
Lack of knowledge by university leadership	31.8	27.3	18.2	22.7	-
Lack of training among staff members	27.3	31.8	13.6	27.3	-
Slowness in the implementation of preservation programmes at your institution	31.8	13.6	9.1	45.5	-
Lack of management support	22.7	27.3	18.2	31.8	-

From the survey results as shown in Table 4.17, the following were identified as the general problems faced by academic libraries in preserving their digital resources: lack of knowledge by university leadership (59.1%) and inadequate resources (50.0%) followed by lack of management support (50.0%) recorded a percentage score within the 50%-60% range, while slowness in the implementation of preservation recorded 45.4%.

As indicated in previous chapters, this study has focused on long-term preservation of digital resources in academic libraries and, in order to achieve this objective, it was necessary to also establish the challenges faced by academic institutions in providing access to digital content. A list of possible challenges identified in the literature was presented in question 33 of the research questionnaire for the respondents to tick applicable challenges faced by their institutions.

Table 4.18: Challenges faced by academic libraries in providing access to digital content

Challenges in providing access to digital content	Responses	
	Total	Percent
Staff do not understand users' needs	8	17.4%
Staff lack training in digital preservation	12	26.1%
Poor management of digital resources	10	21.7%
Lack of access policy	7	15.2%
Lack of procedures	9	19.6%
Total	46	100.0%

As shown in Table 4.18**,** in most academic libraries the leading problems encountered in providing access to digital content were lack of staff training in digital preservation with the dominating score of 12 (26.1 %), followed by poor management of digital resources 10 (21.7%), while a few institutions 9 (19.6%) reported lack of procedure, staff do not understand users' needs 8(17.4%) and lack of access policy 7 (15.2%) as some of their challenges in providing access to digital content. Other factors such as limited budget and poor infrastructure were also reported as some of the challenges institutions face in providing access to digital content, as noted from the "other "category.

4.4 Preservation strategies used in safeguarding digital resources in academic libraries

Another objective of this study was to determine the preservation strategies that are used in safeguarding digital resources in academic libraries in South Africa. The development of these strategies and guidelines can aid in designing a preservation framework applicable to academic libraries in South Africa. As noted by Wright (2012) any long-term access to digital resources may be heavily dependent on digital preservation strategies being in place and underpinned by relevant policy and procedures. In line with this, the respondents were thus asked to indicate whether there is an established strategy for the successful digital preservation in their academic institutions. The majority of respondents 20 (90.9%) indicated that they have developed preservation strategies in their institutions and only 2(9.1%) of the respondents indicated that they do not have preservation

strategies in place. When asked to indicate who are involved in the development of preservation strategies in their institutions, the majority of respondents 17 (34.7%) indicated that responsible staff members were involved in the development of preservation strategies in their institutions, followed by university librarians and systems librarians both with the same score 12 (25.5%), and collection managers with the score of 8 (16.3%). Other respondents indicated in the “other” category that the library directors and repository managers are involved in the development of preservation strategies in their institutions.

Table 4.19: Those involved in the development of preservation strategies in the institution

Those involved in the development of preservation strategies in the institution	Responses	
	Total	Percent
Staff members responsible for digital preservation	17	34.7%
University librarian	12	25.5%
Systems librarian	12	24.5%
Collection manager	8	16.3%
Total	49	100.0%

However, digital preservation is still a relatively new field for libraries, and academic libraries have yet to implement all of the necessary solutions such as a method of checking the integrity of a digital object's bit stream to verify it has not become corrupted, a way of identifying and validating formats, programmes to migrate materials at risk of obsolescence to new formats, a system of replicating digital materials in various locations, or methods for collecting all of the technical and administrative metadata for preservation. This implies that institutions must create mechanisms that allow for the determination of authenticity based on the trustworthiness of the source of the digital entities and the chosen method of their transmission through time, and then adopt the necessary methods and strategies to preserve them in a sustainable way. Several strategies therefore exist to preserve digital materials for the long term including bit preservation, normalization, emulation, migration, replication and risk management approach.

In order to examine the state of preservation strategies used by academic libraries, question 36 of the survey listed nine possible preservation strategies and asked respondents whether each had been implemented in their institutions. Accordingly, in an attempt to find out other preservation strategies used by respondents, respondents were given multiple options to indicate other preservation strategies adopted in academic libraries. As can be observed in Table 4.20, migration 12 (28.6%), replication 10 (23.8%) and bit preservation 9 (21.4%) were the most common digital preservation strategies being employed in the academic institutions followed by the risk management approach 8 (19.0%). Normalization was the least employed strategy with the lowest score of 3 (7.1%). The results are shown in Table 4.20.

Table 4.20: Preservation strategies employed by the institution

Preservation strategies	Responses	
	Total	Percent
Bit preservation	9	21.4%
Replication	10	23.8%
Normalization	3	7.1%
Migration	12	28.6%
Risk management approach	8	19.0%
Total	42	100.0%

When asked as to whether the preservation strategies adopted by their institutions ensure longevity to digital resources, the entire group of 22 (100%) respondents indicated that the purpose of their strategies is to ensure longevity to digital resources. The respondents were further asked to state other strategies to ensure long-term preservation of digital resources as listed in question 39 of the survey questionnaire. As shown in Table 4.21, needs of the user (95.5%), risk management (90.9%), identification of threats and vulnerabilities (90.9%), succession planning (90.9%), well-documented preservation standards (90.9%), involvement in the creation process (90.9%), accepted standards for metadata systems (86.4%), disaster management (81.8%) and deployment of clouding technologies (72.7%) were reported as other strategies to ensure long-term preservation of digital resources.

Table 4.21: Other strategies to ensure long-term preservation of digital resources

Other preservation strategies	Strongly Agree (1)%	Agree (2)%	Neutral 3)%	Disagree (4)%	Strongly Disagree (5)%
Involvement in the creation process	31.8	59.1	9.1	-	-
Well-documented preservation standards	36.4	54.5	9.1	-	-
Accepted standards for metadata systems	50.0	36.4	13.6	-	-
Needs of the user	45.5	50.0	4.5	-	-
Identification of threats and vulnerabilities	36.4	54.5	9.1	-	-
Disaster management	31.8	50.0	18.2	-	-
Risk management	31.8	59.1	9.1	-	-
Succession planning	50.0	40.9	9.1	-	-
Deployment of clouding technologies	31.8	40.9	22.7	4.5	-

Analysis of library documents also revealed that most of academic libraries were using migration, bit preservation, risk management, metadata and backup as common strategies used for effective preservation of their digital resources. Other strategies that were used are checksum and functional preservation. Checksum was used to verify the integrity of full text file overtime. With the functional preservation strategy, the file does change over time so that the material continues to be immediately usable in the same way it was originally while the digital formats (and the physical media) evolve over time.
The respondents were also asked to state the barriers to implementation of preservation strategies in their institution by ticking the category of the column that best described their degree of agreement or disagreement. The results are shown in Table 4.22.

When asked as to whether the preservation strategies adopted by their institutions ensure longevity to digital resources, the entire group of 22 (100%) respondents indicated that the purpose of their strategies is to ensure longevity to digital resources. The respondents

were further asked to state other strategies to ensure long-term preservation of digital resources as listed in question 39 of the survey questionnaire. As shown in Table 4.21, needs of the user (95.5%), risk management (90.9%), identification of threats and vulnerabilities (90.9%), succession planning (90.9%), well-documented preservation standards (90.9%), involvement in the creation process (90.9%), accepted standards for metadata systems (86.4%), disaster management (81.8%) and deployment of clouding technologies (72.7%) were reported as other strategies to ensure long-term preservation of digital resources.

Table 4.22: Barriers to implementation of digital preservation strategies

Barriers	Strongly Agree (1)%	Agree (2)%	Neutral (3)%	Disagree (4) %	Strongly Disagree (5)%
Limited budget	45.5	40.9	9.1	4.5	-
Lack of knowledge	27.3	36.4	18.2	18.2	-
Poor technology infrastructure	27.3	27.3	31.8	13.6	-
Lack of technical expertise	31.8	36.4	4.5	27.3	-
Lack of human resources	40.9	45.5	4.5	9.1	-
Lack of management support	27.3	27.3	13.6	31.8	-
Lack of funding	36.4	40.9	9.1	13.6	-
Lack of collaborative efforts	27.3	40.9	9.1	13.6	-

A large proportion (86.4%) of respondents identified limited budget, lack of human resources (86.4%), lack of funding (77.3%), lack of collaborative efforts (68.2%), lack of technical expertise (68.2%) and lack of knowledge (63.7%) as barriers to implementation of strategies in the institutions followed by poor technology infrastructure (54.6%) and lack of management support (54.6%), ranging from the highest score to the lowest.

4.5 Preservation systems, software and tools used in academic libraries

One of the objectives of this study was to identify the different types of software or technologies that are used in academic libraries in South Africa. In order to ensure long - term preservation, the institutions should look at implementing tools, systems or software to support various digital preservation strategies. This is important as it is part of library and archives' mission to prevent the loss of cultural and historical material, important scientific and research data, and institutional records. There are different types of software or technologies that are used by academic libraries for preservation of their digital resources. Examples of preservation software or technologies mostly used by academic and other institutions around the world are: Rossetta, Tessella, DAITSS (Dark Archive in the Sunshine State), Archivematica, Dspace, Eprints, ETD-db, Greenstone, AHERO and MyCore, the Flexible Extensible Digital Object and Repository Architecture (Fedora), Greenstone digital library software and the Berkeley Electronic Press (Bepress). Using a multi-response list, respondents were then asked to state which of these different types of software or technologies they had adopted and used in their institutions.

Table 4.23: Types of software used for digital preservation practices

Types of software	Responses	
	Total	Percent
DSpace	15	50.0%
Fedora	5	16.7%
E-Prints	3	10.0%
Greenstone	2	6.7%
Innovative	4	13.3%
I-T	1	3.3%
Total	30	100.0%

Most responses on types of software or technologies used for digital preservation in academic libraries from the above batches of questions fell below a 20% range. This may be because, as observed from the preceding question, most of the software for digital preservation identified have not been used in academic libraries or because these institutions are not aware of these software or technologies. The study revealed DSpace as the dominant software that has been used in most academic libraries with a total score of 15 (50.0%), and it is the only software used for digital preservation in academic libraries that recorded above a 50% score. However, it is important to note that Fedora 5 (16.7%), Innovative 4 (13.3%) and E-prints 3 (10.0%) were slowly being reasonably used in academic institutions. Only two (6.3%) of the respondents acknowledged that their institutions use Greenstone while I-T ranked very low in adoption and usage with just one user (3.3%), as shown in Table 4.23. Other software used in academic libraries obtained from the "other" category are access to memory, VITAL, Archivematica and ATOM.

Using a multi-response list, the respondents were also asked to state what motivated them to use a particular software or technology by indicating whether it is ease of use, affordable, used by other institutions, if they have relevant knowledge and if they are abide by the library policy. The majority of respondents indicated that DSpace, E-prints both with the score of 27.3% and I-T (22.7%) were noted as ease of use. 22.7% of respondents also noted that DSpace is affordable while 22,7% of respondents stated that DSpace is used because they have relevant skills. Most of respondents reported that they are using Tesella (31.8%), Greenstone (31.8%), Fedora (27.3%) and E-prints (27.3%) as per library policy while Tesella (45.5%%), Fedora (40.9%), Greenstone (40.9%), Innovative (36.4%), and I-T (31.8%) were not used in most of the institutions. On the other hand, the respondents indicated that they are using Greenstone and Tesella with the same score of 31.8% as per library policy. Fedora and E-prints with the same score of 27.3%. were also cited by respondents as used per library policy. Table 4.24.summarizes these details.

Table 4.24:Reasons for using software

Reasons for using software	Ease to use	Affordable	Has relevant knowledge	It is used by other institutions	Library policy	Not used at my institution
DSpace	27.3	22.7	22.7	4.5	18.2	4.5
Fedora	9.1	4.5	9.1	9.1	27.3	40.9
E-prints	27.3	4.5	18.2	-	27.3	22.7
Greenstone	4.5	4.5	4.5	13.6	31.8	40.9
Innovative	13.6	4.5	9.1	18.2	18.2	36.4
I-T	22.7	-	18.2	13.6	13.6	31.8
Tesella	9.1	-	9.1	4.5	31.8	45.5

It was evident from document review that most of academic libraries were adopting new technologies and are selecting the most effective technologies for preservation of their digital resources. DSpace software was noted as the dominant software used by many institutions in preserving their digital content kept in IR. This software complies with the Open Archives Initiative (OAI); thus allowing items in IRs to be easily discovered by web search engines, services and indexing tools. Review of documents revealed E-print, ETD and Digital commons as other open source software that were commonly used to support IRs in academic libraries while DuraCloud, Fedora, Bepress, BagIT, and Greenstone were slowly being used in these institutions. Corporation for National Research Initiative (CNRI) handler system was also used to support digital preservation practices, and with this system each item in the repository is assigned a unique identifier and it will remain valid even if content migrates to a newer system. However, one institution noted in an institutional document that they are using virtual/cloud server for backup but they suffered very badly with performance and currently use Bare Metal Server as it is faster and user friendly. However, the efficacy of these systems is dependent on the calibre and commitment of the library leadership and management, and on the careful selection, training and development of its staff.

The academic libraries should also look at implementing tools or systems to support various digital preservation strategies in order to ensure long-term preservation of their digital resources. Such tools and systems should also support metadata standards, selection and appraisal policies, and format identification for digital preservation. Therefore, the next step was to establish the types of tools used for digital preservation in academic libraries. Like the software or technologies for digital preservation, different

types of tools were identified in the literature review, and listed in question 42 of the research questionnaire. Using a multi-response list, the respondents were requested to indicate the types of tools used for digital preservation and what motivates them to use the particular tools. The results of the frequency of use give an indication of the different tools that exist in academic libraries. The results reveal that LOCKSS 7 (21.9%) was the dominant tool that has been used in most academic institutions in South Africa. Other common tools of digital preservation used by academic libraries were DigiTool 6 (18.8%), Content dm 6 (18.8%) and Archive-IT 5 (15.6%). DuraCloud with a score of 3 (9.4%), Archivematica 3 (9.4%) and Exiftool 2 (6.3%) were the least used tools in academic libraries, as shown in Table 4.25.

Table 4.25: Types of tools used for digital preservation practices

Types of preservation tools	Responses	
	Total	Percent
LOCKSS	7	21.9%
DigiTool	6	18.8%
Exiftool	2	6.3%
Archivematica	3	9.4%
CONTENT-dm	6	18.8%
DuraCloud	3	9.4%
Archive-IT	5	15.6%
Total	33	100.0%

Regarding the reasons for the motivation of use across the various tools, the two highest scores of 13.6% indicated Digitool and Duracloud were easy to use respectively. In terms of affordability, a score of 13.6% indicated that the Duracloud and Archivematica were affordable. Digitool was also found to be affordable and accounted for 9.1%. Equal scores of 18.2 % among academic institutions indicated that they were motivated to use Exiftool and Archivematica as per library policy. Preservation tools such as CONTENT-dm, Dura Cloud, Archive-IT, Bepress, DROID, BagIT, JHOVE, Rosetta Digitool and LOCCKSS with score between 50-59% were reported as not being used by most of the institutions. Table 4.26 shows a breakdown of multi-responses regarding the reasons cited for motivation to use each of the tools.

Table 4.26: Motivation to use preservation tools

Motivation to use preservation tools	Ease to use	Affordable	Has relevant knowledge	It is used by other institutions	Library policy	Not used at my institution
LOCKSS	9.1	-	9.1	18.2	13.6	50.0
Digitool	13.6	9.1	-	9.1	13.6	54.5
Rosetta	9.1	-	4.5	13.6	13.6	59.1
Exiftool	9.1	-	9.1	18.2	18.2	40.9
Archivematica	9.1	13.6	-	13.6	18.2	45.5
CONTENT-dm	4.5	4.5	4.5	13.6	13.6	59.1
Dura Cloud	13.6	13.6	9.1	13.6	-	50.0
Archive-IT	4.5	-	4.5	18.2	13.6	59.1
BPress	4.5	-	4.5	18.2	13.6	59.1
DROID	4.5	-	4.5	18.2	13.6	59.1
BagIT	4.5	-	4.5	18.2	13.6	59.1
JHOVE	4.5	-	9.1	13.6	13.6	59.1

Another way of addressing the challenges of digital preservation is the development of metadata standards to organize and retrieve content in the digital preservation system. Corrado and Moulaison (2014:25) pointed out that no matter how well a digital file is protected, it cannot be found and retrieved if is not digitally preserved. For this reason, it is important to have descriptive metadata that provides attributes of the content being described, including information such as author, title and subject. Literature also revealed that valuable metadata is the best way of minimizing the risk of digital resources becoming inaccessible and to be most valuable for all and needs to be consistently maintained throughout the process (NISO, 2004). For the current study, the issue of preservation

metadata is critical in understanding the extent to which information systems in the academic libraries captured digital resources to provide evidence. The respondents were therefore asked to state whether they recorded preservation metadata in their institutions and 17 (77.3%) of respondents reported that they are recording preservation metadata while only 5 (22.7%) stated that they are not recording any preservation metadata in their institutions.

While all types of metadata are crucial for the preservation of digital collection, preservation metadata has a unique way of ensuring the long-term access and management of digital collections. Various metadata standards are also being employed by academic institutions to collect preservation metadata as identified from the literature review; among others are: PREMIS, METS, Dublin Core, OCLC and the OAIS model. The study, therefore, sought from respondents the type of preservation metadata that applies to their academic libraries. The majority of the respondents 15(57.7%) reported using Dublin Core, 8 (30.8%) were using OCLC, while only few were using the OAIS model, PREMIS and METS all three with the score of 3.8%. The findings show that accessibility and usability of content in the digital preservation environment are enhanced through the creation and management of preservation metadata.

Table 4.27: Preservation metadata standards used by academic libraries

Preservation metadata standards	Responses	
	Total	Percent
PREMIS	1	3.8%
Dublin Core	15	57.7%
OCLC	8	30.8%
OAIS Model	1	3.8%
METS	1	3.8%
Total	26	100.0%

As indicated in institutional documents, most of academic libraries employ widely accepted national and international standards and practices for digital capture, storage, preservation, curation and access. These institutions thus aimed to produce, preserve and present its digitized collections to the highest recognized standards and also to

provide catalogue records according to international standards. This also implies that academic libraries are committed to applying generally accepted standards for creating, managing and providing access to digitised materials and they adhere to established standards and adopt best practice in digital capture and post-processing activities. Most of these institutions recorded using Dublin Core Schema to collect metadata from the item, consisting of 15 elements and the qualifiers for each, is used to collect metadata from an item or resource, as discussed in Chapter Two of the study. The reasons for collecting metadata was to aid in the retrieval process and for use in later products in their institutions. Review of library documents also indicated that in many institutions metadata is harvested by Google, Google scholar, Worldcat, ROAR, OpenDOAR, NETD and OATD. However, one of the institutions noted that most of their digital resources are available on WorldCat and are downloaded from the OCLC database.

The respondents who indicated that they record preservation metadata in their institutions were also asked to state the kind of preservation metadata information recorded across academic libraries. The majority of respondents cited technical information and structural metadata, both with the score of 17 (20.0%) as the most popular type of preservation metadata recorded in their institutions, followed by rights information with the score of 15 (17.6%), access restrictions 14 (16.5%) and documentation of preservation accounted for 13 (15.3%). Only a few respondents 9 (10.0%) recorded provenance or ownership rights as the type of metadata information recorded. The results are shown in Table 4.28.

Table 4.28: Preservation metadata information recorded in academic libraries

Preservation metadata information	Responses	
	Total	Percent
Technical information	17	20.0%
Documentation of preservation	13	15.3%
Rights information	15	17.6%
Access restrictions	14	16.5%
Structural metadata	17	20.0%
Provenance or ownership history	9	10.6%
Total	85	100.0%

As indicated in institutional documents, many libraries recorded different types of metadata information and the majority of these institutions were recording descriptive metadata as it is very important to give a description of how the file was created in the "Description" field of the submission form, the origin of the file, etc. and to enable access to digital resources submitted to the institutional repository, as long as they are needed. Description field is also use to describe the dimensions of the object, how it was digitized, etc. and this kind of information will help information architects of the future to migrate obsolete files to updated versions, so that it will still be accessible over a long period of time. Other types of metadata recorded by institutions as indicated in institutional documents include provenance metadata, descriptive metadata, administrative metadata, technical metadata and preservation metadata.

4.6 Factors influencing digital preservation sustainability in academic libraries

Another objective was to establish factors influencing digital preservation sustainability in academic libraries. A fundamental fact of digital sustainability is that, without preservation, there is no access (BRTF, 2010). Ensuring sustainable preservation of digital resources can be challenging and it is appropriate to review and discuss various factors influencing digital preservation in academic libraries. This study thus considers that the understanding of the factors or elements influencing digital preservation sustainability can lead to the establishment of a preservation framework applicable to academic libraries in South Africa. An understanding of the factors may also assist academic libraries to develop multiple-option, multiple-path strategies to achieve future goals and to progress in effective digital preservation.

Again, using the Likert scale as a measure of the level of agreement and disagreement, academic institutions were asked to state the factors influencing digital preservation sustainability. As shown in Table 4.29, the entire group of participants (100%) indicated copyrights and intellectual property rights as the major influencing factor for digital preservation sustainability in academic libraries. Other major factors ranked in order of highest percentage scores were implementation of trustworthy digital repository (95.5%), technical expertise (95.5%), management support (95.5%), implementation of policies and procedures (95.5%), skilled trained staff (95.5%), knowledge of preservation tools (95.5%), effective collaboration with other institutions (91.0%), knowledge of metadata systems (91.0%), partnerships with other institutions (90.9%) and good governance (90.9%). The above factors recorded a high percentage score of 90% and above. Other influencing factors on the sustainability of digital preservation that recorded a percentage score within the 70 to 80.9% range are adequate resources (87.5%), implementation of preservation strategies (87.5%), participatory community (87.5%) and knowledge of

preservation tools (70.8%). With regard to implementation of policies and procedures, only 4.2% were neutral.

Table 4.29: Factors influencing digital preservation sustainability in academic libraries

Influencing factors	Strongly Agree (1) %	Agree (2) %	Neutral (3)%	Disagree (4)%	Strongly Disagree (5) %
Organizational/management support	59.1	36.4	4.5	-	-
Implementation of policies and procedures	77.3	18.2	4.5	-	-
Adequate resources	59.1	31.8	9.1	-	-
Effective collaboration with other institutions	45.5	45.5	9.1	-	-
Implementation of preservation strategies	45.5	40.9	13.6	-	-
Participatory community	45.5	45.5	9.1	-	-
Partnerships with other institutions	63.6	27.3	9.1	-	-
Implementation of trustworthy digital repository	50.0	45.5	4.5	-	-
Good governance	50.0	40.9	9.1	-	-
Copyrights and intellectual property rights	59.1	40.9	-	-	-
Technical expertise/Digital preservation experts	68.2	27.3	4.5	-	-
Skilled trained staff	50.0	45.5	4.5	-	-
Knowledge of metadata systems	54.5	36.5	4.5	4.5	-
Knowledge of preservation tools	45.5	50.0	4.5	-	-

The respondents were also asked to indicate the factors that were hindering professional growth in preserving digital resources in academic libraries, using a Likert scale. The majority of respondents (72.7%) stated that limited budget was inhibiting digital preservation growth while 63.7 % of the respondents said time limit was also seen as a

stumbling block to the growth of digital preservation and 54.6% of the respondents indicated that limited support from the institution leadership as also inhibitor of preservation growth. Other factors included: lack of information on training offered accounted for (50.0%), lack of policy with a score of (40.9%), lack of training (40.9%) and lack of motivation (31.8%).The results are presented in Table 4.30.

Table 4.30: Factors hindering professional growth in preserving digital resources in academic libraries

Hindering factors	Strongly Agree (1)%	Agree (2) %	Neutral (3) %	Disagree (4) %	Strongly Disagree (5) %
Limited budget in your institution	31.8	40.9	22.7	4.5	-
Time limit	27.3	36.4	13.6	22.7	-
Lack of policy	22.7	18.2	36.4	22.7	-
Limited/lack of information on training offered	27.3	22.7	40.9	9.1	-
Limited support from the institution leadership	27.3	27.3	27.3	18.2	-
Lack of motivation	18.2	13.6	27.3	40.9	-
Lack of training	22.7	18.2	31.8	27.3	-

Once more, using a Likert scale, when asked to state the factors that need to be considered for effective preservation of digital resources in academic libraries, a list of possible factors identified in the literature was presented in question 49 of the research questionnaire. As in previous questions, respondents were asked to tick the category in the column that best described the degree of agreement or disagreement with respect to the factors enabling the effective preservation of digital resources in academic libraries.The results are presented in Table 4.31.

Table 4.31: Factors enabling the effective preservation of digital resources in academic libraries

Enabling factors	Strongly Agree (1)%	Agree (2)%	Neutral (3) %	Disagree (4) %	Strongly Disagree (5)%
Effective leadership	68.2	27.3	4.5	-	-
Proper ICT infrastructure	54.5	36.4	9.1	-	-
Adequate skilled staff	59.1	36.4	4.5	-	-
Adequate training	50.0	45.5	4.5	-	-
Management support	63.6	36.4	-	-	-
Sufficient budget	54.5	36.4	4.5	4.5	-
Collaboration with other institutions	45.5	45.5	9.1	-	-

Most academic institutions considered management support with a combined score of 100%, adequate skilled staff with a combined score of 95.5%, effective leadership with a combined score of 95.5%, adequate training with a combined score of 95.5%, collaboration with other institutions (91.0%), proper ICT infrastructure (90.9%) and sufficient budget (90.9%) as factors enabling effective digital preservation. As noted in institutional documents, implementing effective digital preservation also relies on the identification and assessment of the extent and suitability of equipment and skills. Therefore, in order to implement effective digital preservation, some of academic libraries perform auditing to identify:

- A critical mass of resources for digitization and preservation;
- Existing useful hardware or software; and
- Required staff skills and training.

The audit thus includes the analysis of skills availability and capacity in supporting functions such as intellectual property rights (IPR) management, metadata development and cataloguing, systems and database development and support.

