Recent Projects of a Preservation Framework for Digital Preservation

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Abstract
This study is an attempt to gain greater understanding of the preservation of primary data and records of social science research in digital formats. In order to achieve this aim, we review previous framework on digital preservation. The work draws from the perceptions and ideas of those involved in the management and preservation of these records namely the researchers, research administrators, records managers and IT officers at the public research institutions and related organizations. Phase one of the study involved the examination and analysis of international best practice models and developed a generic model based on the InterPARES Chain of Preservation (CoP) and the United Kingdom Data Archives (UKDA) models.
Keywords: Digital Preservation; Preservation Framework; Preservation Projects; Primary Data; Research Data

1. INTRODUCTION

Primary research data and records are the products of a research process and they form an increasingly large part of our cultural and intellectual heritage and offers significant benefits to users. They can be organized into four categories namely records documenting the management of the research process; records documenting research outcomes or products; records documenting the management of the research process/projects; and research data in both 'raw' and 'analysed' form (McLeod & Child, 2003; Guercio, 2009; Wang, 2009; Gustavsen, 2009). The creation and maintenance of these records is integral to the research process. Complete, authentic and reliable records are required to demonstrate good research practice and to strengthen the reliability of research evidence; safeguard researchers and institutions from allegations of research misconduct; demonstrate effective stewardship of resources to auditors and research sponsors; protect individual and intellectual property rights; and demonstrate compliance with legislation, regulations and other requirements (Sam, 2009; Duranti, 2013). Whatever the context, preservation is a response to the threat of destruction and loss.The primary research data and records need to be managed and preserved to prevent destruction and loss to benefit further research, innovations and inventions. Increasingly, these records and the systems that generate, manipulate, manage and preserve them, are electronic in nature. One of the most significant problems facing research institutions and related organizations that create and manage their records is that electronic systems they used are

seldom designed to keep records (McLeod, Hare & Rusnah, 2004). Thus the main problem is that of system obsolescence. Systems change rapidly and there is no guarantee that today's software will be readable by tomorrow's hardware. In this case the preservation of primary research data and records in digital formats as part of our intellectual and cultural heritage is critical as there is already evidence that these data and records created or acquired with public money is being lost through neglect or through a lack of awareness of the need to take active steps to ensure its preservation (McDonald, 2003; Aliza & Zuraidah, 2010; Irwan Kamaruddin, 2014).

There has been concern about preservation of primary research data and records in digital formats in the library community internationally as early as in the 1990s. In 1996 the Commission of Preservation and Access (CPA) and the Research Libraries Group (RLG) in the USA published a joint report on *Preserving digital information* which identified problems, made recommendations and suggested areas for further research (Garrett et.al, 1996). In the UK, in November 1995, the Joint Information System Committee (JISC) of the Higher Education Funding Councils and the British Library addressed the question of the preservation of digital media by holding a national conference in Warwick, where a number of action points were identified (Fresco, 1996).

Since then extensive studies and collaborative efforts on preservation of digital data and records were undertaken by the library, archival and publishing communities in the UK. The first study (Bennett, 1997) developed a framework of data types and formats, in order to indicate the likely problems, requirements and responsibilities appropriate to each category, and to identify the most appropriate method of preservation. Closely related to this was a comparison of preservation methods and costing models (Hendley, 1998), which aimed, on the basis of a matrix of data types, to draw up a decision model to assess the most appropriate method of long term preservation and to produce a further model for comparing the costs of the preferred method of preservation. The report emanating from this study (Haynes, Streatfield, Jowett and Blake, 1997) recommended that a national body be established in the UK to coordinate archiving of primary research data and records and that it should be funded form the public sector, with an extension of legal deposit legislation to cover electronic publications. As a result Data Archives at the University of Essex (the first developed in UK and among the first in the world) and University of Manchester were established for the long term preservation of primary research data and records in digital formats of the social science discipline for the purpose of re-use by the public at large nationally and worldwide through an open access model.

Following the success of the UK Data Archives (UKDA), European Data Archives, North America Data Archives and Data Archives in Israel, Australia and New Zealand were established. The concepts and the principles of the preservation of digital resources and open access initiatives of these data archives were developed to ensure that through preservation and open access to global scientific knowledge, knowledge generated and used around the world would enjoy universal input from scholars and stakeholders. Against this background, Aronson and Glover (2005) opined, "Scientists cannot work effectively without access to the information produced by their peers-the basic materials on which most scientific effort is built" (p.279).

