Digital Preservation Policy and Implementation Strategies for National Information Centres in Nigeria

By

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Declaration

I declare that this dissertation is my personal research work. It was never presented anywhere, either wholly or partially, for the purpose of the award of a higher degree. All the quotations and sources of information are, however, duly acknowledged by means of references

…… ……

Ezra Shiloba Gbaje Date

Certification

This dissertation entitled: "Digital Preservation Policy and Implementation Strategies for National Information Centres in Nigeria", by Ezra Shiloba Gbaje meets the regulations governing the award of the degree of Doctor of Philosophy at Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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Dedication

This research work is dedicated to the following people:

1. My Parents, Mr Daniel Daudu Gbaje and Mrs Rachael Zuma Gbaje
2. My wife, Mrs Helen E. Gbaje
3. My daughters:
    - Sharon Shidinje Gbaje
    - Delight Biye Gbaje
    - Wanabiye Gbaje

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Abstract

This study investigated digital preservation policy and implementation strategies in National Information Centres in Nigeria. To achieve the objectives of the study, the study formulated eight research questions. A qualitative research methodology using the case approach was adopted. Documentary sources, semi-structured questionnaire, tape recorder and Interview were the instruments used to collect data. The responses from the sampled staff of the National Information Centres were studied analyzed descriptively, using tables. The finding showed that National Information Centers surveyed collected different types of material for digitization and archiving. The most popular storage media for archiving of digital objects by the institutions studied was the Hard Drive, and CD-ROM. Adobe PDF file format was the most popular file format used to archive digital object. Digital objects created in different file format are converted to PDF file format for digital preservation. The level of awareness of the problems surrounding digital preservation is very low especially among the national information centres. There are no national or international standard digital preservation policy and implementation strategies adopted by Nigerian national information centres. National Library of Nigeria and National Bureau of Statistics have developed their own digital preservation without any clear strategy for the implementation of this policy. The challenges resulting in the partial implementation of the digital preservation policy at the National library include: lack of awareness of challenges surrounding digital preservation by the staff, lack of funds, lack of skilled manpower, lack of equipment and inadequate metadata of digital objects for preservation, all of which were recorded by the National information centres. The

findings also showed that the structures put in place for implementing strategies for digital preservation was inadequate. The study therefore concluded that some level of digital preservation activities is being done at the National information centres. However, this is done haphazardly because of lack of a standard national digital preservation policy and implementation strategies in Nigeria. In view of this a number of recommendations were made including providing a model digital preservation policy and implementation strategies that is holistic in approach and which will a long way to help preserve digital information for long-term re-use.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

There has been an explosion in the growth of the amount of information created, disseminated and accessed in digital form in every human endeavour since year 2000 as observed by the researcher. In Nigeria, the use of computers and the Internet in many organizations especially universities, research institutions, businesses, national examination bodies, national information centres and many other government agencies and parastatals , has also resulted into an enormous amount of digital objects. The increasing use of computers and the Internet in these sectors of the society can be attributed to the policies of the Federal Government of Nigeria in relation to Information Technology and Telecommunication. For example, the first general object of Nigerian National Information Technology policy is to ensure that Information Technology resources are readily available to promote efficient national development (National Policy for Information Technology, 2000:2). Similarly, National Policy on Telecommunication (2000:10) has as one of its short-term objectives the need to promote widespread access to advance communication technologies and services, in particular the Internet.

Currently, every business, government, and academic documents such as scholarly publications, policy documents, newspapers, gazette and details of business transactions, are first created in digital form, even if it is eventually published and preserved on paper. It can be argued that some of the main reasons for the adoption

and use of computers by many organizations are to improve access and encourage the re-use of digital materials. Unfortunately, the investment in the creation of digital materials is threatened by the rapid change in computer software and hardware technologies. The number of ways in which digital materials can be stored is also increasing, resulting in large quantity of digital materials containing vital personal, corporate and societal information, in an ever expanding number of file formats.

According to the Draft UNESCO Charter for Preservation of Digital Heritage by Webb C. (2003:13),

> *Resources of human knowledge or expression, whether cultural, educational, scientific and administrative, or embracing technical, legal, medical and other kinds of information, are increasingly created digitally, or converted into digital form from existing analogue resources. Where resources are "born digital", there is no other format but the digital original. Digital objects include texts, databases, still and moving images, audio, graphics, software, and web pages, among a wide and growing range of formats.*

This draft charter clearly supports the argument that information is largely created in digital forms resulting to digital objects, irrespective of the nature of content or data type. Preservation of these digital objects for future re-use is a long-term commitment which information professionals must provide their user community with. For non digital materials, the provision of adequate storage conditions was the best means to help ensure that materials would remain re-usable far into the future. However, the nature of digital materials is very different from their physical analogues. Traditionally, preserving things meant keeping them unchanged. However, in the digital environment if a digital object is held onto without modifications, it will become increasingly difficult, if not impossible, to access and re-use it. Preservation

is aimed at ensuring that the physical object remains accessible and useable for as long as necessary or possible. Another most obvious difference is that digital materials are mediated by technology. For the digital objects to be used, a user must have access to the right combination of hardware and software to enable the object to be re-created and re-used. According to Wilson (2007:2), computer systems and software applications change so rapidly that there is no guarantee that the existing data sources will be accessible and useable on future computing platforms or software versions. Gladney (2007:1) also posits that the software currently available does not include good tools for saving digital originals in the face of rapid hardware and software obsolescence.

Change in computer technology will ensure that over relatively short periods of time, both media and the technical format of old digital materials will become unusable. Keeping digital resources for use by the future generations will require conscious efforts and continual investments. Digital preservation goes beyond saving digital objects on storage medium and maintaining them. Yakel (2001:339) posits that the greatest challenge in digital preservation is not deterioration of physical media, but technological obsolescence. It is clearly established that preserving digital objects for long-term re-use will include policies and strategies that will address rapid computer hardware, storage media and software obsolescence.

1.1.1 Growth of Digital Materials in Nigeria

Recent studies carried out by eShekels (2009) on recent developments in the Nigeria ICT industries reveals that from 2003-2008, strong GDP growth and an increase

in oil and non-oil revenues spurred economic growth in Nigeria. This in turn generated a high demand for computers in all end-user segments in the country. According to eShekels (2009), in 2008, sales figures for computers were about 407,621 in total, made up of 211,499 desktops and 196,122 laptops. These figures represent a remarkable leap in sales when compared to the number of sales in 2007, which were 154,042 desktops and 77,966 laptops. Similarly, according to the world Internet statistics, there are over 10 million Internet users in 2008 and an Internet penetration rate of 6.8% within the same period.

It has been observed that some key national agencies provide information online. For instance, the National Assembly provides all the legislative bills passed between 1999 to date online(http://www.nassnig.org/legislation.php). The National Bureau of Statistics publishes online some relevant statistical Information relating to the social and economic activities in Nigeria(http://www.nigerianstat.gov.ng/). The Cooperate Affairs Commission provides information on how to register business companies online(http://www.cac.gov.ng/). Also, the National Universities Commission (http://www.nuc.edu.ng) provides information about University education in Nigeria online and maintains the Nigerian Virtual Library(http://www.nigerianvirtuallibrary.com/).

The Nigerian business sectors have also embraced the use of computers and Internet services in their operations. The banking sector for example, has since deployed Information and Communication Technology, infrastructure, ATM Machines and provided online real-time banking services. The online services allow customers to conduct a variety of banking activities in any location in the country. Nigerian

scholarly and research communities are also not left out in the production of digital objects. According to the Nigerian Universities Commission and Federal Ministry of Science and Technology website (2008), there are about 96 universities in Nigeria and more than 56 polytechnics and over 30 research institutes in Nigeria. Researchers and scholars of these universities, polytechnics and research institutions produce enormous amount of data and research output in form of publications, which for the past few years are in digital formats such as online journals. The foregoing clearly reveals that substantial amount of information from the various sectors of the society is in digital format, hence the need to preserve them for future re-use.

1.1.2. Concepts of Digital Preservation

Digital preservation is the process of active management of digital objects to ensure their accessibility in the future. Preserving digital materials is achieved by finding ways to re-present what was originally presented to users through a combination of computer software and hardware. Webb (2003:34) posits that digital preservation consists of the processes aimed at ensuring the continued accessibility of digital materials. Achieving this requires digital materials to be understood and managed at four levels: as physical phenomena; as logical encodings; as conceptual objects that have meaning to humans; and assets of essential elements that must be preserved in order to offer future users the essence of each object. Similarly, the Joint Information Systems Committee (2003:1) defined digital preservation as "the series of actions and interventions required to ensure continued and reliable access to authentic digital materials for as long as they are deemed to be of value". In general,

digital preservation involves a number of organised tasks associated with a variety of technical approaches or strategies for ensuring that digital resources are not only stored appropriately, but are also adequately maintained and thus consistently useable over time. According to Sharma (2009), the term "digital preservation" refers to both preservation of materials that are created originally in digital form and never exist in print or analog form and the use of imaging and recording technologies to create digital surrogates of analog materials for access and preservation purposes.

Digital objects, regardless of whether they are created initially in digital form or converted to digital objects, are threatened by the following, as posited by Rosenthal (2005:4):

i. Media and hardware failure: Storage media(HDD,CDs, DVDs and tapes) and hardware must be expected to degrade with time, suffer breakdown of embedded electronic components, and burnt-out
ii. Software failure: All software has design and implementation bugs that pose a risk to the stored data.
iii. Communication Errors: Systems cannot assume that the network transfers they use to ingest or disseminate content will either succeed or fail within a specified time period, or will actually deliver the content unaltered.
iv. Failure of network services: Accessibility to information might be lost from failures in name resolution (url), misplaced directories and administrative lapses. As examples, domain names will vanish or be reassigned if the registrant fails to pay the registrar, and a persistent URL will fail to resolve if

the resolver service fails to preserve its data with as much care as the digital preservation service.

v. Media, hardware and software obsolescence: Media and hardware components failure due to incompatibility with other systems. Software might fail because of format obsolesces which prevents information decoding and rendering.

vi. Operator error: Operator actions must be expected to include both recoverable and irrecoverable errors. This applies not merely to the digital preservation application itself, but also to the operating system on which it is running, the other applications sharing the same environment, the hardware underlying them, and the network through which they communicate.

vii. Natural disaster: Natural disasters, such as flood, fire and earthquake must be anticipated.

viii. External attack: Deliberate information destruction or corruption by network attacks, cyber-terrorism or war.

ix. Internal attack: Even if a digital preservation system is completely isolated from external networks, it must anticipate insider abuse.

x. Economic and organization failure: The ongoing costs for power, cooling, bandwidth, system administration, and domain registration, could pose a challenge. Organization might vanish entirely, perhaps through bankruptcy, or mission change, which may deprive the digital preservation technology of the support it needs to survive.

It is important to note that these threats are likely to be correlated and relevant in other digitized projects. For instance, software failures are likely to be

triggered by hardware failure. Digital preservation therefore combines policies, digital preservation strategies and actions to ensure that these threats are adequately addressed to ensure the long-term re-use of digital objects.

Preserving digital information is seen as one of the greatest challenges facing humanity. Recognizing this fact, many libraries, archives and scientific institutions at both international and national levels have put in place different initiatives to address the challenges of long term preservation. Preserving Access to Digital Information (PADI) is an initiative of National Library of Australia (Strodl et al., 2007:3). The purpose of the initiative is to identify and promote information of relevant activities in the field of digital preservation and provide guidelines for preservation endeavors. The United States of America established the National Digital Information Infrastructure and Preservation Programme (NDIIPP). Beagrie (2003:10) asserts that the programme, under the auspices of the Library of Congress, funds research in different aspects of digital preservation, including collection practices, risk analyses, legal and policy issues and technology.

In Europe two research projects, Cultural, Artistic and Scientific knowledge for Preservation Access and Retrieval (CASPAR) and Permanent Access to the Record of Science in Europe (PLANETS) for digital preservation were initiated in 2006(Strodl et al., 2007:4). CASPAR focuses on cultural and scientific resources. The project engages the implementations and extension of the Open Archival Information System (OAIS) reference model. PLANETS includes partners from library, archival and research background with a research focus on the integration of methodologies, tools and services for preservation characterization, action and planning for digital

preservation. Digital Preservation Europe (DPE) is a coordinated action of the European Union (EU) aimed at better collaboration and synergies between existing preservation initiatives across Europe. Beagrie (2003:10) asserts that there are some new efforts to provide national or international coordination and collaboration between such initiatives. Studies from these programmes have stimulated international debate on digital preservation, and have helped identify new areas for investigation in digital preservation strategies. The findings of these initiatives are often documented in reports and the resultant strategies are issued in the form of official plans, guidelines and policy statements. These contributions provide important input to, and help inform, digital preservation policy and strategies.

1.1.3. Policies and Implementation Strategies for Digital Preservation

Digital preservation policies and strategies are crucial parts of managing the risk associated with rapid computer hardware and software obsolesces. They are essential for any successful digital preservation programmes. According to the Oxford English Dictionary, policy is "a course or general plan of action". Digital preservation policy at its most basic form is a plan of action for safe-keeping of digital objects. Such a plan of action should address the questions of what needs to be preserved, why, for what purpose, and for how long.

Policies are vital for ensuring compliance with procedural and legal requirements within an organization. By clearly defining a set of procedures, roles and responsibilities, policies help to promote transparency and accountability. Also, policies provide an overall cohesion within an organization and offer guidance for best

practice. According to the Electronic Resource Preservation and Access Network Digital Preservation Policy tool (2003:3), "the primary aims of a policy are to provide guidance and authorization on the preservation of digital objects and to ensure the authenticity, reliability and long-term accessibility of them".

Dahl M. et. al., (2006:129) posit that digital preservation policies are essential for digital preservation. Across many sectors the development of institutional preservation policies is sporadic and digital preservation issues are rarely considered in key strategic plans. The lack of preservation policies and as a result the lack of consideration of digital preservation issues in other institutional strategies is seen as a major drawback to preserving digital information, Beagrie et. al.,(2008). According to the UK Joint Information Systems Committee (2002) digital preservation policies are most effective when integrated into the overall organizational policy framework, reflecting both organizational commitment to preservation and the importance afforded to the activity.

A policy statement would set clear priorities, and a national digital preservation policy would reinforce mutual efforts of government to preserve materials that document our cultural heritage. It would define organizational roles and (funding) responsibilities. The roles of established memory institutions, such as libraries, archives, museums, and National Data Archive would also be addressed.

Nigeria still has a long way to go. This researcher has observed that some important building blocks for the formulation of a national digital preservation policy do exist. According to the decree establishing the National library of Nigeria, fifteen copies of all Nigerian material of high national significance should be deposited at the

National Library, while the National archive also has the mandate by law to collect and preserve government records. It has been noted by the researcher that there is no provision within this law for the collection or acquisition of electronic publication. However, it has been observed that most of these institutions are in the process of digitizing their collections.

The concept of strategy has been borrowed from the military and adapted for use in organizations. It refers to the means by which policy is affected. Strategy is a general framework that provides guidance for actions to be taken and, at the same time, is shaped by the actions being taken. Strategies can be viewed as the step to be taken for the actualization of formulated policies. Any long-term access and future benefits from preserving digital objects may be heavily dependent on implementation strategies being put in place. Many digital preservation strategies have been proposed, but no one strategy is appropriate for all data types, situations, or institutions. Strodl et al (2007:2) posit that every scenario has its own requirements and problems, calling for different strategy to resolve the problem at hand. However, every preservation strategy details the types of activities that will be undertaken to ensure reliable preservation of digital objects (OCLC, 2006:5). These activities may include:

a. assessing the risks for loss of content posed by technology variables, such as commonly used proprietary file formats and software applications.
b. evaluating the digital content objects to determine what type and degree of format conversion or other preservation actions to be applied.

c. determining the appropriate metadata needed for each object type and how it is associated with the objects.

1.1.4 National Information Centres

National information centres are mandated by the laws establishing them to collect vital public data and information within their mandate for preservation and dissemination. The National Bureau of Statistics, the National Library of Nigeria, National Archives of Nigeria, National Population Commission of Nigeria, Cooperate Affairs Commission, National Broadcasting Commission and National Commission for Museum and Monuments fall within this category. These information centers have traditionally been managing, preserving, and provided access to significant government, private, business and research information in paper and digital formats.

Libraries and archives have served as the central institutional focus for preservation, and both types of institutions include preservation as one of their core functions. The purpose of preservation is to ensure protection of information of enduring value for access by present and future generations (Conway, 1990: 206). Libraries and archives have served as the central institutional focus for preservation, and both types of institutions include preservation as one of their core functions. In recent decades, many major libraries and archives have established formal digitization programs as part of preserving their collections, and have also incorporated digital preservation needs and requirements into overall program planning.

1.1.4.1 National Library of Nigeria

The National Library of Nigeria was established for the fundamental goal of ensuring access to the entire fount of recorded knowledge for the progress and development of Nigeria. It is to serve as "the giant memory of the nation, its intellectual store-house, and the data bank for its learning and remembering processes". The National Library of Nigeria was established by the National Library Act 1964 which was later repealed and substituted with the National Library Act No. 29 of 1970. The mission of Nigerian National Library is to acquire, process, organize, disseminate as well as provide links to information resources to all Nigerians and non-Nigerians for their educational pursuits and for informed decision making. Some of the functions of the National Library according to the status establishing it, amongst others, include:

i. assembling, maintaining and extending a collection of books, periodicals, pamphlets, newspapers, maps, musical scores, films and recordings and related information sources which the Board considers appropriate for a library of the highest standing.
ii. to collect legal deposit materials, in order to facilitate the distribution of published materials.
iii. to make the facilities of the National Library available to members of the public and others on proper terms.
iv. To be responsible for the development of the National Bibliography of Nigeria and national bibliographical services, either in a national bibliographical centre or elsewhere.

v. To ensure adequate documentation and dissemination of Nigerian Indigenous literatures.

Digitization Project in the National Library of Nigeria

The National Library in 2004 established a digitization unit, which has been able to digitize nine newspaper titles on a daily basis from December, 2004. The newspaper titles are as follows: New Nigerian, This Day, Vanguard, Daily Sun, Daily Champion, Daily Independent, The Punch, Nigerian Tribune, and The Guardian. In February 2009, the National Library established the Virtual Library Services Department, which subsumed the services provided by the digitization unit. In addition it has the following functions and responsibilities:

i. Ensuring the preservation of electronic and digital information resources of the nation's heritage.
ii. Transforming knowledge into digital content for all levels of education in Nigeria.
iii. Serving as a focal department for resource information/knowledge network.
iv. Evaluating, organizing and structuring available sources of information online.
v. Providing intellectual access to information relevant for research on specific fields of study.

According to the National Library of Nigeria Official website digitization of Government documents commenced in 2004 with Government Commissions of Inquiries looking into some-economic and political problems in the Nation. Currently, over seventy five (75) of such reports have been digitized. These digitized materials are now on CDs and available for sale.

In Nigeria at the time of the establishment of the National Library digital objects were almost in non existence, hence the efforts of the National Library in digitization and digital preservation is commendable. Amending the Act establishing the National Library of Nigeria to reflect the collection and preservation of digital object will provide an enabling environment for digital preservation.

1.1.4.2 National Archives of Nigeria

The National Archives of Nigeria is the repository of the non-current/current records of the Government of Nigeria, within it holds in trust for the use of administrators, scholars and general public. It is an attached office of the Department of National Archives under the Federal Ministry of Information and Communications. The Nigerian Record Office was placed under the administrative control of the Public Works Department until it was transferred to the Ministry of Education in 1957. On the 14th of November 1957, the Public Archives Ordinance No. 43 was passed, and it authorized the establishment of the National Archives of Nigeria to provide for the preservation of public archives. The Act empowered the National Archives of Nigeria to establish as many branches as might be deemed necessary and convenient. The 1957 Archives Ordinance has since been repealed by the promulgation of the National Archives Decree no. 30 of July 8th 1992. By the promulgation of the Decree, the inadequacies observed in the Archives Ordinance were rectified. The Decree requires that National Archive preserve under adequate security conditions, all original constitutional instruments, treaties, law, decrees and other legal enactments of the Federal Government.

The policy thrust of the Department of National Archives of Nigeria is enshrined in its current enabling law - National Archives Act of 1992, which entrusts National Archives of Nigeria with the permanent custody, care and control of all archives of the Federal Government and of such other archives and historical records as may be required, from time to time pursuant to the Act. As the apex archival institution in Nigeria the Act further provides for the management and preservation of public records, records of individuals, private bodies and companies.

Records acquired and preserved by the National Archive include the followings:

(a) Federal Government gazettes
(b) Proceedings and laws promulgated by the National Assembly
(c) Reports of various administrative and Judicial commission on enquires
(d) Federal Executive Council conclusions
(e) Non-current records from Federal Ministries of interior, labour, environment, Customs Services, etc
(f) Publications from ministries, departments and agencies
(g) Photographs of some public officers.

The richness of archives, according to Lafinhan (2009:3), constitutes an important part of the memory of a nation and is also an index of our cultural growth and development. The growth in the holding of the National Archives has vastly increased its public relevance and over the past decades extensive use has been made of materials in the archives. The largest number of users are the academics, students from Nigerian universities as well as post graduate students from both within and outside the country. Legal and administrative enquiries concerning property,

especially land, chieftaincy matters and individuals are also received. Officials of Federal, State and Local governments also consult records.

Digitization of Archives

The digitization process of the National Archive holdings started in 2003. Lafinhan (2009:8) asserts that the digitization programme is designed to enhance the information preservation and service delivery of the department. It is also to ensure easy and quick access to archival information. This initiative has equally contributed to the government wide data base, and it also complies with the regulations on International Access on information as prescribed by UNESCO and International Council on Archives (ICA). Lafinhan (2009:8) also asserts that, the department has succeeded in preserving the content of sensitive and endangered archives in digital format. In addition, the contents of archives are now more accessible and available to local and international communities through archives website (www.nigerianarchives.gov.ng).

1.1.4.3 National Bureau of Statistics

The National Bureau of Statistics (NBS) started as a unit in the Office of the Colonial Secretary in the cabinet secretariat during the British colonial administration in the year 1928. Following a focused re-organization, a statistics section was established in the Department of Customs and Excise. The Section was later upgraded to a full fledged Department of Statistics in the year 1947. The department's responsibilities were expanded and became the centralized National Statistics Office for the country in the year 1949. In 1957, Statistics Act was enacted to provide a legal

frame work for statistical operations in Nigeria, called the Statistics Act of 1957, which empowered the then Chief Statistician as the overall head to conduct statistical enquiries either on census or sample basis. The Department of Statistics was moved from the Customs and Excise to Federal Ministry of Finance and later to Federal Ministry of Economic Development durining which time the name was changed to the Federal Office of Statistics (FOS) when Nigeria attained Independence in the year 1960. Between 1970 and 1980 the Central Bank of Nigeria (CBN) took over the collection of Financial Statistics while the National Population Commission (NPOPC) took over the responsibility of Population Statistics, such as population and housing censuses, as well as vital statistics. In 1989, a standardized computerized Data-Management Agency was established and named National Data Bank. The Agency was responsible for data warehouse, designed to hold time series data as far back as when Nigeria was created.

National Bureau of Statistics (NBS) emerged from the merger of Federal Office of Statistics (FOS) and National Data Bank (NDB), in the year 2004. The 1957 Statistics Act was repealed and replaced with The Statistics Act in 2007. This new Act empowers the National Bureau of Statistics as the custodian of official statistics in Nigeria, the main agency responsible for the development and management of official statistics in promoting statistics as a tool for development planning and evidence-based policy making. The specific objectives amongst others include:

i. Collecting, compiling, analyzing, interpreting, publishing and disseminating Statistical Information alone or in collaboration with other agencies.

Developing and maintaining a comprehensive socio- economic national data bank**.**

National Data Archive of Nigeria

The National Data Archive was primarily established to archive survey and census microdata usually produced by the National Statistics Office and other official data producers. On a selected basis, the National Data Archive also serves as a repository for non-official datasets. The Nigeria National Data Archive has been established to, among other, things:

i. promote the best practice of and international standards for, the documentation of micro data amongst data producers in the country.
ii. provide equitable access to micro data in the interest of all citizens, by protecting confidentiality and following international recommendations and good practice.
iii. promote the effective use of existing survey and census data for statistical and research purposes, thereby encouraging a diverse range of analytical work through secondary research.
iv. ensure a long term preservation of microdata and the related metadata, and facilities their continued viability and usability in the future.

The activities of the National Data Archive according to their official website (http://www.nigerianstat.gov.ng/nada/index.php?editable= yes&page_type= activities.html), include the acquisition, documentation, anonymization, dissemination and preservation of micro-data and related metadata. The National Data Archive implements standard procedures for ensuring the physical security and

long-term usability of its resources, together with associated backup arrangements for minimizing the impact of adverse events.

The National Bureau of Statistic from all indication seems to focus more on the collection and preservation of digital born documents. Hence very little efforts are done to digitize non-digital objects.

1.2. Statement of Problem

Nigerian National Information Centres create digital objects and many are in the process of converting their non-digital materials to digital objects for long-term preservation and re-use. The law establishing National Information Centres makes it obligatory for them to collect, preserve and make available for re-use information within their mandate. However with the emerging digital information technology and the reliance on and use of, digital information, it becomes imperative for these National Information Centres to collect, preserve and make available for re-use digital objects. For example the National Library maintains digital objects of the bibliography information of all published materials in Nigeria for their bibliographic control, while the National Archive collects and preserves records of government transactions or historical documents of national importance. Every digital object, irrespective of the content, is created in a rendition system which is made up of computer hardware, operating system, storage device, and application software. For these digital objects to be accessed and re-used in the long term, they must be rendered in the same rendition system or an emulated rendition system.