4.7 Digital preservation training

The changes from traditional to digital world has posed many challenges to information professionals in academic libraries and are faced with managing hybrid resources (print and electronic) that acquire the necessary skills. Therefore, information professionals at various levels need to strive hard to implement the latest ICT advancements in their libraries and also to handle electronic or digital documents to bring change in the environment as per the goals of the parent organization. In this regard, the respondents were asked to state whether they received any education or training in digital preservation. When asked whether they received training in digital preservation, the majority of respondents 17 (77.3%) indicated that they had received training in digital preservation while a few respondents 5 (22.7%) indicated that they had not received any digital preservation training. Those that agreed that they did receive training in digital preservation were asked to state how this training assisted them to perform preservation duties at their institutions. As shown in Figure 4.5, the majority (40.9%) felt that such training was very useful and 36.3% found it very useful, with only 22.7% of the respondents stating that it was not useful.

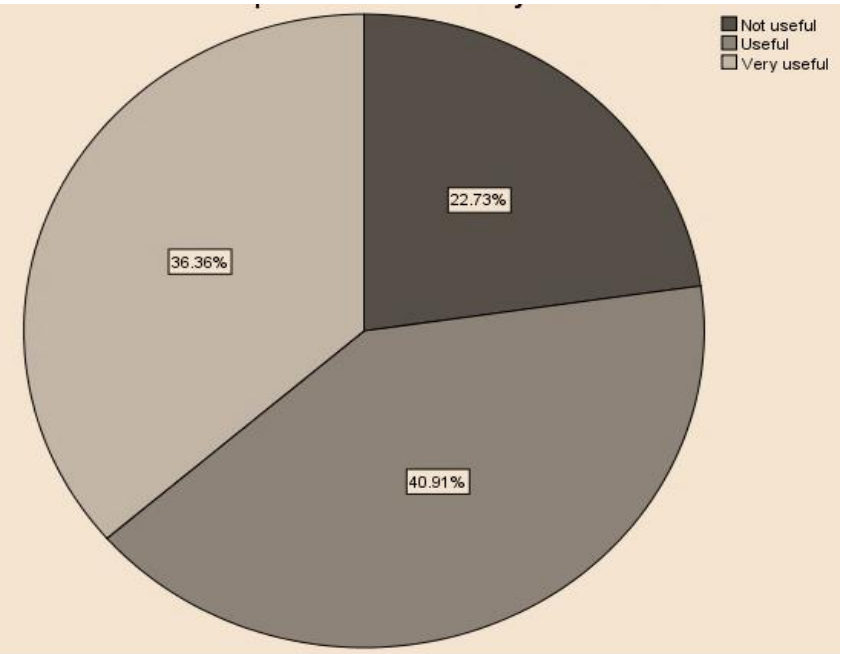

Figure 4.5: Usefulness of digital preservation training

In terms of acquisition of skills, the respondents indicated that most skills and expertise that they have been using were acquired from the past job 12 (50.0%), 7(29.2%) from formal training and a handful of respondents 5(20.8%) acquired their skills from university.

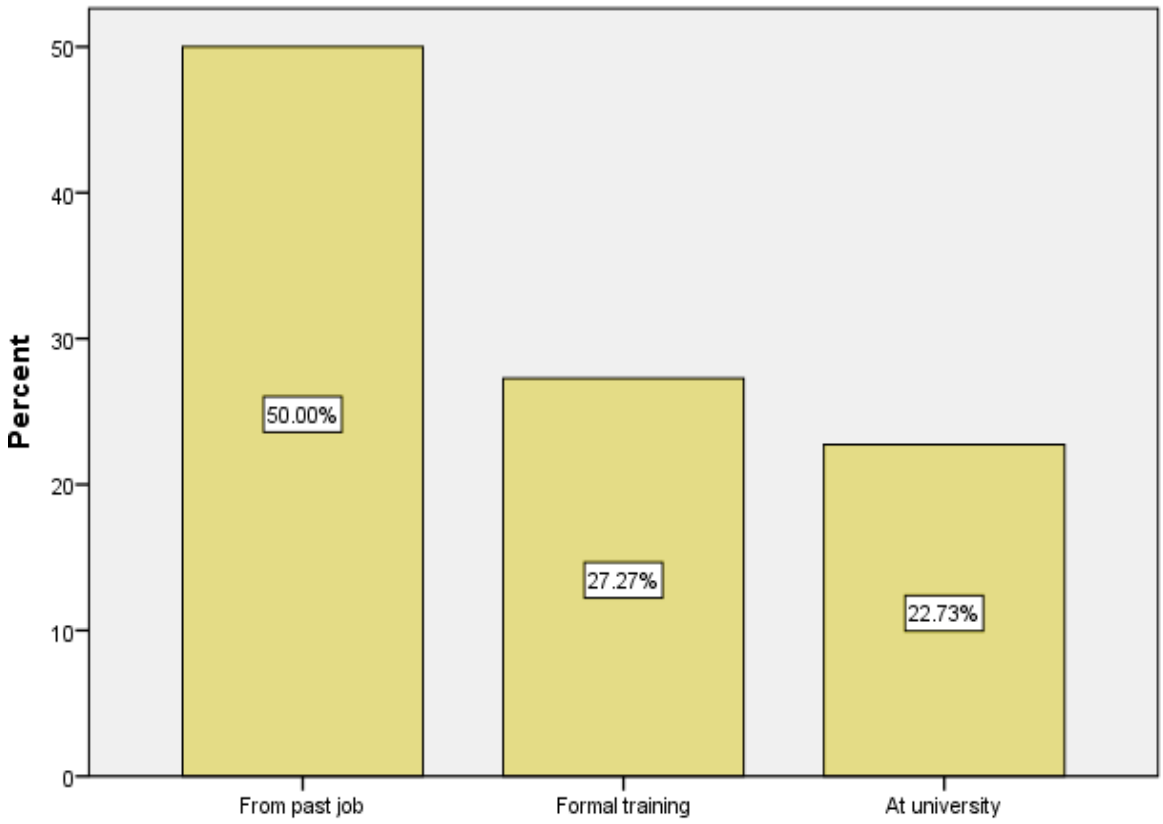

Figure 4.6: Acquisition of skills and expertise

In an attempt to identify the skills or knowledge gap among respondents in the area of digital preservation and to enhance the professional practices, respondents were to choose from possible training programmes suitable for their training needs. Such training programmes have the potential to help information professionals unlock, manage and curate their digital materials. Against the backdrop that digital preservation is an extremely complex area and evolving field that requires great deal of knowledge to understand, respondents were asked about their training needs through the Likert scale. The majority of respondents (90.9%%) preferred digitization and digital preservation programmes followed by preserving electronic resources during their entire life-cycle and the application of digital technologies in preservation practices, both with the same score of 86.4%, as depicted in Table 4.32.

Table 4.32: Training needs in digital preservation

Training needs	Strongly Agree (1)%	Agree (2)%	Neutral (3)%	Disagree (4)%	Strongly Disagree (5)%
Preserving electronic resources during their entire life cycle	45.5	40.9	-	13.6	-
Digitization and digital preservation programme	31.8	59.1	-	9.1	-
The application of digital technologies in preservation practices	40.9	45.5	4.5	9.1	-

The study also agrees with the empirical literature that training programmes are needed to help information professionals manage the anticipated problems of digital records (IRMT, 2008; 2009). When asked about the training programmes that their institutions would prefer to be delivered to their membership to enhance their digital preservation skills, seminars and workshops (23.9%) and on the job training (23.9%) appear to be the most preferred programmes to meet their training needs followed by online training with the score of 19.7%, internships and training in digital preservation in schools and colleges, both with the same score of 12.7%. Use of consultants (7.0%) was not preferred by most institutions.

Table 4.33: Preferred digital preservation training programmes in academic libraries

Preferred digital preservation training programmes	Responses	
	Total	Percent
Seminars and workshops	17	23.9%
Internships	9	12.7%
Use of consultants	5	7.0%
Training in digital preservation school and colleges	9	12.7%
On the job training	17	23.9%
Online training	14	19.7%
Total	71	100.0%

As noted in library documents, some of academic institutions are offering the following modes of training: online (self-help) training, face-to-face training, e-classroom training and virtual training to help information professionals to manage and preserve their digital materials.

4.8. Summary of key findings

This chapter dealt with the presentation of the data collected from academic libraries in South Africa. A summary of the major findings was organized according to the themes raised by the research questions of the study. The summary of the findings of the study are as follows:

4.8.1 Implementation of digital preservation programmes in academic libraries

- The overwhelming majority of academic libraries in South Africa have formal digital preservation programmes in place and have undertaken efforts to preserve their

digital materials;

- These institutions also indicated that they do have a dedicated budget for digital preservation practices; and
- The library management team and repository managers were reported as responsible for digital preservation activities in academic libraries.

4.8.1.1 Types of materials in digital forms

- Theses, dissertations, research data, annual reports, journal articles, conference papers, images, audios and institutional records were the most common types of materials in digital forms in most of academic libraries.

4.8.1.2 Types of materials being preserved

- Academic libraries preserved various types of materials that included theses, dissertation, textual documents, research data, images, journal articles and institutional records;
- Theses were also reported as the most frequent type of material users normally seek;
- The results show that the majority of academic libraries are taking a long-term perspective (as long as they needed) and only a few institutions are taking short term (less than 10 years) and medium term (over 10 years) perspectives; and
- Long-term preservation of digital resources is perceived as very important or extremely important.

4.8.1.3 Measures to protect unauthorized access

- There were clear admissions that security measures were in place to protect digitized materials from unauthorized access;
- Security measures such as access and use policy, secure password authentication, network security, data security and request for access approval were used to protect digitized materials from unauthorized access; and
- Only a few institutions were using an audit trail to protect unauthorized access to digital resources.

4.8.2 Digital preservation policy

- The majority of academic institutions had a written digital preservation policy in place to guide and support the implementation of digital preservation;
- The acceptability of data in academic libraries were therefore guided by digital preservation policy;
- The question, however, is whether these policies are enough to ensure the effective implementation of a digital preservation in every academic institution;
- The preservation policy was developed by systems librarians, repository managers and collection managers in most of academic institutions; and
- The following aspects of policies were covered, namely: collection management and development, digitization policy, preservation policy, open access to digital resources, intellectual property rights, institutional repository policy, selection of materials, security, preservation ethics, retention and storage policy.

4.8.3 Development of institutional repositories in academic institutions and its purposes

- Most of the academic institutions have implemented institutional repositories with the following purposes: to increasing the dissemination of research output by researchers, ensuring long-term accessibility of digital resources, providing a central storage space for intellectual output of an institution, improving visibility to research output and enhancing academic communication by allowing global users to comment on pre-prints it stored;
- However, ensuring long-term accessibility of digital resources was the major purpose of implementing institutional repositories in many institutions; and
- Academic libraries indicated that their digital materials are kept in the institutional repositories for over 15 years.

4.8.3.1 The extent to which digital materials are being preserved

- A significant number of academic libraries are preserving their digital materials locally while only a few institutions indicated that they are preserving their digital materials both locally and collaboratively.

4.8.3.2 Preservation services offered by academic institutions

- The majority of the academic libraries are offering all the services as listed in the questionnaire: research data curation, consulting on digital creation best practices, consulting on digital preservation practices, educational workshops on digital preservation, educational materials on digital preservation such as websites, brochures etc., long-term preservation materials created by faculty, staff, students or others and preservation of institutional records.

4.8.3.3 Digital preservation collaborative efforts

- Digital preservation thrives on collaborative opportunities;
- Collaborative effort can help academic libraries to cut down cost, facilitate networking and share responsibilities;
- The future of digital curation depends on the collaborative efforts from all the various stakeholders;
- Collaboration and strategic alliances should form part of the solutions to the unending problems of digital preservation;
- Most of the academic libraries have in one way or the other made some overtures to some organizations and other memory institutions to collaborate with them; and
- The results show that the majority of academic libraries are involved in various collaborative efforts such as Digital Preservation Network DPN), Archive-IT, OCLC Digital Archive, Deutsche Initiative for Network Information (DINI), Archivematica, DCC, Digitization and Digital Data Preservation Centre, CODATA, COAR, DATACITE.

4.8.4 Challenges hindering the effective preservation of digital materials

- Academic libraries are faced with major preservation challenges such as: funding, inadequate staff with expertise in digitizing resources, intellectual property and copyright issues, inadequate funding to purchase enough infrastructure, poor technology infrastructure, software obsolescence, inadequate resources, lack of relevant training, low awareness on preservation issues, lack of knowledge or skills in digital preservation, lack of practical capacity to preserve digital records.

4.8.4.1 Barriers to ensuring long-term access to digital resources

- Ensuring long-term access to digital resources in academic libraries was very important but a lack of skills in digital preservation, poor ICT infrastructure, lack of funding, inadequate resources and lack of practical capacity to preserve digital records were identified as key barriers to ensure long-term access to digital resources;
- Academic libraries also encountered other problems in terms of preserving their digital resources such lack of management support, lack of knowledge by university leadership and slowness in the implementation of preservation;
- Other barriers in an attempt to provide access to digital content were that staff do not understand users' needs and they lack training in digital preservation.

4.8.5 Digital preservation strategies

- Any long-term access to digital records rests heavily on preservation strategies underpinned by digital preservation policies;
- Most academic institutions reported that they have digital preservation strategies in place and they indicated that the purpose of their strategies is to ensure longevity to their digital resources;
- Responsible staff members, university librarians, systems librarians, collection managers and repository managers were involved in the development of preservation strategies;
- Bit preservation, migration, risk management approach and replication were the most profound preservation strategies being implemented in academic libraries;
- Normalization and emulation were the least implemented preservation strategies;
- Survey findings and document analysis also revealed other strategies to ensure long term preservation including needs of the user, risk management, identification of threats and vulnerabilities, succession planning, well-documented preservation standards, involvement in the creation process, accepted standards for metadata systems, disaster management, back up, checksum and deployment of clouding technologies.

4.8.5.1 Factors hindering the implementation of preservation strategies

- Limited budget, lack of human resources, lack of funding, lack of collaborative efforts, lack of technical expertise and lack of knowledge were identified as the main factors hindering the implementation of strategies in academic libraries.

4.8.6 Digital preservation software, technologies and tools used in academic libraries

- DSpace was the dominant software that has been used in most of academic libraries in South Africa;
- Fedora, E-prints, Innovative and Greenstone were slowly being reasonably used in the academic libraries while I-T ranked very low in usage;
- Other software reported to be used by academic libraries were access to memory, ETD, Digital commons, VITAL, Archivematica and ATOM;
- By comparison of the reasons for the motivation of use across the various software, the DSpace, E-prints and innovative were easy to use and affordable; while Fedora and Greenstone were used as per the library policy; and
- Most of academic libraries were, however, clueless about preservation software such as Fedora, Greenstone and Tesella

4.8.6.1 Digital preservation tools

- LOCKSS was the dominant tool that has been used for digital preservation practices in the academic libraries followed by DigiTool, Content dm and Archive-IT;
- Digital preservation tools such as Archivematica, Exiftool and Dura Cloud ranked very low in adoption and usage;
- However, most academic libraries were clueless about preservation tools such as DROID; Bepress, BagIT, Rosetta, and JHOVE; and
- By comparison, of the reasons for the motivation of use across the various tools, DigiTool and Archive-It were easy to use while CONTENT-dm and LOCKSS are found to be affordable.

4.8.6.2 Digital preservation metadata and standards

- Preservation metadata was noted as one of the strategies used in addressing the challenges of digital preservation;
- The majority of academic libraries are recording preservation metadata and more than half of respondents were aware of the digital preservation standards;
- Preservation metadata standards such as Dublin Core and OCLC were mostly used by academic libraries;
- However, PREMIS, Reference Model for Open Archival Information system (OAIS) and METS were the least used metadata standards; and
- A significant number of academic institutions were recording technical information, structural metadata, rights information, access restrictions and documentation of preservation, however, provenance or ownership history ranked very low.

4.8.7 Factors influencing digital preservation sustainability

- Implementation of trustworthy digital repository, technical expertise, management support, implementation of policies, skilled trained staff, effective collaboration with other institutions, partnerships with other institutions, good governance and knowledge of metadata systems, were identified as main factors influencing digital preservation sustainability in academic libraries; and
- Other influencing factors to the sustainability of digital preservation include: adequate resources, implementation of preservation strategies, participatory community and knowledge of preservation tools.

4.8.7.1 Factors hindering digital preservation growth

- Limited budget was the most inhibiting factor to digital preservation growth, followed by time limit; and
- Other stumbling blocks to the growth of digital preservation are lack of training, lack of policy and lack of motivation.

4.8.7.2 Factors enabling effective digital preservation

- Management support, adequate skilled staff, effective leadership, adequate training, proper ICT infrastructure, sufficient budget and collaboration with other

institutions were noted as the main factors enabling the effective digital preservation.

4.8.8 Digital preservation training

- Over half of respondents reported that they received digital preservation training and only a few respondents indicated that they had not received any education or training in digital preservation in their institutions;
- However, the majority of academic institutions find preservation training to be useful.

4.8.8.1 Digital preservation skills and expertise

- Most of information professionals in academic libraries acquired preservation skills and expertise from their past job through self-learning and through formal training whereas the least of them acquired them from the university.

4.8.8.2 Training needs in digital preservation

- Most of information professionals need training or skills in areas such as digitization and digital preservation programmes, preserving electronic resources during their entire life-cycle and the application of digital technologies in preservation practices.

4.8.8.3 Preferred training programmes

- Preservation training programmes were needed to help information professionals to adequately manage and preserve their digital records;
- Most of the information professionals therefore preferred digital preservation training to be delivered to their membership through a mixture of seminars and workshops, on the job training, online training, internships and training in digital preservation schools and colleges;
- Seminars and workshops were also considered as the most useful in meeting the training needs in digital preservation in academic libraries; and
- Only a few academic libraries preferred using external consultants for digital preservation practices.

CHAPTER FIVE

INTERPRETATIONS AND DISCUSSION OF FINDINGS

5.1 Introduction

This chapter provides the discussion and interpretation of the research findings by relating the findings from the analysis with the findings from the literature review in order to provide the suggested guidelines and recommendations for sustainable digital preservation in academic libraries in South Africa. The library has now expanded its scope to include the generation, collecting, organizing, capturing and preservation of digital materials, instead of sticking to the traditional role of selecting, collecting, and acquisition of books and materials. Wawrzaszek and Wedaman (2008) emphasized that the libraries must actively embrace the changes in the information environment in order to fulfil their traditional mission and to stay relevant in the digital world. The map of research literature created in Figure 2.1 of Chapter Two was a handy guide that demonstrates that academic libraries have shifted from traditional library practice to digital libraries. The question is how do the traditional library mission, structure, processes, and staffing transfer to this new environment and remain relevant in the digital era.

The literature also revealed that academic libraries are challenged by the increasing application of digital technologies that have led to the creation of digital resources by these institutions. This dramatic change to the digital era and associated challenges of preserving digital assets have therefore created the need for best practices and implementation of preservation strategies in ensuring long-term preservation of digital resources in academic libraries. As a way forward, this study investigated the factors that would ensure successful implementation of digital preservation practices in academic libraries in South Africa, and how these factors can be structured into a framework that can inform the implementation of the sustainable digital preservation applicable to these institutions. To achieve this objective, this research went through a series of phases as demonstrated in Figure 5.1.

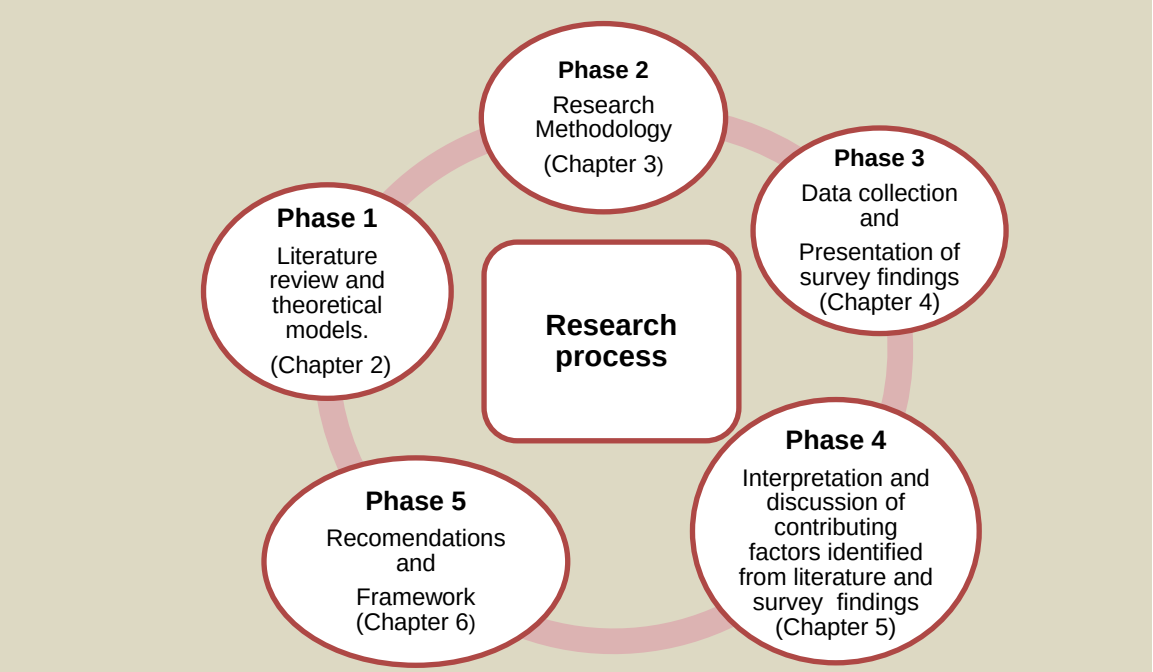

Figure 5.1: Research phases of the study

Literature related to digital preservation was reviewed and discussed in Chapter Two (Phase1). The factors contributing to the implementation of sustainable digital preservation were obtained from the literature review. Chapter Two (Phase 2) also discussed related conceptual framework, and the elements that are considered as enabling factors to successful preservation of digital resources were also identified. The Policy, Strategy and Resources (PSR) troika model (Davies, 2000), three leg stool (Kenney and McGovern, 2003), preservation triad (Corrado and Moulaison, 2014), Digital Preservation Capability Maturity (DPCM) model (Carnegie Mellon University, 1990) and a framework for realizing opportunities for adapting to the digital age (Council of Canadian Academies 2015:58) were found to be the most relevant theories or models to validate the contributing factors. Chapter Three (Phase 2) discussed the research design and methodology, the steps that were used to collect data as well as the techniques and tools used to analyse data.

Data was collected from 27 academic institutions in South Africa, through a survey questionnaire, complemented by document analysis, and the findings from the survey were presented in Chapter Four (Phase 3). This chapter (Phase 4) provides a general discussion and interpretation of the research findings from the survey findings and document analysis. Finally, the study used the factors that were established from the survey findings and literature review to inform the framework for preservation of digital resources in academic libraries in South Africa, presented in Chapter Six (Phase 5). Chapter Six presents a proposed preservation framework and provides the

recommendations for a successful digital preservation in academic libraries in South Africa.

5.2 Interpretation of the research findings

Wilson (2000:77) states that the role of analysis is to bring data together in a meaningful way and enable the researcher to interpret or make sense of the data. After data were cleaned, that is, “reviewed for valid responses, methodological soundness, and indicators of variability and range”, they were reduced to more descriptive information (Greene, 2007:144). According to Leedy and Ormrod (2010) interpretation of the data is the essence of research. Researchers are usually cautioned that even if data were properly collected and analysed, incorrect interpretation would lead to inaccurate conclusions. It is therefore imperative that interpretation is done with due care in an objective manner and also within correct theoretical perspectives (Kothari, 2004:344).

The first step in conducting this study was therefore to review literature on the subject of preservation practices in academic libraries, with the specific reference to the identification of elements that constitute the preservation framework applicable to these institutions. As pointed out by Ngulube, Mathipa and Gumbo (2014) social science researchers start out with models and then progress to concepts that represent an identified research problem within a subject matter and collect data to understand and establish linkages between concepts. This study thus followed the same pattern by reviewing theoretical models, collecting data and establishing linkages between concepts through interpretation and discussion of findings. Theories and models related to digital preservation were thus reviewed and analysed to understand the factors that need to be taken into account in order to assist in the implementation of a digital preservation framework applicable to the academic libraries in South Africa. Examples of the models that informed this study include: Davies’ (2000) Policy, Strategy and Resources (PSR) troika model, Kenney and McGovern’s (2003) three legged stool model, Corrado and Moulaison’s (2014) preservation triad model and the Digital Preservation Capability Maturity (DPCM) model by Carnegie Mellon University (1990), as discussed in Section 2.6 of Chapter of Two. Trusted digital repository (TDR), Open Archival Information System (OAIS) model and Digital Curation Centre (DCC) life- cycle model were also used to inform this study.

TDR is widely accepted standards of curation processes for digital data by libraries and archives and are used by different organizations as guidelines that need to be followed by libraries in order to ensure the uniformity of digital reference services provided by libraries worldwide (RLG-OCLC, 2002) (discussed in Section 2.17.1 of Chapter Two). The

Open Archival Information System (OAIS) model is the most widely used model to be used in developing a broader consensus on what is required for an archive to provide permanent and indefinite long term preservation of digital information (CCSDS, 2002) while the Data Curation Centre (DCC) preservation life-cycle model provides a graphical high level overview of the stages required for successful curation and preservation of data from initial conceptualization or receipt (DCC 2005))(Section 2.6.5 and 2.6.6 of Chapter Two). A look at digital preservation theories and models helped to understand how their elements or factors can influence the effectiveness of digital preservation in academic libraries in South Africa. To make meaning of the findings in this study, theoretical models were also used for analysing and interpreting the vast amount of information collected through the questionnaire and document analysis.

The interpretation and discussion of the results in this chapter were therefore guided by themes from the findings in Chapter Four that were based on the following research objectives:

- The extent of preservation programmes' implementation in academic libraries;
- Challenges for effective preservation of digital resources in academic libraries;
- Preservation strategies that are used in safeguarding digital resources in academic libraries;
- The systems, tools and technologies used for preservation of digital resources in academic libraries; and
- The factors influencing digital preservation sustainability in academic libraries.