Nonetheless, the above mentioned studies and the development of data archiving projects of the UK, Europe, North America, Israel, Australia and New Zealand did not match the situation elsewhere and in the Asian region. A serious and active interest in the preservation of primary research data and records has not taken place. In Malaysia, studies undertaken were mainly on records management, leaving a huge gap for this area to be explored (Zawiyah, 1999; Samsiah, 2000; McDonald, 2003; Rusnah, 2006; Asma', 2008; Aliza, 2009; Azman, 2010; Asmadi, 2011; Nurussobah, 2013; Irwan Kamaruddin, 2014). Therefore, there is a need to examine the management of primary data and records for research in the research institutions and related organizations (such as universities) to identify how these records are being created, managed and preserved. As important assets, did these resources find their way to be reused (through an open access model) for further research and innovation by external researchers, innovators and inventors? If so, is there centralized data bank models preserving these records institutionally or nationally? The aim of this study is to review recent study on preservation project for digital preservation. The significant of this study allow future development of the preservation framework for digital preservation.

2. RESEARCH PROJECTS ON DIGITAL PRESERVATION

Active interest on digital preservation in the library and archival community is a relatively recent, even though there had been concerned about digital preservation for some years. Voutssas (2012) argued that initially digital preservation projects in the past tended to focus on the endurance of CD's and DVD's, tapes and other storage devices, and its artificial aging and how to keep them safely. However in the later part of the 20th century, the literature suggested that large amount of writings were focusing on the issues of philosophical underpinnings and technical aspects of digital preservation. Literature on emulation, migration, refreshing, computer transforming and other technological aspects of digital preservation become the centre stage of the library and archival communities. International collaboration is seen as the driver for building partnership on digital preservation between the librarians, archivists, museologists, sociologists, economists, planners, jurists, and other kinds of information preservers other than the ICT practitioners. Pursuance to this development, numerous projects on digital preservation are undertaken in different parts of the world. It is important to explore the earliest research projects and initiatives on digital preservation as to provide a clear understanding of how it started, how it progressed until the time of writing and how these developments have an impact on the preservation of primary research data and records in digital formats.

2.1 Digital Preservation Projects In The United Kingdom

In the UK one of the earliest initiatives was in a form of seminar held in 1996 at the British Library. It was attended by representatives from the library and archives profession, data archives, and publishers. A conclusive agreement was reached at the seminar whereby the JISC would fund a number of studies on digital archiving, in collaboration with the National Preservation Office (NPO), and the library, archival and publishing communities (Walker, 2012). Funded by JISC through the Electronic Libraries (eLib) Program, the 'JISC/NPO Studies on the

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Preservation of Electronic Materials' was monitored by a Digital Archiving Working Group consisting of experts in the field from higher education, data archives, the Public Records Office (now the National Archives of UK), the NPO, the British Library and the Publishers' Association. The British Library Research and Innovation Centre administered this project.

There were seven studies carried out under the JISC/NPO projects which were carried out throughout 1990s. The first study aimed at developing a framework of data types and formats with the objectives to indicate the related problems, requirements and responsibilities appropriate to each category, and to identify the most appropriate method of preservation (Higgins, 2011). The second study carried out in 1998 aimed at developing a model to assess the most appropriate method of long term preservation and to produce an advance model for comparing the costs of the preferred methods of preservation (Higgins, 2011).

Another two studies were concerned with the needs of data creators and the responsibility for archiving of such data. The report from these studies recommended that a national body be established in the UK to coordinate such archiving based on legal deposit legislations to cover electronic publications (Haynes, Streatfield, Jowett and Blake, 1997). On the other hand, universities and funding agencies which support scholarly research have a responsibility for ensuring that the research they help to create is preserved on a long-term basis. As a result Data Archive at the University of Essex and University of Manchester were established in 1998 for this purpose.

A strategic policy framework which examined how different organizations are approaching the key stages in the life cycle of digital resources was developed in 1998 through a specific study by Beagrie and Greenstein (1998). To find a solution to problems associated to the inaccessibility of data due to hardware and software obsolescence, another study was carried out on 'digital archaeology' in the same year (Ross & Gow, 1998; Lee, Kirschenbaum, Chassanoff, Olsen and Woods, 2012). This important study examined approaches to accessing digital materials where the media have become damaged, through disaster or age, or where the hardware or software is either no longer available or unknown. The findings showed that most data can be rescued if there is enough money to do so.

The Creative Archiving at Michigan & Leeds: Emulating the Old on the New (CAMELEON) Project involved a study on format characterization and validation tools. These format characterization and validation tools were used for the emulation of the British Broadcasting Corporation (BBC) microcomputer obtained from open-source emulation (Holdsworth, 2006). The National Archives of UK through a research project on 'An Online Registry of Technical Information about Digital Preservation' (PRONOM), a project on format registries database that stores information about software products used to create or view electronic records (Green, McDonald & Rice, 2009).