The rapid evolution of the components of the rendition system and lack of standardization makes them obsolete within five years (Ferreira, 2006:3). Therefore

for any national information centre to ensure the accessibility and re-use of its digital object it must have a digital preservation policy and preservation strategy. However, as noted by Strodl et al (2007:2), many digital preservation strategies have been proposed, but no one strategy is appropriate for all data types, situations, or institutions. Every scenario has its own requirements and problems, calling for different strategy to resolve the problem at hand.

The researcher has observed that information centres preserve digital information on storage media such as disk, CD-ROM and Hard drives. But preserving and maintaining digital objects on storage medium alone will not enable the stored digital objects to remain useable over long-term. There must be 'active intervention' to make sure that the digital objects stored in storage media can be located, accessed and used over long-term period. Lawrence (2000:3), Granger (2002:4), Macdonald and Lord (2003:7), Rosenthal et.al (2005:1) and Gladney (2007:2) also observe that digital objects will cease to be accessible without active management and intervention. Software and hardware obsolesce have been identified as the greatest technical threat in terms of digital preservation. The speed of changes in technology means that the time frame during which preservation actions must be taken with respect to digital object is by far shorter than that of non digital materials (Hockx-YU, 2006).

The rate at which Nigerian government institutions, research communities, private and business sectors continue to digitize their collections and create new digital objects, in some cases without print copies, is alarming. This is of great concern particularly since there is no digital preservation policy or any national or institutional framework for digital preservation. Unless significant efforts are urgently

put into active management of digital objects, Nigeria and its national information centres will lose vital digital object of significant importance.

1.3 Research Questions

This study addresses the problem identified in this study by answering the following research questions:

1. What storage media and facilities are used for digital objects preservation in the national information centres ?
2. What file formats are digital objects created for preservation in the National Information Centres?
3. What are the problems encountered in the preservation of digital objects in the national information centres ?
4. What is the level of awareness of the problems surrounding the preservation of digital objects in the National Information Centres?
5. What digital objects preservation policies are available and used in the National Information Centres?
6. What strategies for preservation of digital objects are adopted by the national information centres and to what extent have they affected preservation of their digital objects?
7. What structures are put in place for the implementation of the digital preservation policies and strategies adopted by the national information centers?

8. To what extent have the structures for the policies and strategies implementation by the National Information Centre affected digital preservation?

1.4 Objectives of the Study

The general objectives of the study are to examine digital preservation activities and implementation strategies in some select national institutions. In specific terms the study has the following objectives:

1. To identify storage media and facilities used for digital objects preservation in the National Information Centres
2. To identify the file formats used in creating digital objects for digital preservation in the National Information Centres
3. To identify the problems encountered in the preservation of digital objects in the National Information Centers
4. To determine the level of awareness of the problems surrounding digital preservation in the National Information Centers
5. To identify the digital preservation policies available and used in the National Information Centres.
6. To identify strategies adopted and the extent to which they have affected digital preservation by the National Information Centers.
7. To identify the structures put in place for the implementation of the digital preservation policies and strategies by the national information centres

8. To determine the extent to which the structures for the policies and strategies implementation by the national information centres affected digital preservation

1.5 Significance of the Study

The essence of digitization is to facilitate access and long-term re-use of digital objects. However, this will only be possible if relevant stakeholders understand and appreciate the benefits of digital preservation and the potential dangers of ignoring it.

It has been observed by the researcher that there is currently no research work addressing issues on digital preservation with particular focus on Nigeria. The outcome of this study will result to a model digital preservation policy and implementation strategies that will address the problems identified at the end of the study. The model can be adopted by National Information Centres. In addition the outcome will fill the gap and assist the Nigerian government and other relevant stakeholders in the creation, accessing and preservation of digital objects, and also recommend appropriate measures to safeguard them. Similarly, the study will be of significant value to researchers and scholars in Library and Information Science because it will contribute to the body of knowledge in Nigeria and the world at large.

1.6 Assumptions of the Study

This study is based on the assumptions that:

i. all the National Information Centres appreciate the need to collect and preserve digital objects for long-term re-use.
ii. all the National Information Centres appreciate the need for a National digital preservation policy and implementation strategy.

1.7 Scope and Limitation of the Study

The study covers three national institutions that have within their mandate the need to collect, provide access to, preserve digital objects, create or acquire information from the private businesses and government institutions in Nigeria. The national institutions to be studied are:

i. National Library of Nigeria
ii. National Archive of Nigeria
iii. National Bureau of Statistic

The study is centered on the digital preservation policy and implementation strategies adopted by the National Information Centres for only digital objects; it excludes non-digital objects.

Due to the constraints of time and fund, the researcher could cover more than three National Information Centres with the mandate to collect and preserve information.

1.8 Operational Definition of Terms

For the purpose of this study the following terms are defined:

Data: Facts, figures, or instructions presented in a form that can be comprehended, interpreted, and communicated to by a human being or processed by a computer

Digital Born: This refers to materials which are not intended to have an analogue equivalent of the object, either as the originating source or as a result of conversion to analogue form.

Digital objects: This is the general term used for the body of digital material that is subject to digital preservation; they include digital publications, digital records, digital micro-date, born-digital documents and digitized materials.

Digital preservation: The process of maintaining, in a condition suitable for use, materials produced in digital formats, including preservation of the bit stream and the continued ability to render or display the content represented by the bit stream.

Digitization: The process of converting non digital born items such as images, text, or sound documents to digital format.

Emulation: The process of imitating a certain computer platform or program on another platform or program

Migration: Preservation strategy in which a transformation creates a version of a Digital Object in a different format, where the new format is compatible with contemporary software and hardware environments.

National information centre in the context of this study includes national institutions charge with the mandate to collect vital public data and information for preservation and dissemination.

Online: This refers to digital objects that are connected to some larger network or system

Strategy: A set of the important actions necessary to realize a particular goal

Policy: A definite course or method of action selected (by government, institution, group or individual) from among alternatives and in the light of given conditions to guide and, usually, to determine present and future decisions.

Preservation: A*ctivities associated with maintaining library and archival materials for use either in their original physical form or in some other usable way.*

Obsolescence: A state of becoming obsolete, rather than a state of already being obsolete

Render: To make a Digital Object perceptible to a user, by displaying (for visual materials), playing (for audio materials), or other means appropriate to the Format of the Digital Object.

Storage medium: Any device or material on which data can be electronically placed, kept, and retrieved

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CHAPTER TWO

REVIEW OF RELATED LITERATURES

2.1 Introduction

This chapter reviews the literature related to the area of the study. The main purposes of the chapter are provide an overview of a discourse domain in digital preservation, digital preservation policy, strategies for digital preservation and analysis and comparison of various contributions in digital preservation and strategies. The impacts of these researches, their deficit and future direction are also reviewed.

Although there has been a lot of published work on digital preservation policy and strategies in developed countries, little or nothing has been written on this subject in Nigeria. This trend could not be unconnected with the fact that digital preservation is either relatively new or is an emerging field of studies even in developed countries. Thus, what this researcher does is to only apply the implication of studies conducted in developed countries its ramification to the Nigerian situation.

2.2 Rendition System for Digital Object Access

Information growth and the increasing shift to digital forms of storage and communication have made digital information crucial to effective delivery of modern services. Data are stored in computers as sequence of one and zeros called bit-streams, and without appropriate rendition system, these bits streams cannot be accessible for human perception. Digital objects rendition system undergoes rapid and continual change. Rendition system is the editing software, hardware, operating

system and additional devices and their drivers required to display a digital object on-screen, printed, audio and multimedia presentations. Borghoff et al (2006:5) defines a rendition system as a "complex organism comprising the hardware layer, the OS and driver programs, and the presentation layer". A rendition system is not a monolithic block, but only consists of a multitude of components that interact in a very complex way. A change in one component prompts changes in the others. All digital objects require rendition system to be useful and without an appropriate rendition system the Digital objects cannot be accessed. Thus, either the original digital objects have to be transformed into formats available on current platforms, or a replica of the original rendition system has to be recreated. Only in an appropriate environment can the bit-streams again become the text, graphics, sounds and other component of multimedia documents that can be perceived by humans. The only appropriate rendition environment is the editor that was originally used to create the document or a similar version. Different software manufacturers vary in the ways they structure digital documents and store them as data streams. Rendition system includes a program that displays the document on the computer monitor, appropriate computer hardware, operating system and driver programs that were used to create the digital object (Borghoff et al 2006:5). Preservation of digital objects is influenced by changes in rendition systems, therefore solutions for digital preservation must address all the components of a rendition system.

2.3 Digital Data Life Cycle

Digital preservation is a key component of all digital object life cycle. The life cycle approach is necessary because digital materials are fragile and susceptible to change from technological advances throughout their life cycle. Pennock (2007:2), asserts that activities or lack of activities at each stage in the life cycle of a digital object directly influence our ability to manage and preserve digital materials in subsequent stages.

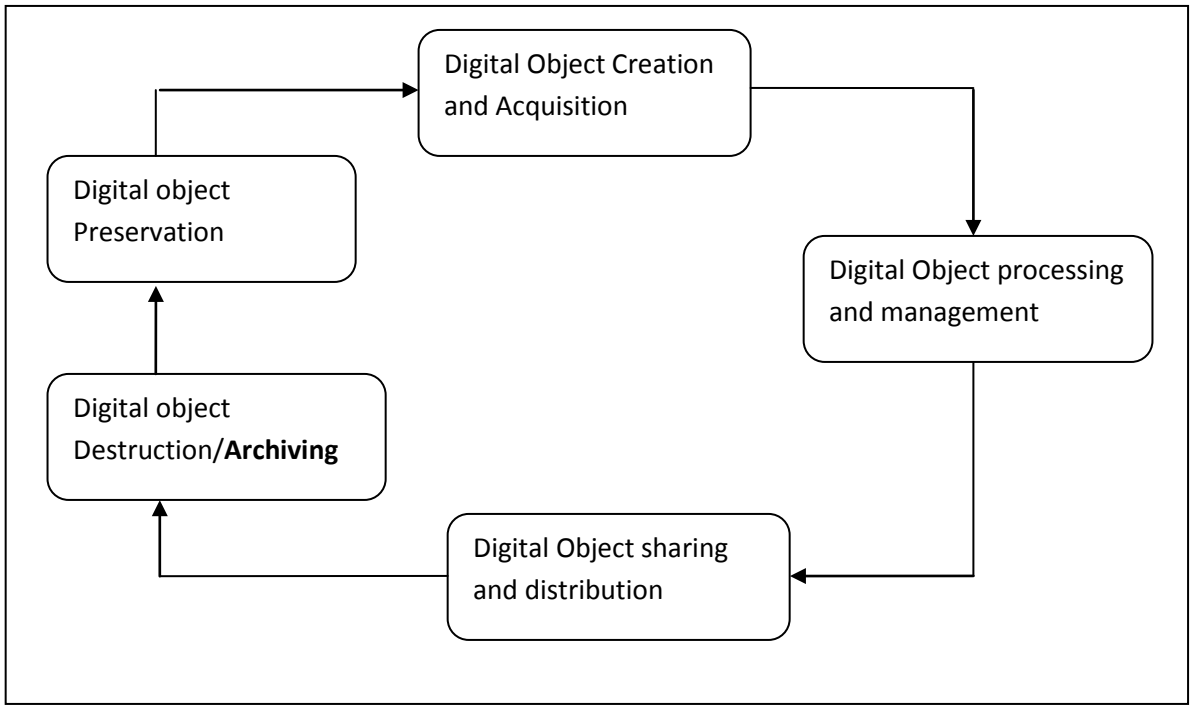


Figure 2.1: Digital Object Life Cycle.

i. Digital object creation and acquisition: This is the first stage in the lifecycle of digital objects. It is the act of producing digital objects or acquiring them from various sources. The producer may be a human author or originator. It could also be a piece of equipment such as a sensing device, satellite or laboratory

instrument. The process of data creation by individuals or institutions may be influenced by a number of different stakeholders. Funding agencies, publishers, and software developers can influence or determine different aspects of the decision process.

ii. Digital Object Data processing and management: Analysis of the digital objects created or acquired, results in the organization of the digital objects in a meaningful and systematic way through the addition of descriptive information and metadata creating secondary information. Search and retrieval tools are added for easy accessibility by users.

iii. Digital objects sharing and distribution: The secondary information created is published and shared amongst relevant stakeholders. Digital repositories are adopted for easy ingest and management of research outputs, access controls and federated searching. At this stage also data are stored on appropriate storage media for retrieval on a future date. The research outputs published are commonly used in decision making, for documentation or reference, and in answering inquiries.

iv. Digital objects destruction or archiving: When digital objects decline in value or are not selected for long-term preservation, they are destroyed. Archived digital objects are preserved for future accessibility and use.

v. Digital Object Preservation: Preservation is the aspect of archival management that preserves the content as well as the look and feel of the digital object. Various digital preservation strategies such as emulation, format migration, media refreshment can be adopted to ensure persistent accessibility of the digital

objects. This stewardship can result in the rediscovery of the digital objects and re-use.

2.4 Digital Object Preservation

Preservation in the digital environment means copying or migrating information, not conserving the actual object on which that information is recorded. It is essential to maintain authenticity, reliability, and functionality of digital objects over long-term. Smith (1999:13), Weber and Dorr (1997:24) argue that digitization is primarily a means of enhancing access and is at present, not a reliable means of preservation. Digital preservation is the act of physically and intellectually protecting and technically stabilizing the transmission of the content and context of electronic records across space and time, in order to produce copies of those records that people can reasonably judge to be authentic. RLG-OCLC (2002:2) defines digital preservation as the activities necessary for ensuring both the long-term maintenance of a byte stream and continued accessibility of its contents. Conway (1990), also asserts that the purpose of preservation is to ensure protection of information of enduring value for access by present and future generations. Similarly, Lievesley(1995:6) lists the following objectives for preservation of digital objects

i. preserving the physical reliability of the data;

ii. ensuring the continued usability of the data;

iii. integration into information and dissemination systems.

A great deal of research on digital preservation issues is currently being conducted around the world. *Berthon and Webb* (2000:4) assert that the past several years have witnessed a significant increase in collaborative international efforts addressing a variety of questions on digital preservation. The United Kingdom Joint Information Systems Committee (JISC) has been one of the leading institutions worldwide in undertaking research and development on the long-term preservation of digital materials through projects and services some of these projects and services include the Arts and Humanities Data Services, CURL exemplars in Digital Archives (Cedars) Project, Creative Archiving at Michigan & Leeds: Emulating the Old on the New (CAMiLEON) Project, and the JISC/NPO Preservation research studies (Beagrie, 2004:3).

Digital preservation activities have also been the focus of collaborative initiatives, because no single agency can undertake the role of preserving all digital objects within its purview. These initiatives include national strategic alliances like the Digital Preservation Coalition (DPC) in the UK and nestor (Network of Expertise in long-term STORage) in Germany, as well as initiatives like the National Digital Information Infrastructure and Preservation Program (NDIIPP) in the US. Verheul (2006:56) also notes that national libraries are often key players in facilitating co-operation on digital preservation on a national level and that a number of countries are beginning to develop national strategies. International co-operation, at least for national libraries, seem to be mainly focused through well-established organisations like the International Federation of Library Associations and Institutions (IFLA) and the Conference of Directors of National Libraries (CDNL)(Day, 2008).

Other collaborative initiatives in the digital preservation domain have a far more practical focus, some examples working on preservation metadata and object-packaging standards, on repository architectures, and on the testing and implementation of preservation strategies. Specific collaboration on preservation infrastructures tends to focus on shared services like registries, e.g. for file format or other types of representation information (Abrams & Seaman, 2003:54).

Digital preservation solutions are partly technical, and the tools being created will enhance digital longevity and accessibility, but these solutions are also equally dependent on organizational issues such as institutional policy for preserving digital objects (Beagrie et al., 2008:11).

2.5 Public Policy

Digital preservation relies on the interaction between the digital preservation environment and wider organizational objectives and procedural issues, hence the need for institutional and national policy on digital preservation. A policy is a plan of action designed to guide decisions and achieve rational outcomes which may be applied to government, private sector organizations and groups, as well as individuals. It forms the pillar for the successful implementation of any program. Jenkins (1978:5) defines policies as "a set of interrelated decisions taken by a political actor or group of actors concerning the selection of goals and the means of achieving them within a specified situation where those decisions should, in principle, be within the power of those actors to achieve."

A policy is a formal statement of direction or guidance as to how an organization will carry out its mandate, functions or activities, motivated by determined interests or programs. The process of making policy has been divided by Kelman (1992:169), into three stages:

i. Policy formulation: Policy formulation or policy making covers the policy process from the inception of an idea to its passage into a law by a legislative body. Ideas for public policies can and do come from anyone, both inside and outside the government. With Digital preservation policy, for example, ideas can come from researchers, information professionals, and professional bodies. Burger(1993:8) posits that in order for policy making to take place, however, people who have the authority to make the policy decisions and those who have the resources and ability to influence those policy makers must be involved. There are several distinct stages in formulating a policy and these stages include:

   a. The Proposal: At this point a person or a group of persons has an idea about how to solve a problem or effect some change. They would propose an action to be taken and would also present some type of rationale for this proposed action. This rationale may or may not be based on good political sense, on existing scientific knowledge, or on all the facts available. But it is based on some rationale for action.

   b. Evaluation Stage of Policy Formation: Once the rationale for a policy is established, some type of evaluation of the rationale takes place. This evaluation may be informal and usually takes the form of internal debate on the merits of the proposed action and the reasons for undertaking it. Once

the policy is evaluated at this stage, prior to its being given a wider audience, it must then be placed on the agenda of the legislative or organizational body that is given the responsibility for enacting laws and regulations.

ii. Policy implementation: Once a policy is embodied into a law, it must be implemented by some executive agency of the government. Its success or failure at this point depends on several factors. There are material factors, such as the availability of monetary resources, equipment, well-trained personnel, and facilities. Making a policy does not ensure its implementation in a form intended by the policy makers. At the implementation stage many changes can occur that often are beyond the control of the policy makers and that often cannot be foreseen by even the most astute political veteran. Formal implementers are responsible for implementing a policy made by another set of people, the policy makers, at a different level of government. Formal implementers include administrators within departments, agencies, bureaus, regulatory agencies, and the Supreme Court (Braman, 1988).

iii. Policy evaluation: Policy evaluation attempts to answer the question of how well or how close the policy comes to achieving its original goals. The success of the policy would have been influenced by many factors. The evaluation must assess not only the original goals, but also the soundness of the rationales put forth for the policy, the history of the formulation stage, the history of implementation and changes to the formulators' original intentions. In order for a policy to be evaluated as objectively as possible, it must meet certain basic tests (Nakamura and Smallwood, 1980:72):

a. Policy goals are stated clearly;
b. These goals are precise enough to be measurable;
c. Implementation activities are directed toward achieving these goals;
d. Objective measures that relate implementation activities to goals exist or can be created; and
e. The data necessary to verify these measures are available.

2.5.1 Policy Paradigms

Policy paradigms are powerful ideas that specify "not only the goals of policy and the kind of instruments that can be used to attain them, but also the very nature of the problems they are meant to be addressing" (Hall 1993:279). By defining what is at stake, policy paradigms have a considerable effect on policy and, in turn, on the society to which those policies apply. A paradigm shift is a change from one way of thinking to another. It is a revolution, a transformation, which does not happen, but which is rather driven by agents of change. Policy paradigms are the broader frameworks that guide policymaking, and understanding their causes and consequences is critical to understanding questions of policy development and change. The increasing shift to digital form of storage and communication are driving a new paradigm shift today. The adoption and use of computer in every facet of human endeavor was impacted government, personal and business environments, and is a catalyst for paradigm shift in preservation policy. There must be a paradigm shift in preservation policy of non-digital information resources to a digital preservation policy.

The policy paradigm can shift the preservation landscape in the following ways:

a. by changing the public perception and agenda status of digital preservation;
b. by changing the boundaries of what is discussed in preservation to include information technology;
c. by bringing in actors out of the domain of traditional preservation and creating new actors with skills in information technology; and
d. by potentially sparking venue shift or opportunities for institutional change.

2.5.2 Digital Preservation Policy

According to the Electronic Resource Preservation and Access Network Digital Preservation policy tool (2003:3), the primary aims of a digital preservation policy are to provide guidance and authorization on the preservation of digital materials and to ensure their authenticity, reliability and long-term accessibility. Digital preservation policy should be directly connected to the aims and goals of the institution. A digital preservation policy would state the principles and long-term direction that would guide preservation strategies and actions.

Digital preservation policy should explain how digital preservation can serve the major needs of an institution and state some principles and rules on specific aspects which then lay the basis of implementation. Beagrie et. al.(2008:3) proposed a model framework and guidance for the development of digital preservation policy and implementation clauses. The model framework clauses can be taken into consideration when creating digital preservation policy for any institution.

Table 2.1: The Model Digital Preservation Policy and Implementation Clauses.

Clause	Description
Principle Statement	Addresses how the digital preservation policy can serve the needs of the organisation and the benefits its well being.
Contextual Links	Highlights how this policy integrates into the organisation and how it relates to other high level strategies and policies
Preservation Objectives	Provide Information about the preservation objectives and how they will be supported
Identification of Content	Outlines what the policy's overall scope is in terms of content and its relationship to collection development aims.
Procedural Accountability	Identifies high level responsibilities for the policy and provide recognition of the most important obligations faced in preserving key institutional resources.
Guidance and Implementation	Guidance and implementation clauses on how to implement the preservation policy and/or identification of where additional guidance and procedures are available in separate documentation or from staff.
Implementation Clauses	
Financial and Staff Responsibility	This section should be about who is responsible for digital preservation within the organization. It should also be about financial sustainability and how the policy sits within the organizational financial plan.
Intellectual Property	This clause shows awareness of copyright issues and how the institution plans to recognize and tackle these key issues.
Distributed Services	In some situations it may be more convenient or cost-effective to outsource some or all preservation activities.
Standards Compliance	Lists here what standards the archive is committed to.
Review and Certification	A description of how often a review of the policy is carried out, for example, bi-annually, yearly, biennially.
Auditing and Risk Assessment	Procedures for carrying out standardized auditing and recognition of risks facing the policy.
Stakeholders	Identification of all parties involved in the policy and its implementation procedures.
Preservation Strategies	A guidance table on preservation strategies adopted and technical implementation of the policy.
Glossary	List of definitions, if required.

2.6 Storage Medium for Digital Preservation

Digital objects are stored, archived and preserved on storage medium. The two primary technologies used for digital storage are magnetic and optic. Magnetic media come in a number of formats, including the floppy disk, tape systems, floppy or removable disks and hard drives. They all rely on magnetic particles in the recording of the substrate that change direction in the presence of a magnetic field. Optical technology including CDROM, CD-R/W, DVD-ROM, DVD-R/W and DVD+R/W are read using a laser beam which reflects the light from the surface of the disc in areas of differential reflectivity (Lesk, 2005:253). Hard drive media are self-contained units, usually internal to a computer system. Hard drives contain one or more magnetic platters which hold the data and a number of read/write heads. Although hard drives vary by capacity, interface and forms, advances in hard drive technology so far have primarily increased hard drive capacities while reducing the price, with insignificant technological change. These physical storage media are dependent upon very specific combinations of hardware and software for access. The accessibility of information stored on any media is highly vulnerable due to the rapidly evolving technological environment.

Most storage media has short life span of between 3-5 years, and unlike paper-based documents, provision of adequate storage conditions is the best means to help ensure that materials would remain readable far into the future. Hence in the not-too-distant future, the need to periodically refresh digital objects onto new media will inescapable. Gladner (2007:211) asserts that hard disk and magnetic tapes are

the most reliable storage media. Server-based hard disk storage is the most effective especially in securing storage system for digital objects, when it is well managed to include an effective back-up strategy. However in many situations this may not be possible or appropriate. Removable media usually have some part to play in the life cycle of any digital objects, as they are convenient for distribution purpose. Brown (2003:4), outlined the following criteria to be considered by data creators when selecting removable storage media for archiving and long-term preservation: longevity, capacity, viability, obsolesce, cost and susceptibility.

Storage media should be stored in an environment which provides protection from direct sunlight and ultra-violet light, and is free from chemical or particulate atmospheric pollutants. The environment should not be subject to rapid fluctuations in either temperature of humidity (Brown, 2003:8).