It must, however, be noted that while all the findings of the research questions were based on the survey and document analysis, part of the findings for the research questions six and seven were addressed in Chapter Six. Therefore, digital preservation practices, challenges, strategies and tools used, as well as factors contributing to digital preservation sustainability are fully interpreted and discussed in the next section as they influence the effectiveness of digital preservation in academic libraries.

5.3 Extent of implementation of digital preservation practices in academic libraries

The underlying assumption was that academic institutions in South Africa, like any other institutions, may be grappling with long-term preservation of digital resources; hence there is a need to understand the extent of preservation of such resources (Section 2.9 of Chapter Two). The literature reveals that, for an institution to achieve its goal of long-term preservation, it should practice an effective digital preservation system (staff capacity, implementation of policy and structures, compliance with standards,

collaboration with other institutions, and security of digital records, etc.). In view of that, the study found it appropriate to investigate the extent to which digital preservation programmes have been implemented in academic libraries in South Africa. The interpretations and discussions of findings regarding the extent of digital preservation implementation is presented according to the following sub-themes:

- Extent of digital preservation implementation;
- Motivation to preserve digital resources;
- Types of materials being preserved;
- Protection of digital records from unauthorized access;
- Digital preservation policy;
- Development of Institutional repositories (IRs); and
- Collaborative efforts to preserve digital resources.

The survey questionnaire and document analysis that were carried out confirmed that the majority of academic libraries were deeply committed to implementing digital preservation programmes in their institutions. This was confirmed in Figure 4.1 by the majority (68.2%) of respondents who stated that they had a formal digital preservation programme in their institutions while only few (31.8%) respondents indicated that they did not have a formal preservation programme. Again, the majority (95.5%) of respondents further stated that they have undertaken efforts to preserve digital materials in their institutions and only 4.5% of respondents indicated that they have not undertaken any effort to preserve their digital materials. This is also confirmed from the literature review (Section 2.5 of Chapter Two) where it is claimed that the majority of African libraries, particularly in South Africa, have digitized their scholarly output and already established institutional repositories and digital libraries to preserve their digital materials. An institutional repository of digital materials would improve the accessibility, resource discovery, preservation and promotion of academic institutions' digital information. IFLA/UNESCO (2010) describes a digital library as an environment to bring together collections, services, and people in support of the full life-cycle of creation, dissemination, use and preservation of data, information and knowledge, that forms an integral part of the services of a library and applying new technology to provide access to digital collections.

A comparative study conducted by Bekele (2006) to examine the status of digital preservation practices in Botswana, Ethiopia and South Africa also showed that there was growing awareness of the need to implement digital preservation programmes and the research revealed that 65% of the institutions surveyed were aware of the risks associated with inadequate preservation, however, only 35% had developed in-house guidelines or policies on how digital files were to be managed. Bishoff and Smith (2015) also conducted a survey of digital collection management activities in academic libraries

to reveal the status of their current digital content creation, management, and preservation and 66% of the respondents indicated that there is an overall commitment to digital content preservation at their institutions. The implication of the survey findings is that most academic libraries were fully committed to digital content preservation and they were thus prioritizing their digital preservation practices (Section 6.8.1 of Chapter Six), and consider it as one of their strategic objectives**.**

In terms of a digital preservation budget, a significant number (63.6%) of respondents indicated that they had a digital preservation budget and only a few (36.4%) of respondents stated that they had no budget for digital preservation. Whilst large proportions of the respondents indicated that they had a budget for digital preservation, it was evident that funding was a current threat to other institutions. It could be that some of the institutions have no idea about their funding requirements or lack of concrete knowledge of how much digital preservation will cost and it is thus very difficult to estimate their annual budget for digital preservation practices. Corrado and Moulaison (2014) added that the cost of long-term digital preservation can also be a difficult task to identify and define. Although Harvey (2005:188) also noted that there is a "lack of concrete knowledge of how much digital preservation will cost", there is a general assumption that any cost is too much, particularly when overall funding is being cut.

The research findings by Meddings (2011) also revealed that only 41% of surveyed institutions who were participating in digital preservation programmes cited cost concerns, and they ranked the three top digital preservation concerns as additional costs, lack of staff resources, and budgets. Further, the uncertainty of digital preservation costs and lack of financial commitments by institutions makes assuming preservation responsibilities more complex. This study thus observed funding as a compelling and ongoing problem across academic libraries in South Africa, especially because implementing digital preservation infrastructure, systems and tools are very expensive. The literature and document analysis findings show that some of these institutions have been slow in adopting formal, comprehensive and systematic digital preservation practices due to lack of funding. However, as noted by Hedstrom (1998:193), across the nation, university archives, libraries, and other types of repositories are trying to meet escalating user expectations with limited financial and technical resources.

The report by Blue Ribbon Task Force on Sustainable Digital Preservation and Access (BRTF-SDPA) (2008) also highlighted inadequacy of funding models to address long-term access and preservation needs as one of the major problems of building a sustainable digital preservation programme. According to Jones and Beagrie (2008) digital preservation costs are based on four interrelated factors, namely:

- The need to actively manage inevitable changes in technology at regular intervals and over a (potentially) infinite time frame;
- The lack of standardization in both the resources themselves and the licensing agreements with publishers and other data producers, making economies of scale difficult to achieve;
- The as yet unresolved means of reliably and accurately rendering certain digital publications so that they do not lose essential information after technology changes; and
- That for some time to come digital preservation may be an additional cost on top of the costs for traditional collections, unless cost savings can be realized.

Developing preservation systems and strategies in academic institutions is thus a question of costs and budgets. As a result, cost models and predictive costing tools that can be used to estimate the preservation costs are very important in mitigating cost in the preservation planning process. However, there are limited numbers of long-term digital preservation cost models for ongoing storage of digital content as observed by Corrado and Moulaison (2014). Lifecycle Information for e-literature (LIFE) project, a collaborative effort between the London library and the British library, developed a cost model and predictive costing tool that can be used to estimate the preservation costs of digital objects across the object's life-cycle, as discussed in Section 2.6.3.1.2 of Chapter Two.

In view of the lack of funding for digital preservation, some of the institutions would have to cooperate with government and seek financial assistance from other digital preservation support organizations. The study established that these institutions are relying on donor or grant funding agencies for their digital preservation practices. For example, the first national grant funding agency to assist in data preservation was the National Science Foundation (NSF) that implemented a requirement for all grant proposals to include a data management plan, and both metadata and preservation of digital resources were to be addressed within the plan (National Science Foundation, 2011).

It was evident from literature review that for an institution to adopt and practice an efficient and effective digital preservation programme, the engagement of digital preservation experts is vital to the successful implementation of the programme. Based on that, the study tries to find out the persons, departments or unit responsible for implementing and facilitating digital preservation programmes in academic libraries in South Africa. The survey established that repository managers, digital preservation units, librarians, archivists and library management were responsible for the implementation and facilitation of digital preservation practices in academic libraries. Repository managers 16 (33.3%) were being considered the most responsible persons for digital preservation in

academic libraries. It could be that most of academic libraries in South Africa have implemented institutional repositories (IRs) in an attempt to preserve their digital resources and are therefore managed by repository managers who are initiating digital preservation projects within their institutions. These repository managers are working in hand with archivists, librarians and digital preservation experts as shown in Table 4.1 of Chapter Four. However, only a few 5 (10.4%) of the respondents indicated that the information technology division is responsible for implementing and facilitating digital preservation practices in their institutions. This is raising a concern especially because digital preservation is an integrative and complex task that requires a creative team from different areas of specializations such as IT specialists, librarians, archivists, content managers, etc. Furthermore, there are a lot of preservation systems and technologies that need to be designed and that require IT specialists and system designers.

Ruusalepp and Dobreva (2013) also describe preservation as a complex activity, not only because of the increasing complexity of digital objects, but also because the context of use needs to be re-created, which means sustaining not only the data, but also any specific software which was used to work with them, and the technological infrastructure (Section 2.9.2 of Chapter Two). Therefore, there needs to be a marriage of the technology-savvy and preservation-savvy advocates in order to elucidate a fundamental "framework of basic concepts" to support digital preservation (Verheul, 2006:268). Thus, the design of a digital preservation system requires a shared purposive activity between IT or system designers, archivists, librarians, library management, digital preservation experts and repository officers.

5.3.1 Motivation to preserve digital materials in academic libraries

Several changes in the information environment were identified in Chapter Two (Section 2.4) that provide compelling reasons for academic libraries to rethink their structures, operations, and services to remain relevant in this digital era. As noted by Raju (2014) the proliferation of social media and the explosive growth of digital devices and related applications have collectively altered the traditional academic library beyond recognition (Section 1.1 in Chapter One). Against this background, academic libraries in South Africa were investigated in order to establish if they were also experiencing similar changes that are driving academic institutions around the world, compelling them to adopt digital preservation even though they are still grappling with its challenges. Literature also revealed several factors that led to the need for preservation of digital resources in academic libraries, as discussed in Section 2.8 of Chapter Two. The findings from the survey revealed that all of the institutions 22(100%) stated that the major reason for digital content preservation was to ensure long-term access to digital resources. This is in line

with the literature review and document analysis that the main goal of preserving digital resources in academic libraries in South Africa is to ensure long-term preservation of these resources. The findings are also in line with several researchers: American Library Association (ALA) (2007); Beagrie and Jones (2008); and Das, Sharma and Gurey (2009) who stated that the main rationale behind digital preservation is to ensure protection of information of enduring value for access by present and future generations. However, Meddings's (2011:57) world-wide study of digital preservation found that despite 85% of respondents claiming that "digital preservation is either important or very important to their library", only less than half of respondents (46.1%) stated that they were currently taking steps to ensure the long-term preservation of digital content.

Other important motivating factors such as managing digital content, the desire to promote library services, increased application of digital technologies and interest in digital technologies have also compelled the academic institutions to preserve their digital resources. With the advent of digital technologies, digital preservation is thus becoming a necessity to academic institutions because it is a technology that institutions can acquire to share valuable information without undue expense. However, as the digital technologies become more sophisticated, it is likely going to trigger more changes in the way academic institutions are practiced and delivered. Similarly, literature revealed increasing application of digital technologies as a major reason for current interests in digital preservation.

Again, other factors such as pressure from other institutions in the developed countries, competition among academic institutions, pressure from researchers and pressure from other libraries were also identified as the major reasons for the adoption of digital preservation. These findings confirm the view that the desire to maintain a competitive edge is a driving motivation behind digital preservation. However, pressure from researchers (31.8%), pressure from library users (22.7%), pressure from other institutions in the developed countries (22.7%) and competition among academic institutions (27.3%) were rated as neutral. It could be that these institutions may not realize the importance of competing and benchmarking with other institutions especially from developed countries that have already made a huge success in digital content preservation. However, these findings contradict with the findings from the literature review as these factors were identified as some of the major driving motivation factors to preserve digital resources in most of the developing and developed countries.

5.3.2 Types of materials in digital forms that are being preserved

As noted by New South Wales Government (2011), the influence of digital technologies has culminated in the creation of different types of digital records. Academic institutions are acquiring different types of digital materials and, in accordance with the findings, theses 19 (14.0%), dissertations 19 (14.0%) and journal articles 17 (12.5%) were recorded as the most frequent types of materials found in digital form. Academic institutions are also preserving different types of digital materials as required by faculties and user communities. The findings reveal that theses 19 (15.1%), dissertations 17 (13.5%), textual documents 16 (12.7%), journal articles 16 (12.7%), institutional records 13 (10.3%), images 12 (9.5%) and audio 11 (8.7%) were reported as types of materials that were being preserved in most of academic libraries, as shown in Table 4.4. This was also demonstrated in the literature review whereby digital materials such as theses, dissertations, journal articles and institutional records are preserved and accessible through institutional repositories in most of academic libraries in South Africa, as illustrated in Table 2.4 of Chapter Two.

Again, the significant number of respondents reported theses, dissertations, journal articles and conference papers as the most frequent type of material users normally seek. This response is not surprising because these resources are among digital materials being preserved and accessible through institutional repositories in academic libraries. However, only a few of the institutions cited images, video and audio as types of material in digital forms. It could be that preserving materials such as images, video and audio need more sophisticated and very expensive technology infrastructure. Funding was regarded as a major threat to digital preservation practices in many institutions as evident from the survey and document analysis findings. These institutions find it difficult to purchase sophisticated technology infrastructure, unless management allocates a budget to improve on the provision of better infrastructure that suits the digital preservation environment.

As mentioned in previous chapters, this study has focused on long-term preservation of digital resources in academic libraries. The study thus determined the current level of digital preservation these institutions are providing and most of the institutions (81.8%) were taking a long-term perspective (as long as are needed) on digital preservation. Only a few institutions were taking a medium-term view (over 10 years). It is also evident from the findings that the majority of institutions (81.8%) are taking a long-term view of preservation of digital resources while only a few are taking a medium-term 2 (9,0%) and a short-term 1 (4.5%) perspective. These results concurs with the findings from the literature review and document analysis as most of institutions indicated that they are focusing on long-term preservation of their digital resources. With regard to the level of

importance of long-term preservation, the majority of the respondents indicated that the long-term preservation of digital resources is very important or extremely important, with only a few saying it is somewhat important. This is evident from the literature review and documents analysis whereby significant numbers of academic institutions have undertaken efforts to implement digital preservation programmes with the aim of achieving long-term preservation of their digital resources.

It was also useful to break down what is understood as ‘effective digital preservation’, in order to understand the process necessary to achieve the long-term digital preservation of objects. The findings from the survey indicated that all the respondents (100%) perceived effective digital preservation as data that can be preserved over a long period of time. This is in line with the main goal of digital preservation which is to ensure that digital content is preserved over a long period of time. Again, data that can be found, extracted and served to a user, data that is maintained in the repository without being damaged, lost or maliciously altered and data that can be interpreted and understood by a user were also perceived as effective digital preservation.

5.3.3 Protection of digital records from unauthorized access

As noted by Bantin (2008) the records created and maintained in digital form are amenable to alteration and changes, and such alteration compromises the essential characteristics of records including the authenticity, reliability, integrity and authentication at the expense of information accessibility. The Digital Preservation Capability Maturity (DPCM) model (Carnegie Mellon University, 1990) also outlines eight digital preservation services needed for continuous monitoring of external and internal environments in order to plan and take actions to sustain the integrity, security, usability and accessibility of electronic records stored in trustworthy preservation repositories. These services focus on a range of actions required to ingest and sustain long-term and permanent electronic records and continuously monitor the technical environment upon which they depend (Section 2.7.4 of Chapter Two).

As pointed out by Corrado and Moulaison (2014) every record stored in the repository should have its own permanent and unique identifier so that the database application can locate, retrieve and disseminate the requested record. ISO 15489 thus requires that the movement of digital records should be documented to ensure that the records can always be located whenever required. In terms of security, a large number of respondents 19 (86.4%) stated that their institutions have put measures in place to protect digital materials from unauthorized access. As shown in Table 4.8 of the findings, access and use policy 18 (24.7%) was widely implemented as a protection to unauthorized access to digital

materials. Network security 15 (20.5%), secure password authentication 13 (17.8%), request for access approval 13 (17.8%) and data security 11 (15.1%) were also used as measures to protect unauthorized access to digital resources. These measures can prevent attacks from computer hackers and also help to guarantee security, confidentiality, availability, accessibility, integrity, and authentication of digital information over the long-term. However, only a few 3 (4.1%) of the respondents indicated that they were using audit trials to control unauthorized access to digital materials. The academic institutions should ensure that their digital preservation system also provides and maintains audit trails or other methods to demonstrate that digital records are effectively protected from unauthorized use, alteration or destruction.

5.3.4 Digital preservation policy

With digital content growing rapidly, it is important to look at how policies have been developed to guide digital preservation in academic libraries. The emergence of this digital content has prompted many policy makers across many academic institutions to put in place policies and procedures to make it mandatory for digital records to be preserved. It is thus very difficult for academic libraries to function effectively without clear policies and procedures that spell out how efficient digital preservation systems are practiced. The literature also reveals that, for institutions to practice an efficient digital preservation system, the institution should roll out a sound digital preservation programme embedded in the general institutional policy in addition to compliance with digital preservation standards. It is therefore necessary for academic libraries to have a defined policy to guide their digital preservation practices as that will show the level of the institution's commitment with respect to preservation of their digital resources. Corrado and Moulaison (2014) described policies as high level documents reflecting the mission of the institution and they guide in the creation of action plans or guidelines and best practices.

Moreover, the existence of a digital preservation policy provides the mandate and overall authority for the creation, use and preservation of records which are vital to the effective management of digital records in academic institutions (Mensah & Adams, 2014). Noonan (2014:12) also reports that the goals of a good digital preservation policy are to provide guidance and authorization on the preservation of digital materials and to ensure the authenticity, reliability and long-term accessibility of them. A good digital preservation policy should explain how digital preservation can serve major needs of an institution and state some principles and rules on specific aspects which then lay the basis for implementation. The study thus sought to find out whether academic libraries have

preservation policies that provide guidelines and responsibilities for the creation, capture, management and preservation of digital resources.

The survey findings in Chapter Four and analysis of institutional documents indicated that the majority of institutions had a written digital preservation policies in place whilst only a few of the respondents indicated that they do not have a policy that guides in preservation practices. The implication of these findings is that most of academic libraries in South Africa have paid attention to the development of digital preservation policies and procedures that guides in the preservation of their digital records. The Policy, Strategy and Resources (PSR) troika model by Davies (2000) has also identified implementation of policy, strategies and allocation of resources as key elements for effective implementation of digital preservation (Section 2.6.1 of Chapter Two). However, some of the studies reviewed in Chapter Two such as Li (2001); Kanyengo (2006); Keakopa (2006); Mbambo-Thata (2007); Kalusopa and Zulu (2009); Luyombya (2010); Sigauke and Nengomasha (2011); Njeze (2012) in Nigeria; Gbaje and Zakari (2013) and Sawant (2014) revealed that there were no policies and guidelines on the preservation of electronic records in most of the institutions and organizations in African countries and this differs from the findings of this study.

In order to assess the policies that should be put in place in academic libraries in South Africa, the respondents were provided with various policies that could be important in the implementation of digital preservation programmes. Encouragingly, there were policies on collection development, collection disaster plan, content management, access of digital resources, intellectual property rights, exhibition, and selection of materials, security, preservation ethics, retention and storage. The entire group of respondents 22 (100%) indicated that all these aspects of policy were covered in their institutions. Policy on selection of materials and access to digital resources were found to corroborate with the Data Curation Centre (DCC) life-cycle model by DCC (2005). Higgins (2008) underlined that policy on appraisal and selection provides the guidelines on how to evaluate and select data for long-term curation and preservation, while access and use ensures that data is accessible to both designated users and re-users on a day-to day basis. It is thus highly appreciated that preservation policies such as access and security helps in protecting institutional records from unauthorized access.

Other policies such as retention and storage, migration and technical infrastructure were reaffirmed in the Electronic Resource Preservation and Access Network (ERPANET) (2003) policy document. Storage is essential to records management as it ensures that records are secure, intact, accessible for as long as they would be needed (Shepherd & Yeo, 2003:173). Digital records, irrespective of format, require higher quality storage and handling and they should also be stored in media that ensure their usability, reliability,

authenticity and preservation for as long as they are needed. However, some digital records are currently at risk because they are not being stored properly and it is imperative for any institution to implement a robust storage and backup system so that all these records be migrated to a robust storage system that is backed up. Thus, policy on storage will ensure that the data is store in a secure manner and adheres to relevant standards.

Document review also revealed that, in some of the institutions, policy development was prioritised in the following areas:

- Funding models that support long-term sustainable efforts;
- Rights management for digitisation, preservation and access;
- Preservation capabilities, standards and best practices;
- Promoting collaboration, including international collaboration for both projects and funding;
- The importance of digital preservation in achieving the strategic objectives of the university mission;
- Commitment to sustainable digital preservation, with ongoing funding and strong institutional support;
- Need to affirm legal mandates for preservation and digital curation;
- Development of preservation standards for all areas of digital curation and a broad sharing of best practices for both technology solutions and business models; and
- File format attempts to support as many file formats as possible.

However, the current study established that in many institutions there were no policies and procedures in place for risk assessment and rights (copyrights and intellectual property). Risk assessment includes physical evaluation of digital materials and analysis of file format. Physical evaluation is essential to determine if the media is stable while file format risk assessment can inform the level of service the institutional repository or other archive defines for certain kinds of digital content. File formats is the most important aspect of digital preservation, as many activities of preservation are carried out around file format to prevent loss of access to a digital material. Rights issues are complex and academic institutions must therefore decide the level of risk it is willing to assume, what level of resources they can dedicate to resolving rights questions and how vulnerable the resources are. This implies that there is lack coordinated approach to management of risk and copyright issues and these institutions should therefore develop rights policies consistent with risk assessment and resource allocation. Although not all aspects of policies were covered, the majority of respondents had a preservation policy in place, and they acknowledged the development of preservation policy as important, and that if there were no policies in place (such as access and security) users and researchers would easily access confidential and private institutional information. The findings from the

survey and analysis of institutional documents indicated that repository managers, university librarians, systems librarians and collection managers were involved in the development of preservation policy.

5.3.5 Development of institutional repositories

According to Corrado and Moulaison (2014:30) digital preservation is not all about technology; however, it is not possible to undertake digital preservation without the use of complex technology. As a result, memory institutions such as libraries, archives and museums are actively building technology infrastructure such as institutional repositories in an attempt to preserve their digital resources for future access (Corrado & Moulaison 2014). These institutions have felt that there was a need for the development of institutional repositories and other archives within their institutions in order to collect, disseminate, manage and preserve scholarly and research outputs in their libraries, including institutions' books, papers, theses and other works which were born digital. An institutional repository ensures the continuity of electronic records and enables the design, operation, and management of preservation. All of the survey respondents 22 (100%) indicated that their institutions implemented institutional repositories (IRs) in order to ensure long-term accessibility of their digital resources. There is therefore a general concern about long-term access and that is why the mission of every repository is to preserve their materials for as long as they are needed.

All respondents agreed that implementation of IRs in their institutions will ensure long-term accessibility of digital resources and increase the dissemination of research output by researchers, while a significant number of respondents also agreed that IRs will improve the visibility of their research output and provide a central storage space for intellectual output of an institution. The implication of these findings is that academic libraries in South Africa recognized IRs as important vehicles and one of their strategies is to preserve their digital resources and understand their role or purpose in their institutions. These findings are in agreement with several researchers such as Ngulube (2012), the UBC Project (1997) and NLA (2007) who suggested that developing institutional repositories in academic libraries will preserve and sustain digital information for the present and future generations, as discussed in Section 2.14 of Chapter Two. Ngulube (2012) further pointed out that identifying, collecting and storing online publications and organizational records will be a futile exercise if strategies such as developing trusted digital repositories are not devised.

The survey results also reveal that theses 20 (18.9%), journal articles 20 (18.9%) and dissertations 19 (17.9%) were the dominating types of digital materials kept in IRs in academic institutions in South Africa. All these materials are accessible electronically

through IRs and are kept for over 15 years as indicated by the majority of respondents, as shown in Figure 4.3 in Chapter Four.

As pointed out by Becker, Faria and Duretec (2014), IRs have to address two conflicting requirements:

- The need to be trusted, a fundamental principle that is indispensable in the quest for long-term delivery of authentic information; and
- The need for scalability, arising from the ever-rising levels of digital artefacts.

These requirements underscored the need for a trusted digital repository (TDR) whose mission is to provide reliable, long-term access to managed digital resources to its designated community, now and into the future (RLG-OCLC, 2002). As pointed out by Chapman, Reynolds and Shreeves (2009) TDR collects, manages and disseminates digital materials produced in an institution for long-term preservation and future access. By so doing, it ensures the reliability, trustworthiness, transparency and accuracy of records.

According to TDR (2002), in determining trustworthiness, one must look at the entire system in which the digital information is managed, including the organization running the repository: its governance; organizational structure and staffing; policies and procedures; financial fitness and sustainability; the contracts, licences, and liabilities under which it must operate; and trusted inheritors of data, as applicable. A trustworthy digital repository should also understand threats to and risks within its systems (TDR, 2002). Carnegie Mellon University's (1990) Digital Preservation Capability Maturity (DPCM) model also identified trustworthy digital preservation repository as one of the elements for enabling effective digital preservation. The RLG/CPA (1996) report also made a clear statement about trust in digital archives that for assuring the longevity of information, perhaps the most important role in the operation of a digital archive is managing the identity, integrity and quality of the archives itself as a trusted source of the cultural record. Therefore, users of archived information in electronic form and of archival services relating to that information need to have assurance that a digital archive is what it says it is and that the information stored there is safe for the long-term (RLG-OCLC Report, 2002). Thus, the attributes of a trusted, reliable digital repository need to be identified and a trusted digital repository should make sure the overall repository system conforms to the OAIS Reference Model.

The OAIS provides both a functional model that includes the specific tasks performed by the repository such as storage or access and an information model that includes a model for the creation of metadata to support long-term maintenance and access. Organizations and institutions building trusted digital repositories should commit to understanding these

models and make sure all aspects of the overall system conform. This implies that trusted repositories have the potential to ensure the reliability, trustworthiness and accuracy of digital records, and guidelines in the RLG-OCLC report show how trustworthy repositories in Africa can be implemented and sustained. However, the question is whether the institutional repositories implemented in South African academic libraries can be regarded as trusted digital repositories to achieve their mission as discussed in Section 1.5 of Chapter One.

5.3.6 Collaborative efforts to preserve digital resources in academic libraries

As noted by Dollar and Ashley (2014) the collaborative initiatives seek to leverage financial, human, and technical resources, promote stewardship, and exchange knowledge about the current and future state of digital initiatives. Chapter Two of the current study brought to the fore the enormous benefits of collaborating with other institutions to share resources, knowledge and operate on the same technical standards. For example, in Canada, aboriginal communities are collaborating with museums to create culturally sensitive content management systems to support access to their cultural heritage and facilitate self-representation (Council of Canadian Academies, 2015:84). Another example is the USA based project, the International Research on Permanent Authentic Records in Electronic Systems (InterPARES, that began in 1999 as a major international research initiative bringing together archival scholars, computer engineering scholars, national archival institutions and private industry collaborating to formulate international, national and organizational policies, strategies and standards for long-term preservation of authentic records created in electronic systems (Duranti, 1996:159).