In order to foster joint action to address the urgent challenges of securing the preservation of digital resources in the UK and to work with others internationally to secure global digital memory and knowledge base, a Digital Preservation Coalition (DPC) was set up in UK in 2001. The DPC aims at publicizing research and good practice; to broaden the number of specialists in the UK; to advocate and raise awareness of the significance of preservation of digital content, especially global memory; and to foster tools and standards for digital

preservation (Walker, 2012; Digital Preservation Coalition, 2012). A Digital Object Management (DOM) project runs by the British Library intended to establish a technical method of securing the storage, preservation and access to such digital objects forever, both to maintain the usefulness of digital-born material and data created as surrogates of analogue objects, and to protect the fragile originals. At the University of Glasgow, a project called an Effective Strategic Model for the Preservation and Disposal of Institutional Digital Assets (ESPIDA) was undertaken to develop a model for the Preservation and Disposal of Institutional Assets which include primary research data created and maintain by higher and further education institutions (Holdsworth, 2006).

2.2 Digital Preservation Projects In Europe

Works in Europe has been spearheaded by the Archives de France, the National Archief in the Netherlands and the Schweizerisches Bundesarchiv among others all working on the issues of digital preservation. In Germany, the Network of Expertise in Long-Term Storage of Digital Resource (NESTOR) digital preservation collaboration project with the UK and the pan-European project Electronic Resource Preservation and Access Network (ERPANET) aimed at raising the awareness of digital obsolescence. According to (Mckemmish & Gilliland, 2013) and Ross (2004), part of ERPANET's work involved interviews with a wide range of companies and other organizations throughout Europe, exploring their awareness of the problem. Another project undertaken in Germany is the Digital Archive for Chinese Studies (DACHS), a project carried out by the University of Heidelberg aimed at archiving and making accessible Internet resources relevant for Chinese Studies. Another project that took place in Germany is the Co-operative Development of a Long-term Digital Information Archive (KOPAL), aimed at investigating solutions to the problems of obsolescence associated with electronic archiving. Implemented from 2004 and concluded in 2007. Project partners include German National Library, Gottingen State and University Library, National Library of Netherlands and IBM (Digital Curation Centre and Digital Preservation Europe, 2007; Ball, Day & Patel, 2008).

Another important project on digital preservation in Germany is Network of Expertise in Long-Term Storage and Long-Term availability of Digital Resources in Germany (NESTOR). It aims at fostering expertise in long-term management of digital information in Germany. Partners of this project include Deutsche Bibliothek, Niedersachsische Staats, Universiteits-bibliotheek, Generaldirektion der Staatlichen Archive Bayerns and Institut fur Museumskunde and the Bundesarchiv (Teper&Shaw, 2011). The Schweizerisches Bundesarchiv in Switzerland has been archiving digital documents since 1980 through the Archiving of Electronic Data and Records (ARELDA) project as part of the Swiss e-government initiative and has as its ultimate aim the long-term preservation of digital records (Ross, 2012).The Documentatiecentrum Nerderlandse Politieke Partijen (DNPP) and UniversiteitsBibliotheek Groningen in the Netherlands are involved in Archipol project aiming at archiving the web sites of political parties in the Netherlands (Ras, 2009). The Dutch universities and several related institutions have

collaborated to develop a centralized trusted repository of local collections of digital documentation through a project called DAREnet: Worldwide Access to Dutch Academic Research Results. The e-Depot project carried out by the National Library of Netherlands (Koninklijke Bibliotheek) was on digital archiving system, emulation. The e-Depot mainly archives online electronic publications from Dutch publishers and content stored in offline media for long-term preservation and access (Ras, 2009).

In Finland a project to create a platform for preservation, cataloguing and by Helsinki University Library. The DORIA project incorporates maintenance, support and development in addition to software and hardware. While in Belgium, a project called Digitale Archivering in Vlaamse Instellingen en Diensten (DAVID) was undertaken by Antwerp City Archives and the University of Leuven. The open standards DAVID project focus on digital archiving and was intended to make available public archives and improve corporation between universities and archival institutions in Belgium (DPimpact, 2009). Sweden on the other hand started its digital preservation project Kulturarw way back in 1996. It is a scheme run by the Royal Library, the National Archives of Sweden, to archive Swedish digital material for public access which was opened in 2003 (Royal Library of Sweden, 2005; Arvidson & Lettenström, 1998).