2.7 File Format for Digital Preservation

The basic premise of preservation as it relates to digital information is the ability to provide meaningful access to file format of digital objects. A file format is a particular way to encode information for storage and use. Risks for loss of digital objects may vary according to the content of the object, the file formats in which the content has been created, the ability to support hardware and software necessary to render the content usable. When file format can no longer be reliably read as a result of obsolescence, access to the digital object is lost. While some file formats may be intended to hide information rather than making it retrievable, most file formats are designed with the purpose of allowing the encoded data to be re-presented, given the

right means. Pearson and Webb (2008:91) observe that file format obsolescence is related to the development of new format encodings that take the place of ready existing format in the market place and the changes in the availability and support of rendering software. A file format whose specification is publicly available without requiring users to pay fees or to observe usage rustication is called an open file format. Gladney (2007:143) asserts that only open file formats are likely to work for preservation without unacceptable risk, because the owner of a proprietary format might in the future vanish or choose to charge unaffordable fees. Supporting this argument Borghoff et al (2006:126) assert that proprietary file format like Microsoft application packages should not be used for preservation, because the file formats can be altered by their owner at any given moment without notice. Sometimes details of such file formats are kept secret in order to obstruct competitors. For the purpose of long-term preservation the following should be used as criteria for selecting file formats:

i. The file format should be public with a full disclosure of its syntax and semantics.
ii. The file format should be standardized by a reputed organization such as the International Organization for Standardization (ISO).
iii. The file format should be generally accepted and widespread. This guarantees availability of suitable rendition software on mainstream hardware platforms now and in the foreseeable future.
iv. The file format should be available and free of patent and license fees.

As a result of prominence of file format in digital preservation, the OCLC developed INFORM (INvestigation of FOrmats based on Risk Management), for investigating and measuring the risk factors of digital formats and providing guidelines for preservation action plans (Stanescu, 2004:6). The United Kingdom National Archives also built a repository called PRONOM which contains information about file formats, software products, and other technical components for long term access to digital objects of cultural, historical and business value (Reis and Lindley, 2007:7). The risk assessment will determine what environments are needed for the most reliable access to the content and what actions need to be taken on a regular basis to ensure preservation of the digital objects.

In 2006, National Library of Australia in collaboration with the Australian National University (ANU) built the Automatic Obsolescence Notification System I (AONS I) prototype. The system was designed to analyse the digital repositories and determine whether any digital objects contained therein may be in danger of becoming obsolescent. It uses preservation information about file formats and the software which supports these formats to determine if the formats used by the digital objects are in danger (Curtis, 2006:3). In order to determine this, the AONS I system used information obtained from the PRONOM and Library of Congress Sustainability of Digital Formats (LCSDF) registries, which it periodically checked against the contents of the repository. When the repository was found to contain objects in danger of becoming obsolescent, a notification report was sent via email to the repository manager. At the conclusion of the AONS I Project, the software code was supported in a DSpace. Webb and Pearson (2008:96), assert that in 2007 the NLA and other

Australian Partnership for Sustainable Repositories (APSR) partners collaborated in the AONS II software development project, to refine and expand the functionality of the prototype AONS I software. The AONS II Project has produced an open source, platform-independent, configurable, downloadable tool in prototype form that is capable of providing information from authoritative international registries.

Nigeria National Information centres can also adopt AONS II as a software tool to determine which digital objects in their holdings is danger of becoming obsolescent and hence take appropriate action.

2.8 Implementation Strategies for Digital Preservation

Over the last years, a lot of efforts were put into defining, improving, and evaluating preservation strategies. A good overview of the preservation of digital heritage and preservation strategies is provided by UNESCO charter for the preservation of the digital heritage. Digital preservation strategies are methods for keeping stored digital objects permanently accessible for long-term re-use. Implementing a digital preservation strategy is a crucial part of managing the risk associated with rapid hardware and software obsolescence. The concept of strategy has been borrowed from the military and adapted for use in organizations. Strategy is a general framework that provides guidance for actions to be taken and, which at the same time, is shaped by the actions being taken. Implementation strategies for digital preservation can be categorized into investment, short-term and long-term strategies.

2.8.1 Investment Digital Preservation strategies

These strategies can be adopted at the start of a digital object lifecycle and include the following:

i. Use of *standards*

This strategy involves the use of preferably open, widely available, supported or agreed standards and file formats, for which there is an increased likelihood of stability and longer term support. Reliance on standards may lessen the immediate threat to a digital document from obsolescence. For example PDF/A standard had been widely adopted as the standard for long-term preservation of document due to its omitting of embedded scripts (Strodl et al., 2007). Other examples would be the conversion of Microsoft word to rich text format (RTF).

ii. Normalization

This involves converting all digital objects into one or more preferred formats. For example, all images might be converted from their original format (such as JPEG or GIF) to Uncompressed Baseline TIFF, and all word-processed documents might be converted to OpenDocumentText (ODT).The re-presentation of content can be liberated from specific software applications and be achieved using different applications as technology. Normalisation is seen as a more cost effective option than migrating to a wider range of formats; if using a single format like XML, repeated cyclical migration into different formats (with its accompanying risk of data loss or corruption) is avoided. In order to control complexity and cost, an institution may decide to

support only a limited number of standardised file formats, and migrate all digital objects to an appropriate supported format.

The National Archives of Australia accepts digital records in any format and converts them all into an XML-based archival format, using the normalising tool, XENA. Xena is a free and an open source software developed by the National Archives of Australia to aid in the long term preservation of digital records. Xena is an acronym meaning 'Xml Electronic Normalising for Archives'. According to the Xena official website Xena is written in Java and is therefore cross-platform, running on Linux, Windows and OS X. It aids digital preservation by detecting the file formats of digital objects and converting digital objects into XML based file formats for preservation (Zierau and Wijk, 2008).

iii. Encapsulation

This is the means of binding together data and the means of providing access to it. It is often impractical and unnecessary to encapsulate the actual means of access such as software and hardware. Hence, encapsulation usually bundles metadata describing or linking the digital objects with software that renders the program. This allows future users to interpret digital objects by running the same software that was used in their creation. According to Boudrez(2005:6), encapsulation is a storage technique in which metadata is added to a digital object and/or several documents are grouped in one digital object. Ferreira (2006:2) argues that encapsulation strategy is generally oriented at collections of objects that are expected to remain unexploited for long periods of time. Using encapsulation on such collections may reduce the

number of preservation interventions lending to a generalized reduction in preservation cost.

2.8.2 Short-term Digital Preservation Strategy

The Short-term strategy is considered to be between 1-5 years. This strategy includes:

i. Technology Preservation

Preservation of the original technology used to create the digital object in order to preserve the functionality and "look and feel" of the product. This is a "museum style" approach which is probably only suitable as a short-term solution. Technology approach focuses on the technological environment rather than on the digital object. Instead of mimicking the original environment, it involves preserving the digital object together with the actual rendition system (hardware, operating systems, original application software and media drives). It could be argued that maintaining the original technology is the most effective and obvious means of preserving the look and feel of a digital environment, and there is certainly merit in keeping samples of old computer systems as a resource for researchers in the future. However, this might offer a short-term solution (Thibodeau, 2002:4). This is not a viable strategy for long-term digital preservation, for the following reasons:

a. The cost and space implications for acquiring and maintaining large quantities of hardware (from computers and peripherals to connectors) are prohibitive for many organisations.

b. Older operating system and application software and appropriate licences must also be acquired and maintained.
c. After some time, the machines will degrade and ultimately fail, so the number of machines capable of reading certain types of old files will continually decrease.
d. Technical support for both software and hardware will also disappear over time.
e. Documentation for older computing environments can be difficult to locate.

ii. Refreshing

This is essentially a means of mitigating media degradation and obsolescence. Refreshing involves the copying of digital objects from one long-term storage medium to another of the same type, with no change whatsoever in the bitstream (e.g. from a decaying 4mm DAT tape to a new 4mm DAT tape, or from an older CD-RW to a new CD-RW). Reis and Lindley(2007:5) posit that media migration describes the transfer of data from one storage medium to another storage medium. Similar to content migration, media migration can hardly be avoided. Bilateral digital media migration (i.e. from a digital storage to a new digital storage) is primarily motivated by the following:

a. information loss due to physical effects like de-magnetization of tapes.
b. digital media storage constantly becomes cheaper, smaller, and faster.
c. new hardware platforms no longer support certain media storage systems (e.g. 5.25" floppy drives simply disappeared).

Andrews and Law (2004:102) assert that refreshing cannot be viewed as a solution to digital preservation in itself, because it does not involve the transfer of the entire digital environment, but only the physical storage medium.

2.8.3 Long-Term Digital Preservation Strategy

Migration and Emulation are the two strategies that have dominated long-term preservation strategy for digital objects.

i. **Migration**

This is the process of transferring data from a platform that is in danger of becoming obsolete to a current platform. The task Force on Archiving of Digital Information (1996:3) defines migration as the periodic transfer of digital objects from one hardware/software configuration to another or from one generation of computer technology to a subsequent generation. The purpose of migration is to preserve the integrity of digital objects and to retain the ability for clients to retrieve, display, and further use them in the face of constantly changing technology. From the above definition, it is clear that migration involves transferring digital objects from one hardware or software generation to another periodically and is not just a single ad hoc transformation step. Migration focuses on the digital object itself, rather than its environment. The aim of migration is to change the object in such a way that hardware and software developments will not affect its accessibility. This includes content migration, which transforms data from a source format in to a target format,

and media migration from one digital medium to another (either digital or non-digital) medium (Reis and Lindley 2007:5). The following has been advanced by Lawrence et. al., (2000:13), as possible reasons to migrate:

1. The format is obsolete or its market share is extremely low. The software company may have gone out of business or changed its business focus and stopped supporting the format.
2. The format is dependent on a specific hardware and operating system. If that environment is abandoned or superseded by another system, the only alternatives to migration are to sustain the technology at any cost or to depend upon software to emulate the technology.
3. The format is proprietary, and the vendor will not place the format information in the public domain.
4. Administration of the digital archive requires a simplification of formats. Large archives often have files created by different generations of the same application.
5. Metadata requirements are increasing. There is a growing realization that current MARC records, code books and readme files, and file names are insufficient for managing large collections of data files.

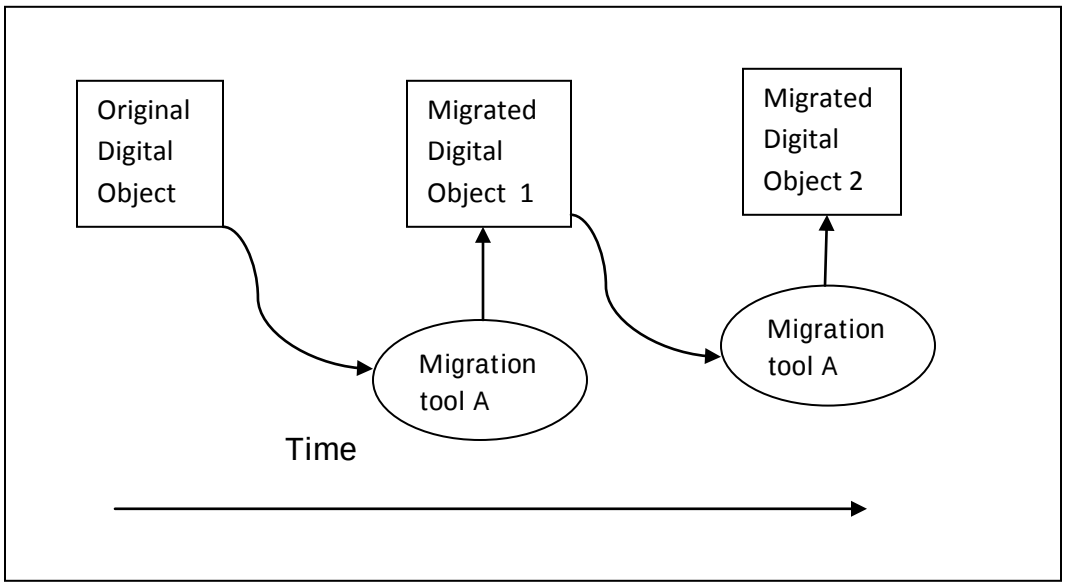


Figure 2.2 A Digital Object Preserved using Traditional Migration
Source: (Mellor et. al., 2002:2).

Migration has measurable risk which varies, sometimes significantly, given the context of the migration project. The notable danger of migration is that of data loss, or in some cases, the loss of original functionality or the look and feel of the original platform (Granger, 2000:3). Migration could result in the following advantages and disadvantage:

a. Advantages:

i. The routine refreshing of digital files;

ii. When successfully achieved, does not require special hardware or software.

iii. Preserves the content of a file but lose the internal relationships or context of the information.

iv. Brings about varying changes in digital format when files are converted from one application to the other;

v. May be most cost-effective for homogeneous collections such as digital image and audio collections that are very widely used, well standardized, and are in non-proprietary formats

b. Disadvantages

i. Inability to provide access to complex digital objects because there may be no way of representing complex functions in the new format

ii. Transformation of the logical encoding may compromise the integrity or essential elements of the material

iii. Small changes between generations may accumulate into major alterations or losses as a result of repeated migrations.

Simple version migration is common in the world of commercial software and has been in use for years. Successive versions of particular proprietary file formats will define linear migration paths for files stored in those formats. Software vendors usually supply conversion routines that enable newer versions of their product to read documents created in older versions and then to save in the current version. Where a digital archive includes material stored in recently-created proprietary formats which are well-supported and well-documented, a repository may decide to leave the material in this format until it is at risk of obsolescence and at this stage, if an upgraded and backwards compatible version of the format has been released, it may be decided to migrate to this format. However, reliance on proprietary formats like this does

not provide a long-term solution, and there are major drawbacks from a digital preservation perspective.

A major drawback with migration strategy is that any errors or omissions from a transformation will propagate throughout and, hence, be present in all future transformations. Migration on request strategy has been identified as solution to address drawback of migration (Mellor et. al., 2002).

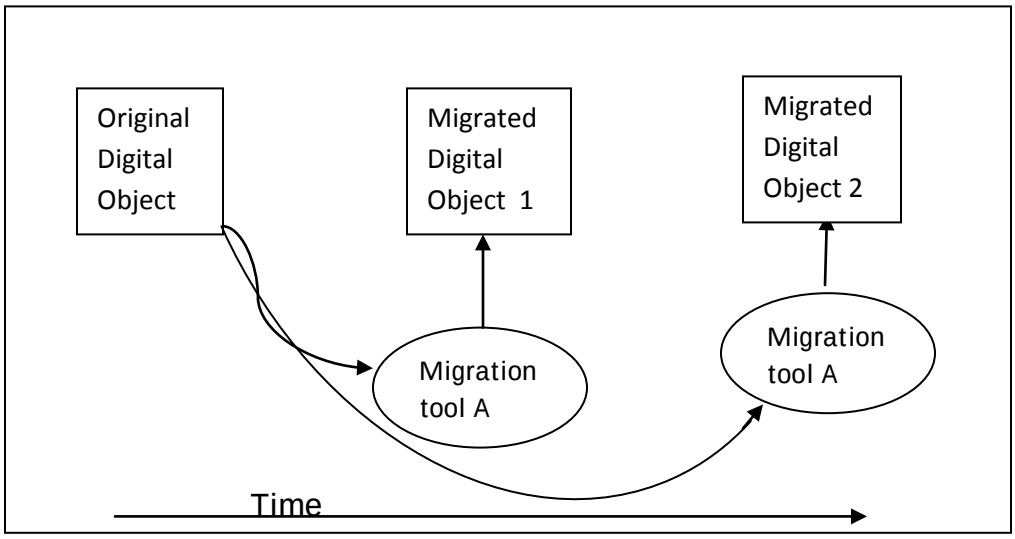


Figure 2.3: Migration on Request

Migration on request focuses on the transformation of migration tools rather than the digital objects. The tool is developed when the format is still in a usable form and the migrated digital object is compared against a rendering of the original object; any future modifications which become necessary as technology evolves would require a similar validation process. This means that original software, screenshots and written documentations about the original environment may also need to be preserved alongside the bitstream and the Migration on Request Tool.

This approach has a number of advantages some of which are:

i. Repeated format conversions are avoided, making the approach more cost-effective.
ii. Migration is carried out on the original bitstream, which mitigates the risk of data loss associated with repeated migrations.
iii. Deferring migration in this way means that by the time an object is requested, emulation techniques may have advanced and the end result seen by the user is likely to be better.
iv. If a record is never requested, it is never migrated, thus saving resources.

Deferring migration may have some disadvantages too:

i. Migration may be required in order to assess the historical value of the archive material and make decisions about its retention.
ii. Migration on request tools must be kept up-to-date for each format in the archive or the tools developed may themselves be obsolete by the time migration-on-demand is requested.

Organizations that adopt migration as a strategy for digital preservation have to establish organizational structures that allow for the following:

a. Regular inspection of the digital objects
b. Planning of the next migration steps as soon as inspection detects a migration need, and
c. Performing individual migration process according to a plan as part of their daily routine.

ii. Emulation.

Emulation is considered as an alternative to migration. Emulation strategy seeks to preserve that environment not through the preservation of original hardware/software but by using current technology to mimic the original environment. This might involve emulation of the original software or emulation of the original hardware (in this case the original software and operating system are stored along with the digital object itself). Rothenberg (1999:3) argues that only hardware platform on which an application runs should be emulated rather than the application or operating system it was rendered. Granger (2000:5) posits that the essential idea behind emulation is to be able to access or run original data/software on a current platform that emulates the original platform. Either way, the strategy relies on a detailed description of the original environment on which to base the emulation in future.

According to Lawrence (2000:4), emulation as a strategy has some limitations. Emulation assumes future access to the following multiple data objects in a cluster or package:

- the data file to be preserved and reused,
- the application software that generated the data file,
- the operating system in which the application functioned, and
- the hardware environment emulated in software using detailed information about the attributes of that hardware.

It is important to note that these are all strategies that have been demonstrated to work in certain circumstances over limited periods of time. They have not proven themselves against unknown threats over centuries of change. But they do have current applications in the management of data, and it seems likely that combinations of them will continue to be researched and proposed for large-scale long-term preservation. Research on long-term digital preservation strategies is ongoing.

2.9. Universal Virtual Computer for Long-Term Preservation

Universal Virtual Computer (UVC) solution was developed at IBM Almaden Research by Raymond Lorie to ensure future use of digital objects (Hoeven et. al., 2005:197). UVC was developed in response to the risks of migration and to the argument against the emulation. This concept combines the best aspects of emulation and migration: emulation through the UVC as a platform independent layer on top of (future) hard- and software, and migration as supported by the conversion of specific formats to universal technology-independent formats based on XML-like specifications. The platform independency promises that programs, developed for the UVC, can run on this platform today as well as in the far future, while the technology independent formats keep the objects accessible and understandable over time.

According to Hoeven et. al., (2005:197), the central idea of the UVC-based preservation method is based on four different components, which are:

i. Universal Virtual Computer: The UVC itself is a virtual representation of a simplified computer. Detailed instructions on how to (re)build a UVC are

documented and must be kept safely in an archive. Given these instructions it is assumed that a UVC can be rebuilt without significant problems at any time in the future.

ii. UVC program (format decoder): The format decoder is a program that runs on a UVC and translates a document in to a logical data view (LDV). A raster image would for example be represented by its pixels in an XML dialect.

iii. Logical Data Scheme (LDS): The logical data scheme (LDS) holds metadata that allows for a correct interpretation of the logical data view for a future rendering application. A LDS for an image would define that a valid LDV must define pixels that themselves specify RGB values.

iv. Logical Data Viewer: The viewer renders a document through its logical data view with the information present in the logical data scheme

A UVC program decodes the file format of a digital object. This format decoder program runs on the UVC, which is the platform-independent layer, independent of future hard- and software changes. Executing the format decoder delivers element tags, which hold specific information about the content of the data in a technology-independent manner.

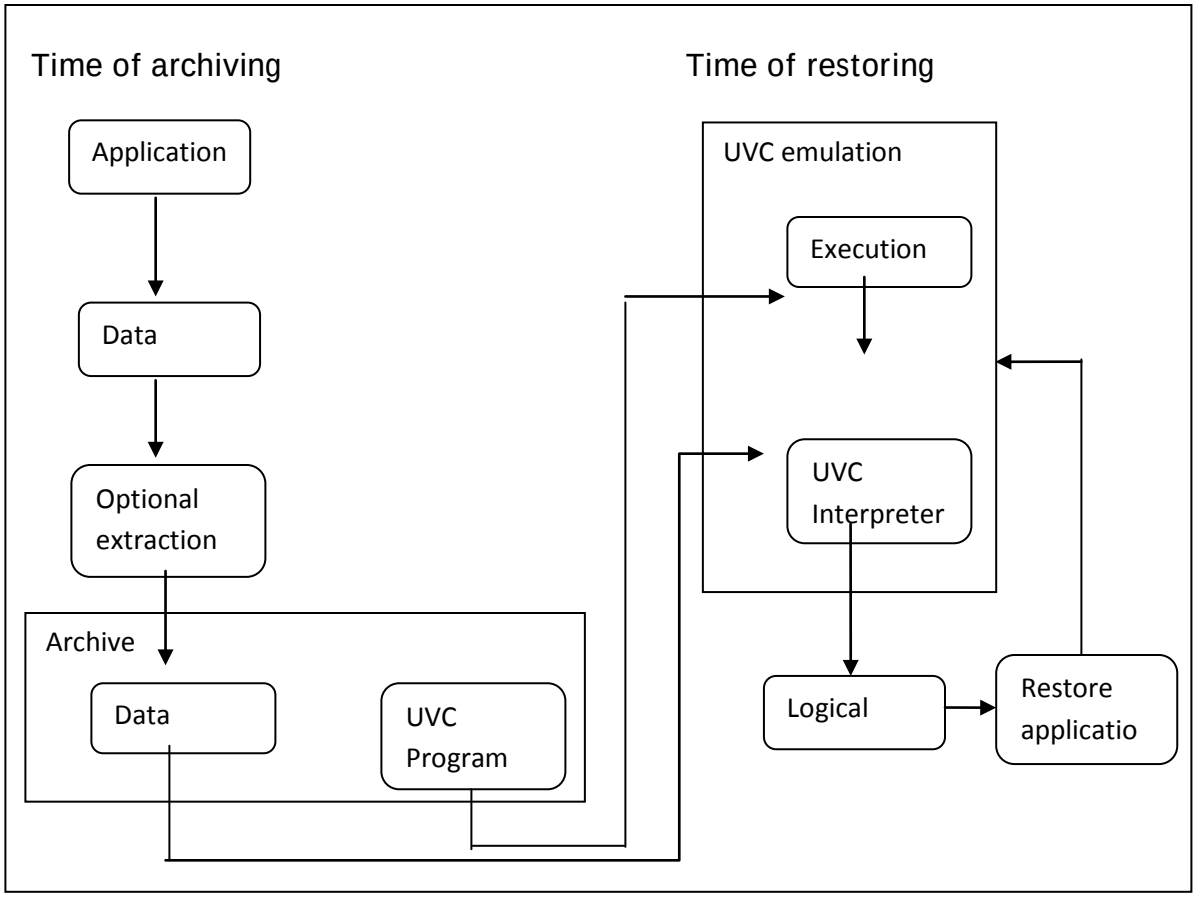


Figure 2.4: Universal Virtual Computer Data—oriented Long-term preservation. Adopted from Borghoff et al (2006:215)

UVC distinguishes between archiving program behavior and preserving data oriented documents. This is illustrated in figure 2.3 above. At archiving time a program has to be developed that runs on the UVC and that can render a logical view of the preserved bit-stream. In addition, metadata is created that can be restored by a UVC program. At restoration time the program is executed on an UVC emulation, which in turns runs within a future generation environment. Borghoff et al (2006:215) asserts that by interpreting the preserved bit-stream, a logical view is created which can be represented by future generation application. The core component of this

approach is the UVC, which is a virtual general purpose computer with a basic architecture. Secondary properties such as performance aspects or memory consumption are neglected. The input and output operation is carried out by the UVC emulator and the restored application using virtual memory shared with a UVC memory program. According to UNESCO Draft Charter for Preservation of Digital Heritage(2003:129), the potential advantages of UVC approach include:

i. May provide options for preserving the behavior of both document-type materials and software programmes.
ii. Defining a single intermediate platform may reduce the development work required to accommodate different software and platform combination
iii. Data encodings and decoder programmes could be tested at the time of creation on a contemporary UVC implementation.
iv. No need to define document formats.

The major challenge of the UVC approach to long-term digital preservation is that it is currently in experimental phase and further work is required to apply the approach to software program. This is in addition to the fact that for a developing National Information infrastructure, it will be very challenging for any National Information Centres to adopt this strategy.

2.9 Open Archival Information System (OAIS)

Open Archival Information System (OAIS) Reference model was published 2002 by the Consultative Committee for Space Data Systems (CCSDS) to deal with long-term preservation of digital objects, (Borghoff et al 2006:21). The term open refers to the fact that the reference model was developed and released in an open public forum, in

which any interested party was encouraged to participate. An archival information system is "an organization of people and systems that have accepted the responsibility to preserve information and make it available for a Designated Community" (ISO 14721, 2003).The Reference model's main objectives are to clarify basic terms of long-term preservation and to identify the corresponding key processes. Although it originated from space research, the OAIS Reference Model is a general, theoretical model describing the organization of an archive. It examined the problem of long-term digital preservation from an information and process model point.

a. The Information Model

The information Model of the OAIS Reference Model provides a fundamental distinction between Data object and Information object. The digital object is the focus of preservation, along with metadata necessary to support its long-term preservation and access, bound into a single logical information package. Hence, the information model is built around the concept of a conceptualization of the structure of information as it moves into, through, and out of the archival system.