Scalable Preservation Environments (SCAPE) also developed scalable services for preservation planning and execution of institutional preservation strategies on an open source platform that orchestrates semi-automated workflows for large-scale, heterogeneous collections of complex digital objects. This consortium brings together experts from memory institutions, data centres, research labs, universities and industrial firms in order to research and develop scalable preservation systems that can be practically deployed within the next three to five years (SCAPE, 2014) and it is also dedicated towards producing open source software solutions available to the entire digital preservation community. Collaboration initiatives are thus essential as they provide an opportunity for academic institutions to increase their exposure and also assist in developing and maintaining relationships between these institutions and various communities. It is therefore crucial for all academic institutions to work together with other institutions in implementing digital preservation practices in their academic libraries. In line with this, academic institutions should also consider collaboration and partnerships

with other national institutions such as NRF, as that could possibly put them at a more competitive edge in any tripartite framework, where they have to contend with sophisticated institutions and industries that have information resources and are skills based.

To demonstrate the impact of the spirit of collaboration in academic libraries in South Africa, the majority of the respondents (59.0%) indicated that they were preserving their digital resources collaboratively, while 36.3% of institutions were preserving them both locally and collaboratively and only a few (4.5%) reported that they were preserving their materials locally. Further, significant number of respondents 10 (43.5%) indicated that they have executed digital preservation programmes largely through participation in collaborative efforts such as Digital Preservation Network (DPN), while 7 (30.4%) of institutions were involved with OCLC Digital Archive. Only a few 4 (17.4%) of the respondents indicated that their institutions were being involved with Archive-IT and DINI with the lowest score of 2 (8.7%).

Other interesting collaborative projects reported by respondents in the “other’ category were: COAR, CODATA, Smithsonian Folksway, Alexander Street Press, DATACITE, CALICO project plan, SEALS consortium, DCC, Archivematica, ATO developers, Digitization and Digital Data Centre. This implies that these institutions created the environment for collaboration and partnership that could enable effective digital preservation practices. According to Stewart (2012) creating cross-organizational collaborations is not easy, as some will be wary of sharing resources, desire greater authority over decisions, or have legitimate concerns about privacy and regulatory requirements. However, forging these partnerships is necessary although it may be difficult and by implication all survey respondents indicated strongly that collaboration was a key factor to the success of digital preservation practices.

This study, however, observed that little was known of international digital preservation support organizations such as the CEDARS, PREMIS, NETSOR, INTERPARES, Data Seal of Approval, DRAMBORA, TRAC, DCMI, NEDLIB, DPE and PLANET, which in many cases offer evaluation criteria, certification process, self-assessment methods/tools and risk assessment tools and also present organizational, technological and digital object management criteria for digital repositories (OCLC/RLG, 1995; PREMIS, 2005; RLG/NARA, 2007; Hofman et al., 2007). In order to advance their digital preservation work and take advantage of resources in the larger library and digital preservation community, the academic institutions in South Africa need to collaborate with some of these international institutions for best practices, as they have the necessary expertise and most of them succeeded in digital preservation.

As mentioned by Bishoff (2012), you cannot do it on your own. This involves understanding and raising awareness within the library, educating and demonstrating competency to campus stakeholders and ultimately leveraging limited resources to foster multiple collaborations. In this regard, the respondents were requested to state whether management is supporting digital preservation practices in their institutions. The majority (95.4%) of respondents indicated that management in academic libraries was supportive of preservation practices, willing to collaborate with other organizations (95.4%) and willing to benchmark with other institutions (68.2%) while most of respondents (86.3%) indicated that management do not support the initiative. It is true that digital preservation is not a technical problem but an organizational problem as noted by Kolowich (2012). Thus, digital preservation cannot be left to a small team of specialists within an organization; it needs to be embedded within an organization (Jones, 2006:99). Developing clear policies and processes requires effective leadership or library management that makes recommendations to staff about standards, technology options, feasibility and training. If staff members do not have a clear mandate from management to provide recommendations, then digital preservation collaboration is stymied. The library management should therefore:

- Provide leadership for digital preservation implementation;
- Recognize, appreciate and integrate the concept of digital preservation into their core business operations in order for it to be effective;
- Explain the meaning and purpose of digital preservation initiatives to staff in academic libraries so that they can understand the specific and collective goal of digital preservation;
- Other staff members in the academic libraries are likely to pay attention to digital preservation if the management positively communicates its importance to all the staff. Therefore, the managers should work together with people who are facilitating digital preservation practices in academic libraries on the benefits of digital preservation;
- Be willing to commit the library's budget towards supporting digital preservation activities, recognize and appreciate partnerships and collaborative efforts, and achievement in the area of digital preservation;
- Be committed to and address any inherent challenges or barriers to digital preservation;
- Organize digital preservation training for inexperienced staff;
- Further, for digital preservation to be successful it needs to be included in strategic planning and allocated funding.

5.4 Key challenges to effective digital preservation

Despite the efforts that have been put in place to promote digital preservation, there are still a lot of challenges that need to be addressed to ensure long-term preservation of digital resources in academic libraries in South Africa. It was thus crucial to identify the challenges that hinder effective preservation of digital resources in academic libraries in South Africa in order to identify practical and sustainable solutions to digital preservation problems. The evidence presented in Table 4.15 showed that academic institutions have been plagued by digital preservation challenges, and major concerns were inadequate staff with expertise in digitizing resources, intellectual property and copyright issues, inadequate funding to purchase enough infrastructure, poor technology infrastructure, software obsolescence and lack of human resources.

This result confirms the finding from the literature review and analysis of institutional documents that highlighted numerous challenges involved in preserving digital materials for long-term use among other institutions in South Africa, which include: absence of established standards, policies, procedures, lack of knowledge and adequately trained personnel in managing digital resources, technological obsolescence due to constantly changing software and hardware, weakness or absence of preservation policies and strategies, costs related to preservation management, legal issues regarding intellectual property rights, poor collaboration efforts and partnerships, poor ICT infrastructure in digital preservation management and failure to provide archivists and librarians with the necessary standards and guidelines to enable them to effectively collect, describe and preserve digital information as highlighted in Section 2.10 of Chapter Two (Kanyengo, 2006; Sigauke & Nengomasha, 2011; Ngulube, 2012).

Literature revealed that many files have been made inaccessible due to technology obsolescence. This was also observed by Corrado and Moulaison (2014) that, because of rapid rate of technological change, electronic documents may be inaccessible just a few years after they were created. A survey of 54 institutions by Hedstrom and Montgomery (1998) also found that collection managers view technology obsolescence as the greatest threat to sustain the continuous access to digital resources. Even if materials are digitized appropriately, metadata attached, and backed-up, they may become inaccessible very quickly. In order for academic libraries to avoid this disaster, and thus manage this potentially expensive risk, a digital preservation programme that will ensure that important files are safe and recoverable need to be implemented. Academic libraries should thus make sure that their digital materials remain accessible and usable regardless of technology obsolescence. Furthermore, survey respondents noted lack of skills in digital preservation, poor ICT infrastructure, lack of funding,

inadequate resources and lack of practical capacity to preserve digital records as the biggest barriers to ensure long-term access to digital materials, as shown in Table 4.16.

Other barriers to long-term access were inappropriate preservation policy and lack of knowledge in digital preservation. With regard to general problems faced by the institutions in preserving their digital resources, the respondents reported lack of knowledge by university leadership, inadequate resources, slowness in the implementation of preservation and lack of management support as inhibiting factors. These findings concur with the findings of several scholars. For instance, studies undertaken by Sigauke and Nengomasha (2011) identified some of the challenges that hinder NAZ's efforts towards long-term digitization and preservation of their historical records as under-valued staff establishment which requires further training and exposure to modern digitization technologies, the absence of a digitization policy programme, inadequate funding and lack of collaboration efforts. These challenges as depicted in Tables 4.15, 4.16 and 4.17 can pose threats and destabilize the implementation of digital preservation initiatives in an institution if no immediate action is taken by management in academic libraries in South Africa.

5.4.1 Challenges faced by academic libraries in providing access to digital content

Chen (2001) and Baker (2014) observed that continuous changes in technology was a major problem to digital preservation whilst Duff, Limkilde and Van Ballegooie (2006) noted that a great deal of knowledge is needed to understand the issues of digital preservation and skills training. In addressing these issues, the availability of funding can enhance the continuous changes in hardware and the commitment level of management to the activities of digital preservation, particularly when many of the problems of digital preservation are solved through collaborative opportunities (Council of Canadian Academies, 2015). In most of academic libraries, the major problems encountered in providing access to digital content were lack of digital preservation training among staff, poor management of digital resources, lack of understanding of users' needs and lack of procedure.

Only a few 7 (15.2%) of the respondents reported lack of access policy as one of their challenges in providing access to digital content, as shown in Table 4.18. This result is in conformity with the findings of several researchers (Njeze, 2012; Asogwa, 2012) who also identified lack of comprehensive preservation policy, lack of trained and competent manpower, lack of infrastructure, copyright issues, technological obsolescence, lack of technical expertise in preserving digital resources, inadequate funding and ICT infrastructures as the barriers to effective digital preservation. There was thus a

consensus between the literature review and the survey respondents that there were digital preservation challenges that hinder digital preservation success. The fact that the majority of the institutions implemented digital libraries, institutional repositories and other archives in their institutions shows that they were fully prepared to move forward with the digital preservation activities but they were hampered with these challenges. For effective digital preservation, management should:

- Be ready to go the extra mile to address these issues and challenges as they arise by assembling very specific and concrete resources such as funding, the necessary infrastructure and equipment and organize some training for staff;
- Consider getting external expertise, send users for training and be in support of digital preservation initiatives; and
- Attend annual conferences and workshops, together with staff members who are responsible for and facilitating digital preservation initiatives within their institutions, to discuss challenges they face and improvements on the system they would like to be made. Since these conferences or workshops in digital preservation management are attended by management and staff from various institutions across the world, the implementation gaps for digital preservation can be bridged.

5.5 Preservation strategies used in safeguarding digital resources in academic libraries

South Africa was observed as one of the countries that has made very little progress with regard to putting in place strategies and guidelines in the preservation of digital resources as compared with other countries around the world (as highlighted in Chapter Two). Academic institutions in South Africa are challenged by new digital technologies, and in order not to lose their digital content forever, ICT experts, policy developers, decision makers and key players need to design and coordinate contextual strategies to effectively manage how these technologies are affecting preservation of their digital resources. The preservation of digital resources in academic libraries thus require some level of efforts and strategies because digital resources can be inaccessible after a few years of creation and formats that are outdated might similarly not be accessible. The PSR troika model by Davies (2000:28) also suggested multiple-options, multiple paths and multiple-outcome aspects of strategy as an enabler to get around insurmountable obstacles, avoid unacceptable consequences and be tolerant to changes in conditions.

Digital preservation in practice means provisioning secure storage systems, refreshing aging media, fixity checks, and replication in multiple systems or locations, format

migration, emulation and other techniques to keep information safe and accessible over time (Ruusalepp & Dobreva, 2013). The findings in confirming if preservation strategies were employed in academic libraries shows that the overwhelming majority of respondents 20 (90.9%) have preservation strategies in place and only 2 (9.1%) of the respondents indicated that they do not have preservation strategies in place. Interestingly, all the respondents 22 (100%) indicated that the purpose of their strategies was to ensure the longevity of their digital resources. In Illinois, Senator Biss has sponsored a bill called the Open Access to Research Articles Act that would require that, among other things, all faculties at public institutions must provide long-term preservation of and free public access to published research articles in a stable digital repository maintained by the employing institution; or in any repository meeting conditions determined favourable by the employing institution, including free public access, interoperability, and long-term preservation (Illinois General Assembly, 2013: 3-4). If this law applies to academic institutions, then each institution will be required to implement proper strategies or techniques in order to meet this requirement and this will be an ideal opportunity for library management and digital preservation pioneers to take part in the promotion of digital preservation standards.

The study identified several strategies employed by academic libraries to preserve digital materials for the long-term including bit preservation, normalization, emulation, migration, replication and the risk management approach. The implementation of these preservation strategies were triggered by the recognition that digital materials were proliferating, and there was thus a need to ensure that digital materials remain authentic and accessible to users and systems over a long period of time, regardless of the challenges of component and management failures, natural disasters or attacks. Accordingly, survey findings and review of institutional documents revealed migration, bit preservation, functional preservation, checksum and the risk management approach as the most widely implemented preservation strategies within academic libraries. As observed by Beagrie and Jones (2008:112) migration is currently the preferred strategy for most digital archives and this concurs with the survey results and document analysis showing migration as one of the most implemented strategies within the academic institutions.

The challenge for many memory institutions is thus preservation of both digital data and the technology such as operating systems and media. The use of migration in most academic libraries could be related to the fact that many large data-sets at universities have been made obsolete by changing technologies. Technical digital preservation strategies such as migration, emulation and normalization can be effective strategies to combat technological obsolescence, the state of being sufficiently technically out of date so as to impede access to digital content (British Library, 2013). For example, migration transfer of digital resources from one hardware or software generation to another could

also help users to access data using new computing technologies and transform the digital content from its existing format to a different format as confirmed by the literature (Harvey, 1997; IRMT, 2009). This strategy involves copying digital materials from an older format to a newer format as technology changes.

The use of migration was also demonstrated under occasional actions in the stages of the DCC life-cycle Model, where data is migrated to a different format to ensure the data's immunity from hardware and software obsolescence (Higgins, 2008). By implication, replacement of old technologies was taken into account by academic libraries in order to overcome technological obsolescence. However, the study found that normalization and emulation were the least implemented preservation strategies in academic libraries simply because of costs as it is a formalized implementation of reliance on standards. Emulation involves recreating the behaviour of old hardware and software with newer hardware and software, and it keeps documents readable for a long time (Borghoff, Rodig & Lothar, 2007). However, these technical strategies or approaches alone do not constitute preservation programmes. Other preservation strategies reported in the survey include: risk management, identification of threats and vulnerabilities, succession planning, well-documented preservation standards, understanding the users' needs, involvement in the creation process, accepted standards for metadata systems, disaster management and deployment of clouding technologies as shown in Table 4.22. Risk management is a continuously developing arena whose ultimate goal is to define prevention and control mechanisms to address the risk attached to specific activities and valuable assets, where risk is defined as the combination of the probability of an event and its consequences (Barateiro, Antunes & Borbinha, 2009).

In order to achieve the goals of digital preservation, repositories must protect digital objects against several threats that can affect their future interpretation (Barateiro, Antunes & Borbinha, 2009), and protecting digital objects against threats is equivalent to reducing the risk of those threats, which is the main goal of the broad area of risk management as pointed out in Section 2.14.3 of Chapter Two. As noted by Smith (2003) about 40% of digital data loss is due to hardware failure, 29% due to human error, and 13% due to software corruption. Using the disaster recovery may also be a good strategy to safeguard digital resources in case the files get corrupted or the server becomes obsolete. According to Rinehart, Prud'homme and Huot (2013), any digital material loss could be colloquially termed a "disaster", depending on the importance of the digital material, how much it would cost to recovery it, and if it is recoverable at all. For important digital material, the cost of recovery in the United States is estimated at 18.2 billion per year (Smith, 2003). Thus, digital preservation practitioners should:

- Integrate digital preservation risk management strategies into collection management so that digital risks are treated comparably with those facing analogue content and regular preservation risk assessments undertaken; and
- Implement tools and end-to-end workflows for digital content, so that they constantly and consistently control the risks associated with acquiring, preserving, managing, processing and ingesting digital collection content.

Analysis of institutional documents also revealed metadata, back up and checksum as some of the strategies employed in academic libraries. Metadata was also identified as one of suitable strategies for the preservation of digital resources because it takes cognizance of provenance, authenticity, preservation activities, technical environment, and rights management (Oehlerts & Lui, 2013). Metadata indicates where the data is located, the ownership relationship, its quality and conditions, and it facilitates the retrieval and usability of digital information. The survey agrees with Corrado and Moulaison (2014) that accessibility and usability of content in the digital preservation environment are enhanced through the creation and management of preservation metadata. The study by Li and Banach (2011), in investigating whether long-term preservation is part of the mission of institutional repositories in Association of Research Libraries (ARL) member institutions, revealed that 90% of respondents reported that their IR content is at least backed up and stored in a secure storage system while 63% of the respondents reported that they had a checksum algorithm to detect errors in the data stored in their IRs. Cloud computing was also identified as one of other preservation strategies suggested within academic libraries in South Africa. By implication, information professionals in academic libraries are up to date and fully aware of the benefits of using current technologies such as cloud computing. Cloud computing may be one of the best strategies to address the funding challenges because academic libraries will pay for the space they use and extra space only as its data grows, and it allows users to access data from any location via any device that can be connected to the internet.

This study concurs with Wright (2012) that any long-term access to digital resources may be heavily dependent on digital preservation strategies being in place and underpinned by relevant policy and procedures. However, a review of these strategies shows that there are no specific agreed strategies on the preservation of digital resources in academic libraries, in that these strategies have different purposes depending on the institution's capabilities, limitations and the availability of resources. In terms of barriers to implementation of digital preservation strategies, most of the respondents identified limited budget, lack of human resources, lack of funding, lack of collaborative efforts, lack of technical expertise, lack of knowledge, poor technology infrastructure and lack of management support as shown in Table 4.21. In order to address these challenges, management should have continued partnerships and collaborate with other institutions

as the latter could then provide frequent support in the form of strategies, best practices, resources, tools and training of staff.

5.6 Preservation systems, software and tools used in academic libraries

It was also crucial to identify the software, technologies and tools used to enable digital preservation in academic libraries. A proper technology infrastructure will support the capturing and preservation of digital resources, promote collaboration and provide easy access to digital content within academic libraries. Accordingly, the study took cognizance of the preservation software, technologies and tools used as well as digital preservation metadata and standards as guidelines. The technology leg in Kenney and McGovern's (2003) three leg stool model also combines hardware, software, formats, storage media, networks, security measures, workflows, procedures, protocols, documentations, and both technical and archival skills as a means to ensure continued access to digital materials. In an attempt to address the digital preservation conundrum, many institutions are creating their own digital preservation systems, while others have chosen to implement open source or proprietary systems. More new software and technologies are being designed in academic libraries as the demand for digital technologies increases and these include DSpace, Fedora, E-prints, Greenstone, Innovative, I-T, Archivematica, Rosetta, Tesella, just to name a few. These software and technologies are intended to provide academic institutions with the capability to create, capture, classify, store, preserve, track and retrieve digital resources, regardless of the format (paper, digital documents, database transactions, etc.).

With regard to the software or technologies used, the survey findings and literature revealed that the DSpace was the dominant software that has been adopted and used in most academic libraries in South Africa, with a total score of 15 (50.0%). Similarly, Biswas and Paul (2010) looked at open source software for institutional repositories around the world and their study revealed that out of the 72 institutions studied with various open source software, DSpace had 42 installations. DSPACE (2013) allows users to deposit digital objects into a repository, using a web-based interface. There is an indication that the use of DSpace is extending towards improving the efficiency of institutional repositories in academic libraries. As noted by Kari and Barro (2016), DSpace creates indexes and retrieves various forms of digital content and is adaptable to various community needs. They highlighted some of the reasons to choose this software:

- It is an open source platform that can be customized;
- It is a service model for open access and/or digital archiving for perpetual access;

- It is a platform for an institutional repository and the collections are searchable and retrievable using the Web; and
- Collections will be open and interoperable.

It is, however, important to note that Fedora 5 (16.7%), Innovative 4 (13.3%) and E-prints 3 (10.0%) were slowly being reasonably used in most academic institutions, while Greenstone and I-T ranked very low in adoption and usage, as shown in Table 4.23. The findings further affirmed that with regard to the reasons for the motivation to use the various software or technologies, the DSpace, E-prints and Innovative were reported as easy to use, while I-T and Tesella were found to be affordable. In line with this finding, the literature and analysis of institutional documents also identified DSPACE, Eprints and ETD-db as some of the prominent software tools used by digital repositories to support the preservation of digital records as depicted in Table 2.4 of Chapter Two. Some of the respondents mentioned using other software such as Access to Memory, VITAL, Archivematica and ATOM. The implication of this findings is that the respondents were very familiar with current preservation software or technologies. With these examples of available repository software, organizations need to decide how to select an appropriate repository option by considering the capabilities and limitations of each and the extent to which the repository software meets archival requirements and suits the digital content to be preserved.

In line with these findings, the study observed that academic institutions are using different software or technologies that meet their archival requirements and that also suit their budget and the digital content to be preserved. For example, University of Stellenbosch and University of Pretoria use open source software called DSpace for preservation of their digital resources while Rhodes University and University of Cape Town use the E-Prints open source software system. However, there are many advantages and disadvantages of using open source software and therefore digital preservationists should evaluate this software and determine whether the software meets their needs, what resources (human and financial) will be necessary to implement them and what their limitations might be (Corrado & Moulaison, 2014). As implementation of digital technologies evolve, it is also important for system designers or developers to examine whether systems that have been developed, purchased or implemented are without consideration of how the digital resources created will be integrated with digital resources created by other systems.

Academic libraries are also creating various tools in an attempt to ensure long-term preservation of their digital resources. For example, California Digital Library and Stanford University developed a tool for digital preservation called BagIT, a specification for the packaging of digital content for the purpose of automating the content's receipt, storage,

and retrieval (Oehlerts & Liu, 2012). Survey respondents reported using a variety of systems and tools for digital preservation such as Content-dm, Archivematica, DigiTool, Fedora, LOCKSS, Archive-IT, DuraCloud, DROID, JHOVE, Rosetta, BagIT, and Exiftool. However, LOCKSS 7 (21.9%) was the dominant tool that has been used in most academic institutions in South Africa followed by Digitool, Content-dm and Archive-IT, as shown in Table 4.25.

With regard to the reasons for using the various tools, Digitool, Archivematica and DuraCloud were found to be easy to use and affordable. According to Rosenthal et al. (2015) nearly 20 networks use the LOCKSS technology to preserve content, including books, journals, government documents and collections stored in institutional repositories. Similarly, respondents in Bishoff and Smith's (2015) study indicated that they have digital preservation programmes in collaborative efforts such as Portico and LOCKSS. Understandably, technologies such as Exiftool and LOCKSS were only used in most of the academic libraries as per library policy, while Rosetta, Archive-IT, Bepress, DROID, BagIT and JHOVE were not used in most of academic libraries. By implication, academic institutions were not aware that these tools offer much of the functionality needed for digital preservation. Although any institution may have established digital preservation tools, these would not be effective unless they are supported by qualified digital preservation experts with adequate knowledge and skills as well as regular financial support to implement and maintain these tools

5.6.1 Preservation metadata and standards used by academic libraries

For the current study, the issue of preservation metadata is critical in understanding the extent to which information professionals in academic libraries captured metadata to provide evidence. The study by Groenewald and Breytenbach (2011) revealed that negligence with regard to format specifications and standardization can cause huge electronic information losses in the future, and commended the use of metadata structures embedded in digital objects from the outset as a starting point towards good preservation principles. Sugimoto (2014) also underscored how the preservation of both metadata and digital resources are crucial to any digital archive as the extinction or loss of a metadata can render the resources of a digital archive inaccessible. PREMIS (2005) describes a preservation metadata as the information a repository uses to support the digital preservation process that is necessary to ensure that a digital object remains viable, render able, understandable, authentic, and identifiable.

According to Groenewald and Breytenbach (2011) preservation metadata contains archival information, which is needed for the long-term preservation of the object and the

migration to other digital formats as software and hardware changes continuously. It is interesting to note that 17 (77.3%) of the respondents indicated that they were creating and recording preservation metadata in their institutions while only 5 (22.7%) stated that they were not creating any metadata. The result agrees with Corrado and Moulaison (2014) that accessibility and usability of content in the digital preservation environment are enhanced through the creation and management of preservation metadata. The Digital Preservation Capability Maturity (DPCM) model by Carnegie Mellon University (1990) also identified preservation metadata as one of the elements for a successful digital preservation programme.

In the mid-1990s, various organizations and coalitions began to produce standards to inform digital preservation and these included standards for descriptive, technical, structural and preservation metadata (Kott, 2012). The evidence presented in Table 4.28 showed technical information, structural metadata, rights information with the access restrictions and documentation of preservation as the most popular types of preservation metadata recorded in academic institutions. Provenance or ownership rights was the least type of preservation metadata recorded in these institutions. It could be because managing rights is still a challenge in academic libraries and the rights policies to guide in this regard are not in place. Several research projects on digital preservation have centred on developing functional and technical requirements that guide the capture of specific metadata for long-term preservation. The literature also revealed that for any institution to meet its objectives, the institution should be guided by standards and regulations. In view of that, the study sought to find out if academic institutions in South Africa comply with the international and national digital preservation standards. The adherence to standards and regulations as it happens in academic libraries is likely to improve and strengthen their digital preservation practices.

Several different standards were used for preservation metadata including PREMIS, Dublin Core, and OCLC, Reference Model for Open Archival Information System and Information (OAIS) and METS. A significant number of institutions 15 (57.7%) were using Dublin Core metadata standard while 8 (30.8%) were using OCL. The Dublin Core is for descriptive metadata and it is made up of 15 metadata elements that offer expanded cataloguing information and improved document indexing for search engine programmes (DCMI, 2009), as discussed in Section 2.17.5.1 of Chapter Two. Surprisingly, only two of the institutions were using the OAIS model while only one institution was using PREMIS and another one institution was using METS. It implies that the respondents were not familiar with metadata standards such as PREMIS, OAIS model and METS. Preservation Metadata: Implementation Strategies (PREMIS) facilitates preservation decisions, detects preservation threats and provides measures for minimizing risks to long-term access.

PREMIS also supports a level of complexity in preservation metadata that would be difficult to sustain (Kott, 2012) while METS is used for storing technical metadata. The OAIS serves as a useful high-level reference model to establish a metadata and packaging framework to ensure that what is deposited can be retrieved and used. It facilitates the implementation of digital preservation by capturing data, migrating data and providing access to digital data, and using OAIS as a reference model will insure that the digital repository can meet essential requirements: to be able to ingest digital objects, maintain them, and disseminate the objects to the depositor or other services in a predictable way (Kott, 2012). Many of the digital preservation initiatives depend on the OAIS model and thus this underscored the point that any institution undertaking a digital preservation project ought to ensure that the implementation complies with the OAIS model. Furthermore, this model formed part of the conceptual framework of the current study. The lack of awareness of standards and best practices is still highly prevalent.