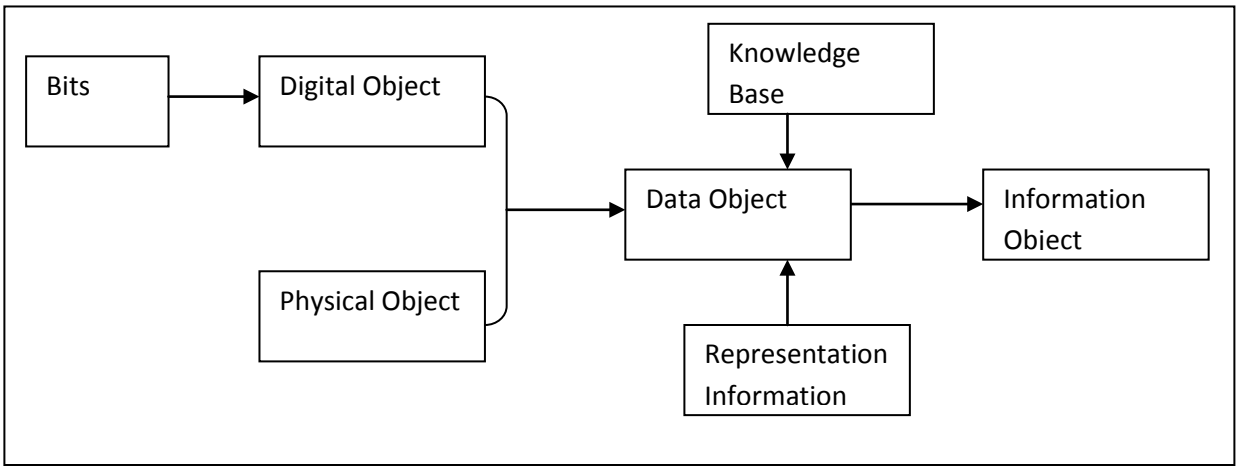


Figure.2.5 Information model of the OAIS Reference Model

Data turns into information only if the corresponding Knowledge base and additional Representation Information are available. Certain knowledge has to be presupposed for data to be interpreted and assigned a meaning. The knowledge which is required to understand data object is called Knowledge Base in the OAIS Reference Model. Borghoff et al (2006:23) assert that unavailability of the Knowledge Base can result to the inability to interpret the data at all. There is also the need for additional information to understand the data object which is subsumed by the term Representation Information in the OAIS Reference Model. Representation Information might include a description of the hardware and software environment needed to render the Content Data Object and/or access its contents (Lavoie, 2004:12).

b. The OAIS Process Model

The OAIS Process Model describes the flow of information within an institution from producers to archive and from archive to consumer. The OAIS Reference Model models these processes and groups them (see figure 2.6) according to the following:

i. Ingest Process: This process receives a submission Information Package and prepares it for storage and administration within the archive. The Submission Information packages (SIPs) must be transformed into Archival Information Packages (AIPs) and Descriptive Information corresponding to the AIP created. Finally the AIP is passed onto the Archival Storage process and the corresponding Descriptive information to the Data Management process.

ii. Storage Process: This process is responsible for the storage management, maintenance of the bit-steam and the retrieval of the AIPs. The process

ensures the periodic refreshing of storage media and guarantees the reconstruction of the AIPs in the case of system failure.

iii. Data Management Process: This process manages the Descriptive Information and the data necessary to run the system. The data are saved in a database and can be queried for editing and updating.

iv. Administration Process: The Administration process handles routine work in the archive. The process checks whether the delivered SIPs meet the archive's standard. It is also responsible for the hardware and software architecture of the archive

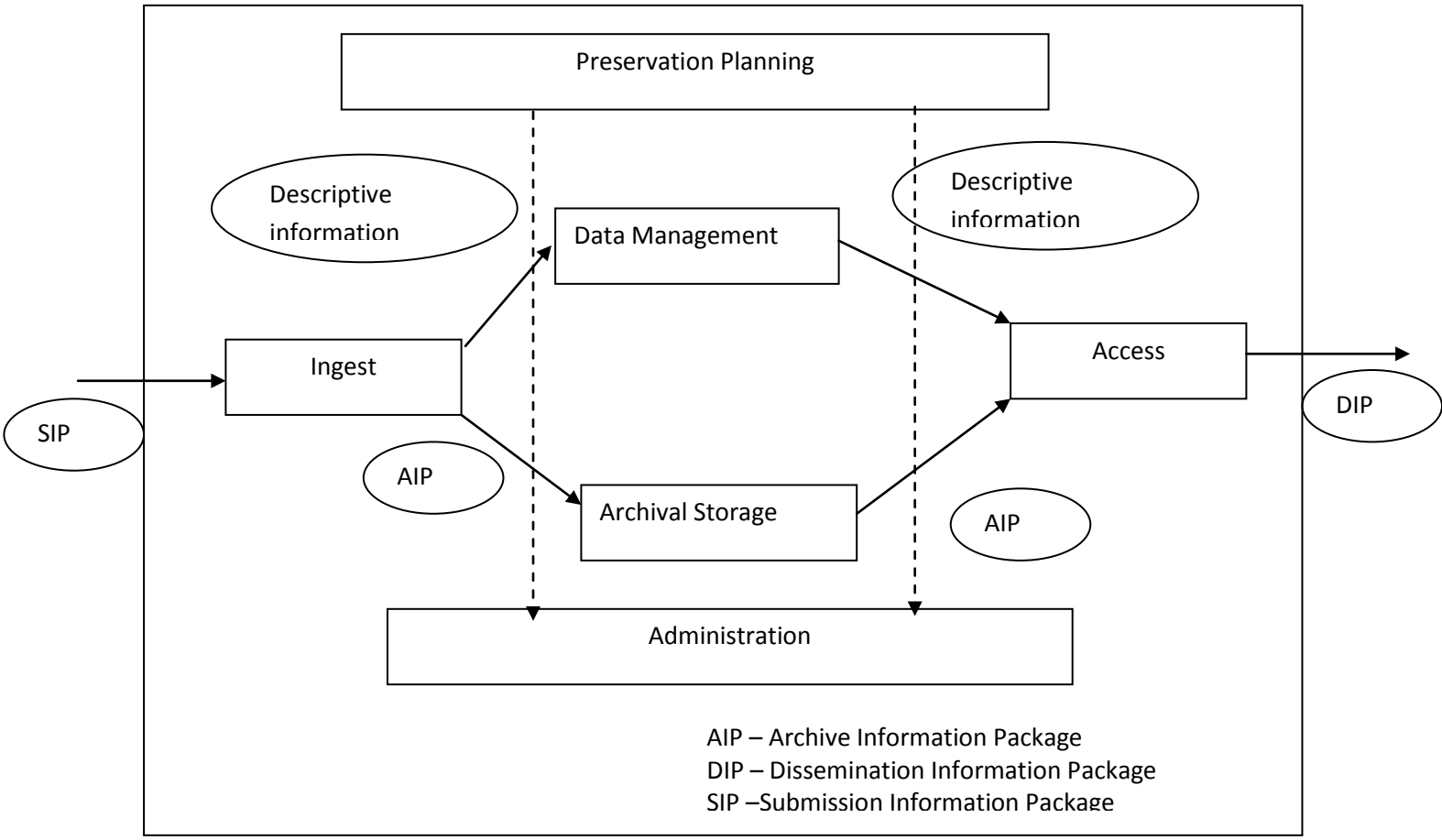


Figure 2.6: Process Model of the OAIS Reference Model

v. Preservation Planning Process: This process monitors the environment and provides recommendations to ensure the long-term accessibility of the stored information. This includes monitoring of the technology and designed community and evaluation of the archive and periodical recommendations on archival update for migration.

vi. Descriptive Information is information that supports discovery and retrieval of Content Information by the Designated Community through the OAIS's finding aids. For example, Descriptive Information Might take the form of a Dublin Core metadata record maintained by the OAIS to facilitate resource discovery by the consumer.

The OAIS Reference Model is a conceptualization of the environment, functional components and information objects associated with a system designed to effect the long-term preservation of digital materials. Lavoie (2004:14) asserts that OAIS Reference Model provides nothing about system architectures, storage or processing technologies, database design, computing platforms or any of the myriad technical details involved in setting up a functioning archival system. The OAIS Reference Models only articulate the requirements to be met by digital archive and library systems (Borghoff et al., 2006:30). The implication is that different implementation instances within different institutions may vary.

2.11 Preservation Planning

Preservation planning is a process by which the general and specific needs for the care of collections are determined, priorities are established, and resources for implementation are identified. Its main purpose is to define a course of action that

will allow an institution to set its present and future preservation agendas. In addition, it identifies the actions an institution will take and those it probably will never take so that resources can be allocated appropriately.

A range of tools exists today to support the variety of preservation strategies such as migration or emulation. Different preservation requirements across institutions and settings make the decision on which solution to implement very difficult. Preservation planning activities include conducting research on problems of long-term preservation and that of developing solution strategies. According to Strodl,et al (2007:4) preservation planning involves evaluating preservation strategies and choosing the most appropriate strategy to adopt . The selection of the preservation strategy and tools is often the most difficult part in digital preservation endeavours; technical process as well as the financial aspects of a preservation strategy forms the basis for the decision on which preservation strategy to adopt.

Preservation process comprises the following component process:

i. Develop Preservation Standards and Strategies. This process develops standards and strategies that enable an archive to react in flexible and adequate way to future developments in digital objects.

ii. Develop Packaging Designs. This process defines and continuously enhances the design for building submission information package(SIP), Archive Information package (AIP) and Dissemination information Package.

iii. Monitor designated Community. This process monitors service requirements of the consumers and producers. The monitoring of the designated Community can be done through survey.

iv. Monitor Technology: This process monitor ongoing Information technology development that can affect digital preservation.

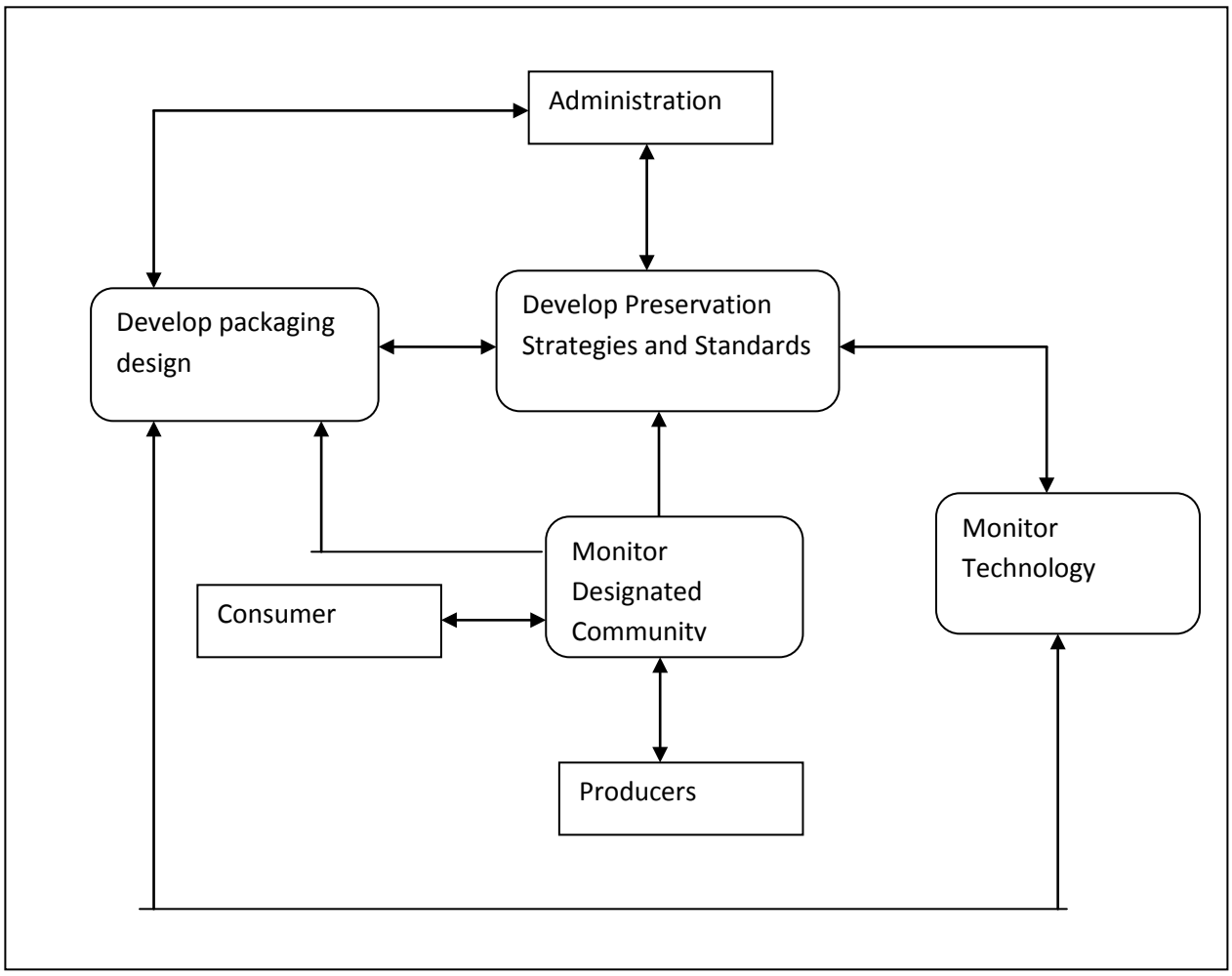


Figure 2.7: Preservation Planning

Figure 2.7 shows in detail the functional entries of preservation planning. The Monitor Designated Community function and Monitor Technology functions report changes of service requirements, technologies and standards technologies and designated communities to the Develop Preservation Strategies and Standards function. In response to these reports the Develop Preservation Strategies and Standards function starts to evaluate and develop preservation strategies and

standards to ensure accessibility and usability of the current archive holdings and for new submissions. These recommendations are sent to the administration for appropriate action.

2.12. Preserving Web Digital Objects for Long-term

Web based digital objects have grown over the past 15 years, thereby generating interest in preserving web based digital objects. According to Yakel (2001:347), the most publicized project to capture Web-based information has been carried out by Kahle (1997), who developed the technology to take snapshots of the Web, thus creating the Internet Archive. The National Library of Australia project on Preserving and Accessing Networked Documentary Resources of Australia (PANDORA) has as one of its goals to develop and to implement procedures for the identification, capturing, and long-term digital preservation of online Australian publications, such as serials, newspapers, books, scholarly papers, theses, and home pages.

Lots Of Copies Keep Stuff Safe (LOCKSS) program is an OAIS-Compliant, open source, peer-to-peer, decentralized, distributed, digital preservation infrastructure for preserving all formats and genres of static content published on the Web. Reich and Rosenthal (2009), assert that LOCKSS collects and preserves not merely the intellectual content, but also its original look and feel. The technology also enables nontechnical administrators to create and manage their own preservation network via a "Private LOCKSS Network". LOCKSS makes it economically and technically possible for even relatively small libraries to actively preserve their own content. In the

LOCKSS system, ingest, preservation and dissemination are all highly automated, minimizing the staff time required of participating libraries.

Making Content LOCKSS complaint requires the publisher (or whoever is hosting the content on the Web) to gives explicit permission for the LOCKSS system to collect and preserve content via the Manifest Page. The LOCKSS model is inherently based on interlibrary cooperation and is largely automatic and invisible (Reich, 2002:1**).** A library uses LOCKSS software to turn a low-cost PC into a digital preservation appliance called a LOCKSS box. Libraries run a LOCKSS Box that collects the content they are interested in preserving. The Boxes form a peer-to-peer network that continually audits the content to other Boxes. Content is preserved in its original format; if this format becomes obsolete the system can, on demand, create temporary access copies in a newer format to provide transparent, on-access format migration.

The LOCKSS boxes continually audit the content they are preserving via the LOCKSS peer-to-peer polling protocol. If the content in one LOCKSS Box is damaged or incomplete, that LOCKSS Box receives repairs from the other LOCKSS Box peers. The LOCKSS audit mechanism proves at regular intervals that a copy agrees with the consensus of the copies at peer libraries. The more LOCKSS Boxes hold a copy of given content, the safer it is. The more organizations preserve given contents, the stronger the guarantee that they will all have continued access to it. Seven copies are the recommended minimum for normal conditions.

Keller et. al. (2003:5) asserts that a group of American government documents librarians are exploring the possibility of adapting the LOCKSS system to build and

maintain collections of U.S. and local government documents. While librarians are exploring and applying LOCKSS to medical gray literature (mostly evidence-based) and other corpora of literature, such as university theses and dissertations. According to Rosenthal et. al.(2005:5), the LOCKSS system was released for production in April 2004 and public LOCKSS network currently comprises about 200 research institutions worldwide (Reich, 2002:4**)**. Similarly, according to LOCKSS official website (2009), approximately 400 leading scholarly publishers have granted permission for their content to be preserved by LOCKSS Alliance participants

2.13 Skill Sets for Digital Preservation

The field of digital preservation is an emerging field where new theory and practice is being rapidly developed and applied. (Harvey,2009:1) opines that it is apparent that there is a severe skill shortage in digital preservation, even though the required skill-sets are still being defined. However, Cedars Guide to Digital Preservation Strategies categorically states that "preserving a byte-steam is a relative routine IT operation (Cedars, 2002). The key element for digital preservation program planning and strategy implementation lies in the people who have the Information Technology skills to assemble and maintain equipment, and the IT infrastructure. Due to the complex and evolving nature of digital preservation strategies, the digital preservation staff shoulder with the responsibility of digital preservation need to include a diverse mix of professionals and specialists, such as information scientists, librarians, archivists, programmers, IT support personnel, business managers, and website developers. In addition, there is an ongoing need for these staff/personnel to

learn about new or changing practices and theories in order to keep their knowledge current.

2.14 Authenticity and Trustworthiness of Digital Objects

An authentic object is one whose integrity is intact, one that is and can be proven or accepted to be what its owners say it is. It matters little whether the object is handwritten, printed, or in digital form. Digital objects that can speak to their own authenticity are called *trustworthy digital objects* (TDOs)(Gladney 2004:64). TDOs were proposed by Henry M. Gladney to enable digital objects to maintain a record of their changed history so that future users can know with certainty that the contents of the object are authentic. According to Yakel (2001:340) authenticity refers to the capability of a record-keeping system to ensure that the record has been created, changed and maintained, according to established authority or procedures

Duranti et al. (2002: 23) assert that that authenticity is a characteristic of all archival documents and it relates to the quality of the object. Authenticity also implies that the document is genuine, it is what it claims to be, and is reliable – the content can be trusted. A digital object must be authenticated at the time of its creation by a means that will convey a high degree of confidence to all users, including subsequent use by the originator (Cullen et. al. 2000:3).

According to Jantz (2009:5), an internationally recognized method for meeting the requirements of authenticity is to create certificates by encrypting and digitally

signing the source document. By digitally signing the object, the archivist is making the following three claims on behalf of the institution:

a. metadata for the object has been created by an approved representative of the institution;
b. the metadata is accurate and complete. Note that this does not include any claims as to the accuracy of the intellectual content of their source; and
c. the signer verifies that the digital object has been created and ingested using established trusted repository processes as documented by the institution's policies.

In order to interpret the authenticity of a document, a reader would need access to more than the informational content. The reader would need to examine the metadata, which would indicate when and if changes were made and whether these were authorized. Specific mechanisms for maintaining authenticity and reliability include authentication, version control, date stamping, digital signatures, and encryption(Yakel, 2001:340).

Jantz (2009:4) posits that institutions should incorporate risk analysis in determining which digital objects require authenticity and they might start by applying this approach to born-digital objects that are used for scholarly and research purposes.

2.16 Summary of Reviews

The review of discourse in the domain of digital preservation policy and strategies emphasize that digital preservation is a relatively new area of research.

However, the potential threats faced by digital objects as a result of the rapid evolution and obsolesce of rendition systems have resulted in various initiatives by both national and international organizations to identify strategies that can best preserve the ever growing digital heritage being created for long term. The review revealed that although the number of proposed strategies for digital preservation continues to grow, none of them has been adequately proved or universally accepted. No single digital preservation strategy can be considered as the best, but each circumstance calls for a specific implementation strategy. The literature review also revealed that collaboration is on going in the development of open source software such as AONS II and XENA to keep track of the file obsolesce and convert any file format to a most appropriate file format like XML, PDF/A standard for long-term preservation and re-use.

In conclusion it has been argued by researchers as revealed in this chapter that strategies and models for long-term digital preservation of digital objects are yet to be fully tested or deployed in a large scale.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research method adopted for carrying out the research. It captured the population of the study, the sampled population and sampling procedure, the research instrument used for the study and the procedures for data collection and analysis.

3.2 Research Methodology Adopted for the study

This study was designed to examine exhaustively, the policies and strategies implemented to preserve digital objects for long term use in the National Library of Nigeria, the National Archive and the National Bureau of Statistics. The study adopted the qualitative methodology approach. Qualitative research is defined as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification" (Strauss & Corbin, 1990:17). According to Creswell (2003:181), qualitative research takes place in the natural setting. He states that the qualitative researcher often goes to the site (office) of the participants to conduct the research. This enables the researcher to be more detailed about the individual or place and be highly involved in the actual experiences of the participants.

The choice of these methodologies and method was based on its appropriateness, which as observed by Creswell (2003:179), employs different knowledge claims, strategies of inquiry, and methods of data collection and analysis. Tesch (1990:4) also asserts that qualitative researchers reject the idea of

standardized methodologies, preferring the freedom to do what works. According to Denzin and Lincoln (1994:12), qualitative methodologies include “interviewing; observing; artifacts, documents, and records; visual methods; personal experience methods; data management methods; computer-assisted analysis; and textual analysis”. All of these methods may be useful in gaining an insight into digital preservation policy and strategies implemented but not revealed by quantitative methods.

The case study methodology which allows the researcher explores in depth the digital preservation policy and implementation strategies in the target population was adopted. In case study methodology the legitimacy of the study does not spring from numbers, either of the organizations to be studied or people that will provide response to the data collection instruments to be used. Stake (1995:23) asserts that case studies are bound by time and activity and researchers collect detailed information using a variety of data collection procedures over a sustained period of time.

3.2 Population of the Study

The population of the study consists of the National Library of Nigeria, the National Archive of Nigeria and the National Bureau of Statistics. The target population of the study population size cuts across the senior management and staff of the digitization/preservation unit of national information centres.

3.3 Sample and Sampling Procedure

A purposive and criterion-based (Maxwell, 1996:70) sampling technique was used to select sample from these three national information centres. While a homogeneous sampling of 5 staff in the digitization/digital preservation unit as well as 1 top management staff from the rank of Assistant Director of each of the selected three national information centres was sampled for data collection.

Table 3.1: Sampling size

S/N	National Information Centre	Category	Sample size
1.	National Library of Nigeria	Assistant Director	1
		Staff of Digitization/ Preservation unit	5
2.	National Archive of Nigeria	Assistant Director	1
		Staff of Digitization/ Preservation unit	5
3.	National Bureau of Statistic	Assistant Director	1
		Staff of Digitization/ Preservation unit	5
Total			18

The sample population and size better informed the researcher of the current focus of the investigation (Krathwohl, 1998:172). The justification for choosing the three national information centres was that they have traditionally been managing, preserving, and providing access to significant government, private, business and research information in paper and digital formats.

The exclusion of users of the selected national information centres was because they have no role to play in the digital preservation of digital information.

1.4. Instruments for Data Collection

The instruments used to collect data for this study were consultation of documentary sources, direct observations, semi-structured, unstructured interviews and the use of digital recorder to record the interview process. The semi-structured interview involved the researcher personally interviewing staff of the digital preservation unit and management staff, based on a structured set of questions that have been prepared before the interview. This enabled the researcher to explain or elaborate on any question that was not well understood by the respondents.

3.4.1 Documentary Sources

Documents to be reviewed could be letters, memoranda, agendas, administrative documents, newspaper articles, or any document that is germane to the investigation. The documents will serve to corroborate the evidences from other sources. Documents are also useful for making inferences about events.

3.4.2 Interview

A semi-structured focus group interview similar to a survey was used to collect information. Bryman (2007:315), opines that when conducting a multiple-case study research, there was a need for some structure in order to ensure cross-case comparability. The semi-structured interview was used to find out if the National Information Centres had a digital preservation policy; the extent to which the digital preservation policy was implemented; the physical media used for storage of digital objects for long-term preservation; how the storage medium were maintained to

preserve the digital objects; the extent to which the staff are aware of the threats facing digital objects; the digital preservation strategy they had adopted for long-term preservation of their digital objects; the extent to which the strategies they adopted was effective; and the file format adopted for long-term preservation.

Another question to be asked is the availability of the necessary equipment and skilled personnel to carry out digital preservation. In conclusion the interviewees were asked to comment on what they taught was the major challenge toward digital preservation policy and strategies implemented for long term digital preservation.

The unstructured interview will emanate from follow-up questions in response to some of the structured questions as well as observations during visit. The response will be captured using digital recorder and analyzed thereafter.

3.4.3 Observation

Observation involves the use of the eyes rather than the ear and the voice. Direct observation of facilities available for digital preservation, such as computer hardware and software available and conditions of storage medium will be conducted to provide additional information that may be needed for the research.