5.7 Factors influencing digital preservation sustainability in academic libraries

Sustainable digital preservation is meant to ensure the continuity of digital resources within resource levels over the required period of time. In digital preservation terms, Corrado and Moulaison (2014) describe economic sustainability as a set of business, social, technological and policy mechanisms that encourage the gathering of important information assets that support the indefinite persistence of digital preservation systems, enabling access to and use of information assets into the long-term future. According to Corrado and Moulaison (2014) digital preservation sustainability encompasses a range of issues and concerns that contribute to the longevity of digital information and concentrates more on building an infrastructure and approach that is flexible with an emphasis on interoperability and incorporates activities that will facilitate access and availability in the future. Academic libraries thus require the commitment of long-term sustainability of their digital resources in order to address preservation challenges that they are facing. As suggested by Nabe (2009) factors such as necessary resources and manpower to preserve digital information, institutional commitment and involvement of every staff member in the library, technical staff for maintenance of the server, programming to create metadata, policies, standards and proper guidelines; budget provision by the parent organization; selection of software (open source or commercial) and file formats and copyright issues should be kept in mind before proceeding with digital preservation.

The evidence presented in Table 4.29, showed that the entire group of respondents (100%) reported copyrights and intellectual property rights as major influencing factors for digital preservation sustainability in academic libraries. Factors such as

implementation of trustworthy digital repository, technical expertise, management support, implementation of policies, skilled trained staff, and effective collaboration and partnerships with other institutions, good governance and knowledge of metadata systems were some of influencing factors for digital preservation sustainability in academic libraries. According to Dollar and Ashley (2014), an organization with a digital preservation mandate should have a formal decision-making process aligned to its enterprise information governance framework that assigns accountability and authority for the preservation of electronic records with permanent value, and articulates approaches and practices for preservation repositories sufficient to meet stakeholder needs. Good governance includes the processes, roles, standards and metrics that ensure the effective and efficient use of information in enabling an organization to achieve its goals.

Other factors influencing the sustainability of digital preservation identified in this study are adequate resources, implementation of preservation strategies, participatory community and knowledge of preservation tools. This implies that most of the respondents agreed with all the factors as depicted in Table 4.29. This finding also confirms the results from several researchers (Alemna, 1999; Granger, 1999; Buchanan et al., 2012) who also identified various essential factors that contribute to the sustainability of digital preservation as human resources and education, effective implementation of policies and strategies, proper allocation of resources, collaboration, participatory and partnerships, understanding intellectual property issues, outreach and sustainability, management issues (policies, procedures and strategies),copyrights and intellectual property rights, financial resources and technical issues. The Blue Ribbon Task Force on Sustainable Digital Preservation and Access (BRTF-SDPA) also identified conditions necessary for digital preservation sustainability in their final report including recognition of the benefits of preservation on the part of key decision-makers, incentives for decision-makers to act in the public interest, a process for selecting digital materials for long-term retention and mechanisms to secure an ongoing, efficient allocation of resources to digital preservation activities, appropriate organization and governance of digital preservation activities and ensuring financial sustainability. The study also agreed with Zlotin and Zusman (2005) that for any country to effectively manage its digital resources, resources such as financial, infrastructure, equipment, human and adequate time are imperative.

Davies's (2000) PSR troika model also considers the development of policies, the implementation of strategies and allocation of resources as key aspects to sustainable digital preservation (Section 2.6.1). In the three leg stool model, Kenney and McGovern (2003) also summarize the factors contributing to the sustainable digital preservation as organizational infrastructure (that includes policies, strategies, resources and

procedures), technological infrastructure and the content as vital to preservation success in academic libraries. The Council of Canadian Academies' (2015:58) framework further outlines infrastructure, partnerships, rights, human resources, funding, collaborative and participatory opportunities as supporting factors to the sustainable digital preservation. Davies' (2000) PSR troika model, Kenney and McGovern's (2003) three leg model, the Council of Canadian Academies' (2015:58) framework are thus relevant to this study as they outlined elements that are perceived as influential factors that can be used to sustain digital preservation in academic libraries. These models and frameworks were therefore able to assist in understanding organizational and management issues, legal issues, resources issues and technological issues in relation to digital preservation success.

5.7.1 Factors enabling the effective preservation of digital resources in academic libraries

A viable digital preservation capability requires organizations to have sufficient expertise in electronic records management and digital preservation to support all of the infrastructure and requisite key processes, including on-going professional development for personnel and certification of the repository (Dollar & Ashley, 2014). With regard to the factors enabling effective digital preservation, the evidence presented in Table 4.31 showed that most of academic institutions considered management support, adequate skilled staff, effective leadership, adequate training, proper ICT infrastructure, sufficient budget and collaboration with other institutions as main factors enabling digital preservation. Effective leadership is one of the crucial variables that academic libraries need to consider when implementing successful digital preservation programmes. Effective leadership is required to organize, direct, control and coordinate activities regarding digital preservation in the academic libraries. These results are in conformity with the research article by the Council of Canadian Academies (2015) that documented the key factors that contribute to the success of memory institutions in the digital age as digital policies, resource sharing, institutional risk-taking, participatory and collaborative culture, volunteers, effective leadership in both institutional and national levels, human resource capabilities, management support, technical standards, managing copyright and intellectual property, innovation and reallocation of resources (Section 2.11 of Chapter Two).

The findings also concur with the study by Moghaddam (2010) who identified factors influencing digital preservation as technical issues (print and digital media), organizational issues (costs of preservation, expertise in digital preservation and selection of digital materials) and legal issues (copyright, intellectual rights management and business models and licensing) as well as cooperation and collaboration among different

organizations (Section 2.11 of Chapter Two). Council of Canadian Academies (2015: 58) also identified the external opportunities for realizing digital age as participatory opportunities and collaborative opportunities. Specific factors identified from the survey corroborate with the elements or aspects discussed in the models, and this model perhaps remains more relevant to this study. It is therefore clear that the sustainability of digital preservation in academic libraries is influenced by key aspects or elements from the literature review, the preservation triad by Corrado and Moulaison (2014), the PSR model by Davies (2000), the three leg stool by Kenney and McGovern (2003), the Digital Preservation Capability Maturity (DPCM) model by Carnegie Mellon University (1990) and a framework for realizing opportunities for adapting to the digital age by Council of Canadian Academies(2015:58). This study thus considered all the elements identified in this models as contributing factors to a sustainable digital preservation of digital resources in academic libraries in South Africa.

5.7.2 Factors hindering professional growth in digital preservation

The study further established factors that hinder the professional growth in digital preservation in academic libraries. The evidence presented in Table 4.30 showed limited budget (72.7%) as the major obstacle to digital preservation. Time limit (63.7%) was rated as the second barrier to digital preservation growth in academic libraries. It was also established that limited support from the institution leadership, lack of policy, lack of training and lack of motivation were inhibiting factors to digital preservation growth in academic libraries. However, the fact that there was limited support from the institution leadership, lack of training and lack of motivation may reflect the fact that there is lack of commitment in digital preservation practices by management within these institutions By implication, it could be that management in many institutions was not fully supporting digital preservation practices and they were not prioritized, and management were not able to fully address many of the other factors that may inhibit effective digital preservation**.** Therefore, in order for digital preservation to be effectively implemented, academic institutions often have to deal with many cost-related issues and need to allocate budget and more time for digital preservation practices.

5.8 Digital preservation training

Evidence from the literature review proved that digital preservation is an extremely complex field and requires a great deal of knowledge to understand (Duff, Limkilde, &

Van Ballegooie, 2006:203). Staff training and education are thus essential when digitizing or digitally preserving materials. For academic institutions to practice an efficient digital preservation system, it should have competent information professionals and staff that have knowledge and skills in digital preservation. The literature observed that in terms of education and training, information professionals in the developed world were far ahead of their counterparts in Africa. Educating digital librarians should therefore be an important agenda in the Library and Information Science field due to the changing nature of librarianship resulting from the increasing amount of information available in digital format. This calls for educators to determine what skills and knowledge are required for information professionals to be effective in the digital work place. In a survey of digital library education in library schools in Africa, Baro (2010) also reported that only a few schools offer courses specifically related to digital libraries and added that many schools have not developed “digital libraries” as a standalone course in their library and information science curriculum in Africa.

As suggested by Mensah (2011), for an efficient preservation of digital resources to exist, there is the need for academic libraries to create digital preservation awareness for staff and also employ staff who have the requisite knowledge and skill in the preservation of digital resources throughout its life cycle. Studies conducted by the IRMT (2003:5) in the ESARBICA region have also shown the absence of core competencies in records and archives management and further observed lack of training, knowledge and skills in digital preservation as among major factors hindering effective digital preservation in academic libraries. Nengomasha (2009:178) also cited lack of training as one of the factors that had led to poor records keeping in the public service in Namibia where only two of ten heads of records keeping function indicated that they had attended some records management training or awareness courses. Kamutula (2010) also concluded in his study that archivists lack skills, procedures, standards and practices for e-records management. It could be that whilst academic libraries have staff assigned to digital preservation responsibilities and have adequate organizational and technical expertise in digitizing their materials, they lacked training in digital preservation. However, this assertion contradicted with the survey findings where the majority of respondents (77.3%) indicated that they had received training in digital preservation while only a few respondents (22.7%) indicated that they had not received any digital preservation training. On the contrary, in academic libraries in South Africa, a significant number of institutions had done quite well in training in digitization though there remained a challenge in terms of training in preservation of digital resources and generally inadequate staffing to facilitate digital preservation activities in other institutions. It is thus important to underscore that there is still a need for more training in the preservation of digital resources. These institutions should have strategic human resource development plans that could benefit their staff in the electronic age.

In order to fulfil their training needs, respondents indicated that they prefer training areas such as digitization and digital preservation programmes, preserving electronic resources during their entire life-cycle, and the application of digital technologies in preservation practices (Table 4.32). Further, seminars and workshops, on the job training online training, internships and training in digital preservation school and colleges were considered as the most useful in meeting their training needs in digital preservation. Only a few 5(7.0%) of the respondents considered the use of consultants to facilitate their digital preservation practices. In effect, the use of consultants could in the long run advantage them in their quest to represent their institutions and it would therefore be in their interest to use external consultants.

5.9 Chapter summary

This chapter interpreted and discussed the research findings presented in Chapter Four. It was established that the creation of digital records was occasioned by the increasing application of digital technologies and that has changed the way libraries operate. These dramatic changes pose new challenges to both library management and digital preservation researchers. As a result, academic libraries are now faced with numerous challenges that hinder the effective preservation of digital resources, such as technological obsolescence, training and staffing, and funding requirement. This has therefore, created the need for best practices and implementation of preservation strategies in ensuring long-term preservation of digital resources in these institutions. The questions that still remain are: What digital preservation strategies are best suitable for digital preservation practices in academic libraries? What are the costs of the digital preservation? How would a digital preservation programme be planned, organized and staffed? Despite the challenges and the fact that we still have some unanswered questions, academic institutions in South Africa have made great advances towards digital preservation in the last few years.

So far there is progress in terms of preserving digital materials in academic institutions in Africa, particularly South Africa. These institutions:

- Have developed digital libraries and institutional repositories to preserve, manage and provide access to the scholarly output of the university, and are using preservation systems and open source repository software such as DSpace, Fedora, E-prints and ETD-db for preservation of their digital resources, as well as preservation tools such as LOCKSS, DigiTool, CONTENT-dm and Archive-IT;

- Have a written digital preservation policy in place to guide in their path forward and implemented strategies such as migration, bit preservation, replication and risk management approaches;
- Have built collaboration with other international and national organisations such as Digital Preservation Network (DPN), OCLC Digital Archive, Archive-IT and DINI. Although, little was, known of digital preservation support organisations such as the DPC, DCC, INTERPARES, DRAMBORA, Trustworthy Repositories Audit & Certification (TRAC), UK Web Archiving Consortium, DPE and PLANET, the findings showed that academic libraries were also involved in other collaborative projects such as COAR, CODATA, Smithsonian Folksway, Alexander Street press, DATACITE, CALICO project plan, SEALS consortium, DCC, Archivematica, ATO developers, Digitization and Digital Data Centre.

The next step would be to look at the Five College Digital Preservation Planning Guide and follow the steps outlined to make sure academic libraries in South Africa are fully prepared to implement solutions that would help them provide long-term digital preservation for materials that have enduring value, as suggested by Bergin (2013). Academic libraries should also work with the Five Colleges to test and possibly implement new digital preservation tools and technologies, and should closely follow the development of national level collaborative digital preservation efforts such as the Digital Preservation Network and others (Bergin, 2013). Again, academic libraries need to comply with the Open Archival Information System (OAIS) reference model standard in the development of institutional repositories or digital archives and align its policy, procedures, and practices with the Trustworthy Repositories Audit & Certification (TRAC).

These institutions should also adhere to prevailing preservation standards in developing and maintaining its organizational and technological context such as Data Seal of Approval and DIN 31644, as well as trusted digital repository certification and the European Framework for Audit and Certification of Digital Repositories, that is intended to help organizations in obtaining appropriate certification as a trusted digital repository and establishes three increasingly demanding levels of assessment. Data Seal of Approval has also been created for giving an indication of quality, preservation and accessibility of data. The next chapter provides conclusions, a summary and recommendations of how academic libraries can achieve its long-term preservation goal. It also proposes a framework for preservation of digital resources in academic libraries in South Africa and it is hoped that such a framework will help academic institutions in implementing a sustainable digital preservation programmes.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The previous two chapters provided analysis, interpretation and discussion of the results based on data collected from survey questionnaire and document analysis in order to answer the main research question that was presented in Chapter One. This chapter provides a summary of the findings, conclusions and recommendations of the research work undertaken based on the data presented and interpreted in the previous two chapters. It highlights the various elements or factors that contribute to a digital preservation framework appropriate to academic libraries in South Africa and it also makes some recommendations to management that will enable effective implementation of digital preservation in these institutions. This chapter thus proposes an integrated framework for preservation of digital resources in academic libraries that is presented and discussed in Section 6.5. It is hoped that such a framework will help academic institutions to sustain their digital preservation practices. The following research questions as outlined in Section 1.8 of Chapter One, will be addressed in this chapter:

- What is the integrated framework to be proposed for preservation of digital resources in academic libraries?
- What recommendations can be made to management on preservation issues?

Furthermore, this chapter also provides the suggestions on future research arising out of the study as well as the implication of theory, practice and policy presented at the end of the chapter.

6.2 Summary of research findings

This section presents a summary of the research findings based on the research questions of the study.

6.2.1 The extent of implementation of digital preservation practices in academic libraries

- From the questionnaire responses it is clear that the majority of academic libraries have implemented digital preservation programmes and they have therefore undertaken efforts to preserve their digital materials;
- The findings of the study also show that the majority of these institutions had a dedicated budget for digital preservation;
- There were policies, standards and procedures to enable them to manage and preserve their digital records;
- The findings of the survey questionnaire and document analysis showed that most of academic institutions implemented institutional repositories with the aim of ensuring long term accessibility of their digital resources;
- Long-term preservation was considered as very important to most of the academic institutions, and they were therefore taking a long-term perspective in preserving their digital resources;
- Theses, dissertations, journal articles and institutional records were the sorts of materials in digital form that were being preserved in academic libraries;
- Data security, access and policy and passwords were used to ensure secure access to private and vital institutional documents, and this was essential in a networked environment;
- The findings show that academic libraries were preserving their digital resources collaboratively and these institutions were involved in collaboration with other institutions such as Digital Preservation Network (DPN), OCLC Digital Archive, Archive-IT, COAR, CODATA, Smithsonian Folksway, Alexander Street Press, DATACITE, CALICO, etc;
- In some of the institutions, management was supporting digital preservation initiatives and were willing to collaborate and benchmark with other institutions; and
- However, little was known of international digital preservation support organizations such as the DPC, DCC, INTERPARES, DRAMBORA, TRAC, UK Web Archiving Consortium, DPE and PLANET.

6.2.2 Key challenges or barriers to effective digital preservation

- The majority of academic libraries were faced with preservation challenges such as inadequate staff with expertise in digitizing resources, intellectual property and copyright issues, inadequate funding to purchase enough infrastructure, poor

technology infrastructure, software obsolescence, low awareness of preservation issues and lack of human resources that hinder effective digital preservation;

- Lack of skills in digital preservation, poor ICT infrastructure, lack of funding, inadequate resources and lack of practical capacity to preserve digital records were noted as the biggest barriers to effective digital preservation;
- Survey respondents and the document review also revealed general problems faced by academic institutions in preserving their digital resources, including lack of knowledge by university leadership, inadequate resources, slowness in the implementation of preservation and lack of management support; and
- In terms of providing long-term access to digital content, the following challenges were identified: lack of digital preservation training among staff, poor management of digital resources, staff do not understand users' needs and lack of policies and procedures.

6.2.3 Strategies to digital preservation

- The findings indicated that were preservation strategies in place in most of the academic libraries;
- University librarians and systems librarians were involved in developing these strategies;
- The findings reveal migration, bit preservation and replication as the most implemented strategies in these institutions;
- However, limited budget, lack of knowledge and lack of technical expertise hinder the implementation of preservation strategies in most of the institutions;
- Other alternative strategies identified from survey results and analysis of institutional documents include risk management and identification of threats and vulnerabilities, succession planning, well-documented standards, disaster management plans, back up, checksum and deployment of clouding technologies.

6.2.4 Preservation systems, software and tools used in academic libraries

- The findings indicated that academic libraries developed software, systems and tools to be used in preservation of digital resources;
- DSpace was identified as the dominant software used in most of the academic institutions;
- Analysis of documents identified other preservation software that were commonly used, namely: ETD and Digital commons while Tesella and Fedora were slowly being used in these institutions;

- Greenstone was the least used software or technology;
- DSpace, Eprints and ETD were further reported as being easy to use and affordable;
- With regard to preservation tools used, LOCKSS was the dominant tool that has been used in most academic libraries;
- Other preservation tools that were commonly used are DigiTool, Content-dm and Archive-IT;
- Dura cloud, Archivematica and Exiftool were the least used preservation tools in academic libraries;
- However, the findings indicated that most of academic institutions were not using Bepress, DROID, BagIT, JHOVE and they were therefore unfamiliar with these tools;
- On the other hand, Digitool, Archivematica and Duracloud were found to be easy to use and affordable;
- Survey findings and review of institutional documents also revealed that the majority of academic libraries were recording metadata, and types of metadata information that was recorded was technical information, structural metadata rights information, access restrictions and documentation of preservation;
- A significant number of academic institutions were reported using preservation metadata standards such as Dublin Core and OCLC, and they were not familiar with other international standards such as the OAIS model, PREMIS and METS.

6.2.5 Factors influencing digital preservation sustainability

- The findings from literature and the survey indicated copyrights and intellectual property rights, implementation of trustworthy digital repository, technical expertise, management support, implementation of policies, skilled trained staff, effective collaboration with other institutions, partnerships with other institutions, good governance and knowledge of metadata systems as major influencing factors for digital preservation sustainability;
- Other influencing factors identified from this study include adequate resources, implementation of preservation strategies, participatory community and knowledge of preservation tools;
- Most academic institutions also considered management support, adequate skilled staff, effective leadership, adequate training, proper ICT infrastructure, sufficient budget and collaboration with other institutions as other factors enabling effective digital preservation; and

- Limited budget, limited time, limited support from the institution leadership, lack of policy, lack of training and lack of motivation were seen as stumbling blocks to the growth of digital preservation.

6.3 Conclusions

Leedy and Omrod (2010:296) pointed out that “the conclusions should be entirely supported by the data presented”. According to Kalusopa (2011:263) the purpose of a conclusion is to re-state the findings of the study and to state the implications of the findings for the research questions at hand. Williamson (2000:300) suggests that when writing conclusions and recommendations, they should clearly be related to findings, the researcher should not over-conclude meaning, unwarranted conclusions and generalizations need to be avoided and, finally, the research questions should be answered. Therefore, the conclusions of this study are based on the findings provided in Chapter Four and Chapter Five, drawn from and presented as per the research questions guiding this study as alluded to in Chapter One, Section 1.8. In drawing conclusions, only the major findings that directly addressed the research questions were discussed. Therefore, the following conclusions took cognizance of the extent of digital preservation practices, digital preservation challenges, strategies for digital preservation, digital preservation systems and tools as well as factors influencing digital preservation sustainability in academic libraries.

6.3.1 The extent of implementation of digital preservation practices in academic libraries

The first objective was to establish the extent to which digital preservation practices have been implemented in academic libraries. Interestingly, it has been discovered that most academic libraries in South Africa have implemented digital preservation programmes. Ensuring long-term access to digital resources, managing digital content and the desire to promote library services were some of the major reasons to preserve their digital resources. Most of the institutions reported that they had a budget for digital preservation practices and they were taking a long-term perspective (as long as are needed) of digital preservation. However, funding seemed to be an inhibiting factor for some institutions as they reported that they do not have a budget for digital preservation activities.

Although the literature review indicated that the preservation policies did not exist in most of the academic institutions, most of the survey respondents agreed that preservation

policies were in place in their institutions and this was also supported by document analysis whereby most of institutions documented their preservation policies. The majority of these institutions had since attempted to develop preservation policies and procedures to enable them to manage and preserve their digital records. Survey responses and document analysis indicated that digital preservation policies such as collection development, content management, access and security, retention, storage, intellectual property rights and a disaster recovery plan were put in place to safeguard the digital resources in most of academic libraries. Among survey respondents, only a few indicated that they have a disaster plan and preservation ethics as part of the content of their policies while policy in the area of scope, standards, conversion and formatting were not in place.

The study further established that repository managers, digital preservation units, librarians, archivists and library management were the responsible people or units in facilitating and designing digital preservation systems for academic institutions, with repository managers being considered the most responsible persons for digital preservation in these institutions. Survey responses and document review also indicated that most of the academic libraries in South Africa have implemented institutional repositories (IRs) to preserve their digital resources. The study discovered that materials such as theses, dissertations, journal articles and institutional records were the most common types of digital information that were in digital form and being preserved. As noted by Dollar and Ashley (2014) digital preservation requires processes that restrict access to the physical repository where digital content is stored, ensure the security of electronic records through techniques that block unauthorized access, protect the confidentiality and privacy of records and intellectual property rights, support periodic backup of electronic records that are stored at offsite storage repositories, and support disaster recovery and business continuity. In line with this, the study underlined that some of the digital resources required some level of access and security. Accordingly, security measures were needed to protect unauthorized access to digital materials. However, most academic libraries were aware of the threat posed by security in the area of digital preservation and the implications in the event of unauthorized access to vital digital records. Therefore, the majority of academic libraries could point to any arrangements being in place, such as data security, access and use policy, secure password, network security and request for access approval for the protection of their vital digital records.

The study further observed that despite the threat posed by security in the area of digital preservation, efforts were also being made to put in place measures such as security policy, access and use policy to prevent unauthorized access, alteration or damage to digital information. However, control measures such as audit trail, tracking and verifying changes to digital objects were not being used as part of the measures of ensuring reliability and integrity of records.

The UNESCO Vancouver Declaration (2012) proposed that stakeholders of digital preservation collaborate with international professional associations and other international bodies to develop academic curricula for digitization and digital preservation. The Library of Congress in 2005 under the NDIIPP (NDIIPP, 2008) invited heads of state libraries, archives and other corporate institutions to a workshop to develop strategies for the preservation of significant state and local government information in a digital form that could be adopted by academic libraries in South Africa. It emphasized that stakeholders should build trusted relationships with other memory institutions through participatory projects such as national debate on digital preservation infrastructure and acquisition of digital heritage resources. Dollar and Ashley (2014) also emphasized that an organization with a mandate to preserve electronic records is well served by maintaining and promoting collaboration among its many stakeholders, as highlighted in Section 2.7.4 of Chapter Two. However, as noted by Ryan (2010:29), African countries face many challenges which are often unknown to their partners in the developed countries when it comes to collaborative digital preservation projects.

In order to enhance and advance digital preservation practices, this study observed that the majority of academic institutions were collaborating with Digital Preservation Network (DPN) while others were involved in other collaborative projects such as OCLC Digital Archive, Archive-IT, COAR, CODATA, Smithsonian Folksway, Alexander Street Press, DATACITE, CALICO project plan, SEALS consortium, DCC, Archivematica, ATO developers, Digitization and Digital Data Centre. Survey responses and review of documents also indicated that management in academic libraries were supporting digital preservation activities in some of the academic institutions, and they were willing to collaborate and benchmark with other institutions. Surprisingly, little was known of digital preservation support organisations such as DPE, INTERPARES, DPC, DRAMBORA, DCC, TRAC and PLANET. These support organisations in many cases offer evaluation criteria, certification process, risk assessment tools and self-assessment tools for co-operative networks of repositories and other third-party service providers (Becker et al., 2009; TRAC, 2007). The gross lack of knowledge about these international support organisations underscored the point that little was being done to collaborate with other support organisations to improve the digital preservation environment in academic libraries.

6.3.2 Key challenges or barriers to effective digital preservation

The second objective investigated the challenges of or barriers to effective digital preservation. The study highlighted numerous challenges with respect to digital preservation, including inadequate staff with expertise in digitizing resources, intellectual

property and copyright issues, inadequate funding to purchase enough infrastructure, poor technology infrastructure, software obsolescence and lack of human resources. Inadequate funding was observed as one of the compelling and ongoing problems across academic libraries, particularly because funding has major effects on every single element that drives digital preservation. For instance, purchasing or upgrading technology infrastructure and training of staff require more funding. Apart from funding, the study also observed that digital materials belonging to academic institutions were being lost due to technology obsolescence. The thrust of the digital losses was attributed to the necessity to continuously change hardware and software of computers, media incompatibility and configuration problems (Chen, 2001; Baker, 2014). The academic libraries are thus faced with the major challenge of making sure that users can access the content that has been ingested into the institutional repositories and other archives in the past and make sense of its intellectual property, despite hardware and software obsolescence. To address this phenomenon, survey results and analysis of documents revealed that many of academic libraries were copying their digital records to a different storage media and migrating their digital content to a current version of file formats whenever they receive digital content for the first time.

A viable digital preservation capability requires institutions to have sufficient expertise in digitization and digital preservation to support all of the infrastructure and requisite key processes, including on-going professional development for personnel. It was, however, observed in previous chapters that most of the IT experts and information professionals lacked training in the area of digital preservation as it was viewed as a conceptually simplistic exercise (Duff, Limkilde & Van Ballegooie, 2006). The study concluded that academic libraries lacked staff who were technically astute to preserve their digital preservation activities. Thus, lack of training was reported as one of the major factors hampering their initiatives in undertaking digital preservation projects. Intellectual property rights and copyrights issues were also seen as major challenges faced by academic libraries.

As noted by Corrado and Moulaison (2014:65), training on the job, talent and dedication can determine the extent to which digital preservationists will catch up and cope with this emerging discipline. The survey findings and analysis of documents indicated that there were preferences in training areas such as digitization and digital preservation programmes, preserving electronic resources during their entire preservation life-cycle and the application of digital technologies in preservation practices. Training format such as seminars and workshops, on the job training, online training, internships and training in digital preservation schools and colleges and use of consultants were considered by information professionals in academic libraries as preferred modes of training in meeting their training needs. Again, the copyright issue involves acquiring permission to use

copyright-protected content and therefore academic institutions must identify all content that is part of the project as there may be content in the public domain or protected content that needs permission or the rights must be acquired from content contributors and copyright holders.

Survey respondents and the literature review also reported other factors impeding long-term access to digital content such as lack of training among staff, poor management of digital resources, lack of understanding of users' needs, lack of policies and procedures, lack of skills in digital preservation, poor ICT infrastructure, lack of funding and inadequate resources and lack of practical capacity. Barriers such as lack of knowledge by university leadership and inadequate resources, slowness in the implementation of preservation and lack of management support were also identified as the general problems faced by academic libraries in preserving their digital resources. According to Corrado and Moulaison (2014:21), management is responsible for the creation of policies and documentation as well as the oversight of resource issues, i.e. human resources and financial resources. Although it was evident from the survey responses and document analysis that management played an important role in crafting digital preservation policies and strategies and creating awareness of digital preservation in some of academic libraries, some of the respondents indicated that there is still lack of clear policies, proper procedures and awareness in digital preservation in their institutions. The study identified digital preservation policies, collaborative opportunities and knowledgeable staff as part of the strategies for ensuring best practices.

As noted by Dollar and Ashley (2014) the organization that has responsibility for preservation and access to permanent electronic records is well served through proactive outreach and engagement with its designated community of records producers and users. Literature revealed that libraries, archives and museums (LAM) are working to establish meaningful relationships with a diverse set of designated communities so that people are aware and trusting of opportunities awaiting them (Corrado & Moulaison, 2014). These institutions are seeking new ways to retain their relevance by encouraging partnerships and a participatory culture as well as contributions from the public range from simple tagging activities to sharing of historical knowledge to design of software by expert volunteers (Council of Canadian Academies, 2015 :61), as discussed in Section 2.7.4 of Chapter Two.

6.3.3 Preservation strategies used in safeguarding digital resources in academic libraries

The third objective explored the digital preservation strategies employed in academic libraries. In establishing digital preservation strategies, the study identified the most widely implemented digital preservation strategies and the least implemented digital preservation strategies. Survey responses indicated that the majority of academic libraries were putting in place strategies such as migration, bit preservation, replication and risk management to safeguard their digital resources. Migration received overwhelming approval from respondents on the assumption that this strategy transforms or converts the old digital resource to a format that is independent of the particular hardware and software. It is a way to combat technological obsolescence as it provides a way of preserving the functionality of access to digital information which may be lost with the software or hardware when it becomes outdated (National Library of Australia, 2008). Normalization was the least implemented strategy while emulation was unknown to all respondents. In other words, technical preservation strategies such as normalization and emulation appeared to be an unfamiliar terrain and unknown to respondents.

In spite of these drawbacks, the study held the view that emulation keeps documents readable for a long time, it programmes the newer computer systems to emulate on demand the older obsolete platforms and operating systems and it also combines software and hardware to reproduce in all essential characteristics the performance of another computer of a different design, allowing programmes or media designed for a particular environment to operate in a different, usually newer environment (Cornell University Library, 2007; UKOLN, 2006), whereas normalization involves the migration of digital records to standard formats, by converting the record to an open standards based format that allows it to be documented and accessible. Other preservation strategies noted in the study were understanding the needs of the user, identification of threats and vulnerabilities, succession planning, well-documented preservation standards, involvement in the creation process, accepted standards for metadata systems, disaster management and deployment of clouding technologies. Analysis of institutional documents also revealed back up, checksum and functional preservation as other strategies that were used by academic libraries. Checksum is used to verify the integrity of full text files over time. With a functional preservation strategy, the file does change over time so that the material continues to be immediately usable in the same way it was originally while the digital formats (and the physical media) evolve over time. Some file formats are functionally preserved using straightforward format migration (e.g. TIFF images or XML documents). However, there were no back-up and recovery policies in place in most academic libraries and this implies that there is lack of coordinated approach to disaster recovery and management.

6.3.4 Preservation systems, software and tools used in academic libraries

The fourth objective was to determine the systems, software and tools used for preservation of digital resources in academic libraries. The study revealed that DSPACE was the dominant software used to support the preservation of digital records in academic institutions in South Africa. However, Fedora, Innovative and Eprints were slowly being reasonably used in academic libraries while the use of Greenstone and I-T ranked very low in uptake and use. The findings have, however, contradicted with the findings from document analysis whereby E-print, ETD and Digital Commons were the software that were commonly used by academic libraries for preservation of their IRs.

In terms of preservation software, most academic libraries used DSpace and Eprints while LOCKSS, DigiTool, Content dm and Archive-IT were common tools used by these institutions. That notwithstanding, respondents were familiar with software and tools needed for the preservation of digital their resources. Whilst the study observed that the respondents still need to acquaint themselves with other systems and software, the findings appear to be positive. However, the literature review showed some confusion between technology as not being an enabler of digital preservation but there is no preservation without technology (Corrado & Moulaison, 2014). Interestingly, both literature and survey findings agreed that technology was an enabler of digital preservation. That optimism was further demonstrated by respondents' continuous use of software, file formats, storage media and hardware to extend the life of digital materials with PDF as the most preferred text document format used in most of institutional repositories in the academic libraries.

The study also showed that most of academic libraries were recording metadata in ensuring the authenticity and reliability of their digital resources. It identified technical information, structural metadata, rights information, access restrictions and documentation of preservation as the most common type of preservation metadata being recorded in academic libraries. Various metadata standards such as Dublin core and OCLC were also being employed by academic institutions, PREMIS being the dominant metadata standard used whereas other standards such as Open Archival Information System (OAIS) and METS were unknown in most of these institutions. This has raised a concern, especially with the OAIS model, since many of the digital preservation initiatives are guided by the OAIS model, a reference model that has been widely accepted by the digital preservation community as a key standard for digital repositories and it describes roles, processes and methods for long-term preservation. It is simply a set of standardized guidelines intended to aid the people and systems behind a repository that has been designated with the responsibility of maintaining documents for archival purposes over a

long period of time (ISO 14721, 2003), as discussed in Section 2.6.5 in Chapter Two, while METS (Metadata Encoding and Transmission Standard) is an XML encoding standard which enables digital materials to be packaged with archival information. However, some of the institutions noted in their institutional documents that their IRs were implemented in line with the OAIS model and other international metadata standards, i.e Dublin core.

6.3.5 Factors influencing digital preservation sustainability in academic libraries

The fifth objective was to establish the factors influencing digital preservation sustainability in academic libraries. Survey responses and literature review indicated that the main factors influencing digital preservation sustainability in academic libraries were copyright and intellectual property rights, implementation of trustworthy digital repository, technical expertise, management support, implementation of policies, skilled trained staff, effective collaboration with other institutions, partnerships with other institutions, good governance, knowledge of metadata systems, adequate resources, implementation of preservation strategies, participatory community and knowledge of preservation tools. These factors are enabling effective digital preservation in academic libraries. Survey responses also indicated adequate skilled, effective leadership, adequate training, proper ICT infrastructure, sufficient budget and collaboration with other institutions as enabling factors. Due to the fact that some of the survey respondents indicated that they had not received training in digital preservation, they yearned for this training and preferred that it be delivered to them through a mixture of seminars and workshop mode, online training, on-site training, internships, in digital preservation schools and colleges and use of consultants. The study concludes that digital preservation sustainability may be influenced by factors such as the following:

- Good governance;
- Participation and collaboration;
- Knowledge of preservation software, tools and metadata systems;
- Increase in education and training among staff members;
- Increase awareness, commitment and outreach in preservation activities;
- Technical expertise; and
- Knowledge of copyrights and intellectual property rights.

6.4 Recommendations

The current study observed that irreplaceable digital information will be lost if digital preservation issues are not resolved in the near future. Therefore, the factors influencing digital preservation sustainability in academic libraries in South Africa were investigated in this study. The study further makes recommendations to address the digital preservation issues and challenges identified from the survey findings and document analysis, in order to enhance and improve digital preservation programmes in academic libraries. Therefore, the recommendations proposed in this chapter will guide information professionals in academic libraries on how to employ more targeted efforts in implementing effective digital preservation in their institutions so that they may enhance their practices for competitive advantage in the changing information environment. The recommendations made in this section thus address each of the research questions of the study.

6.4.1 Extent of implementation of digital preservation programmes in academic libraries

The study established that most of academic libraries in South Africa had implemented digital preservation programmes and it is therefore clear that these institutions have undertaken efforts to preserve their digital materials. An overwhelming number of these institutions have developed digital libraries and institutional repositories (IRs) as a vehicle to preserve their digital materials. Theses, dissertations, journal articles and institutional records are types of digital materials that are kept in their institutional repositories (IRs). However, a critical component is the implementation of the overall infrastructure supporting the reliability and sustainability of their digital repositories so that these institutions and their designated communities can trust that digital resources will be preserved for the long-term. As noted in RLG-OCLC Report (2002) for a trusted digital repository to meet its expectations, it must:

- Accept responsibility for the long-term maintenance of digital resources on behalf of its depositors and for the benefit of current and future users;
- Have an organizational system that supports not only long-term viability of the repository, but also the digital information for which it has responsibility;
- Demonstrate fiscal responsibility and sustainability;
- Design its system(s) in accordance with commonly accepted conventions and standards to ensure the ongoing management, access, and security of materials deposited within it;

- Establish methodologies for system evaluation that meet community expectations of trustworthiness;
- Be depended upon to carry out its long-term responsibilities to depositors and users openly and explicitly; and
- Have policies, practices, and performance that can be audited and measured.

The academic institutions should thus build an infrastructure guided by the above principles to ensure that their IRs are able to prove reliability and trustworthiness over time. The adoption of the Beagrie's (2008) policy by academic libraries can also provide guidance for the implementation of the digital preservation infrastructure in academic libraries in South Africa. The study also established that most of the academic institutions had a dedicated budget for their digital preservation projects. However, funding was reported as a major problem faced by some of the academic libraries, especially because digital preservation is very complex and expensive. As a result, most of institutions and organizations are now receiving external funding and donations for their digital preservation initiatives. External funding can be supplied by the government or a third party on a national or international level, but is mostly incidental. Academic libraries in South Africa may also seek funding from donors or government, for example, the ministry of higher education, to assist them in building their digital repositories. The Netherlands is an example of the country where the library receives extra structural funding for digital preservation activities.

From the survey, most of academic libraries lacked digital records creation policies; however, they recognized procedures and standards for creating, capturing, storing, preserving and accessing digital records so that they could be well preserved and accessed easily when needed. To this end, it is recommended that academic libraries put in place digital records creation policies that stipulate requirements for the description of digital records for the purposes of capturing, registering, classification, retention, storage, tracking, access and disposal (ISO 15489-1, 2001:7). There is therefore a need for detailed guidance on policies and practices to preserve the digital resources in academic libraries. Such policies, standards and procedures are required for managing and preserving digital records throughout their life-cycle. The study also established that there was no policy on risk assessment and disaster management and it would thus be necessary to develop and introduce these policies for digital records protection. As has been observed in Chapter Two, there are other countries such as the UK, Netherlands, Australia and United States that could be used as models for benchmarking of such policies. The recommended models are those that focus on responsibilities and obligations, and that specify monitoring and compliance mechanisms.

Security policies and standards should also be developed that support the protection and security of digital material from unauthorized access. Therefore, all digital materials,

regardless of the medium in which they were created and accessed, should be subject to an overarching security policy. The policies would need to be effectively communicated, and training and resources be provided to staff members so that they can be implemented. The study also recommends the implementation of succession planning policies so that in the event of experts leaving the institution, replacements would fill their positions. The experienced and preservation experts should be identified so that they can train and transfer digital preservation knowledge to junior staff members in these institutions.

The survey also revealed that repository managers, digital preservation units, librarians, archivists and library management were responsible for designing and facilitating digital preservation programmes in their institutions and only a few indicated that information technology (IT) experts or divisions were part of the digital preservation team in their institutions. This is a major concern because digital preservation needs a combination of experts from different arears, including the IT division, as it also involves technical issues. IT professionals should thus be part of digital preservation teams and be well trained in preservation strategies and tools, digitization, copyright issues and metadata, security of digital records, implementing digital repositories through training formats such as seminars and workshops, on-line training, on-the-job training and internships. IT experts and digital preservation experts should also keep abreast with new technologies and new trends in the field of digital preservation. The study thus supported the view that educating digital librarians should be an important agenda in IT and the Library and Information Science field due to the changing nature of librarianship resulting from the increasing amount of information available in digital format.

The study also established that academic institutions are utilizing various measures such as access and use policy, network security, data security, request for access approval and password authentication to protect unauthorized access to their private and confidential digital resources. However, it was established that the audit trail was the least method used in protecting unauthorized access to digital materials. It is thus recommended that academic institutions should design and implement effective digital preservation systems, and to ensure that adequate audit trails are built into these systems so that a history of access and use of digital records is maintained. The monitoring and use of records should be linked to workflow and action tracking when this brings efficiency gains and this is particularly effective in the electronic environment (ISO 15489-1).

Ensuring continued access to the content of digital resources also calls for collaborations and partnerships with other institutions. It was, however, clear from the study that little attention had been paid in terms of collaboration with other national and international organizations that made a success in digital preservation. In that light, there is a need for academic institutions in South Africa to collaborate with other international organizations

such as DPC, DCC, INTERPARES, DRAMBORA, TRAC, UK Web Archiving Consortium, DPE and PLANET. Management in academic libraries should therefore encourage and support collaboration and partnerships with other institutions and they should also adopt the international strategies in digital preservation. Such strategies may act as a blue print that would ensure that digital preservation becomes embedded in academic libraries' culture, functions and processes, integrated with the preservation life-cycle, from creation through storage, preservation, access and use. To that extent, preservation specialists from around the world can learn from one another (Hirtle, 2008).

The survey established that most of those preserving digital records still need more education and training in digital preservation. In view of this, if academic libraries were to spearhead a digital preservation guided way of operating, outreach and awareness programmes, education and training in digital preservation to all staff members would be anticipated. It is therefore recommended that library management should educate staff in digital preservation through organizing training in this field. The academic institutions should also employ qualified personnel to facilitate the digital preservation projects. In addition, this research study recommends the managers of the academic institutions to develop digital preservation platforms and training centres where digital preservation principles are imparted.

The library management should also organize seminars and workshops, online training and on the job training in order to ensure an effective learning environment amongst staff members at regular intervals. Preservation policies and education programmes should thus be implemented and accessible to everyone in the institution for use, so as to present staff of academic libraries with opportunities for gaining a better understanding of the strategic importance of digital preservation. Finally, in the awake of these constraints and demands, management should use all available possibilities that best apply to situations as they arise during the implementation of effective digital preservation programmes. This should be done through establishing partnerships and participatory opportunities with other stakeholders, including users in their respective categories, as well as acquiring and disseminating relevant information to all stakeholders and devise better planning and decision making methods.

6.4.2 Key challenges or barriers to digital preservation in academic libraries

Like other institutions around the world, academic libraries in South Africa are faced with challenges in preserving their digital resources such as inadequate staff with expertise in digitizing resources, intellectual property and copyright issues, inadequate funding to purchase enough infrastructure, poor technology infrastructure, software obsolescence,

lack of human resources, lack of relevant training, inadequate resources, lack of funding, lack of management support, lack of knowledge by university leadership and low awareness of preservation issues. It was established that all these factors inhibited effective digital preservation in academic libraries, and therefore library management should be able to alleviate all these challenges through developing policies, strategies and allocating budget for all digital preservation efforts and initiatives, building a proper technology infrastructure, allocate adequate resources (human and financial resources) as well as raising awareness. Management in academic libraries should raise awareness and promote their digital preservation services as the introduction of awareness would also encourage staff members to be involved in digital preservation activities.

Digital preservation activities also have legal implications and preservation infringes upon current copyright laws that remain unclear and it is a current impediment to effective preservation practices. Copyright law and licensing arrangements may prevent problems for libraries that aim at preserving their digital resources in the long-term or even short-term if they are not properly managed. Policy makers and responsible staff in digital preservation thus need to identify where current copyright protections inhibit digital preservation and how technical strategies might impinge on copyright laws. Digital materials may also be dependent on software for search and retrieval and other functionality. However, software and hardware obsolescence seemed to be the biggest threat as changes in coding, formats, software, operating systems and hardware can render digital materials unreadable. Technical strategies such as migration, emulation and other technology preservation strategies should thus be employed to combat technology obsolescence.

6.4.3 Preservation strategies used in safeguarding digital resources in academic libraries

The current study established that a huge amount of digital data was created as a result of the increasing application of digital technologies, and it is accessible electronically. However, preserving these digital data over a long period of time is a major challenge faced by academic libraries in South Africa. It was noted in Chapter Two of the study that digital resources can be lost if they are not well preserved. With a high probability that these digital resources can be lost, academic institutions must put in place strategies to ensure that these digital resources are well preserved and long-term access is guaranteed. According to Holdsworth (2007), ensuring that digital data remains accessible and re-usable over time requires the implementation of proactive, scalable and sustainable preservation strategies.

Encouragingly, survey findings and document analysis have established that preservation strategies were in place in academic libraries, and strategies such as migration, bit preservation, replication and risk management were the most frequent strategies used in these institutions**.** Although the strategies for safeguarding digital resources were in place in most of academic libraries, the study further recommends that the continuous loss of digital records can also be ameliorated through the implementation of preservation strategies such as analogue backup, metadata, reliance on standards, and digital archaeology. Backup means that digital records will be copied and stored in multiple locations to create readily available data, and an analogue copy of a digital object can, in some respects, preserve its content and protect it from obsolescence, while sacrificing any digital qualities, including sharability and lossless transferability. In line with this, the academic institutions should also implement metadata systems to support the goals of long-term digital preservation, which are to maintain the availability, identity, persistence, understandability, and authenticity of digital objects over long periods of time. Metadata will support the discovery and use of digital information while digital archaeology includes methods and procedures to rescue content from damaged media or from obsolete or damaged hardware and software environments.

In order to achieve their long-term preservation goals, academic libraries also need to comply with prevailing preservation standards and practices such as Open Archival Information System (OAIS) and Trustworthy Repository Audit and Certification (TRAC) etc. However, libraries and archives need more practical experience in implementing and using all these strategies for continuing access. There should thus be some guidelines that include both technical and legal implications for these strategies. Whilst the study identified areas for improvement for long-term preservation of their digital resources, only a few academic libraries were noted to have policies and strategies in place. This also reinforces the need for training on preservation strategies and have a clear understanding of the policies, especially because any long-term access to digital resources rest heavily on preservation strategies underpinned by digital preservation policies.

6.4.4 Preservation systems, software and tools used in academic libraries

Best practices involve developing systems and technologies to support workflows for efficient and effective digital preservation. The study established that there were various tools and software employed in academic libraries. DSpace was the dominant software due to ease of use and affordability. Literature also identified DSPACE, Eprints and ETD-db as some of the prominent software tools used by digital repositories to support the preservation of digital materials in academic libraries. Fedora, Innovative and E-prints were also being used in academic institutions due to affordability. However, it is not yet

clear that current systems and tools are best suited to the purposes of long-term preservation. As a result, the systems and software such as these that enable long-term storage, and access to digital resources should be tested or existing systems be modified. There is still a pressing need for unique and persistent systems for identification of digital information. The system designers in the digital preservation unit should therefore design and develop systems for the unique, persistent identification of digital objects that expressly support long-term preservation.

Again, LOCKSS, Digitool, Content dm and Archive-IT were the dominant tools used in most academic libraries in South Africa and the study further recommends the use of other preservation tools such as:

- DROID (Digital Record Object Identification) that will identify and standardize file formats and metadata extraction;
- XML Electronic Normalizing for Archives (Xen) that will convert digital files to a range of preservation formats that are open, well supported and transform digital files into open formats for long-term preservation;
- Rosetta is designed to provide ingest, access and preservation functionalities;
- The metadata extraction tool automatically extracts preservation-related metadata from digital files then outputs that metadata in a standard format (XML) for use in preservation processes and activities;
- Preservica will provide a comprehensive suite of OAIS (Open Archival Information System) compliant workflows for ingest, data management, storage, access, administration and preservation;
- Archivematica uses a micro-services design pattern to provide an integrated suite of software tools that allows users to process digital objects from ingest to access in compliance with the ISO-OAIS functional model; and
- DAITSS (Dark Archive in the Sunshine State) will provide automated support for the functions of submission, ingest, archival storage, access, withdrawal, and repository management.

The study also observed that most of institutions were using metadata to record activities that have been performed upon the digital materials and as a basis on which future decisions on preservation activities can be made, as well as supporting discovery and use. These institutions should also develop tools to support the automatic generation and extraction of metadata that should be able to:

- Define what technical and administrative metadata will be needed for the long-term preservation of digital files;
- Define metadata that will be critical to support continued rendering and functionality; and

- Provide descriptive information that will be needed to support long-term semantic interoperability.

Dublin Core and OCLC were types of preservation metadata standards that were mostly used in academic libraries in South Africa. The study also recommends the application of the PREMIS and OAIS model in their preservation practices. PREMIS will support a level of complexity in preservation metadata that would be difficult to sustain while the Open Archival Information System (OAIS) model provides a framework for building and maintaining repositories for long-term preservation and access to digital materials, as discussed in Section 2.6.5 of Chapter Two, and they should also create policies and procedures that are in line with the OAIS model, as that will insure that a digital repository meets functional requirements that are accepted by the community.

6.4.5 Factors influencing digital preservation sustainability in academic libraries

Survey responses and the literature review pointed out adequate resources, implementation of preservation strategies, participatory community and knowledge of preservation tools as some of the major factors influencing digital preservation sustainability in academic libraries. The study further established that copyright and intellectual property rights, implementation of trustworthy digital repository, technical expertise, management support, implementation of policies, skilled trained staff, effective collaboration with other institutions, partnerships with other institutions, good governance and knowledge of metadata systems were also the enabling factors of digital preservation. In some instances, academic institutions were not fully involved in collaboration and partnerships with other institutions, therefore, this research recommends these institutions should build collaboration and partnerships with other institutions, nationally and internationally. By collaborating with other institutions, they would be exposed to new ideas, strategies and tools and be able to acquire knowledge and skills needed to successfully preserve and manage their digital resources. As a result, management in these institutions will also be able to benchmark with other institutions in terms of good governance, implementation of policies and building proper infrastructures through collaborative and partnership efforts.

6.5 Proposed framework for preservation of digital resources in academic libraries in South Africa

In Chapter Five of the study answers to research questions were discussed, as sought by means of a survey questionnaire, document analysis and a literature review. Theoretical models related to digital preservation were discussed in Chapter Two (Phase 1) of the study. A priliminary model based on the findings from the literature review and theoretical models was then provided in Phase 2 of the study. Reeves (1997:386) describes a model as a hypothetical structure used in an investigation of interrelated aspects which are developed from intuition, from earlier studies and from theoretical considerations. This chapter thus seeks to address the main research objective "To develop an integrated framework for preservation of digital resources in academic libraries in South Africa", using the answers that were provided to the research questions, which were discussed in the preceding chapters. In order to achieve this research objective, the study investigated the factors contributing to the development of an integrated digital preservation framework applicable to academic institutions in South Africa.

The composition of integrated preservation framework is thus based on factors identified from the literature review, the theoretical models, the survey questionnaire and findings from the document analysis. The updated version of these factors is illustrated in Figure 6.1 of this chapter and a proposed framework for preservation of digital resources is presented in Figure 6.2, which is Phase 5 of the study, as illustrated in Figure 5.1 in Chapter Five. Dix (2007:116) describes a framework as a general structure that provides an overarching set of concepts and processes while a model is a specific structure of interrelated factors hypothesised to be tested. It is hoped that the preservation framework will be a useful guide for academic libraries planning to create digital preservation programmes, and it will inform academic librarians and archivists, collection managers, digital librarians, systems librarians and digital content creators on the best practices regarding digital preservation practices.

6.5.1 Justification of a framework

Frameworks are used to provide comprehensive solutions to problems that exist within the specific domain (Lethbridge & Laganiere, 2006). Frameworks may be provided in the form of narratives or illustrations (Miles & Hubberman, 2005), and are composed of parts including features, variables or components that have fundamental relationships. This study thus provides an integrated preservation framework based on the opinion of these

authors. For purposes of the current study, an integrated preservation framework can be seen as a general structure that provides an overarching set of assumptions, concepts and processes, values and practices that guide the preservation of digital resources in academic libraries in South Africa. An integrated framework was therefore developed from survey findings, the literature review of previous studies and theoretical considerations based on the digital preservation best practices. Integration here is taken to mean logical linkage of key selected components that could be used to examine and understand preservation of digital resources in academic libraries in South Africa which include: current digital preservation practices, digital preservation challenges, strategies for digital preservation, systems and tools used for digital preservation and factors influencing digital preservation sustainability. The justification of the framework is therefore premised on findings from the survey and document analysis presented in Chapter Four of this study as well as the literature review and theoretical considerations which established that:

- There were lot of preservation challenges hindering the effective preservation of digital resources in academic libraries in South Africa;
- There was no clear understanding of processes, strategies and tools for effective digital preservation practices in academic libraries in South Africa; and
- There was no clear framework dedicated to examining and understanding digital preservation practices in academic libraries in South Africa.