3.4.4 Focus Groups

The researcher systematically questioned the staff of the digitization/digital preservation unit as a focus group. The interview adopted an unstructured and semi-structured questioning technique in order to elicit information on digital preservation

policy and the strategies adopted for long-term digital preservation (Fontana & Frey, 2003). The focus group interview was used to build on data collected from individual interviews by verifying and elaborating on information supplied by the informants individually. The interviews was audio taped and transcribed verbatim. Lofland and Lofland (1995:21) recommend, considering focus group interviews as a supplement to intensive, one-on-one interviews, if the topic is reasonably public and not something that would cause embarrassment to participants. They believe that the focus group offers "the advantage of allowing people more time to reflect and recall experiences. Something a person mentions can spur memories and opinions in others" Also, because it is possible to allow moments of silence, and it takes time to listen to others, participants can rethink and amend initial statements.

3.5 Validity

The study used triangulation to ensure the validity of data collected from different sources. Golafshani (2003:603) posits that triangulation is typically a test for improving the validity and reliability of research or evaluation of findings. Similarly Creswell (2003:196) suggests that triangulation can be used to establish validity. In triangulation all data items are corroborated from at least one other source and normally by another method of data collection (Keen and Packwood, 1995).

3.6 Pilot Study

A pilot study was conducted at the outset of the research which purpose were:

i. to test the method of data collection, and

ii. to pre-test the questionnaire and Interview schedule.

It was hoped that any difficulties inherent in the administration of these instruments would be revealed during the conduct of the pilot study leading to the acceptance of the research method, revision of the instruments, or adoption of another research method.

Arewa House was chosen for the pilot study. This is because it is not among the three National Information Centres selected for the study and beside being a center for historical documentation and research, Arewa House is concerned with procuring, preserving, analyzing and discussing issues of national and international interest. The entire staffs of the digitization/digital preservation unit were used for the pilot study. The procedure for the pilot study entailed

i. administering questionnaires to a focus group;

ii. physically inspecting the digital preservation activities in the centre.

The completed questionnaires from the focus group were carefully examined to determine if any changes or additions were necessary and if any difficulties were encountered.

Although no formal statistical test was conducted owing to the small size nature of the sample, some difficulties were noted in the questionnaires. Because of the basis of the pre-test, it was discovered that the use of computer jargons and acronyms like refreshing, XML, ASCII were confusing. Hence it was decided that during

the focus group interview the researcher will provide explanation to some of the jargons and acronyms and where possible use avoid using them.

3.7 Procedure for Data Collection

Before the personal visit to each of the site selected for this study, a letter of introduction was collected from the Department, Introducing the researcher as a Ph.D candidate conducting research on Digital Preservation Policy and Implementation Strategy in Nigerian National Information Centres. The letter was passed to the Chief Executive (CEO) of each of the National Information Centres to give approval for the researcher to collected data. The researcher also sought for interview appointments with the CEOs of these information centres, and on all occasions, had to travel to Abuja at least twice before succeeding in getting an appointment and approval to conduct the focus group interview.

The researcher succeeded in conducting the interview using the interview schedule with the CEO and Assistant Director of the National Archive of Nigeria while the researcher was referred to other senior personnel who provided answers to the Interview scheduled in the remaining two selected National Information Centres.

After the focus group interview, the researcher was allowed to observe some of the digital preservation activities like digitization of non-digital born document at both the National Library of Nigeria and National Archive of Nigeria. The researcher also observed how storage media were stored and preserved in the three National Information Centres.

The heads of each section of the digitization/digital preservation unit in the three selected institutions helped to identify and select participants of the focus

group interview. Each participant in the focus group was given a copy of the questionnaire and each question was jointly discussed and the right response was agreed and indicated on the questionnaire.

3.8 Data Analysis Technique

The data that was collected from the research instruments was organized for analysis and transcribed into different types, depending on the source of information. The data was then tabulated, analysed and discussed descriptively.

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CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter deals with the analysis of the data generated from the documentary sources consulted through direct observation and semi-structured and structured interviews with the focus group. The findings are based on the responses collected during the focus group interviews and on the transcribed data obtained during formal interviews with the senior administrative staff of the National Information Centres studied.

4.2 Response Rate

All the five sampled staff members in the digitization/digital preservation unit and one top management staff from each of the three national information centres participated in the semi-structured and structured interviews. This represented 100% response rate. Table 4.1 shows the response rate.

TABLE 4.1: RESPONSE RATE

S/N	National Information Centre	Category of Staff	Sample Size	Response rate
1.	National Library of Nigeria	Assistant Director	1	1
		Staff of Digitization/ Preservation unit	5	5
2.	National Archive of Nigeria	Assistant Director	1	1
		Staff of Digitization/ Preservation unit	5	5
3.	National Bureau of Statistic	Assistant Director	1	1
		Staff of Digitization/ Preservation unit	5	5
Total			18	18

A hundred percent response rate was achieved for the structured and semi-structured focus group interviews. This high response rate was achieved because of the fact that the population was very small. And the researcher had to formally seek for permission from the Chief Executive officers of all the national information centres, who instructed the staff of the digitization / digital preservation to give the researcher all the necessary support and cooperation in the data collection exercise.

4.2 Data Analysis

The data collected for this study was discussed under two main sections; the descriptive analysis and the statistical analysis.

4.2.1 Descriptive Analysis

This involved a descriptive analysis of digital preservation policies and implementation strategies in the National Archive of Nigeria, National Library of Nigeria and National Bureau of Statistics as derived from the responses to the semi-structured focus group interview and structured interview. The answers to the research questions for the study are evident in this analysis. The findings under descriptive analysis are as follows:

4.2.2 Storage Media and Facilities Used For Digital Objects Preservation In National Information Centres

It was found out that the national information centres collected information according to the mandate given to them by the Federal Government of Nigeria. The emergence and growth of digital objects in every facet of the society has resulted in

additional responsibility for the national information centres. At first, the researcher sought to identify if the national information centres studied acquired digital objects from outside their organizations or created digital objects within their organization for long-term preservation. The National Library of Nigeria (NLN) and the National Archive (NA) indicated that the digital objects they have were created within their organizations as products of their digitization projects. Both of them did not acquire digital objects from outside their organizations for their digital archive. The National Bureau of Statistics (NBS) was not involved in any digitization project. Hence, it acquired digital objects from outside its organization mainly from different government agencies.

4.2.3. Type of Information resources collected by the National Information Centres

Information resources such as government document/records, Gazette, Newspaper, scholarly journals, Arabic Manuscripts, Macro and micro Economic data contain information that is very vital for both the citizens and the government. They are used as sources of information for policy formulation, planning, legal or research purposes by current and future generations. The researcher tried to identify the type of information resources the centres collected for digital preservation irrespective of whether they are digitally born or non-digital born. This is shown on table 4.1 below:

TABLE 4.1: TYPE OF INFORMATION RESOURCES COLLECTED BY THE NATIONAL INFORMATION CENTRES

Information Resources	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Government Document/Records	X	√	X	1
Gazette	X	√	X	1
Newspapers	√	√	X	2
Historical Documents	X	√	X	1
Private Collections	X	√	X	1
Business Document	X	X	X	0
Macro and Micro Economic Data	X	X	√	1
Scholarly Journals	X	X	X	0
Microfilms	X	√	X	1
Arabic Manuscripts	X	√	X	1

Key: X = Not Available √ = Unavailable

Table 4.1 shows that newspapers were the popular information resources collected for digitization and archiving by the National Library and National Archives. It was observed that the National Archives collected, digitized and archived government document/records, gazette, newspapers, historical documents, private collections, microfilms and Arabic manuscripts, while the National Bureau of Statistics collected only macro and micro economic data in digital format for their digital preservation. The researcher also noted that none of the selected national information centres collected and preserved digital copies of scholarly journals. The National Library of Nigeria which has the mandate to collect and preserve all publications in Nigeria through the legal deposit act (1992) revealed during the interview session that the non-compliance of journal publishers is one of the reasons for their inability to preserve scholarly journals. The implication of this is that the

academic community and other relevant stakeholders will be unable to access the growing digital intellectual output from the academic and research community in the long-term.

4.2.4 Types of Digital Objects Collected by the National Information Centres

None digital Information resource digitized results to digital objects irrespective of the nature of content or data type. However, the type of digital object plays a significant part in the file format for digital preservation. The research therefore tried to identify the types of digital objects collected by the National Information Centres. The responses collected are shown in table 4.2 bellow:

TABLE 4.2: TYPES OF DIGITAL OBJECTS COLLECTED BY THE NATIONAL INFORMATION CENTRES

Type of Digital Objects	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Data Set	X	X	√	**1**
Textual Document	√	√	√	3
Database	X	X	X	0
Still Images (Pictures)	√	√	X	2
Video	X	X	X	0
Audio	X	X	X	0
Geographical Information Systems Data [GIS]	X	X	√	1
Websites	X	X	X	0

Key: X = Not Available √ = Available

The responses collected from the respondents indicated that the National Library and the National Archive collected same type of digital objects for digital preservation. The digital objects common amongst the three sampled information centre is textual document, such as government documents or records, Gazette, and

Newspapers. The table also reveals that none of the National information centres sampled preserved digital video, audio and websites. This is alarming particularly with the growing amount of government official websites containing vital information.

4.2.5 Types of Storage Media Used for Storing Digital Objects for Archiving by the National Information Centres

The most popular storage media for archiving by the institutions studied were Hard Drive, and CD-R as shown on table 4.3 below. This corroborates Gladney's (2007) assertion that the current best digital preservation medium is the server-based hard disk storage. None of the institutions studied used other storage media such as floppy disk, CD-RW, DVD-R, DVD-RW, magnetic Tape, Flash drive, and memory stick to store information for preservation. The non use of storage devices with higher capacity such as DVD will result to the use of many lower capacity storage devices which will require more space.

TABLE 4.3: TYPES OF STORAGE MEDIA USED FOR STORING DIGITAL OBJECTS FOR ARCHIVING

Storage media	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
5 ¼ and 3 ¼ floppy Disk	X	X	X	0
CD-R	√	√	√	3
CD-RW	X	X	X	0
DVD-R	X	X	X	0
DVD-RW	X	X	X	0
Magnetic Tape	X	X	X	0
Flash Drive	X	X	X	0
Memory Stick	X	X	X	0
Hard-drive	√	√	√	3
External Hard drive	X	√	√	2

Key: X = Not Available √ = Available

The responses also showed that the National Library does not use external hard drive to preserve their digital information. This limits the flexibility of access and portability of the digital objects preserved.

During the interview session, the researcher sought to find out if the selected National information centres had any storage medium failure in retrieving some of the archived digital objects for the past five years. The response was in the negative. This can be attributed to the fact that the period in which they started archiving their digital objects on storage media had been between 3-6 years which is within the lifetime of the storage media.

4.2.6 Method of Preservation of Physical Storage Medium

It is expected that some general precautions such as ensuring that storage media storage media are kept under the recommended temperature and humidity can be observed to mitigate their risk of physical degradation. Hence, the researcher sought to know the precautions taken by the National Information centres to mitigate the risk of physical degradation and eventual loss of digital objects. In Table 4.4, it was discussed that all institutions studied took appropriate measures necessary to mitigate the loss of their digital objects. The National Bureau of Statistics took more precautions to mitigate the risk of their digital objects physical degradation than other national information agencies studied. None of the respondents had adopted an effective back-up strategy that involved keeping their backup copies outside the building, apart from the National Bureau of Statistics. This implies that in cases of fire incidences or any disaster, the National Library and National Archives are likely to lose everything except the data they had hosted on their websites outside their physical locations.

TABLE 4.4: METHOD OF PRESERVATION OF PHYSICAL STORAGE MEDIUM

Methods of Preservation	National Information Centres								
	NLN			NAN			NSB		
	CD	HD	External HD	CD	HD	External HD	CD	HD	External HD
Kept Under Control 45% Relative Humidity	√	√	X	√	√	√	√	√	√
Kept Away from Magnetic Fields	√	√	X	√	√	√	√	√	√
Kept under Under ^{o}C Temperature	X	X	X	X	X	X	X	X	X
Kept Back Up Copies Outside the Office Location	X	X	X	X	X	X	X	X	X
Kept in a Special Storage Medium Device	X	X	X	X	X	X	√	√	√
Kept under a minimum exposure to sunlight and Ultraviolet rays.	X	X	X	X	X	X	√	√	√

X = Not Applicable √ = Applicable

4.2.7 Life Time of the Physical Storage Media

The magnetic materials used to make storage media have a life span, after which it will starts to deteriorate thereby resulting to the loss of digital objects. The

life time of physical storage media used by the selected institutions is presented in Table 4.5.

TABLE 4.5: LIFE TIME OF THE PHYSICAL STORAGE MEDIUM

Life Expectancy of storage media	National Information Centres								
	NLN			NAN			NSB		
	CD	HD	External HD	CD	HD	External HD	CD	HD	External HD
Less than 2 years	X	X	X	X	X	X	X	X	X
3 - 5 years	√	X	X	√	X	X	√	X	X
6 – 10 years	X	√	X	X	√	X	X	X	X
More than 10 years	X	√	√	X	√	√	X	√	√

X = Not Applicable, √ = Applicable, HD = Hard Drive

The table indicates that when properly handled computer hard drives and external hard drive have the highest life expectancy of about 10 years, while CDs have life expectancy of about 5 years . The respondents from all the Nation Information Centres indicated they had no idea about the life expectancy of the storage media they use This revelation poses great danger to long-term preservation of digital objects. This is because knowledge of life expectancy of a storage media used for digital preservation would not enable users to refresh digital objects onto new storage media that will extend longevity of the digital objects.

4.2.8 Duration of Digital Objects on Storage Media

Duration of digital objects on storage media helps to determine the need to refresh the digital object onto a new media. The study sought to find out the duration

of digital objects on storage media in the sampled national information centres. The responses are presented on table 4.6 below:

TABLE 4.6: DURATION OF DIGITAL OBJECTS ON STORAGE MEDIA

Duration	National Information Centres								
	NLN			NAN			NSB		
	CD	HD	External HD	CD	HD	External HD	CD	HD	External HD
1 - 2 years	√	X	X	X	√	√	X	X	X
3 - 5 years	√	X	X	√	X	X	√	X	X
6 – 8 years	X	X	√	X	X	X	X	X	X
9 – 10 years	X	X	X	X	X	X	X	X	√
Over 10 years	X	X	X	X	X	X	X	√	X

Key: X = Not Applicable, √ = Applicable, HD = Hard Drive

The respondents indicated that the duration of digital objects on storage media was less than ten years with the exception of the National Bureau of Statistics, which indicated that they had data stored in some of their digital objects stored on computer hard drive over 10 years. When an organization archives digital objects for a long time, it is likely to have an immediate problem with accessing the digital objects over long-term, due to degradation of the storage media. However, an organization that started collecting and archiving digital objects within the last 10 years may not have such a challenge.

In response to a follow up interview question, on the likely challenges of the retrieval of the digital objects stored in the National Information Centres storage

media, the respondents indicated that they had never had any challenge. This can be supported with the fact that their digital collections were relatively less than 10 years and the storage media has not started deteriorating.

4.2.9 Inspection of Digital Objects Stored On Storage Media

Life time predictions of storage media are complicated because many chemical and physical conditions contribute to degradation and eventual failure of storage media. This makes it imperative that inspection of digital objects on storage media be scheduled after every period of time to ensure that they are accessible. The frequency of inspection of digital objects stored in storage media to determine their accessibility and rendition differed in each of the national information centres as shown on Table 4.7.

The National Library of Nigeria inspected digital objects stored CD-ROM once a year, and does so on digital objects on computer hard drive and External hard drive only on demand. The National Archives conducted inspection of digital objects stored on all the storage media only on demand, particularly when there was a need to access the digital objects.

TABLE 4.7: FREQUENCY OF INSPECTION OF DIGITAL OBJECTS STORED ON STORAGE MEDIUM

Frequency of Inspection	National Information Centres								
	NLN			NAN			NSB		
	CD	HD	External HD	CD	HD	External HD	CD	HD	External HD
Less than 6 months	X	X	X	X	X	X	√	√	√
Bi-annual	X	X	X	X	X	X	X	X	X
Once a Year	√	X	X	X	X	X	X	X	X
Once in Two Years	X	X	X	X	X	X	X	X	X
Once in Three Years	X	X	X	X	X	X	X	X	X
Once in Four Years	X	X	X	X	X	X	X	X	X
Once in Five Years	X	X	X	X	X	X	X	X	X
Not at all	X	X	X	X	X	X	X	X	X
On Demand	X	√	√	√	√	√	√	√	√

Key: X = Not Applicable √ = Applicable, HD = Hard Drive

The National Bureau of Statistics carries out inspection of its digital objects on CD, computer hard drive and external hard drive every six months and the on demand. Conducting a regular inspection at least once in a year will enable the National Library and National Bureau of Statistics to detect the deterioration of a storage media early and quickly refresh the digital objects onto a new media or migrate it to a completely new type of storage media. However, there is a great danger in inspection of digital objects on storage media on demand, the implication

of this being that when there is no demand for a long period, no action will be taken even where the digital objects are in danger of being inaccessible.

4.2.10 Metadata Recorded for Stored Digital Objects

Digital objects have very little value without metadata. Metadata records for stored digital objects are important information for the rendition of any digital objects. They provide the necessary information required to recreate and access digital objects. The metadata recorded of each digital object produced by the sampled institution is shown on Table 4.8:

TABLE 4.8: METADATA RECORDED AND USED FOR ACCESSING THE DIGITAL OBJECTS STORED FOR ARCHIVING

Types of Metadata	National Information Centres																							
	National Library of Nigeria								National Archive of Nigeria								National Bureau of Statistics							
	Type of Digital Objects								Type of Digital Objects								Type of Digital Objects							
	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Websites	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Website	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Web site
Date digital object was stored on storage media	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	√	X	X	X	X	X	√	X
Author(s) of digital object	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	√	X	X	X	X	X	√	X
File format	X	√	X	√	X	X	X	X	X	√	X	X	X	X	X	X	√	X	X	X	X	X	√	X
Operating System digital objects were created	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hardware requirement for displaying the digital objects	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
File name	X	√	X	√	X	X	X	X	X	√	X	X	X	X	X	X	√	X	X	X	X	X	√	X
Date of Data creation	X	√	X	√	X	X	X	X	X	X	X	X	X	X	X	X	√	X	X	X	X	X	√	X

X = Not applicable √ = applicable

Table 4.8 shows that the default file formats used for creating textual document, still images (pictures), data sets and Geographical Information digital objects as well as the filenames were always recorded by the selected National Information centre studied. Only the National Bureau of Statistics collected information on the date digital objects and author(s) of digital objects such as data set and Geographical Information System.

It can be argued from the fore going that the National Library of Nigeria and National Bureau of Statistics collected more metadata of their digital objects because they used software that had some features of digital preservation. The National Library uses Greenstone Digital Library Software, which according to Tansley et al.(2003), was not appropriate for digital preservation because its design and development was focused on publishing. The National Bureau of Statistics uses the International Household Survey Network (IHSN) application known as NADA 2.0 which requires that all the necessary metadata are provided for all digital objects archived for digital preservation.

Table 4.8 also shows that none of the sampled national information centre collects metadata on the operating systems and hardware requirements for the digital objects. This will make rending of digital objects very challenging and in accessible in the long-term, particularly where none of the current staff is available to provide the necessary information.

4.2.11 File Formats Used to Create Digital Objects for Preservation in the National Information Centres.

The file format used to create digital objects for digital preservation plays a vital role in the rendition of the digital object. Hence, the research sought to find out the file formats used to create digital objects for digital preservation in the national information centres. The responses were presented on the Table 4.9.

TABLE 4.9: FILE FORMATS USED TO CREAT DIGITAL OBJECTS FOR LONG-TERM PRESERVATION

File Format	National Information Centres																							
	National Library of Nigeria								National Archive of Nigeria								National Bureau of Statistics							
	Types of Digital Objects								Types of Digital Objects								Types of Digital Objects							
	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Websites	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Website	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Web site
Adobe PDF	X	√	X	√	X	X	X	X	X	√	X	√	X	X	X	X	√	√	X	X	X	X	√	X
PDF/4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ASCII	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Open Office File format	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Microsoft Office	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	√	X	X	X	X	X	X
SPSS, SAS/ Stata	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	√	X	X	X	X	X	√	X

X = Not applicable √ = applicable

Adobe PDF file format was the most popular file format used to archive digital object as indicated on Table 4.9. The finding corroborates Borghoff et al's (2006) position that PDF and TIFF are the de facto standards for digital documents. It can also be argued that the archived digital objects are products of the institution's digitization process, which results in PDF file formats in most cases. The data collected shows that PDF/4 and Open Office file format are the file format not used for digital preservation in the sampled National Information Centres studied. This is despite its preference for long term preservation by experts in digital preservation (Borghoff et al, 2006). The implication of choosing PDF and Microsoft office as the file format for digital preservation is that rendering the digital objects in the long-term might be impossible hence the inability to access the digital objects.

A number of reasons such as organizational policy, availability of software/technology and original file format used to create digital objects were given for the choice of file format used, the results of which are preserved on Table 4.10.

TABLE 4.10: REASONS FOR THE CHOICE OF FILE FORMATS

File format	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Organization policy	√	X	√	2
Available facilities (software/technology)	√	√	√	3
Original file format of the digital objects	X	X	√	1

Key: X = Not Applicable √ = Applicable

All the National information centres sampled indicated that the available facilities played a major role in the choice of file formats used for archiving the digital objects. It was also indicated that institutional policy, where available, played

a role in the choice of file format for digital archive. It was not surprising that only the National Bureau of Statistics preserved digital objects in their original file format because it acquires digital objects from outside its organization, which accounts for the many file formats they use to preserve digital objects.

4.2.12. Challenges Encountered in the Preservation of Digital Objects in the National Information Centres

The study sought to find out some of the problems encountered by the national information centres in their preservation activities. Their responses were presented and discussed below:

TABLE 4.11: CHALLENGES ENCOUNTERED IN THE PRESERVATION OF DIGITAL OBJECTS

Problems	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Lack of Institutional Policy for digital preservation	X	√	X	1
Lack of Awareness of the Challenges Surrounding Digital Preservation	√	√	X	0
Lack of Equipment for Digital Preservation	√	√	X	2
Lack of technical skill for digital preservation	√	√	X	2
Technological (hardware) Obsolesce	X	X	X	0
File Format Obsolesce	X	X	√	1
Operating Systems Obsolesce	X	X	√	1
Lack of Funds	√	√	X	2
Lack of Skilled Staff for Digital Preservation	√	√	X	2

Key: X = Not Applicable √ = Applicable

From Table 4.11, it is clear that the National Library and National Archives indicated that lack of awareness of the challenges surrounding digital preservation, equipment, technical skills, funds and skilled staff for digital preservation were some of the problems they encountered in the preservation of their digital objects. The table also shows that the National Bureau of Statistics had fewer challenges in preserving their digital objects. It was observed with interest that the National Bureau of Statistics was well equipped in terms of computer and information technology staff which accounts for the small number of challenges they encountered. The implication of these responses is that no meaningful digital preservation activities can be done without addressing these challenges.

4.2.13. Level of Awareness of the Challenges Surrounding the Preservation of Digital Objects in the National Information Centres

The researcher sought to find out the level of awareness of the challenges surrounding the preservation of digital objects in the national information centres. This is because knowledge of the level of awareness of the problems surrounding the preservation of digital objects by an organization will help them put in place a policy and appropriate strategies that will prevent the loss of digital objects considered to be of long-term value.

TABLE 4.12 LEVEL OF AWARENESS OF THE PROBLEMS SURROUNDING DIGITAL PRESERVATION

Rendition systems	National Information Centres											
	NLN				NAN				NSB			
	Level of Awareness				Level of Awareness				Level of Awareness			
	NA	NVMA	A	VMA	NA	NVMA	A	VMA	NA	NVMA	A	VMA
Hardware obsolescence	X	X	√	X	X	X	√	X	X	X	X	√
Software obsolescence	X	√	X	X	X	√	X	X	X	X	X	√
Storage media obsolescence	X	√	X	X	X	√	X	X	X	X	X	√

Key: X = Not Applicable, √ = Applicable, NA= Not Aware, NVMA = Not very Much Aware, VMA = Very Much Aware, A = Aware

Table 4.12 shows that the National Library and National Archives were not very much aware of the challenges of software and hardware obsolescence in digital preservation, while they are both aware of the challenges of hardware obsolescence. The implication of this is that they will not be able to adequately deal with these challenges because of their limited level of awareness of these challenges. However, there was remarkable difference from the level of awareness of the staff of the National Bureau of Statistics for whom such awareness was very much. This could be one of the reasons why the National Bureau of Statistics had a relatively better digital preservation policy, strategy, an expert that is a data curator and a data archivist who paid more attention to its digital objects. It is assumed that the level of

awareness of the challenges surrounding the preservation of digital objects by an organization will help it put in place a policy and appropriate strategies that will prevent the loss of digital objects considered to be of long-term value. So there is a need to create a very high level of awareness of all the challenges as well as the solutions to address them.

4.2.14 Digital Objects Preservation Policies Available and Used in the National Information Centres

In response to the question on availability of digital preservation policy in the National Information centres, the National Library of Nigeria indicated that it has a digital preservation guideline. However, the researcher could not confirm its existence. The Director/Chief Executive Officer of the National Archive, indicated during an interview with him that the organization at the time of the interview was yet to embed their digital preservation activities into policy documents, even as it was managed at an operational level. He, however, acknowledged that policy development was imminent and that he had put in place a mechanism to develop one. It was observed that there is no explicit obligation at the regulatory level mandating any national information centre to draft a policy on digital preservation. Hence the formulation of a digital preservation policy is entirely optional and therefore scarcely developed. This supports Beagrie's (2006) assertion that the development of institutional preservation policies is currently sporadic and digital preservation issues are rarely considered in key strategic plans. This therefore affects the level of commitment in terms of finance, staff, capacity building and digital preservation policy formulation and implementations.

The areas covered by the digital preservation policies in the national information centres studied were reported on Table 4.13

Table 4.13: Areas covered by digital preservation policy

Areas Covered	National Library of Nigeria	National Archive of Nigeria	National Bureau of Statistics	Total
Acquiring materials in digital format	X	X	√	1
Clear policy statement	X	X	√	1
Authority and responsibility	√	X	√	2
Selection and acquisition criteria	X	X	√	1
Access and Dissemination	X	X	√	1
Implementation	X	X	X	0
Standards	X	X	√	1
Converting materials from print to digital form	X	X	X	0
File format for Storage	√	X	X	1
Preservation strategy to be adopted	X	X	√	1
Type of storage media to be adopted for long-term storage of digital objects	X	X	√	1
Guideline for preserving storage media	X	X	√	1

Key: X = Not Applicable √ = Applicable

There was a remarkable difference between the policy developed by the National Library and National Bureau of Statistics. The policy adopted by the National Library of Nigeria covered authority and responsibility, and file format storage only out of the ten listed for the study, whereas that of the National Bureau of Statistics covered ten areas. The National Library of Nigeria policy covered authority and responsibility, and file format storage. The National Bureau of Statistics covered such policy areas as acquisition of materials in digital format, clear policy statement,

authority and responsibility, selection and acquisition, criteria, access and dissemination. The other areas covered were standards, file format for storage, preservation strategy to be adopted, the type of storage media to be adopted for long-term storage of digital objects and guidelines for preserving storage media. This clearly indicates that with good implementation, the National Bureau of Statistics digital preservation activities will be more effective.

Table 4.14 provides information on the method adopted for the development of digital preservation policies in the national information centres used for this study.

TABLE 4.14: METHOD ADOPTED FOR THE DEVELOPMENT OF THE DIGITAL PRESERVATION POLICY

Method	National Library of Nigeria	National Archive of Nigeria	National Bureau of Statistics	Total
Developed in-house by the organization	√	X	X	1
Developed in collaboration with other Government agencies	X	X	X	0
Developed by a consultant	X	X	X	0
Developed in collaboration with International agencies	X	X	√	1

Key: X = Not Applicable √ = Applicable

The National Library of Nigeria developed its digital preservation policy in-house, while the National Bureau of Statistics developed its own in collaboration with International agencies like the International Household Survey Network and the World Bank. During the interview session, the National Bureau of Statistics revealed that it had collaboration with respect to the preservation of its data objects with some international organizations outside the country. This collaboration had enabled it develop its digital preservation policy and also to train some of its staff outside the

country. This clearly indicates that the National Information Centres will benefit more, in terms of training opportunity and development of digital preservation policy when they collaborate with other international agencies in their digital preservation activities.

4.2.15. Digital Preservation Policy Review and Level of Implementations

The dynamism and development of information technology make it paramount for policies that relate digital preservation be reviewed. The review will address emerging changes and challenges. Hence, the frequency with which the national information centres reviewed their digital preservation policies was investigated. The investigation revealed that the National Library had never had any cause to review its digital preservation policy while the National Bureau of Statistics reviewed its policy once every two years. The National Bureau of statistics revealed that the review of the digital preservation policy was done by the management, IT staff and staff of the digital preservation unit.

The National Bureau of Statistics indicated that it fully implemented of its digital preservation policy while the National Library indicated that it partially implemented its policy. The full implementation by the National Bureau of Statistics suggests why the organization had a good digital preservation programme. Policy implementation is therefore important for the success of any programme.

4.2.16 Challenges to Policy Implementation

The success of any policy is dependent on its implementation. A number of challenges were faced by the national information centres in the course of implementing their digital preservation policies as reported in Table 4.15.

TABLE 4.15: CHALLENGES IN THE IMPLEMENTATION OF THE DIGITAL PRESERVATION POLICY

Challenges	National Library of Nigeria	National Archive Nigeria	National Bureau of Statistics	Total
Lack of institutional support	X	X	X	0
Lack of awareness of the challenges surrounding digital preservation	√	X	X	1
Lack of funds	√	X	X	1
Lack of skilled manpower	√	X	X	1
Lack of equipment	√	X	X	1
lack of staff	√	X	X	1
Insufficient skilled staff in digital preservation unit	√	X	√	2

Key: X = Not Applicable √ = Applicable

Table 4.15 reveals that the National Library of Nigerian was faced with so many challenges in the implementation of its digital preservation policy. These challenges included lack of awareness of the challenges surrounding digital preservation, funds, skilled manpower, equipment, staff and skilled staff in the digital preservation unit which suggests why digital preservation was still underdeveloped in the institution. The researcher observed that the National Library spent more of its resources to digitize and archive Newspapers. The only challenge the National Bureau of Statistics faced was insufficient skilled staff in the digital preservation unit, which in the long

run could also affects its digital preservation activities. The complete absence of a digital preservation policy at the National Archive means they never had the opportunity to implement it.

4.2.17 Access Point for Digital Archive

The access points for digital archives are the starting point to locate and retrieve digital objects from the digital archive. The access point used in the National library and the National Bureau of Statistics was the build-in online catalogue for the software used for digital archiving, while the National Archives of Nigeria used lists. The access points as observed by the researcher provide easy and fast access to their digital objects through the digital repository system they have adopted. During the interview session it was revealed that the National Archives was in the process of acquiring and adopting a digital repository system that would facilitate access and re-use of it digital content over long-term. The current method adopted by the National Archive makes it very difficult and time consuming to locate digital objects.

4.2.18 Strategies for Preservation of Digital Objects Adopted by the National Information Centres

Digital preservation strategies are methods used for keeping stored digital objects permanently accessible for long-term re-use. The strategies adopted by organizations studied depend largely on the file format and infrastructures. However, more than one strategy can be adopted by an organization. The researcher sought to find out the strategies adopted by the national information centres and the extent to

which they have affected preservation of digital objects. The findings were captured in Table 4.16.

TABLE 4.16: PRESERVATION STRATEGIES USED FOR DIGITAL PRESERVATION

Preservation strategies	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Refreshing	X	X	X	X
Technology preservation	X	X	X	X
Normalization	X	X	√	1
Migration	√	√	√	3
Emulation	X	X	X	0
Encapsulation	X	X	√	1
Universal Virtual Computer	X	X	X	0
LOCKSS	X	X	X	0
Open Archival Information System (OAIS) Model	X	X	X	0

Key: X = Not Applicable √ = Applicable

Table 4.16 shows that migration digital objects is the only digital preservation activity carried out by all the National information centres. It can be argued that the relative by short period (6-8 years) they had been involved in building their digital collection was the reason for this choice. It was also revealed during the interview session that migration of the digital objects in these two institutions was limited to transfer of digital objects from one computer hardware to a more recent computer hardware.

The National Bureau of Statistics on the other hand is taking a lifecycle approach to digital preservation. It viewed preservation as including collecting material, producing metadata and making storage decision. This explains the reasons

why it was able to adopt strategies such as normalization, migration, and encapsulation. So it is able to preserve different types of digital objects.

A number of factors are considered in selecting preservation strategies and these are as shown on table 4.17.

TABLE 4.17: FACTORS CONSIDERED IN ADOPTING PRESERVATION STRATEGY

Preservation strategies	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Look and feel of the document	√	√	X	2
Content of the document	√	√	√	3
Size of document to be preserved	X	X	X	0
Authenticity and reliability	X	√	√	2

Key: X = Not Applicable √ = Applicable

The content of the document to be digitized and preserved was a common factor taken into consideration in selecting the digital preservation strategies adopted by the three national information centres. The other two factors taken into consideration by the National Library of Nigeria and National Archives were the look and feeling of the documents. Authenticity and reliability of the information resources were factors taken to consideration by the National Archives and National Statistics. The size of the document to be preserved was not a factor considered in the adoption of digital preservation strategy by any of the national information centres. This might be connected to the fact that storage space was relatively cheap in the years 2005 and during the study.

The reasons that informed the adoption of digital preservation strategies by the national information centres differ. The National Library indicated that the choice of migration was for short term access. The National Bureau of Statistics and National

Archives however revealed that the choice of migration of its digital object was to preserve the digital object for long-term. The choice of migration as a strategy for digital preservation is not adequate, since it has been established that some data type like data sets and Geographical Information Systems are best preserved for long-term use using other digital preservation strategy.

4.2.19 Threats to Digital Objects

The factors considered as threats to digital objects were ranked and the response from the national information centres are presented on table 4.22.

TABLE 4.18: RANKING OF FACTORS CONSIDERED AS THREATS TO DIGITAL OBJECTS

Threats	National Library of Nigeria	National Archive	National Bureau of Statistics
Natural disasters	4	4	3
Technological (hardware and software) obsolescence	3	3	4
Insufficient policy or plan for preservation	2	1	2
Insufficient resources for preservation	1	2	1

Key: 1 = greatest threat, 2 = great, 3=small threat, 4 = smallest threat

Table 4.18 shows the ranking of four (4) problems considered as threat to digital objects. It was found that insufficient resource for preservation programme ranked highest among the factors that constituted a threat to digital objects by both the National Library of Nigeria and National Bureau of Statistics. The two national information centres also indicated that after insufficient resources, insufficient policy or plan for digital preservation is considered as the next threat to digital objects. The least threat as indicated by the National Archive and the National library of Nigeria is natural disaster, whereas the national Bureau of Statistics indicated that technology

obsolescence was the least threat faced by the digital objects. The choice of natural disaster as the least threat can be attributed to the fact that none of these National Information Centres has experienced any natural disaster.

4.2.20 Structures Put in Place for the Implementation of the Digital Preservation Policy and Strategies

The structures put in place for the implementation of the digital preservation policy and strategies were analyzed and discussed under: budget allocation for digital preservation activities; methods of accessing digital objects for digital preservation action; staff strength of digital preservation unit and their areas of specialties; specialized training on digital preservation attended by the staff; copyright issues; and mode of access of the digital objects.

The data collected revealed that even though the sampled institutions indicated that they made budgetary provision for digital preservation, which were imbedded in the total budget for digitization projects, they were however unable to indicate the percentage of the budget allocated for digital preservation. The National Bureau of Statistics revealed that they receive funding from the parent ministry and other international agencies outside Nigeria. This can be seen from the facilities they have and the training opportunities many of the staff have enjoyed specifically outside the country.

During the interview session, the senior management staff from the National Archive indicated that their digitization and digital preservation project were receiving some financial support from Federal Government of Nigeria presidential committee. The implication of the above finding is that adequate and necessary

planning and attention might not be given to the long-term digital preservation of digital objects created in the country.

4.2.21 Methodologies for Assess Digital Objects for Preservation Action

Digital preservation action needs to be taken when the digital object has been assessed to be in danger of either technology or software obsolescence. The preservation action can be any or a combination of the digital preservation strategy. The national information centres studied adopted a number of methods of assessing digital objects for digital preservation action. These methods are as shown on Table 4.19.

TABLE 4.19: METHODS OF ASSESSING DIGITAL OBJECTS FOR DIGITAL PRESERVATION ACTION

Structures placed	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Methods of assessing the risks for loss of digital objects	X	X	√	1
Methods of determining file format of digital objects	X	X	√	1
Methods of determining the rendition system of digital objects	X	X	X	0
Methods of determining what digital preservation strategy to be adopted	X	X	X	0

Key: X = Not Applicable √ = Applicable

It can be seen from 4.19 that apart from the National Bureau of Statistics, none of the sampled national information centres had put in place a mechanism to monitor and provide warning on the need for preservation action. It can be argued that the National Library and the National Archives of Nigeria lacked mechanism to monitor

and provide warning on the need for preservation action. They were yet to stock large mixed-format collections which would require automated discovery of existing preservation risk. However, with the growing digital information this would become very necessary with time to prevent the loss of vital digital objects. A mechanism therefore that will assess the risk of a digital object needs to be put in place.

4.2.22. Staff and Staffing for Digital Preservation Unit

Digital preservation activities must include staff and staffing. The National Library of Nigeria and the National Archive had only between 0-15 staff in their digital preservation section, which was centralized and located at their National Headquarters. The structure of the National Archives was such that the digital preservation/digiziation unit were structured in three zones: Kaduna, Ibadan and Enugu zones. Kaduna zone was responsible for the digital preservation of digitized materials from the Northern part of Nigeria, the Ibadan Zone is responsible for the digital preservation of the digitized content from the Western part of Nigeria, and the Enugu Zone is responsible for the preservation of the digital objects from the Eastern part of the country. The digitized contents are shared amongst the different zones. It was revealed during interview that each of the zones had about five (5) staff working in the digital preservation unit.

In all the three sampled areas respondents also indicated that the number of staff they currently assigned to the digitization unit and digital preservation was insufficient. It was also revealed during the interview session that as a result of the amount of newspapers available for digitization and archiving in the National Library,

the management has decided to outsource some of the jobs to some consultants. The implication of this is that a lot more materials can be digitized and preserved digital for re-use in the long-term

The staff of digitization/digital preservation sections in the national information centres had their areas of specialities as indicated on Table 4.25

TABLE 4.20: AREAS OF SPECIALTIES OF STAFF OF THE DIGITIZATION/DIGITAL PRESERVATION SECTION

Area of Specialization	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Library and Information Science	√	X	X	1
Computer Science	X	X	√	1
Electrical Engineering	√	X	√	2
Archives and Records Management	X	√	√	2

Key: X = Not Applicable √ = Applicable

The National Bureau of statistics digital preservation unit has specialists in computer Science, electrical engineering, archives and records management. This clearly suggests that it has capable hands to effectively manage digital objects for long-term re-use. The National Library of Nigeria has specialists in library and information science, and electrical engineering. The National Archives has only a specialist in archives and records management, and this situation definitely has some negative affects digital preservation activities which require some computer science skills.

4.2.23. Skills and Training for Digital Preservation

The key element for digital preservation activities, planning and strategy implementation lies in the people who have the information technology skills to assemble and maintain equipment, and the IT infrastructure. Table 4.21a contains the responses of the national information centres in respect to the skills requirement of digital preservation as perceived by the National Information Centres.

TABLE 4.21a: SKILLS REQUIREMENTS FOR DIGITAL PRESERVATION

Skills set	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Computer programming	√	√	√	3
Basic Computer application skills	√	√	√	3
Library skills	√	X	√	2
Archival skills	X	√	X	1
Computer hardware skills	X	X	X	0

Key: X = Not Applicable √ = Applicable

Table 4.21a shows that all the respondents considered basic computer application and computer programming skills very important for digital preservation. None of the respondents considered computer hardware skills important for digital preservation. This likely suggested why the National Bureau of Statistics has on its payroll a lot of computer programmers and a robust information technology unit as observed by the researcher. The National Library and National Bureau of Statistic considered library skills as important skills in digital preservation. Only the National Archives of Nigeria considered traditional archival skills as important skills for digital

preservation. The implication of these responses is that while the National library of Nigeria and National Bureau of statistics are well informed on the need of computer programmer and individuals with basic computer application to effectively carry out the task of digital preservation, the National Archive is not.

Special short term training is another way of equipping the staff of any organization with the necessary skills set to effectively carry out their jobs. The national information centres studied were expected to provide opportunities for special training on digital preservation to their personnel. Their responses on these are contained in Table 4.21b.

TABLE 4.21b: SPECIAL TRAINING OPPORTUNITY/PROGRAMMES ON DIGITAL PRESERVATION STRATEGY

Special Training	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Refreshing of storage media	X	X	√	1
Technology preservation	X	X	√	1
Normalization	X	X	√	1
Migration	X	X	√	1
Emulation	X	X	√	1
Encapsulation	X	X	X	0
Universal Virtual Computer	X	X	X	0
LOCKSS	X	X	X	0
Open Archival Information System (OAIS)	X	X	√	1
Institutional Repository – Greenstone	√	X	X	0
Institutional repository – Dspace	X	X	X	0

Key: X = Not Applicable √ = Applicable

From Table 4.21b, reveals that the staff of National Bureau of Statistics had the opportunity to attend most training workshops on digital preservation strategies. The staff of the National Library of Nigeria indicated that they had undergone training only on the use of Greenstone digital library software, assumed to cater for the digital preservation of their digital objects. None of the staff of the National Archive had any formal training on digital preservation. However, during the interview session it was revealed that the staff of National library had only training on digitization which was organized by the vendor that supplied their digitization scanner. This training had no relevance to digital preservation process. The implication of lack of attending training programmes on digital preservation is that the staff will not be equip to carry out the staff of digital preservation effectively.

A number of reasons were given for the failure of the staff of the national information centres to attend specialized training in digital preservation. Their responses were recorded in Table 4.21c.

TABLE 4.21c: REASONS FOR NOT ATTENDING SPECIALIZED TRAINING IN DIGITAL PRESERVATION

Reasons	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Lack of funds	√	√	X	2
Lack of availability of such training in Nigeria	X	X	√	1
Lack of awareness of the a place for training	√	√	X	2
Lack of support from management	X	X	X	0
Lack of Interest to attend such training/workshop	X	X	X	0

Key: X = Not Applicable √ = Applicable

From Table 4.21c the National library and National Archive indicated that lack of funds and awareness of the place for digital preservation training were the reasons for not attending specialized training in digital preservation. The National Bureau of Statistic revealed that lack of availability of digital preservation training in Nigerian had limited the number training opportunities they had. The response from the 3 sampled national information centres indicated that lack of support from management staff and lack of interest to attend specialized training on digital preservation was never a problem when it comes to the issue of training. This can be attributed to the interest of the management staff to preserve their digital objects as also revealed in the interview session with the management.

Except funds are made available and a training institution for digital preservation established in Nigeria, the National Information Centres will continue to have shortage of skill man power for digital preservation activities.

4.2.24. Copyright Issues on Digital Preservation

Copyrights become issues when national Information centres have to collect and preserve materials that are copyrighted. The copyright information kept for preserved digital objects in the institutions studied are as shown on table 4.22a.

TABLE 4.22a: COPYRIGHT INFORMATION KEPT FOR DIGITAL OBJECTS PRESERVED

Copyright Information	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Copyright holders personal data	X	X	√	1
Contact information for rights clearance	√	√	√	3
Copyright history	X	X	√	1
Records for any transaction concerning the content	X	X	√	1
Statement of rights available over the content for your institution	√	X	√	2

Key: X = Not Applicable √ = Applicable

Table 4.22a shows that contact information for copy right clearance was maintained by all the national information centres. It was revealed that most of the digital objects archived for preservation were public documents in the public domain. It can be seen from the table that the National Bureau of Statistics maintained more copyright information for digital objects that were not in the public domain. With these information it collects, the National Bureau of Statistics is not likely to violate any copyright law.

The responses of the national information centres on copyright ownership of digital objects preserved are presented on table 4.22b.

TABLE 4.22b: COPYRIGHT OWNERSHIP OF DIGITAL OBJECTS PRESERVED

Copyright ownership	National Library of Nigeria	National Archive	National Bureau of Statistics	Total
Your organization	√	√	√	3
Individual	X	X	√	1
Authors	X	X	√	1

Key: X = Not Applicable √ = Applicable

Table 4.22b shows that the national information centres owned the copyright for the public documents they digitized and preserved. Hence, to use their digital objects for commercial purpose permission from them must be sought. However, during the interview session, the National Bureau of Statistics indicated that some of its digital objects are licensed from other sources and can be accessed under the licenses agreement, which sometimes require that users access them onsite. However, for digital objects which own the copyright, there are no restrictions on it's used. The implication is that even though the National Bureau of statistics has a rich collection of digital objects, some might only be accessible onsite and not remotely.

Table 4.23 presents the responses of the various national information centres on the mode of access to their preserved digital objects.

TABLE 4.23: DIGITAL ACCESS MODE

File Format	National Information Centres																							
	National Library of Nigeria								National Archive of Nigeria								National Bureau of Statistics							
	Types of Digital Objects								Types of Digital Objects								Types of Digital Objects							
	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Websites	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Website	Data Set	Textual Document	Databases	Still Images (Pictures)	Video	Audio	Geographical Info Sys	Web site
Content is available under payment of a fees	X	√	X	√	X	X	X	X	X	√	X	√	X	X	X	X	√	√	X	X	X	X	√	X
Content available only under subscription	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
The content is available for free to the general public	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Not applicable √ = applicable

Table 4.23 shows that the National library and the National Archives of Nigeria provided access to their digital content such as textual documents and still images for a fee. Depending on the nature of the digital object, the National Bureau of Statistics provides both free access and paid subscription to their digital objects. Free access is provided for digital objects that are in the public domain while subscription fee is charged for licensed digital objects.

During the interview session it was discovered that the National Library of Nigeria sell its digital object on CD-R for a fee, while the National Archives of Nigeria provides online access for a fee for its digital objects through its website. The National Bureau of Statistics, apart from providing online access, also provides onsite access to their digital objects. This practice is likely to deprive certain users' access to the digital objects collected by these National Information Centres.

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CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides the summaries of the study and findings, from which recommendations were made.

5.2 Summary of the Study

The purpose of the study was to assess the digital preservation policy and implementation strategies in the three Nigerian National Information Centres (NNICs). These are the National Library of Nigeria, the National Archives of Nigeria and the National Bureau of Statistics. The study tried to find out the storage media and facilities used for digital objects preservation and the file formats used in creating digital objects for digital preservation. The problems encountered in the preservation of digital objects, the level of awareness of the challenges surrounding digital preservation, the digital objects preservation policies available and used, were also examined. In addition the study examined strategies adopted by the NNICs and the structures put in place for the implementation of the digital preservation policies and strategies by the National information Centres.

In order to achieve the objectives of the study, eight research questions were formulated. This study adopted the case study and qualitative methodology approaches. The population of the study was made up of three Nigerian National Information Centres. The subjects of the study were the staff of the digital preservation/digitization units and the senior administrative staff of the National Information Centres. Purposive sampling method was used to draw a sample of the

three National Information Centres with specific mandate by law to collect and preserve information on behalf of the government and people of Nigeria. The instruments used to collect the needed data were semi-structured questionnaire and interviews.

A semi-structured questionnaire was designed and administered to a focus group of five staff of the digital preservation/digitization unit of the National Archive of Nigeria, National Library of Nigeria and National Bureau of Statistics. The semi-structured questionnaire covered all the research questions which sought to find out the digital preservation and implementation strategies in the selected National Information centres.

An outline of questions administered during the interview sessions with the senior administrative staff of the National Information Centres was also designed. The interview sessions elicited responses from senior administrative staff to clear some gray areas from the top management of the National Information Centre on digital preservation and implementation strategies they adopted.

5.3 Summary of Major Findings

The summary of the findings of the descriptive analysis discussed below were derived from the analysis of the responses from the structured and semi-structured interview of the focus groups.

1. The study discovered that the most popular storage media for archiving of digital objects by the institutions studied were the Hard Drive, and CD-ROM. Newspapers were the popular information resources collected for digitization and archiving by both the National Library and the National Archives.

2. Adobe PDF file format was the most popular file format used to archive digital objects. The digital objects created in different file format were converted to PDF file format for digital preservation.
3. The level of awareness of the problems surrounding digital preservation was very low among the National Information Centres (NIC).
4. There were no national or international standard digital preservation policy and implementation strategies adopted by the Nigerian National Information Centres. However, the National Library of Nigeria and the National Bureau of Statistics have developed their own digital preservation policy without any clear strategy for their implementation.
5. The level of implementation of the digital preservation policy by the National Library of Nigeria was partial while that of National Bureau of Statistics was full.
6. The challenges resulting in the partial implementation of the digital preservation policy at the National Library of Nigeria include: lack of awareness of challenges surrounding digital preservation by the staff, lack of funds, lack of skilled manpower and lack of equipment. Whereas at the National Bureau of Statistics, it was insufficient skilled staff in the digital preservation unit
7. Migration strategy was the only digital preservation strategy used by all the National Information Centres to preserve their digital objects. However, the National Bureau of Statistics in addition, uses normalization and encapsulation strategy to preserve their digital objects.

8. Inadequate metadata of digital objects for preservation were recorded by the National Information Centres. The study revealed that the national information centres budgets on digital preservation were often embedded in other projects.
9. In all, the three sampled National Information Centres and the number of staff currently assigned to digital preservation activities was insufficient. With the exception of the National Bureau of Statistics none of the sampled National Information Centres had specialized and skilled manpower for digital preservation activities.

5.4 Conclusions

Arising from the findings of the study, it could be concluded that some level of digital preservation activities were being carried out at the National Information Centres, but haphazardly due to lack of a standard national digital preservation policy and implementation strategies in Nigeria. Hence, the need for a unified National /International digital preservation policy and implementation strategies that will address the lapses identified in the findings of this study. A national digital preservation policy and implementation strategies based on international standard is needed to provide a well articulated roadmap for digital preservation activities for the Nation Information Centres and other related efforts in digital preservation in the country.