It has been established in this study that academic libraries are suffering from inability to provide permanent access to the large amount of information that is available in electronic format, and they are therefore running a risk of losing vital intellectual output if preservation is not considered and prioritized. The goal of any digital preservation system is that the information it contains remains accessible to users over a long period of time. Indeed, in order to fulfil the mission to provide discovery and access to digital assets over a long period of time, academic institutions must develop strategies and mechanisms to effectively preserve these assets. A fundamental fact of digital sustainability is that, without preservation, there is no access (BRTF, 2010). However, preserving digital content over a long period of time has become a more complex task and it adds a new set of challenges for libraries and archives in preserving their digital materials. Literature revealed that the academic institutions are faced with numerous challenges as they attempt to adapt to the digital age, including dealing with rapid obsolescence of the technology used, making accessible mass quantities of digital data and remaining trusted as repositories that hold documentary evidence of scholars and citizens (Corrado & Moulaison, 2014; Canadian Memory Institutions, 2014) (as discussed in Section 1.2 of Chapter One), and these are one of the key challenges that motivated this study.

Sigauke (2011) also observed that for the past few years, these institutions have been grappling with how to manage and preserve digital intellectual output they produce and as a result some of the digitized materials have been lost and to date remain inaccessible due to the original software being outdated or incompatible with modern operating systems. In order to address these challenges, the study responded to the call by Sinclair et al. (2009) and Quistbert (2008) that new thinking, new models, policies and frameworks are needed to cope with the digital preservation problems. This implies that academic libraries need to re-strategize and put benchmarks in relation to the manner in which they preserve and manage their digital resources, be it planning, organizing and decision making. The need to have a clear framework for understanding and guidance in digital preservation practices is thus critical for the overall integration of academic libraries with the e-environment in South Africa. The elements or factors contributing to the digital preservation framework were therefore identified from survey results, literature review and previous studies, models and frameworks discussed in this study. Figure 6.1 provides an illustration of the updated version of the factors contributing to the digital preservation framework within academic libraries in South Africa.

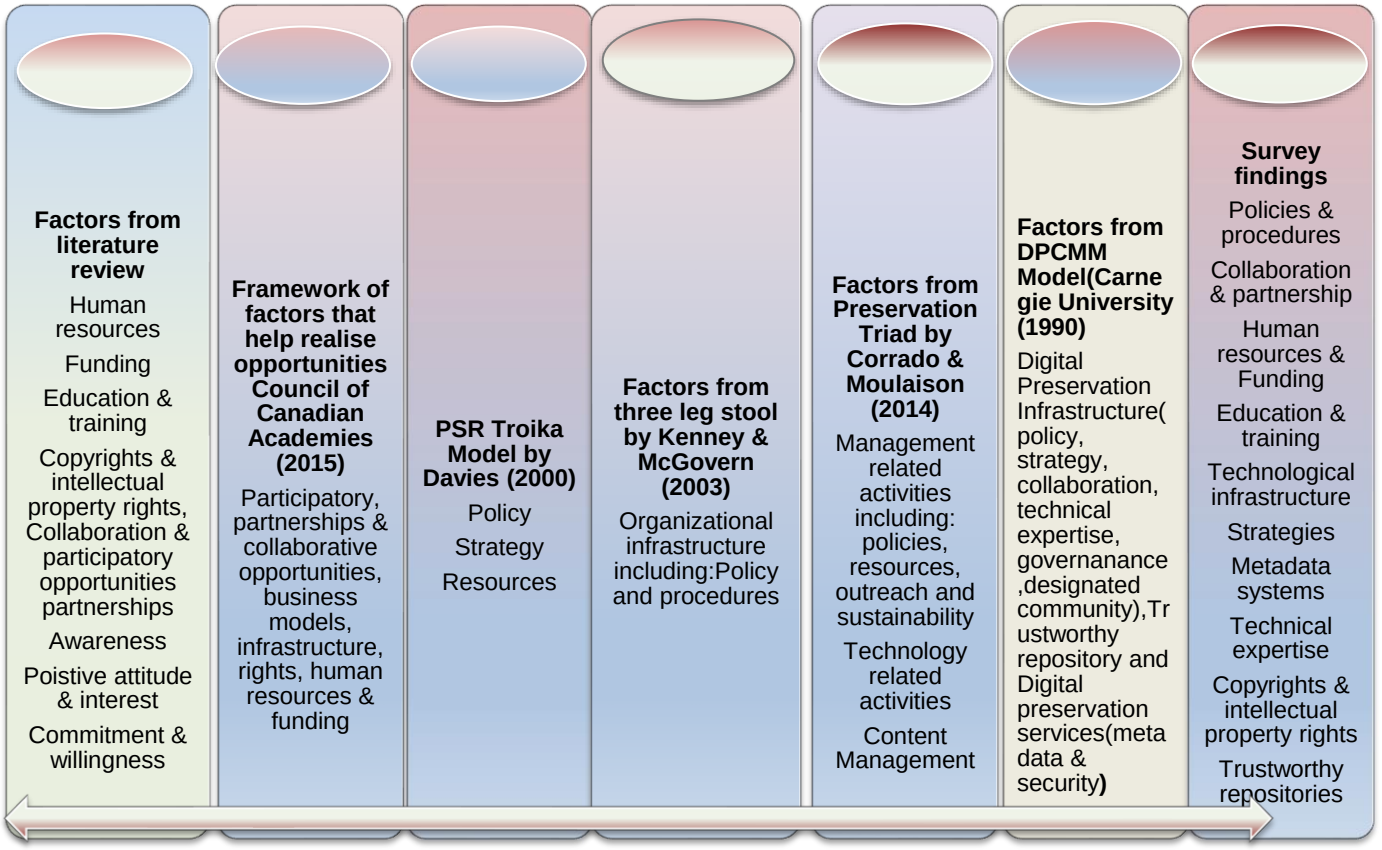

Figure 6.1: Factors that contribute to digital preservation framework (Davies, 2000; Kenney & McGovern, 2003; Corrado & Moulaison, 2014; Carnegie Mellon University 1990; Council of Canadian Academies, 2015)

It is clear from the above figure that the various authors represent the same views on the factors contributing to digital preservation framework. The findings from literature review, models and frameworks used in this study, as well as the survey questionnaire, seem to all agree that sustainable digital preservation is determined by the implementation of clear policies, procedures and strategies, collaboration, participatory partnerships, copyright and intellectual property rights, human resources and education, financial resources, technology infrastructure, content management, outreach, sustainability, positive interest, commitment and willingness (Davies, 2000; Kenney and McGovern, 2003; Corrado and Moulaison, 2014; Carnegie Mellon University, 1990; and the Council of Canadian Academies, 2015). A preservation framework was therefore developed based on the factors from the literature review, models and frameworks related to digital preservation and it was mapped with the function requirements of the OAIS reference model and the attributes of the Trusted Digital Repository (TDR) model (international preservation standards). Thus, whereas the integrated preservation framework placed emphasis on the development of policies, procedures, structures and systems to ensure the longevity of digital resources, the OAIS model helped to explain how the implementation of digital preservation programmes can be facilitated by creating and capturing their digital content as well as providing access to digital content. The OAIS model was further used to investigate and guide on how academic libraries preserved their digital resources. Figure 6.2 depicts the proposed integrated framework for academic libraries.

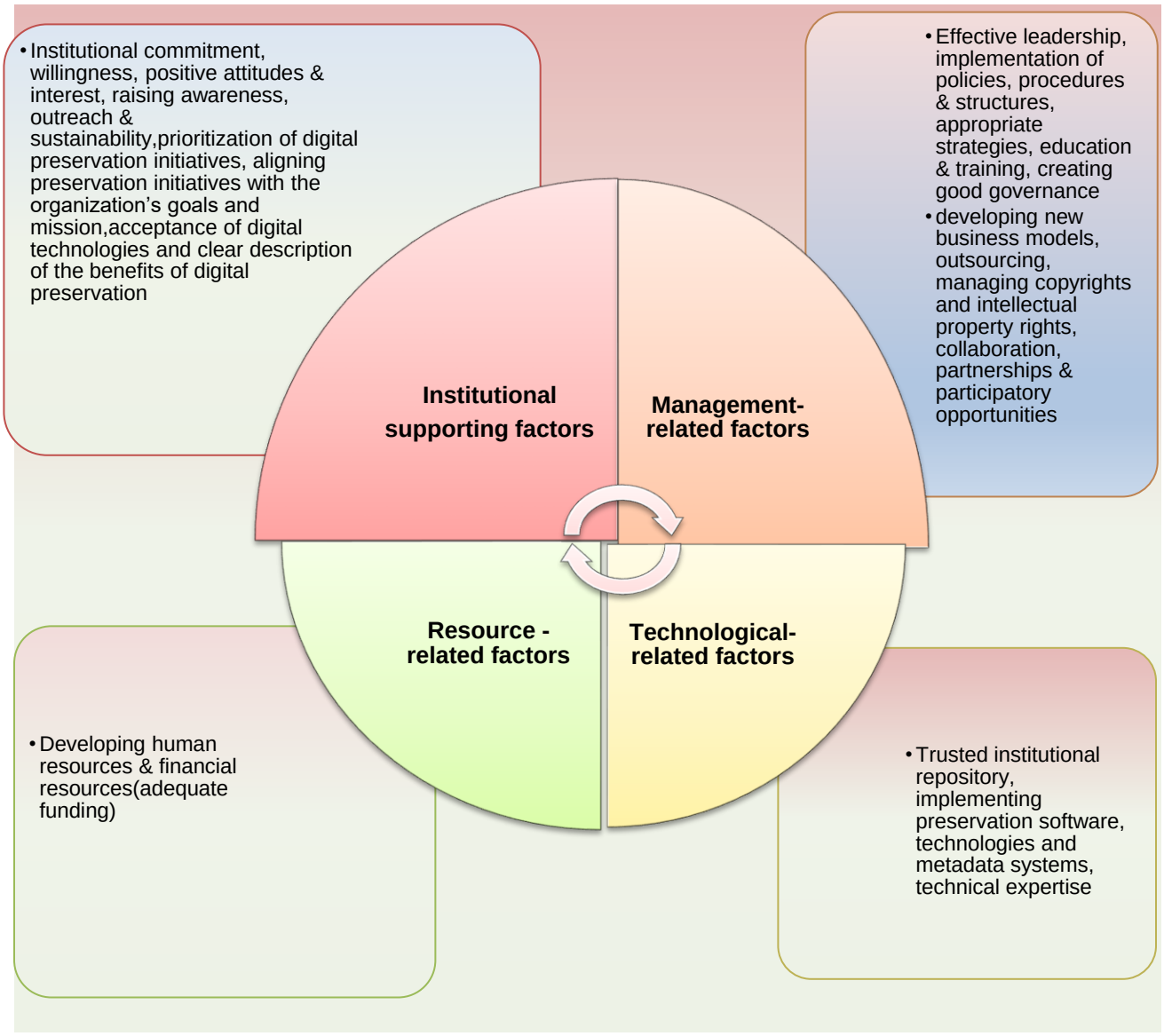

Figure 6.2: A proposed digital preservation framework for academic libraries

6.5.2. Explanation of the framework

An integrated framework for preservation of digital resources in academic libraries in South Africa was proposed in this chapter. This proposed integrated framework builds on the existing body of knowledge on digital preservation and was developed from the findings in the literature review in Chapter Two and survey findings and document analysis in Chapter Four. In that light, the framework draws heavily from theoretical models and frameworks, contributing factors from the literature review, survey findings and document analysis. On the other hand, the integrated preservation framework should be guided by what academic libraries can accomplish within their existing human and financial resources, technology infrastructure and funding capabilities, including understanding current preservation challenges. They are also required to improve the utilization of their existing resources within the institutional culture.

The digital preservation framework was therefore drawn from the principal capability factors upon which digital preservation for academic libraries depends, and there are four components of the framework, namely: institutional or organizational supporting factors, management-related factors; resources-related factors and technological-related factors, many of which the study discussed in Chapters Two, Four and Five. It is argued that all these factors are key to understanding and guiding digital preservation practices and are appropriate for implementing the sustainable digital preservation programme in academic libraries in South Africa. The first part of a framework underscored the supporting factors needed at institutional levels to realise the aforementioned factors. The following section discusses the factors composing the digital preservation framework

6.5.2.1 Institutional supporting factors

As established in the literature review in Chapter Two, many libraries and other cultural institutions have not been able to make digital preservation a high priority (Corrado & Moulaison, 2014). Digital preservation seemed to be not a primary concern to most of the institutions. As mentioned by Moulaison (2014:6) even big and well-funded projects can go awry if digital preservation is not a primary concern at the outset. Firstly, management must recognize the importance and the benefits of digital preservation as that will enable them to prioritize digital preservation initiatives. Again, the sustainable digital preservation requires not just technical solutions but also clear organizational commitment and willingness. The study thus observed that lack of commitment and willingness hinders the effective implementation of digital preservation and thus management needs to commit themselves and have positive attitudes and interest towards digital preservation

initiatives. Academic institutions in South Africa need to align their digital preservation initiatives with the organization's core mission, goals and vision.

Literature revealed that the majority of institutions creating digital materials or designing digital content management systems do not take great interest in their long-term preservation as it is clear that many systems still do not take long-term preservation into account. In this regard, academic institutions need to develop systems that take long-term preservation into account and ensure that all staff with the responsibility for digital resources enter the initiatives with a long-term vision. It is also essential to understand the preservation requirements and issues associated with digital preservation ensure that business needs are identified and fed into the preservation project as well as developing a preservation plan. Hofman et al. (2008:2) describe a preservation plan as "a series of preservation actions to be taken by a responsible institution due to an identified risk for a given set of digital objects or records (called collection)". The preservation plan takes into account the preservation policies, legal obligations, organizational and technical constraints, user requirements and preservation goals. Becker et al. (2009) also identified elements for a preservation plan such as description of the institutional setting, description of the collection, requirements for preservation, evidence of decision for a preservation strategy, and digital preservation costs, roles and responsibilities. Academic institutions need to take all these elements or factors into account in achieving their long-term preservation goal.

Research by Olatokun (2008) of fifteen universities in Nigeria also found out that digitization and preservation projects were rarely reported basically because of lack of awareness. Therefore, academic institutions need to:

- Be engaged in an advocacy and raise digital preservation awareness as it is vital for achieving the goals for long-term access and integrity of digital content; and
- Establish meaningful relationships with a diverse set of designated communities so that people are aware and trusting of opportunities awaiting them.

According to Dollar and Ashley (2014) the organization that has responsibility for preservation and access to permanent electronic records is well served through proactive outreach and engagement with its designated community of records producers and users. Academic institutions also need to be engaged in communications and outreach programmes to clarify the necessity for digital preservation. The outreach tools may include training events, instructional videos, reports, seminars, workshops, conferences, etc. Thus, awareness, outreach, communication and training are keeping everyone on the same page with regard to understanding the procedures and strategies regarding digital preservation.

6.5.2.2 Management-related factors

Firstly, management needs to understand the users' needs or interests, the preservation needs of the content, communicate requirements to the development team, communicate status of their digital preservation to stakeholders, communicate priorities, monitor and assess preservation tools and services to determine applicability toward meeting users' needs and preservation requirements. Management in academic libraries also need a thorough systematic understanding of the barriers to digital preservation in their own libraries and how they are influenced by institutional workflows and users' needs, and they should therefore analyse digital preservation environments and adequately address related challenges. With more and more libraries preserving their digital collections, policy concerns and procedures surrounding digital preservation are becoming increasingly paramount. Corrado and Moulaison (2014) also identified resources, policies, content management and planning of technology as part of management functions. Implementation of policies and procedures, appropriate strategies and staffing of skilled and knowledgeable personnel are vital for effective preservation of digital resources. As a result, management has to establish clear policies and workflows, securing at least minimal resources in terms of time and advocating for digital preservation among staff, administrators and leaders of parent institutions. Relevant policies, procedures, standards, and systems development should be documented so that they may be sustained and understood over time.

The academic institutions also need to have a governance over their digital preservation practices. Governance includes the processes, roles, standards and metrics that ensure the effective and efficient use of digital information in enabling an organization to achieve its goals. Effective governance framework is thus essential to deliver the diverse organizational components of the strategy. The governance framework enables the compliance of the preservation repository with applicable laws, regulations, record retention schedules, disposition authorities and standards. Digital preservation is regarded as a global issue and there is therefore a need to collaborate on digital preservation programmes so that they can be implemented effectively. Libraries, archives and museums (LAM) are therefore seeking new ways to retain their relevance by encouraging a participatory culture; contributions from the public range from simple tagging activities to sharing of historical knowledge to design of software by expert volunteers (as discussed in Section 2.7.4 of Chapter Two). Management in academic libraries also needs to seek appropriate opportunities to collaborate with other institutions and organizations on digital preservation initiatives so that their institutions may benefit from shared resources available to address shared challenges. This will also enable them to exchange knowledge and expertise across the wider international digital preservation communities, as noted by the Council of Canadian Academies (2015:61). Through

collaboration and partnerships, a basic digital preservation programme can be devised and put into operation with support from others in the institution and with the development of key policies and workflow. Effective and efficient collaboration, partnership and participation are thus the key to digital preservation success.

Copyright and intellectual property are important issues in the stewardship of scholarly and research output. The copyright issue relates to acquiring permission to use copyright-protected content and therefore academic institutions must identify all content that is part of the project as there may be content in the public domain or protected content. As stated by Chuma-Okoro (2010) the principle of fair use recognizes the lawful use of copyrighted work without deeming it an infringement, not withstanding that the copyright holder has not authorized the use. Digital resources must be copied if they are to remain accessible whereas traditional resources may not be copied as part of a preservation programme, and thus acquiring the rights or permission is an integral part of collecting content. Therefore, library management and staff members responsible for preservation of digital resources need to acquire the rights or permission from content contributors and copyright holders, for example, to distribute the content freely or to make copies of the PDF file for preservation purpose. Managers in academic libraries also need to know that they have the right to copy for the purposes of digital preservation and the appropriate permission must be obtained from the rights holders to give digital preservation practitioners control over their digital materials and to carry out their preservation responsibilities efficiently. As noted by Kari and Baro (2016) to meet preservation objectives, the archiving institution may have to alter the archived content in some way, for example by migrating it to another format to keep pace with changing technologies. Library managers therefore need to know what technologies have been used to control rights management and what implications there are for controlling access.

There is also increased demand for information professionals with skills needed to run a digital preservation programme, especially for academic libraries in South Africa and other developing countries. Rosenberg (2006) also noted that skills in e-resources management, e-services development, and digitization and preservation skills are lacking in African university libraries. However, lack of management support for training of staff was identified as one of major problems impeding digital preservation in academic libraries. Library managers need to provide training to ensure that staff are able to maintain and enhance their digital preservation expertise. As a result, constant training of libraries and archivists in the development and management of institutional repositories and digital preservation will enhance their efficiency and effectiveness in this field. An important step in dealing with this need is to design educational and training programmes appropriate for preparing future digital librarians for the workplace. To design such programmes, they need to understand the staffing patterns in repositories or digital

archives, the activities performed in IRs and the practical skills that are needed to manage and preserve digital content over a long period of time.

6.5.2.3 Resource-related factors

Adequate and proper allocation of resources is fundamental for a sustainable digital preservation. According to Murphy (2008:20), digital preservation is not just about technical solutions for combating bit rot and technological obsolescence, it is also about ensuring that digital preservation activities are provided with sufficient resources to ensure that preservation objectives can be met in an ongoing, sustainable way. As a result, digital preservation activities require a substantial resource commitment to sustain them over time. Ruusalepp and Dobreva (2013) also emphasized that ensuring the ongoing and efficient allocation of resources to digital preservation is an urgent societal problem because digital information is inherently fragile, prone to information loss and degradation. Murphy (2008) added that we need to allocate resources to support long-term preservation of digital resources. The effective resource allocation is thus essential to effective digital preservation.

The study also established that digital preservation is too complex and costly. The costs of digital preservation and building of digital repositories required a lot of time and financial resources as observed by Hughes (2004). However, lack of funding was among factors inhibiting preservation of digital resources in academic libraries in South Africa. These institutions are faced with the challenge of funding their digital preservation initiatives or projects, for example, they do not have long term funding to build and sustain their IRs. Again, providing technical support for digital preservation activities may be neither feasible nor affordable in academic libraries in South Africa as a result of inadequate funding for library services. For example, creating metadata manually is too expensive and preservation metadata may not always be easily generated automatically. Additional metadata for digital preservation needs therefore requires careful cost or benefit trade-offs.

Digital preservation is also a life-cycle concern and the costs of digital preservation should be dispersed across the entire life-cycle. As pointed out by Arms (2000), careful management of the human and financial resources related to all aspects of the preservation life-cycle enables successful implementation of a digital preservation programme. Library management thus needs to plan and budget for long-term preservation of content at the point of acquisition so that financial sustainability is considered early in the preservation life-cycle. In order to achieve this, library management also needs to work with the institution's financial division to manage digital preservation finances and cost models. If less funding is available than currently

budgeted, management has to seek external funding. Government, institutions, and non-governmental organizations should also endeavour to allocate a substantial part of their budgets to support and fund digital preservation projects within academic libraries.

Human factors are related to staff ability to perform roles in digital preservation; however, it was established that there was a lack of knowledge, skills and training in digital preservation among staff. The personnel involved in digital preservation initiatives do not possess the required skills to manage and preserve their digital resources. To assist staff to broaden their skills, management needs to create a combined mentoring, training and development programme to develop necessary skills. Management may also audit existing skills to identify key gaps or hire experts in digital preservation. Lack of sustainable funding and adequate staffing are thus regarded as obstacles in implementing successful digital preservation programmes and it is imperative that these issues be addressed in the planning process for building an effective digital preservation programme. With major limitations in funds, personnel, and adequate resources, minimal interventions and basic preservation might be all that many academic institutions can do whereas doing this much is essential.

6.5.2.4 Technological-related factors

This final lap of the framework underscored the need for the development of systems to take care of adequate resources, technical expertise and proper technology infrastructure. Arguably, technology has been viewed as both the problem and solution for digital preservation. Digital resources are dependent on hardware and software to render them intelligible and, as a result, more new software and hardware is being designed in libraries, and the trend for digital hardware and software to be integrated into library systems is also increasing. Digital preservation software and systems such as trustworthy digital repository, metadata systems and other preservation systems need to be in place for effective preservation of digital resources. Managers need to record the technical requirements so that decisions on appropriate preservation systems and access strategies may be made.

A viable digital preservation capability also requires organizations to have sufficient staff with technical expertise to support all of the technology infrastructure and requisite key processes for digital preservation, and this will inevitably facilitate the preservation of digital content and guarantee the long-term storage of digital materials. As suggested by Dollar and Ashley (2014) technical expertise may exist within internal or contracted staff, may be provided by a centralized service bureau, or by external service providers. Again,

management needs to appreciate the fact that the exponential changes and development of digital technologies has drastically changed the way information professionals create, disseminate and use information in the library world, and they therefore need to adopt a culture of willinginess to change and to consider the mentality and understanding of the needs of the users. The study thus suggests that these four connecting circles are inseparable and very dependent on each other and their combination is therefore central to the future and success of digital preservation practices within academic libraries in South Africa.

6.5.3 Implication for theory, practice and policy

The current study has answered several questions as to the extent to which digital preservation theories and models may be used to understand the contributing factors, as well as the extent to which policies and strategies contribute towards effective digital preservation. Theoretical frameworks and models in digital preservation gave an insight into what work has been happening in archival science and they are important to the study of digital preservation in the context of academic libraries. Most of these theories and models have centred on general understanding of digital preservation at national and organisational levels. Critical to this, the review of these theories and models helped in understanding the elements or factors contributing to preservation frameworks applicable to academic libraries, and they have thus been helpful in informing the development of this framework.

As discovered in the literature review, digital technologies have created some challenges such as preservation of digital information for future access. With massive quantities of information now being digitally processed and stored, our computer-based society is faced with a great challenge: how to preserve and efficiently access these vast amounts of digital data well into the future (Kari & Baro, 2016). The literature review also revealed that the dramatic change to the digital era and associated challenges of preserving digital assets have created the need for best practices in ensuring long-term preservation to digital resources in academic libraries. This study thus identified preservation challenges and demonstrated several fundamental approaches or strategies to address them. It has contributed to the numerous solutions that have been recommended to address the digital preservation challenges through proposing an integrated framework (outlining contributing factors), that may provide a basis for understanding the depth of digital preservation in academic libraries in South Africa, as depicted in Figure 6.2. It is hoped that such a proposed preservation framework could pave the way for understanding the digital preservation practices and guide academic libraries in achieving their goal of long-term preservation of their digital resources.

The study has also presented the recommendations that will eventually provide the very basis upon which digital preservation will be implemented, hoping that the aforementioned recommendations will be integrated into the preservation policy document of academic libraries and be implemented accordingly. Furthermore, corrective actions were proposed to enhance the success of the implementation of the digital preservation systems, and if the recommendations of the present study are taken into account, they could help academic institutions in South Africa to implement and sustain digital preservation. This study thus adds to the existing theoretical and conceptual issues that form the on-going discourse on the implementation of digital preservation in the academic environment, and will thus serve as a guide to academic institutions in South Africa in terms of good understanding of governance, policies and procedures in driving digital preservation practices.

It was established that academic libraries in South Africa are actively leading the way in implementing digital preservation programmes, as compared to other African countries. This study is thus important because academic libraries, particularly in South Africa, perform a number of digitization and preservation practices that need further investigation due to the fast changing information environment which is affected by advances in digital technologies. The findings of this study may go a long way in influencing policy and practice and will further assist librarians, archivists, policy makers, library management, collection managers, IT and digital preservation specialists and practitioners and other stakeholders in improving and benchmarking with other key sectors on the extent of their implementation of their digital preservation programmes in South Africa. However, the findings of the present study may also be of use to academic institutions, researchers and scholars undertaking studies into digital preservation practices all over the world.
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6.5.4 Suggestion for future research

As has been ascertained in the current study, there is a dearth of empirical studies on digital preservation in academic libraries in South Africa. Most of the studies on digital preservation have tended to largely focus on cultural heritage institutions, archival institutions and the public sectors in South Africa. Much of the literature, discussions and recommendations were centred on issues of digital preservation in these institutions and little was thus discussed about digital preservation in academic institutions, particularly in South Africa. Therefore, there is still a need for an in-depth study into digital preservation within the context of South African academic libraries. There are also few digital preservation initiatives or studies that have been devoted to implementing strategies and developing a viable digital preservation framework to guide and support preservation practices in academic libraries in South Africa. A review of the current initiatives shows

that there is no specific agreed framework on the preservation of digital resources applicable to academic libraries in South Africa. The current study therefore breaks new ground and brings out several issues that would require further in-depth research on digital preservation practices in academic libraries.