5.5 Recommendations

Based on the findings of this study and the conclusion reached, the following recommendations are made. That there is the need for:

1. Hard drive both internal and external should be used as storage media for Digital preservation.
2. The National Information Centres should use open source software and PDF/4 file format for achieving digital objects. While XML file format should be used for Normalization where appropriate.
3. The establishment of Nigerian National Centre for Digital Preservation (NNCDP) to be responsible for monitoring, creating awareness and conducting researches in digital preservation in Nigeria. The centre should be well budgeted for and funded.
4. The National Information Centres should ensure that all the necessary metadata of digital objects necessary for the recreation of the digital objects are recorded.
5. Digital preservation training for the staff of the National Information Centres such as the training programme recently set up by ULCC, the DPC, Connel University and British Library. Such trainings would equip the participants with the skills and confidence to apply practical strategies to their organizational requirements for digital preservation activities. Similarly, components of digital preservation should be incorporated into the Nigerian Library and Information Science Schools' curriculum.

6. The adoption of the proposed National Digital Preservation Policy and Implementation strategies (See Appendix I). The proposed digital preservation policy and implementation strategies will provide a holistic approach to digital preservation activities in Nigeria.

The proposed digital preservation policy and implementation strategy is based on Beagrie et.al (2008) model framework, Open Archival Information System and Dspace Institutional Repository software. The proposed policy and prototype model can be adopted and modified by any National Information Centre in Nigeria.

5.6 Suggestions for further Studies

The research established that no digital preservation strategies has been identified as the best strategy to preserve the growing amount of digital objects being created daily. Hence, the need for continuous investigation, testing and validation of digital preservation strategies with the view to adopting appropriate implementation strategy for each digital objects.

Further studies can be conducted on how the National Information Centers can authenticate and provide Integrity of the digital objects they archived for long-term re-use.

5.6.1 Proposed Draft Model for Nigerian National Centre for Digital Preservation (NNCDP)

The Nigerian National Digital Preservation Policy

POLICY PRINCIPLE STATEMENT

The National Information Centres have the mandate and commitment to digital object preservation as well as ensure that digital objects are available for current and future use. This digital preservation policy is to guarantee several benefits at each institutional level, such as ensuring that digital objects are available over long term for current and future use.

POLICY MISSION

The primary mission of this policy is to ensure that digital objects created and preservation at the Nigeria National Information Centres are available, accessible and re-use in short and long term.

MANDATE

The Nigerian National Centre for Digital Preservation (NNCDP) shall serve as a parastatal of the Federal Government of Nigeria responsible for among others functions documentation, preservation and digitization of information resources as well as acquisition, management and utilization of print and electronic media to meet the information needs of their clients. The centre shall also be responsible for monitoring and conducting research activities in digital preservation and implementation strategies.

DIGITAL PRESERVATION OBJECTIVES

The main objective of the Nigerian National Centre for Digital Preservation (NNCDP) is to preserve digital objects to be accessible to users over long period of time. The specific objectives of the digital preservation programme are to:

i. maintain a comprehensive and responsive digital preservation programme that identifies, acquires, verifies, archives and facilitates access and re-use of its digital objects;

ii. Include in the scope of the programme materials that are digital born and those that were converted to digital form through a digitization process;

iii. demonstrate the information centres commitment through the identification of sustainable funding for the programme and its digital archive;

iv. Identify and support the core working team to develop and operate the digital archive and provide requisite training and development as needed;

v. comply with prevailing national and International standards for digital preservation and access

vi. seek, expand, and develop digital preservation methods that are appropriate for Nigerian National Information Centres

vii. promote Nigeria's digital heritage through a fully-implemented digital preservation programmes.

Nigerian National Centre for Digital Preservation (NNCDP) DIGITAL CONTENT

The Nigerian National Centre for Digital Preservation (NNCDP) shall collect for preservation electronic digital information resources of the nation's heritage which shall include digital born and digitized government documents/records, Gazette,

Newspapers, Historical documents, private collections, Microfilms and Arabic manuscripts and others which shall not be in variance with the National Archives decree no 30 of 1992, National Library Act No 29 of 1970 and the National BuREAU Statistics Act, 2007.

SELECTION POLICY

Digital objects shall be evaluated for digital preservation on the basis of the following guidelines:

i. Digital born materials – to be selected for preservation shall have perpetual preservation quality.
ii. Digitized materials – to be selected for preservation shall be of national and long-term values.
iii. Unique digital objects –acquired through donation or purchase and which are unlikely to be preserved anywhere else, shall be preserved.

PROCEDURAL ACCOUNTABILITY POLICY

The Nigerian National Centre for Digital Preservation (NNCDP) shall be committed to ensuring that the digital preservation program:

i. Comply with the Open Archival Information System (OAIS) reference model standard or any other acceptable standard/model in the development of the digital archive.
ii. Select digital objects for preservation based on institutional mission, needs priority and national responsibilities

iii. Commit to ensuring that the digital archive is as interoperable as possible by utilizing open source options whenever feasible and to work with other organizations on core issues to enable interoperability

iv. Employ appropriate storage management for digital content, utilizing on-line, near-line and off-line storage media as appropriate.

v. Archive versions which are not currently online and a duplicate off-line copy may be created for storage at a different site.

vi. Manage hardware, software, and storage media containing archival copies of digital content in accordance with environmental, quality control, security, and other standards and requirements

vii. Define policies and procedures for the preservation and availability of digital objects with respect to intellectual property ownership and rights.

GUIDANCE AND IMPLEMENTATION POLICY

The Nigerian National Centre for Digital Preservation (NNCDP) shall be committed to preservation of its digital objects, including:

i. Keeping abreast of technological changes and monitoring new developments in the digital preservation field, including awareness of international standards

ii. Technical infrastructure (equipment purchases, maintenance and upgrades of software/hardware and network connectivity)

iii. Financial planning (strategy and methods for financing the digital preservation programme and commitment to long-term funding).

iv. Providing appropriate skills training to staff (technological and metadata creation) and increasing awareness of digital preservation.

v. Employing qualified and skilled staff for digital preservation

vi. Rights management.

ACCESS POLICY

Access to digital objects preserved by the Nigerian National Centre for Digital Preservation (NNCDP) shall be over large network environments particularly the Internet and Wide Area Network where possible. Public documents shall be made accessible free while for copyright materials shall be accessible for a small fee to be charged.

FINANCIAL RESPONSIBILITY POLICY

The overall financial commitments and budgetary provision for digital preservations are substantial. Normal digital preservation activities shall therefore include several different ongoing costs which include:

ii. Technical infrastructure (storage media, equipment purchases and ongoing maintenance, technological obsolescence monitoring, and network connectivity)

iii. Staffing (hiring, general and specialized ongoing staff training)

iv. Financial planning (seeking for project grantsand, securing ongoing budget commitments)

v. Outsourcing (preservation methods undertaken by outside vendors)

STAFF REQUIREMENT AND TRAINING POLICY

Staff requirements for Digital Preservation activities at Nigerian National Centre for Digital Preservation (NNCDP) shall include:

iii. Digital Curator: who collects and manages digital objects

iv. Repository Manager- who manages the 'human' side of the repository including content policies, advocacy, user training and a liaison with wide range of institutional departments and external contacts.

v. Repository Administrator- who manages the technical implementation, customization and management of repository software, manages metadata fields and quality, creates usage reports and tracks the preservation issues.

vi. Computer Engineer: Responsible for managing the computer hardwares

vii. Computer programmers – Responsible for all the software components of the digital preservation activities

viii. Data entry Staff – Responsible for data entry

ix. Librarians to ensure that digital objects can be located and retrieved, and ensure that intellectual property is up-held,

x. Administrative staff –Responsible for the day-to-day running of the centre

There shall be scheduled staff training both at home and abroad for the staff Nigerian National Centre for Digital Preservation (NNCDP). This will enable them keep track of developments in digital preservation activities.

INTELLECTUAL PROPERTY RIGHT POLICY

Digital objects shall be preserved in accordance with the Nigerian Intellectual Property rights and/or other legal rights related to copying, storage, modification and

use of the specific resource. As a member of World Intellectual Property Organization (WIPO), Nigerian National Information Centres shall abide by WIPO copyright treaty in their digital preservation activities

DISTRIBUTED SERVICES POLICY

The Nigerian National Centre for Digital Preservation (NNCDP) shall be committed to collaborating with other institutions to advance the development of digital preservation programme. The NNCDP shall adopt the Dspace open software developed by MIT for digital preservation using the OAIS reference model.

STANDARDS COMPLIANCE POLICY

The National Information centre shall conform with the ISO standard (ISO 14721:2003), OAIS reference model and adopt, deploy and maintain dspace open source software as its digital institutional repository.

The following file standards shall be accepted for ingest by the National Information Centres:

Content Type	**Format Standard**
Text (Newspapers, Government document/records, Gazette, Newspapers, Historical documents, and Arabic manuscripts)	PDF/4, Adobe PDF, Open Office file format, ASCII (ANSIX3.4 ECMA-6, ISO646), UTF-8 Unicode
Audio (voice, music of National Value)	AIFF, Wave, MP2
Video (o	MPEG, MPEG-2, AVI
Image (Pictures	Gif (Gif87a, Gif89a), JPEG, JPEG2000, TIFF (TIFF4.0, TIFF5.0, TIFF6.0)
Databases (Geographical Information Systems, and Macro and Micro economic data)	DBF, DBO

NORMALIZATION TOOL POLICY

For the purpose of normalization an open source program XENA which converts all file format to XML shall be use before ingest. However any other computer software capable of converting any digital object to XML for long term digital preservation may be used as well.

INSPECTION OF DIGITAL OBJECTS POLICY

A bi-annual inspection of all digital objects shall be scheduled to ensure their accessibility and re-use in the long term.

STORAGE MEDIA POLICY

The Nigerian National Centre for Digital Preservation (NNCDP) shall preserve digital objects for long-term re-use only on Computer Hard Drive and External Hard drives.

REVIEW AND CERTIFICATION POLICY

The National Information Centre shall review its policy document annually to ensure currency with respect to technical developments and resources available

STAKEHOLDERS POLICY

The The Nigerian National Centre for Digital Preservation (NNCDP) stakeholders shall include: government agencies, business sectors, researchers and scholars, private sectors and international organizations.

PRESERVATION STRATEGIES POLICY

The National Information centre shall adopt any of the following digital preservation strategy or a combination of them :

1. Refreshing
2. Technology preservation
3. Normalization
4. Migration
5. Emulation
6. Encapsulation
7. Universal Virtual Computer
8. LOCKSS
9. Open Archival Information System (OAIS) Model

5.4.1 A Proposal on Implementation Strategies for Digital Preservation Using Dspace Open Source Software and OAIS Reference Model Introduction

The need to access and retain the content of digital information over long time remains a substantial challenge. By taking a strategic approach to long-term digital preservation, the The Nigerian National Centre for Digital Preservation (NNCDP) will ensure that it monitors hardware and software developments and adopt appropriate strategy to ensure the long-term accessibility and re-use of its collection.

THE OAIS REFERENCE MODEL

The ISO standard (ISO 14721:2003) provides functionalities and procedures of a digital archive establishing a common framework of terms and concepts which comprised an Open Archival Information System (OAIS). A broader task for the OAIS development has been defined as articulating the functionality and components of any system responsible for preserving any type of information over any length of time (Beedham et. al 2004). The OAIS reference model defines the basic functional components of a system dedicated to the long-term preservation of information and could be applied to the long-term preservation of items in any form, including physical artifacts.

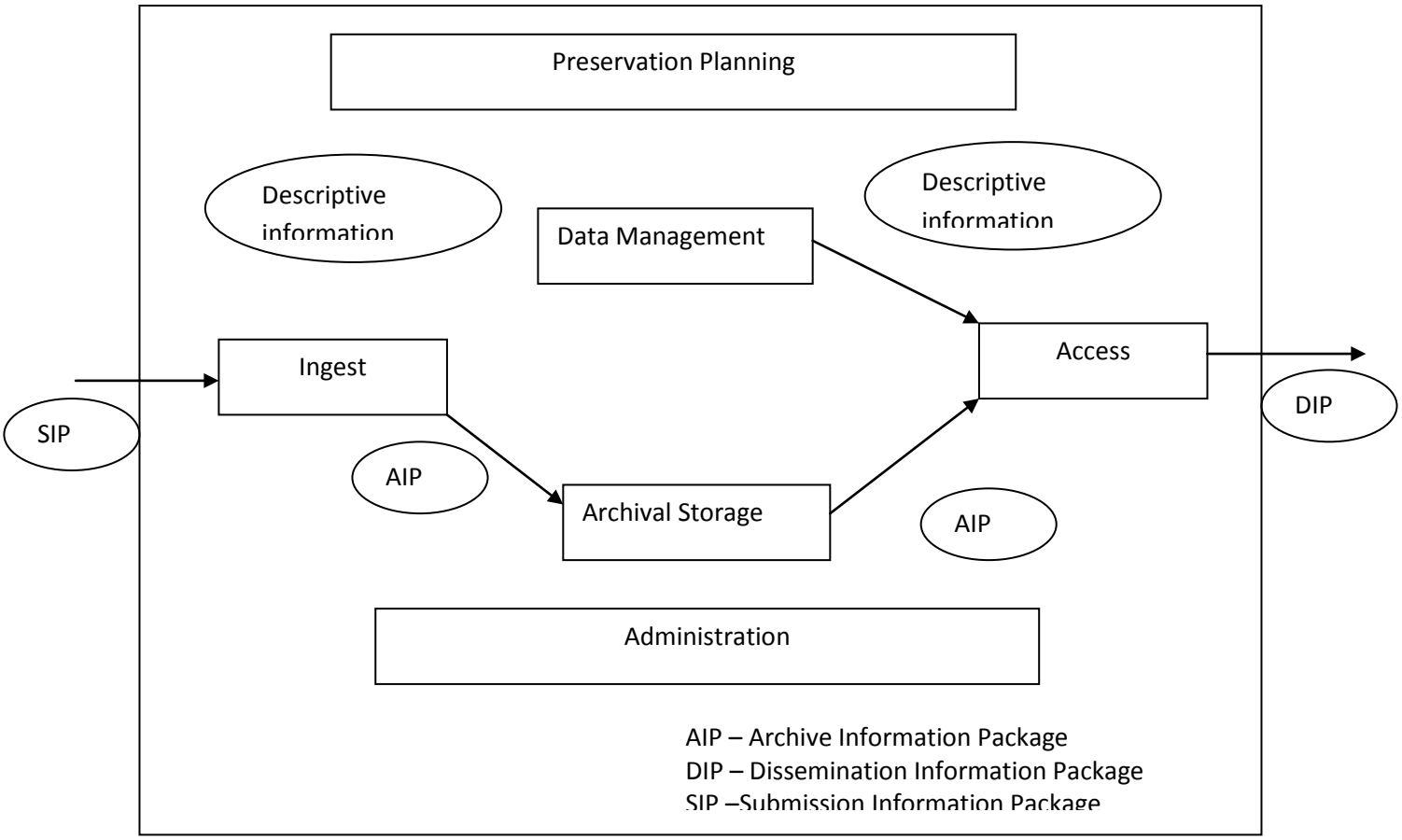


Figure 5.1:Open Archival Information System (OAIS)

Lavoie (2004:14) asserts that OAIS Reference Model provides nothing about system architectures, storage or processing technologies, database design, computing platforms or any of the myriad technical details involved in setting up a functional archival system. The OAIS Reference Models only articulates the requirements to be met by digital archive and library systems (Borghoff et al., 2006:30). In the context of this work, the OAIS reference model is modified and re-designed for the preservation of digital objects using computer hardware and Dspace Open Source Software.

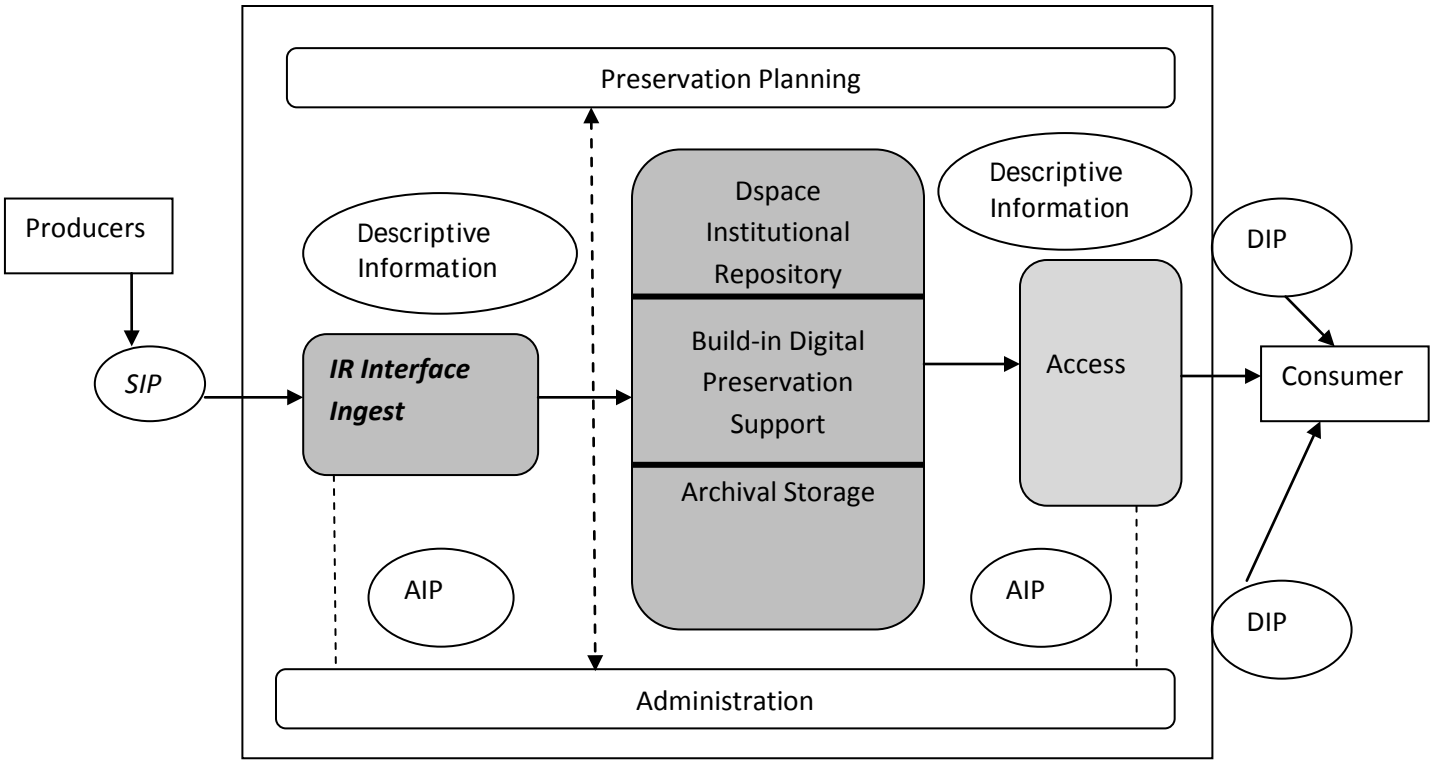
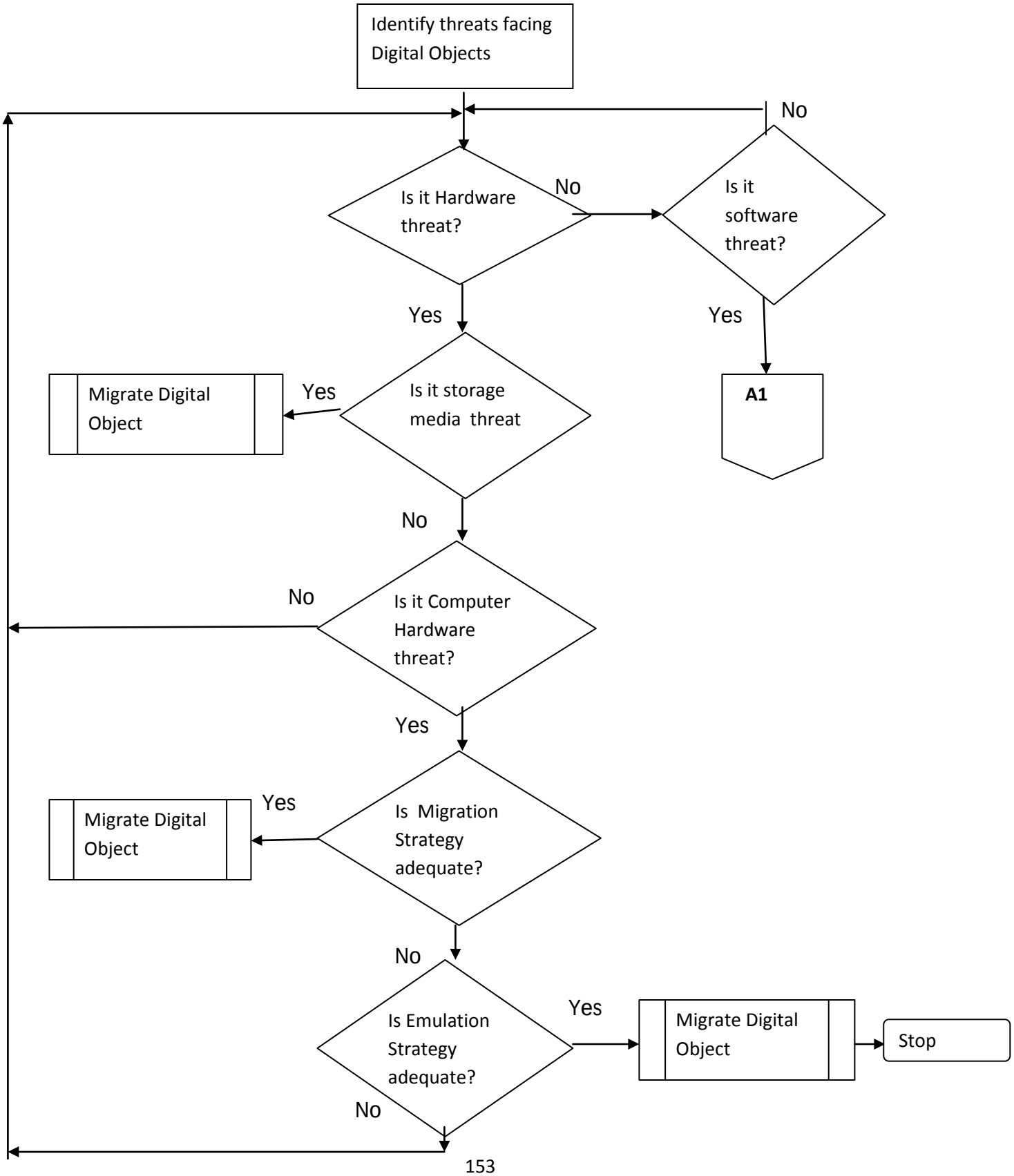


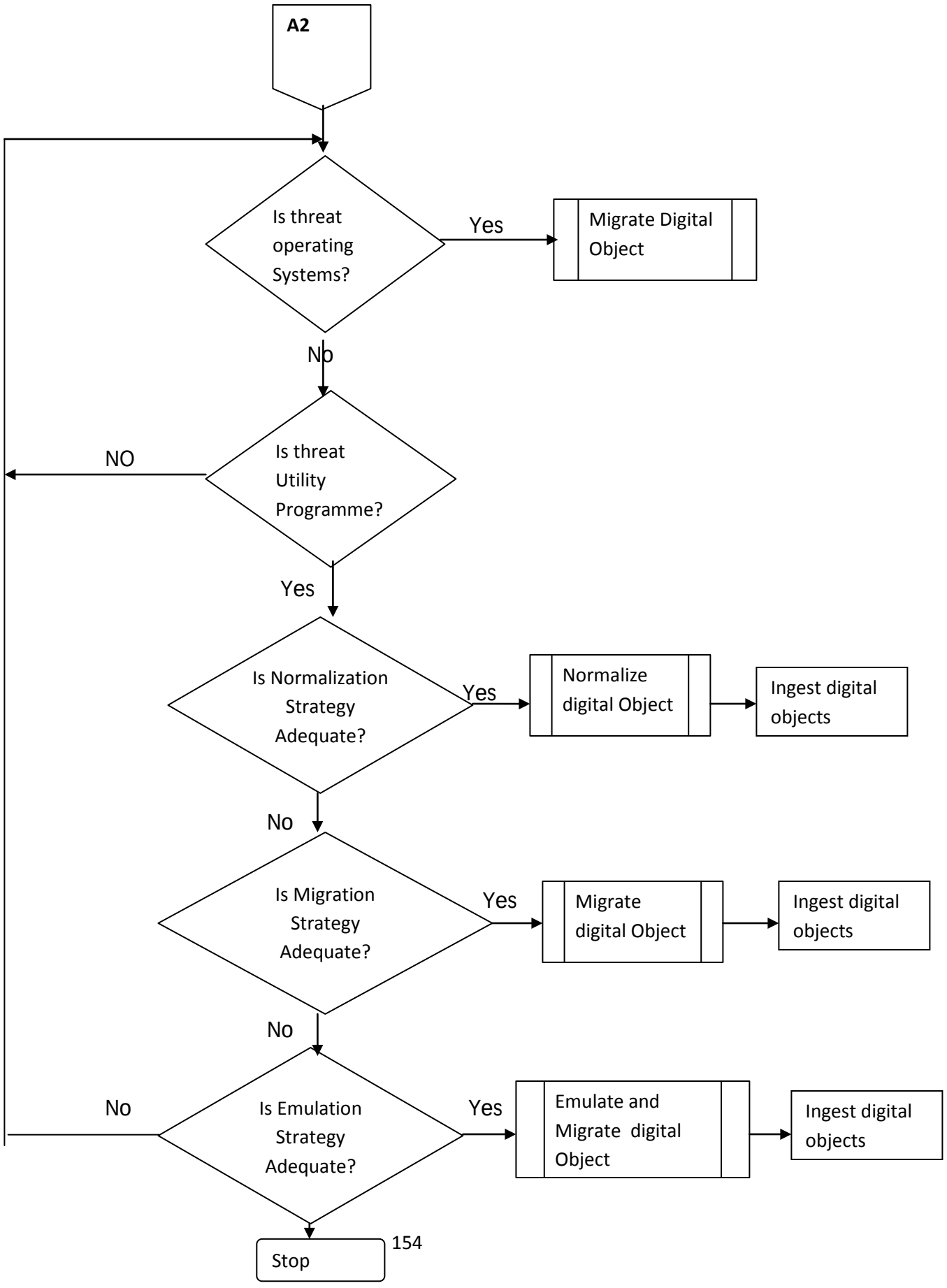
Figure 5.2: Proposed National Information Centre Digital Preservation Strategy

The changes in the service models are shown in the dark-grey rectangle with the highlighted text and are all focused on four of the OAIS functional entities: the ingest of digital object, management of digital objects, storage of digital objects, and access. The relationships are shown by the connecting arrows.