Although it was established from this study that most of academic libraries in South Africa have implemented IRs as a way to capture, preserve and provide free access to their members' intellectual output, the current study did not specifically focus on the extent to which IRs are managed and preserved and if these repositories meet the requirements of the Trusted Digital Repositories (TDRs). TDR accepts responsibility for long-term maintenance of digital resources and applies commonly accepted standards such as OAIS Reference Model,Trusted Digital Repositories: Attributes and Responsibilities, Digital Repository Audit Method Based on Risk Assessment (DRAMBORA) and Trustworthy Repositories Audit and Certification: Criteria & Checklist (TRAC) to ensure ongoing management, security and access to digital resources. These standards also guide in auditing the repository against a recognised digital preservation repository audit methodology, so that the institutions may independently validate their approach and measure their progress over time. There is thus a need to assess the current digital preservation capabilities of institutional repositories in academic libraries in South Africa, as neither of the preservation standards identifies explicit performance metrics. Therefore, future research needs to focus on:

- The implementation level issues to specify minimum requirements in respect of policies, processes and metadata required to measure and validate a repository's trustworthiness in respect of authenticity, integrity and reliability of the digital materials in academic libraries in South Africa; and
- Examining if their institutional repositories meet the criteria for trusted digital repositories, whose mission is to provide reliable, long-term access to managed digital resources to its designated community, now and in the future (RLG-OCLC Report, 2002).

Strategies such as cloud computing can also improve digital preservation initiatives. Like other institutions in the world, it is clear that academic libraries in South Africa are still grappling with the possibilities of the adoption of these technologies. Survey and document analysis findings have shown that, given the nature of digital preservation that heavily require more funding, such technology may be beneficial as it is capable of only billing customers for the storage they use. It would therefore be a worthwhile investigation to undertake an in-depth qualitative study on the extent to which these newer technologies could be useful in the context of current digital preservation practices and standards in academic libraries. Thus, a cloud service, encompassing both storage and

preservation of digital objects based on the user's policies for the retention period, preservation level of service, and data confidentiality, can be an attractive alternative to self-provisioning for digital libraries and archives. For this reason, further enquiry could be undertaken on Long-Term Digital Preservation as a Service (LDPaaS).

The study also identified numerous factors influencing digital preservation sustainability in academic libraries, thus a depth investigation into these factors can be a topic of research on its own. Metadata is critical to preservation and retrieval, however, little has been done to improve metadata knowledge and practice. Future studies in this area should also explore the use of metadata as a strategy to preserve digital resources in academic libraries. Finally, bearing in mind that each academic library has a unique set of distinct characteristics and operating procedures that can play an important role in the creation and implementation of digital preservation practices, case studies may be carried out in selected academic institutions in order to gain unique insight into digital preservation in those institutions.

6.5.5 Final conclusion

The current study investigated digital preservation practices in academic libraries in South Africa with a view to proposing an integrated framework applicable to these institutions. The findings revealed a growing awareness about digital preservation in South Africa, with an increasing number of academic institutions making efforts to preserve their library materials through implementation of institutional repositories and digital libraries. Despite all the efforts to create digital preservation programmes, roadblocks such as copyright issues, funding, institutional support, technical drawbacks and conservation of originals have always hampered meaningful progress in building digital libraries and institutional repositories (Hughes, 2004). This study also established that preservation efforts were being hampered by challenges such as limited or complete lack of human, financial and technological resources by the institutions with statutory responsibility for digital preservation and the recommendations were made to management on how to alleviate the encountered challenges.

The loss of digital information was highlighted as a major concern and as a result, academic libraries were putting in place strategies such as migration, bit preservation, back up and risk management for safeguarding their digital materials. Based on the findings presented in Chapter Four, effective leadership, adequate training, proper ICT infrastructure, sufficient budget, partnerships and collaboration opportunities were among factors enabling effective digital preservation practices in academic libraries. To improve effective digital preservation in academic libraries, several recommendations that pointed to the adoption of best digital preservation practices were documented and these include

enactment of preservation policies, proper allocation of resources (human and financial resources), more collaborative and partnership opportunities, improving technology infrastructure or deploying cloud technologies to address the storage needs and to overcome software and hardware technological obsolescence.

Furthermore, a proposed framework, based on survey findings, document analysis and literature, was presented. The study also discussed the implication of theory and practice, as well as suggested areas for further research. However, it is clear from the study that a road to successfully implementing an effective digital preservation programme is not an overnight work and this means that academic libraries in South Africa still have a long road ahead towards achieving a sustainable digital preservation programme. However, reviewed literature has shown progress and a common impetus for digital preservation initiatives in international countries such as Europe, New Zealand, United Kingdom, and United State of America, Netherlands and Australia, just to name a few. There is therefore a need to collaborate and benchmark with these international organizations as to what is successfully operating in their institutions that may be learned by other countries' institutions such as academic libraries in South Africa.

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APPENDICES

APPENDIX 1: REQUEST FOR PRE-TESTING THE QUESTIONNAIRE

UNIVERSITY OF SOUTH AFRICA

SCHOOL OF ARTS

DEPARTMENT OF INFORMATION SCIENCE

A FRAMEWORK FOR PRESERVATION OF DIGITAL RESOURCES IN ACADEMIC LIBRARIES IN SOUTH AFRICA

Dear Sir/Madam

I am a PhD student at the University of South Africa (UNISA) in the Department of Information Science conducting a study entitled developing a framework for preservation of digital resources in academic libraries in South Africa. The research includes a questionnaire survey as data collection tool and I therefore kindly request you to pre-test the attached questionnaire to ensure its validity and reliability. Therefore, please scrutinize the attached questionnaire using the checklist that is provided below and feel free to write comments or advice for improvement on the questionnaire.

1. Are there any misspelt words? Yes [ ] No [ ]

_____

2. If your answer is “Yes”, please indicate them in the questionnaire.

3. Are the most crucial aspects covered? Yes [ ] No [ ]

4. If your answer is “No”, please, provide some suggestions below:

_____

5. Are there questions which should be omitted? Yes [ ] No [ ]

6. If your answer is “Yes” please indicate in the questionnaire

7. Is the survey too long? Yes [ ] No [ ]

8. If your answer is “Yes”, please, provide some suggestions below:

_____

_____

9. Do the sections of the questionnaire and the questions have a logical flow? Yes [ ] No [ ]

10. If your answer is “No”, please, provide some suggestions below:

_____

_____

11. How long did it take to complete the questionnaire?

_____

12. Do you have any criticisms, comments or suggestions on the format of the

Survey? Yes [ ] No [ ]

13. If your answer is “Yes”, please, provide some suggestions below:

_____

_____

Please return the completed questionnaire to me, Mrs. Tlou Maggie Masenya by the 16th September, 2016, University of South Africa, School of Computing, C/o Christiaan de Wet Road & Pioneer Avenue, Florida Park, Roodepoort. Email:emasentm@unisa.ac.za. Telephone: (011) 670 9176

Thanking you in advance

Yours Sincerely

Tlou Maggie Masenya (PhD Candidate)

APPENDIX 2: COVER LETTER FOR SURVEY QUESTIONNAIRE

UNIVERSITY OF SOUTH AFRICA
SCHOOL OF ARTS
DEPARTMENT OF INFORMATION SCIENCE

A FRAMEWORK FOR PRESERVATION OF DIGITAL RESOURCES IN ACADEMIC LIBRARIES IN SOUTH AFRICA

Dear Sir/Madam

I am a PhD student in the Department of Information Science and Senior Lecture in the School of Computing at University of South Africa (UNISA), conducting a study to investigate the current status of digital preservation practices in academic in South Africa with a view to developing a framework for preservation of their digital resources. You are therefore kindly invited to voluntarily participate in a research project entitled " a framework for digital preservation of digital resources in academic libraries in South Africa". In the context of this study, digital preservation can be briefly described as follows:

- As combination of policies, strategies and actions to ensure that digital objects remain authentic and accessible to users over a long period of time, regardless of the challenges of management failures, natural disasters or attacks; and
- As aiming to ensure protection of information of enduring value for access by present and future generations and hence it comprises of planning, resource allocation and application of preservation methods and technologies necessary to ensure that digital information of continuing value remain accessible and usable.

Academic institutions are faced with the major challenge of preserving and maintaining access to digital content that has been ingested into their university archives over the long- term. This challenge underscored the need for the development of strategies to ensure long-term preservation of digital resources in these institutions. The information gathered from this research will thus be used to propose a framework that will provide a well-articulated road-map and serve as a useful guide in bench-marking and supporting digital preservation activities in academic libraries.

The study was cleared by the UNISA ethics committee and there is no apparent risk or negative consequences to the participants involved in this study. I also wish to assure you that all the information supplied will be treated in utmost and strictest confidence; hence you do not have to write your name or give any information that will reveal your identity. I sincerely do understand that you have a very busy schedule but I will be very grateful if you can kindly complete an online questionnaire and submit. I will however, endeavor to share the findings of this study with your institutions and should you have any queries about the study, please do not hesitate to contact me at the University of South Africa, College of Science Engineering and Technology, School of Computing, Florida Campus, GJ Gerwel Room 4-19, Tel No: 011 670 9176, Email address: emasentm@unisa.ac.za

I hope you will take the time to complete the questionnaire- your participation and prompt response will be greatly appreciated

Your Sincerely

Tlou Maggie Masenya (PhD Candidate)

APPENDIX 3: QUESTIONNAIRE

SURVEY QUESTIONNAIRE FOR COLLECTING DATA ON DIGITAL PRESERVATION PRACTICES IN ACADEMIC LIBRARIES IN SOUTH AFRICA

INSTRUCTIONS FOR FILLING IN THE QUESTIONNAIRE

Kindly pay attention to the following instructions when filling in the questionnaire:

- Please select the applicable by placing an X in the box next to it.
- Use spaces provided to write your answers to the questions and please do print
- Please, do not leave blank spaces
- If the question does not apply, please indicate "n/a".

SECTION 1: PERSONAL PROFILE

1. Indicate your job title……

2. Indicate the name of your institution……

3. What staff category do you belong to? (Please tick once where applicable)

- ❑ Full-time employee
- ❑ Part-time employee
- ❑ Library consultant

4. What is your highest level of education? (Please tick the most appropriate answer)

Matric (Grade 12)		Certificate		Diploma		Degree		Post graduate degree		Other professional qualifications, please specify	

SECTION 2: DIGITAL PRACTICES IN ACADEMIC LIBRARIES

5. Please tick "Yes" or "No" in the box that best suits your response

Does your institution have a formal digital preservation programme in place?

Yes [ ]

No [ ]

5.1 If yes to question 5, does your institution have a dedicated budget for digital preservation practices?

Yes [ ]

No [ ]

6. Please indicate who is responsible for digital preservation in your institution (Please tick all that may be applicable)

a. Library management team [ ]

b. Digital preservation unit [ ]

c. Information technology department [ ]

d. Librarian or archivist [ ]

e. Content manager [ ]

f. Repository manager [ ]

g. Other, please specify……

7. Have you undertaken any efforts to preserve digital materials at your institution?

a. Yes [ ]

b. No [ ]

8. If yes to question 7, what has been your motivation to preserve digital materials?

Reasons for preservation	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Pressure form library users and researchers					
Increase application of digital technologies					
Pressure from other institutions in the developed countries					
Ensuring long term access to digital resources					
Competition among academic institutions					
Managing digital content					
Competition among academic institutions					
The desire to promote library services					
Interest in digital technologies					
Other (please specify)					

9. What sorts of materials does your institution have in digital forms? (Please tick all that may apply)

a. Theses [ ]

b. Dissertation [ ]

c. Research data [ ]

d. Annual reports [ ]

e. Journal articles [ ]

f. Conference papers [ ]

g. Images [ ]

h. Audio [ ]

i. Video [ ]

j. Institutional records [ ]

Other, please specify……

10. What types of digital materials is your institution preserving? (Please tick all that may be applicable)

a. Textual documents [ ]

b. Research data [ ]

c. Theses [ ]

d. Dissertation [ ]

e. Images [ ]

f. Emails [ ]

g. Audio [ ]

h. Video [ ]

i. Journal articles [ ]

j. Institutional records [ ]

k. Other, please specify: ……

11. How does your institution ensure successful implementation of preservation practices? (Please tick all that may apply)

a. Institution has developed preservation policy and procedures [ ]

b. Institution has dedicated budget for preservation practices [ ]

d. Institution has built collaboration with other institutions [ ]

e. Institution has sufficient trained and skilled staff [ ]

f. Institution has proper technology infrastructure and resources [ ]

g. Institution developed training and education programmes [ ]

h. Preservation strategies are in place [ ]

i. Other please specify……

12. What level of digital preservation your library is currently providing?

Short-term		Long term	
Medium term		Don't know	

13. What type of digital materials do users normally seek? (Please indicate Yes or No by the side boxes provided)

Digital materials	**Yes**	**No**
Theses		
Dissertation		
Research data		
Annual reports		
Journal articles		
Conference papers		
Other, please specify		

14. What do you regard as effective digital preservation?

Effective digital preservation	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Data is maintained in the repository without being damaged, lost or maliciously altered					
Data can be found, extracted and served to a user					
Data can be interpreted and understood by a user					
Data can be preserved over a long period of time					

15. How important do you consider the long-term preservation of digital materials?

Extremely important		Very important		Somewhat important		Not very important		Not at all important	

16. Are there any measures taken by your institution to protect digitized materials from unauthorized access?

a. Yes [ ]

b. No [ ]

c. Do not know [ ]

17. If yes to question 16, what measures are taken to protect unauthorized access to digital materials? (Please tick all that may apply)

a. Access and use policy [ ]

b. Secure password authentication [ ]

c. Network security [ ]

d. Data security [ ]

e. Request for access approval [ ]

f. Using audit trail [ ]

e. Other please specify……

18. Does your institution have a written digital preservation policy in place?

a. Yes [ ]

b. No [ ]

c. Do not know [ ]

19. If yes to question 18, who are involved in the development of policy regarding preservation of digital materials in your institution? (Please tick all that may apply)

a. University Librarian [ ]

b. Systems Librarian [ ]

c. Collection manager [ ]

d. Information technologist [ ]

e. Repository manager [ ]

Other, please specify……

20. What does the policy cover? (Please tick Yes or No in the box that best suits your response)

Policy aspects	Yes	No
Collection development		
Collection digitization		
Collection disaster plan		
Digital preservation policy		
Content management		
Access and use of digital resources		
Intellectual property rights		
Information technology strategic plan		
Exhibition and loan		
Selection of materials		
Security		
Preservation standards and ethics		
Retention		
Financial policy		
Storage		
Other, please specify		

21. Do you think the development of preservation policy is important?

a. Yes [ ]

b. No [ ]

c. Not sure [ ]

22. Do you have institutional repository (IR) in your institution?

a. Yes [ ]

b. No [ ]

23. If yes to question 22, does your institutional repository (IR) serve its purpose of the following?

Institutional repository purposes	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Increasing the dissemination and impact of research output of staff and researchers					
Storing long-term availability and accessibility of digital resources					
Enhancing academic communication by allowing global users to comment on pre-prints it stored					
Providing a central storage space for intellectual output of an institution					
Improving the visibility to research output					
Other (please specify)					

24. What types of materials are kept in the institutional repository (IR) in your library? (Please tick where applicable)

a. Theses [ ]

b. Dissertations [ ]

c. Annual reports [ ]

d. Journal articles [ ]

e. Conference paper [ ]

f. Research notes [ ]

g. Research data [ ]

h. Artwork [ ]

i. Other, please specify……

25. For how long are digital materials kept in your institutional repository

Over 5 years		Over 15 years		As long as they are needed	
Over 10 years		Over 20 years		Other(please specify)	

26. What preservation services does your institution offer to the user community?

Services offered	**Yes**	**No**
Research data curation		
Consulting on digital creation best practices		
Consulting on digital preservation best practices		
Educational workshops on digital preservation		
Educational materials on digital preservation such as websites, brochure etc.		
Long-term preservation of digital materials created by faculty, staff, students or others in your user community		

Preservation of institutional records		
Outsourcing		
Other, please specify		

27. How is your digital materials being preserved?

Locally		Collaboratively		Both locally and collaboratively		Digital preservation practices are outsourced	

28. If there are any collaborative efforts, what is the collaborative preservation effort your institution involved with? (Please tick all that may apply)

a. Digital preservation network (DPN) [ ]

b. Archive-it [ ]

c. OCLC Digital Archive [ ]

d. Deutsche initiative for networked information (DINI) [ ]

e. Other, please specify……

29. Do you think management in your department is:

Management support	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Supportive for preservation practices					
Willing to collaborate with other organizations					

Willing to benchmark with other institutions					
Do not support the initiative					

SECTION 4: DIGITAL PRESERVATION CHALLENGES

30. What hinders the smooth and effective preservation of digital materials?

Digital preservation challenges	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Inadequate staff with expertise in digitizing resources					
Inadequate funding to purchase enough infrastructure					
Lack of relevant training					
Technology obsolescence					
Low awareness on preservation issues					
Intellectual property and copyright issues					

lack of human, financial resources					
Poor technology infrastructure					
Other please specify:					

31. What do you envision as the biggest barriers for ensuring long-term access to digital materials?

Barriers	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Lack of practical capacity to manage and preserve digital records					
Lack of policies					
Poor ICT infrastructure					
Lack of adequate resources					
Lack of funding					
Lack of knowledge and skills in digital preservation					
Other, please specify					

32. What are general problems faced by your institution in terms of preserving digital resources

General problems	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Lack of adequate resources					
Low knowledge and understanding by university leadership					
Lack of skills & training among staff members					
Slowness in the implementation of preservation programs at your institution					
Lack of management support					
Lack of collaboration with other institutions					
Any other (Please specify)					

33. Which of the following challenges do you face in providing access to digital content? (Please tick all that may apply)

a. Staff do not understand users' needs [ ]

b. Staff lack training in digital preservation [ ]

c. Poor management of digital resources [ ]

d. Lack of access policy [ ]

e. Lack of proper procedures procedures [ ]

e. Other, please specify [ ]

SECTION 5: DIGITAL PRESERVATION STRATEGIES

34. Do you have any preservation strategies in place?

a. Yes [ ]

b. No [ ]

35. If yes to question 34, who are involved in the development of preservation strategies in your institution? (Please tick all that may apply)

a. Responsible staff members [ ]

b. University Librarian [ ]

c. Systems Librarian [ ]

d. Collection manager [ ]

e. Other, please specify……

36. What strategies do you employ in preserving your digital materials? (Please tick all that apply)

a. Bit Preservation [ ]

b. Replication [ ]

c. Normalization [ ]

d. Migration [ ]

e. Emulation [ ]

f. Risk management approach [ ]

g. Other, lease specify……

37. Do current strategies ensure longevity to digital resources?

a. Yes [ ]

b. No [ ]

38. What factors, in your opinion hinder the implementation of strategies for the effective preservation of digital resources in your institution?

Hindering factors	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Limited budget					
Lack of skills and knowledge					
Poor technology infrastructure					
Lack of technical expertise					
Lack of resources (human & financial resources)					
Lack of management support					
Other please specify					

39. What other strategies would you suggest need to be considered to ensure the achievement of the goals of long term preservation of digital resources in your institution?

Other preservation strategies	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Involvement in the creation process					
Open and well-documented standards and systems					
Accepted standards for metadata systems					
Needs of the user					
Identification of threats and vulnerabilities					
Disaster management					
Risk management					
Succession planning					
Deployment of clouding technologies					
Other (please specify)					

SECTION 6: PRESERVATION SOFTWARE AND TOOLS

40. What type of software is used by your institution in preserving digital materials? (Please tick all that may apply)

a. DSpace [ ]

b. Fedora [ ]

c. E-prints [ ]

d. Greenstone [ ]

e. Innovative [ ]

f. I-T [ ]

g. Tesella [ ]

Any other (please specify) ……

41. What motivates you to use the software listed above in your institution?

Software	Ease to use	Affordable	Has relevant skill/knowledge	It is used by other institutions	Library policy
DSpace					
Fedora					
E-prints					
Greenstone					
Innovative					
I-T					
Tesella					

42. What types of tools used by your institution for preservation practices? (Please tick all that may apply)

a. LOCKSS [ ]

b. DigiTool [ ]

c. Rosetta [ ]

d. Exiftool [ ]

e. Archivematica [ ]

f. CONTENT dm [ ]

g. Dura Cloud [ ]

h. Archive-IT [ ]

i. BPress [ ]

j. DROID [ ]

k. BagIT [ ]

l. JHOVE [ ]

m. Other, please specify……

43. What motivates you to use the tool(s) listed above in your institution?

Preservation tools	**Ease to use**	**Affordable**	**Has relevant skills**	**Other institutions are using it**	**Library policy**
LOCKSS					
DigiTool					
Rosetta					
Exiftool					
Archivematica					
CONTENT dm					
DuraCloud					

Archive-IT					
BPress					
DROID					
BagIT					
JHOVE					
Other, please specify					

44. Are you recording preservation metadata?

a. Yes [ ]

b. No [ ]

45. If yes to question 44, what preservation metadata standards are you using? (Please tick all that may apply)

a. PREMIS [ ]

b. Dublin Core [ ]

c. OCLC [ ]

d. OAIS Model [ ]

e. METS [ ]

f. Other, please specify……

46. If you record preservation metadata what kind of information is recorded? (Please tick all that may apply)

a. Technical information [ ]

b. Documentation of preservation [ ]

c. Rights information [ ]

d. Access restrictions [ ]

e. Structural metadata [ ]

f. Provenance or ownership history [ ]

g. Other, please specify……

SECTION 7: FACTORS INFLUENCING DIGITAL PRESERVATION SUCCESS

47. What factors you think are influencing or can influence digital preservation success in academic libraries?

Influencing factors	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Organizational/management support					
Implementation of policies, procedures and strategies					
Adequate resources(Human and financial resources)					
Effective collaboration and partnerships with other institutions					
Participatory community					
Implementation of trustworthy digital repository					
Good governance					
Copyrights and intellectual property rights					
Technical expertise/ Digital preservation experts					
Skilled trained staff					
Outreach and sustainability					

Knowledge of metadata systems and other preservation tools					
Knowledge of international preservation standards					
Other, please specify:					

48. What are the factors hindering your professional growth in preserving digital resources in your institution?

Hindering factors	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Limited budget in your institution					
Time limit					
Lack of policy					
Limited/lack of information on training offered					
Limited support from the institution leadership					
Lack of motivation					
Lack of training					
Other, please specify					

49. What are the factors that need to be considered to enable the effective preservation of digital resources in your institution?

Enabling factors	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Adequate supervision					
Effective leadership					
Proper ICT infrastructure					
Adequate skilled staff					
Adequate training					
Management support					
Sufficient budget					
Collaboration with other institutions					
Other, please specify					

SECTION 8: TRAINING NEEDS IN DIGITAL PRESERVATION

50. Have you received education or training in preservation of digital resources?

a. Yes [ ]

b. No [ ]

51. If yes to question 50, how has the training assisted you to discharge your preservation duties at your institution?

Not useful		Useful		Very useful	

52. Most of the skills and expertise that you have been using in your job for the past 12 months are acquired: (Please tick where is applicable)

From past job		Through formal training	
At university		Through self-learning	

53. Which of the following best indicates your training needs in digital preservation at your institution?

Training needs	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Preserving electronic resources during their entire life cycle					
Digitization and digital preservation program					
The application of digital technologies in preservation practices					
Other, please specify					

54.Which of the following would be useful in meeting your training needs in digital preservation? (Please tick all the applicable options)

a. Seminars and workshops [ ]

b. Internships [ ]

c. Use of consultants [ ]

d. Training in digital preservation schools and colleges [ ]

e. On the job training [ ]

f. Other, please specify.....……

THANK YOU FOR TAKING TIME OUT OF YOUR BUSY SCHEDULE COMPLETING THIS QUESTIONNAIRE!!!!

APPENDIX 4: RESEARCH PERMISSION

UNISA university of south africa

RESEARCH PERMISSION SUB-COMMITTEE OF THE SENATE RESEARCH, INNOVATION, POSTGRADUATE DEGREES AND COMMERCIALISATION COMMITTEE (SRIPCC)

31 October 2016

Dear Ms. Tlou Masenya,

Decision: Research Permission Approval from November 2016 until 30 April 2017.

Ref #: 2016_RPSC_066
Ms. Tlou Masenya
Student #: 49125303
Staff #: N/A

Principal Investigator:
Ms. Tlou Masenya
College of Human Science
UNISA
emasentim@unisa.ac.za, 081 245 1242

Supervisor: Prof Patrick Ngulube
ngulup@unisa.ac.za, (012) 429-2832/ 082 852 7612

A study titled: "A framework for preservation of digital resources in the academic libraries in South Africa."

Your application regarding permission to conduct research involving UNISA data in respect of the above study has been received and was considered by the Research Permission Subcommittee (RPSC) of the UNISA Senate, Research, Innovation, Postgraduate Degrees and Commercialisation Committee (SRIPCC) on 27 October 2016.

It is my pleasure to inform you that permission has been granted for the study. You may send a link to an online survey to Library employees through the gatekeeping assistance of ICT.

You are requested to submit a report of the study to the Research Permission Subcommittee (RPSC@unisa.ac.za) within 12 months of completion of the study.

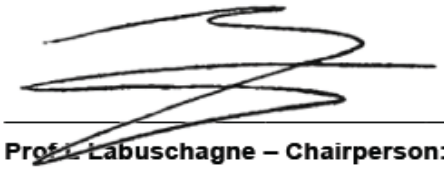
University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

The personal information made available to the researcher(s)/gatekeeper(s) will only be used for the advancement of this research project as indicated and for the purpose as described in this permission letter. The researcher(s)/gatekeeper(s) must take all appropriate precautionary measures to protect the personal information given to him/her/them in good faith and it must not be passed on to third parties.

Note:
The reference number ***2016_RPSC_66*** *should be clearly indicated on all forms of communication with the intended research participants and the Research Permission Subcommittee.*

We would like to wish you well in your research undertaking.

Kind regards,



Prof L Labuschagne – Chairperson: RPSC
Email: llabus@unisa.ac.za, Tel: (012) 429-6368

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