The functions of the remaining two entities, Administration and Preservation Planning, are performed by the staff of the National Information Centres. The activities of preservation planning are described in the chart below:

Preservation Planning Work Flow




A2
Is threat operating Systems?
Yes
Migrate Digital Object
No
Is threat Utility Programme?
NO
Yes
Is Normalization Strategy Adequate?
Yes
Normalize digital Object
Ingest digital objects
No
Is Migration Strategy Adequate?
Yes
Migrate digital Object
Ingest digital objects
No
Is Emulation Strategy Adequate?
No
Yes
Emulate and Migrate digital Object
Ingest digital objects
Stop

Ingest Process and Workflow in Dspace

The ingest part of an OAIS is to receive a Submission Information Package (SIP) and transform it into an AIP suitable for inclusion in archival storage. The DSpace ingest process is depicted in figure 5.5 bellow.

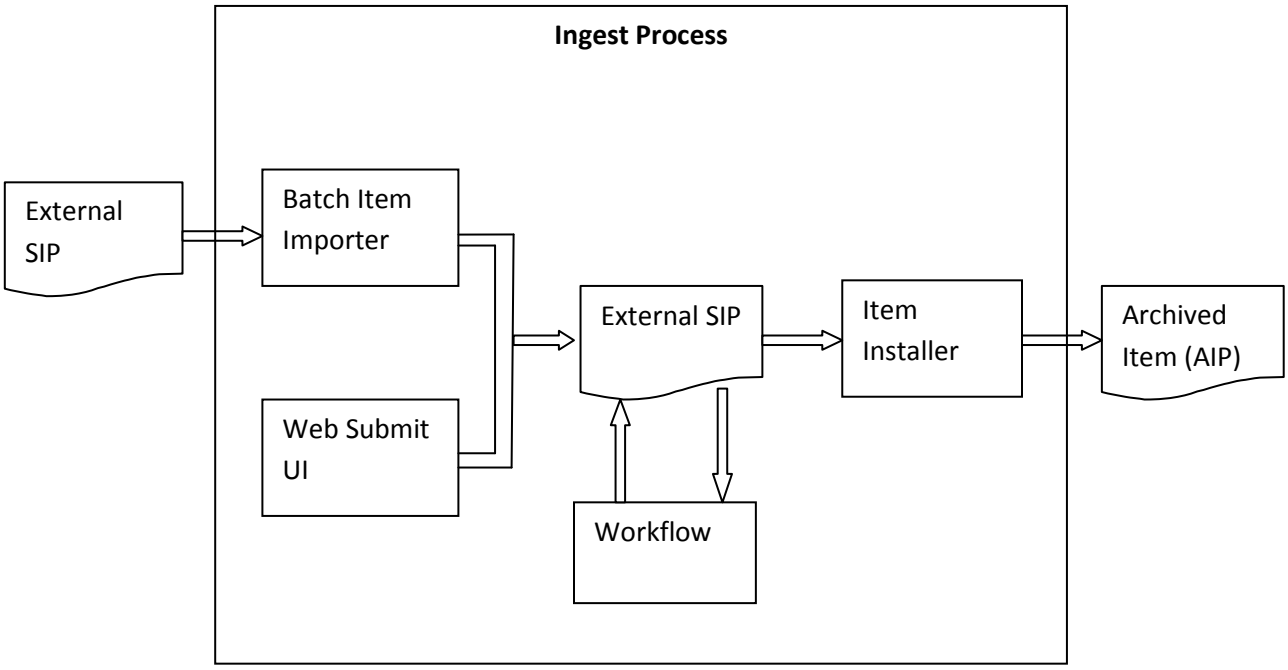


Figure 5.5: Dspace Ingest Process for the proposed model

DSpace supports two methods of ingest. Firstly there is a batch item importer, which is an application that turns an external Submission Information Package (SIP) in which the metadata (Dublin Core) is stored in an XML file, in a directory with the associated content files. The batch importer takes these external SIPs, and converts them into DSpace SIPs stored in the DSpace database and Bitstream store. Content to be imported must be copied to a temporary directory on the server running DSpace, and the batch importer tool run via a remote shell.

Secondly, DSpace features a Web-based submission user interface. Using this, a submitter (producer using OAIS terminology) fills out appropriate metadata fields,

and uploads the content files to DSpace.

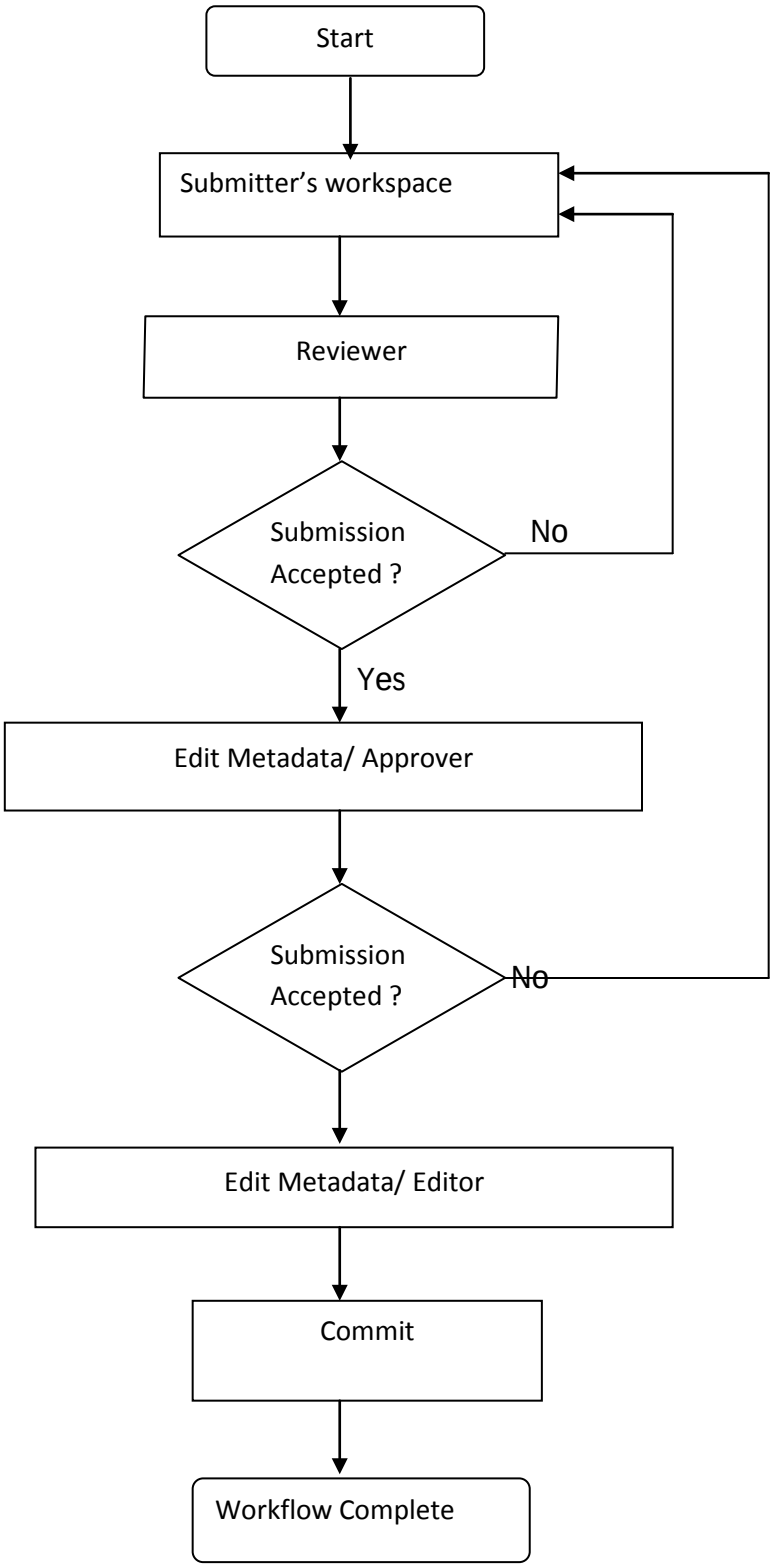


Figure 5.6. Dspace workflow

Once the workflow process is successfully completed, the Item Installer is responsible for transforming the DSpace Submission Information Package into a DSpace Archive Information Package. Specifically, the operations it performs are:

i. Assigns an accession date
ii. Adds a "date.available" value to the Dublin Core metadata record of the Item
iii. Adds an issue date if none already present
iv. Adds a provenance message (including bitstream checksums)
v. Assigns a Handle persistent identifier
vi. Adds the Item to the target Collection, and adds appropriate authorisation policies
vii. Adds the new item to the search and browse indices

JUSTIFICATION FOR THE ADOPTION OF DSPACE SOFTWARE FOR OAIS

Dspace software application and its supporting software are open source software that can be configured and modified to suit any institution. Digital Preservation services are built-in in dspace software. (Tansley,et al, 2003 and Hitchcock et al., 2007). Current and stable version of Dspace software is available free for download from the Dspace official website www.dspace.org

SYSTEM ARCHITECTURE

The main code of Dspace is implemented in Java. It runs on any UNIX-like Systems and Windows based system. It makes use of several third-party open source systems:

i. PostgreSQL, an open source relational database system, available for download from www.postgresql.org

ii. Jakarta Tomcat Java Servlet container

iii. Apache HTTPD server.

The main Dspace system is organized into application layer, Business logic layer and Storage layer, each of which consists of a number of components.

HARDWARE REQUIREMENT

HP Server rx2600, powered by dual 64- bit Intel Itanium

Dual Core Processor Speed 3.0GHZ

Random Access memory (RAM) 8GB

Storage Harddrive (HDD)- 8 Terabytes (Additional Terabytes can be added as amount of digital objects grow.

DSPACE DIGITAL OBJECTS PRESERVATION

DSpace have extensive rendition information for digital objects securely archived at two levels:

i. Bit preservation: This level of digital preservation ensures that a file remains exactly the same over time while the physical media evolve around it.

ii. Functional preservation: At this level of digital preservation 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 can be functionally preserved using straightforward format migration such as TIFF images or XML documents.

LIMITATION OF Dspace

Dspace runs on a web server platform. To be effective as a tool for digital preservation it must be connect to the Internet. Dspace also must be migrated to a new hardware platform in the event of hardware obsolesce.

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Appendix I

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This questionnaire was designed to be administered during the semi-structure interview with staff of the digital preservation/Digital unit the selected organizations.

1. Do you have digital objects for archiving?
   Yes [ ] No [ ]

   i. If yes what type of digital materials does your institution preserve ?
      a. Government document/records [ ]
      b. Gazzated [ ]
      c. Newspapers [ ]
      d. Historical document [ ]
      e. Private collections [ ]
      f. Business document [ ]
      g. Scholarly Journals [ ]
      h. Others please specify……
      ……..

   ii. If No, which of the followings best describes the reasons
      a. We do not create digital objects [ ]
      b. We do not acquired digital objects [ ]
      c. We are not required to preserve digital objects [ ]
      d. We do not see the need to archive digital objects [ ]
      e. Other reasons please specify……
      …….

2. Which of the followings best describes your type of digital objects?
   (Tick as many as applicable)
      a. Data set [ ]
      b. Textual documents [ ]
      c. Databases [ ]
      d. Still images [ ]
      e. Video [ ]
      f. Audio [ ]
      g. Geographical Information Systems data [GIS] [ ]
      h. Web sites [ ]
      i. Email [ ]
      j. All of the above [ ]
      k. Others please specify……
      ……..

3. Which of the following storage media do you use for storing digital objects for archiving ? (Tick as many as applicable)

a. 5 ¼ floppy Disk	[ ]	f.	3.5 floppy Disk	[ ]
b. CD-R	[ ]	g.	CD-RW	[ ]
c. DVD-R	[ ]	h.	DVD-RW	[ ]
d. Magnetic Tape	[ ]	i.	Flash drive	[ ]
e. Memory stick	[ ]	j.	Hard Drive	[ ]

f Others please specify.....
.....

4. How are these storage medium persevered ?

a. Under control temperature and humidity [ ]
b. Away from Magnetic fields [ ]
c. Normal temperature [ ]
d. Outside the office location [ ]
e. In a Special Storage device [ ]
f. Others please specify.....
.....

5. What is the current lifetime of physical storage medium you are using ?

a. No idea [ ]
b. 2 years [ ]
c. 5 years [ ]
d. Others, please specify.....
.....

6. For how long have you had data stored in the storage medium for preservation

a. Less than one year [ ]
b. 1 - 2 years [ ]
c. 3 - 5 years [ ]
d. 6 – 8 years [ ]
e. 9 – 10 years [ ]
f. Others, please specify.....
.....

7. How frequent do you conduct regular inspection of the digital objects stored ?

a. Less than 6 months [ ]
b. Bi-annual [ ]
c. Once a Year [ ]
d. Once in Two Years [ ]
e. Once in three Years [ ]
f. Once in four Years [ ]
g. Once in Five Years [ ]
h. Not at all [ ]
i. On demand [ ]

j. Others, please specify.....
.....

8. Which of the following metadata are recorded and used for accessing the digital objects stored for archiving ? ((Tick as many as applicable)
   a. Date digital object was stored on storage media [ ]
   b. Author(s) of digital object [ ]
   c. File format [ ]
   d. Operating System digital objects were with [ ]
   e. Hardware requirement for displaying the digital objects [ ]
   f. File name [ ]

9. In what file format are digital objects saved for preservation ?
   a. Adobe PDF [ ]
   b. PDF/4 [ ]
   c. XML [ ]
   d. ASCII [ ]
   e. Open Office file format [ ]
   f. Others, Please specify.....
   .....

10. Which of the following best describes the reasons for the choice of the file format
   a. Organization policy [ ]
   b. Available facilities (software/technology) [ ]
   c. Original file format of the digital objects [ ]
   d. None of the above [ ]
   e. Others, Please specify.....
   .....

11. What are the problems encountered in the preservation of digital objects in your organization ?
   a. Lack of Institutional policy for digital preservation [ ]
   b. Lack of awareness of the challenges surrounding digital preservation[ ]
   c. Lack of equipment for digital preservation [ ]
   d. Lack of technical skill for digital preservation [ ]
   e. Technological (hardware) obsolesce [ ]
   f. File format obsolesce [ ]
   g. Operating systems obsolesce [ ]
   h. Lack of funds [ ]
   i. Lack of staff for digital preservation [ ]
   j. Others please specify.....
   .....

12	To what extent are you aware of the problem surrounding the preservation of digital information ?	No Extent	Small Extent	Moderate extent	Large extent	Very large extent
	Hardware obsolescence					
	Software obsolescence					
	Storage media obsolescence					

13. Do you have a digital preservation policy ?
    a. Yes [ ] b. No [ ]

I). If yes, which of the following areas does the preservation policy cover?
- a. Acquiring materials in digital format [ ]
- b. Clear policy statement [ ]
- c. Authority and responsibility [ ]
- d. Selection and acquisition criteria [ ]
- e. Access and Dissemination [ ]
- f. Implementation [ ]
- g. Standards [ ]
- h. Converting materials from print to digital form [ ]
- i. File format for Storage [ ]
- j. Preservation strategy to be adopted [ ]
- k. Type of storage media to be adopted for long-term storage of digital objects [ ]
- l. Guideline for preserving storage media [ ]
- m. Non [ ]
- n. Others please specify.....

.....

ii). Who developed the digital preservation policy?
- a. Developed in-house by the organization [ ]
- b. Developed in collaboration with other Government agency [ ]
- c. Developed by a consultant [ ]
- d. Developed by an International agency [ ]
- e. None of the above [ ]
- f. Others please specify.....
  .....

iii). How frequent is the policy reviewed?
- a. Annually [ ]
- b. Once after every two years [ ]
- c. After every five years [ ]

d. When the need arises [ ]
e. Never [ ]
f. Others, Please specify.....
.....

iv). Who review the digital preservation policy?
a. Management Staff of the organization [ ]
b. Management Staff and IT staff of the digital preservation [ ]
c. Consultants [ ]
d. Others, Please specify.....
.....

iv) What is the level of implementation of the digital preservation policy ?
a. Full implementation [ ]
b. Partial Implementation [ ]
c. None Implementation [ ]
d. Others, Please specify.....
.....

v). What are the challenges in the implementation of the digital preservation policy ?
a. Lack of institutional support [ ]
b. Lack of awareness of the challenges surrounding digital preservation [ ]
c. Lack of funds [ ]
d. Lack of skilled manpower [ ]
e. Lack of equipment [ ]
f. lack of staff [ ]
g. Others, Please specify.....
.....

14. If No, which of the following best explains why the lack of digital preservation policy ?
a. Lack of awareness of the challenges surrounding digital preservation [ ]
b. Lack of technical know-how to develop a digital preservation policy[ ]
c. Lack of support from top management [ ]
d. Lack of conviction to have one [ ]
e. Others, Please specify.....
.....

15. Do you maintain any of the following for your digital archive
a. Register [ ]
b. List [ ]
c. Index [ ]
d. None [ ]
e. Others please specify.....

.....

16. Which of the following preservation activities have you carried out on your storage media within the past 5 years

a. No action [ ]
b. Refreshing [ ]
c. Migration to another different type of storage media [ ]
d. Others, please specify.....
.....

17. Which of the following preservation strategy or combination of strategies are you exploring or using for digital preservation ? (Tick as many as applicable)

a. Refreshing [ ]
b. Technology preservation [ ]
c. Normalization [ ]
d. Migration [ ]
e. Emulation [ ]
f. Non [ ]
g. Encapsulation [ ]
h. Universal Virtual Computer [ ]
i. LOCKSS [ ]
j. Open Archival Information System (OAIS) [ ]
k. Others, please specify.....
.....

18. What are the factors you considered in selecting preservation strategy ?

a. Look and feel of the document [ ]
b. Content of the document [ ]
c. Size of document to be preserved [ ]
d. Authenticity and reliability [ ]
e. Others, please specify.....
.....

19. Why have you chosen to pursue those strategies?

a. Short term preservation (2 years) [ ]
b. Medium-term preservation (5 Years) [ ]
c. Long-term preservation (10 years and above) [ ]
d. Non [ ]
e. Others, please specify.....
.....

20. How would you rank the following factors as threats to the loss of digital materials at your institution? 1 = greatest threat, 2 = great, 4 = smallest threat

a. Physical condition [ ]
b. Technological obsolescence [ ]

c. Insufficient policy or plan for preservation [ ]
d. Insufficient resources for preservation [ ]
e. Other, please specify……..

21. Does your organization makes budget provision for digital preservation ?
Yes [ ] No [ ]

i). If Yes, what percentage of your budget is allocated for digital preservation ?
a. No budget allocation [ ]
b. Less than 1% of your annual budget [ ]
c. More than 1% and less than 5% of your annual budget [ ]
d. More than 5% and less than 10% of your annual budget [ ]
g. Others, please specify……..
……

ii). If No, which of the followings best explains the reason why funds are not allocated for digital preservation
a. Lack of awareness on the need for budget allocation for digital preservation [ ]
b. Poor funding from the Government [ ]
c. Lack of justification for budget to be allocated [ ]
d. Others, please specify……..
……

22. Which of the following methods of accessing digital preservation ?
a. Methods for assessing the risks for loss of digital objects [ ]
b. Methods for determining file format of digital objects [ ]
c. Methods for determining the rendition system of digital objects [ ]
d. Methods for determining what digital preservation strategy to be adopted [ ]
e. Others, please specify……
……

23. Which of the following digital Preservation software does your organization have for digital preservation ?
a. PDF/4 [ ]
b. Open Source Office [ ]
c. PDF [ ]
d. XANE [ ]

Staff Digital Knowledge/Training:

24. How many staff are involved with digital preservation program?
a. 1 – 5 [ ]
b. 5 – 10 [ ]
c. 10 – 15 [ ]
e. 15 - 20 [ ]

f. Others, please specify……

……

25. In your estimation, are is the staff available ?
    a. Sufficient [ ]
    b. More than sufficient [ ]
    c. Insufficient [ ]

26. What is the level of training/education of staff of the digitization/digital preservation section ? (Tick as many as applicable)
    a. O' level [ ]
    b. OND [ ]
    c. HND [ ]
    d. Post-graduate [ ]
    e. First Degree [ ]
    f. Masters degree [ ]
    g. Ph.D [ ]
    h. Others, please specify……..
    ……

27. Which of the following field(s) does the staff of the digital preservation have their degrees in ?
    a. Library and Information Science [ ]
    b. Computer Science [ ]
    c. Electrical Engineering [ ]
    d. Archives and Records Management [ ]
    e. Others, please specify……..
    ……

28. Did your staff receive any special training on digital preservation ?
    a. Yes [ ]
    b. No [ ]

    i. If yes, which of the following best describes the training/workshop you received ?
        a. Refreshing [ ]
        b. Technology preservation [ ]
        c. Normalization [ ]
        d. Migration [ ]
        e. Emulation [ ]
        f. Non [ ]
        g. Encapsulation [ ]
        h. Universal Virtual Computer [ ]
        i. LOCKSS [ ]
        j. Open Archival Information System (OAIS) [ ]
        k. Others, please specify.....

.....

ii. If No, which of the following best explains why you have not attended any specialized training in digital preservation

a. Lack of funds [ ]
b. Lack of availability of such training in Nigeria [ ]
c. Lack of awareness of the a place for training [ ]
d. Lack of support from management [ ]
e. Lack of Interest to attend such training/workshop [ ]
f. Others, please specify.....
.....

29. Which of the following skill sets do you regard important for digital preservation

a. Computer programming skills [ ]
b. Bisic Computer application skills [ ]
c. Library skills [ ]
d. Traditional archival skills [ ]
e. Others, please specify.....
.....

30. What kind of copyright information are you currently keeping? What copyright-related information would you like to keep and preserve in the future?

a. Copyright holders personal data [ ]
b. Contact information for rights clearance [ ]
c. Copyright history [ ]
d. Records for any transaction concerning the content [ ]
e. Statement of rights available over the content for your institution [ ]
f. Others, please specify.....
.....

31. Who owns the copyright of the content you are preserving

a. Your organization [ ]
b. Individual [ ]
c. Authors [ ]
d. Others, please specify.....

32. How does your organization provide access to the preserved content?

a. Free [ ]
b. Content is available under payment of a fees
c. Content available only under subscription [ ]
d. The content is available for free to the general public [ ]

33. Do you have a formal way of authenticating digital materials for digital preservation ?

30	To what extent is the institutions digital preservation policy or guideline implemented?	No Extent	Small Extent	Moderate extent	Large extent	Very large extent

31	To what extent has the strategy adopted affected preservation of their digital objects?	No Extent	Small Extent	Moderate extent	Large extent	Very large extent

32	To what extent has the lack of appropriate digital preservation skills affected the preservation of digital objects	No Extent	Small Extent	Moderate extent	Large extent	Very large extent

Thank you

Ezra Shiloba Gbaje

Interview Schedule for Management Staff

1. Do you have a digitization project in your institution ?
2. What is the purpose of digitizing your collections?
3. Do you have a preservation unit in your institution?
4. How many staff do you have engaged in the preservation of your digital objects?
5. Do you collect digital objects for preservation other than that generated by your institution storage ?
6. What are you doing with respect to preserving your digital information (either digital born or digitized) ?
7. What digital materials can be deposited/acquired by your organization ?
8. What type of digital services are offered by the institution?
9. Do you have any digital preservation initiative within your organization ?
10. Do you have any digital preservation collaboration with any other organization or institution
11. Do you have the appropriate qualified staff to support digital preservation projects ?
12. What effort is the management making in providing requisite skills and training for the digital preservation ?
13. What are the challenges faced by the institution in preserving digital information ?

14. Do you have any written policies that specified the nature of any legal permission required to preserve digital contents ? If Yes can I please see it
15. Do you have any framework to keep track of technological development and trends in digital preservation ?
16. Do your document of the changes, procedures, software, and hardware linked to relevant preservation strategies the potential effects on preserving digital content
17. Do you manage, preserve and/or provide access to digital materials on behalf of another organization ?