In Denmark a project called Netarchive.dk started in 2005 which was initiated by the University Library and the Royal Library. The main aim of Netarchive is to collect and preserve the Danish portion of the internet as required under the legal deposit law (Kruse& Thestrup, 2013). In Austria the Sun Centre of Excellence for Trusted Digital Repositories project was established at the University Library of Innsbruck. The goal is to develop a framework to handle the preservation mechanisms within a trusted digital archive, a user interface for accessing the trusted digital archives and methods to apply digital signatures and time stamps to the digital documents (Covey, 2010).

2.3 Digital Preservation Projects In USA

The JSTOR/Harvard Objects Validation Environment (JHOVE) Project aimed to develop tools to identify the format of a supplied object in order to determine whether the digital object is valid. Developed at Harvard University, JHOVE is being used at various points in the archiving process by many digital archives (Stieglitz, 2014). Groups such as the DIG35 Initiative Group, National Information Standards Organization (USA), and the audio engineering society carried a project on the development of valuable technical metadata standards for classes of digital files. However many digital formats have never been documented in this way and suggested that there remains a need for archives to develop a deeper understanding of the specifications of many digital formats in order to develop accurate data models and to ensure they are tracking the information in the right way.

The Approach to Digital Archiving and Preservation Technology (ADAPT) project of University of Maryland aimed at developing technologies for building a scalable and reliable infrastructure for the long-term access and preservation of digital assets in the form of geospatial scientific collections. Partners in this project include the San Diego Supercomputer Centre, Library of Congress, George Mason University, the University of New Hampshire and Fujitsu Laboratories of America. A Certification of Digital Archives (CDA) is a project of the

Centre for Research Libraries (CRL) to further work required to audit and certify digital archives (Currall, Johnson & McKinney, 2005). The Classic Software Preservation Project (CLASP) set up in 2004 by Internet Archive to assist in the permanent archiving of retail software dating from the late 1970s to the early 1990s. Earlier, Stamford University Libraries launched a project called CLOCKSS: Controlled Lots of Copies Keep Stuff Safe to develop a distributed, validated, comprehensive archive that preserves and ensures continuing access to electronic scholarly content (Reich & Rosenthal, 2010).

The National Geospatial Digital Archive established at the University of California-Santa Barbara and Stanford University in the USA is collaborating on the National Geospatial Digital Archive (NGDA). The NGDA project intends to establish a national network to archive geospatial information, including images, seek and archive potentially endangered geospatial data. Another project undertaken on geospatial data is the North Carolina Geospatial Data Archiving (NCGDAP). It focuses on the collection and preservation of digital geospatial data resources from state and local government agencies in North Carolina. One of the projects runs by the US Library of Congress's National Digital Information Infrastructure and Preservation Program (NDIIPP). The key aim of the project is the foundation for the establishment of digital repository technical framework for geospatial information using open-source software such as DSpace (Erwin & Singer, 2009).

LeFurgy (2013) listed Top 10 Digital Preservation Development of 2012 in the USA. The list includes LIBER working group on E-Science and Research Data Management; the NDIIPP-funded Preserving State Government Information projects; project on the Impact of Digital Resources Model; Digital Preservation Network; DataUp project; Demystifying Born Digital project and Web Archiving project.

2.4 Digital Preservation Projects In The Middle East

There are several projects on digital preservation undertaken in universities in Saudi Arabia, focusing on the assurance of ongoing usability of digital resources over significant time periods. In 2006 the Nidae Al-Riyadh project of Free Access to Scientific and Technical Information calls for the preservation of scientific literature for the purpose of dissemination. On the other hand the Saudi Digital Library (SDL) preservation projects aimed at supporting university education systems in the Kingdom of Saudi Arabia. Likewise in 2011, KAUST Library at King Abdullah University of Science and Technology (KAUST) undertaken a digital preservation project based on the concept of e-science through the establishment of a digital repository for its administrative electronic records which include primary research data and records, web-based services and data curation using Dspace technology. In September 2012 KAUST formally launched its Digital Archive services. The King Fahd University of Petroleum and Minerals (KFUPM) library has also launched similar projects [http:www.dpconline.org/newsroom/whats-new/933-whats-new-issue-50-nov-2012 (Accessed 25 June 2013)].

Other Middle Eastern countries such as Qatar have also undertaken digital preservation initiatives. A project carried out by Salam Technical Services to manage archives for Qatar Foundation's Educational Broadcast Channel utilizes Distributed Intelligent Versatile Archive (DIVArchive) software for the process of digital preservation, managing and accessing digital

content. Virginia Commonwealth University in Qatar has also established digital collection and archives as part of its digital preservation project. [www.qatar.vcu.edu/.../intranet/digital-collections-and-archives-team (Accessed 25 June 2013)].

3. INTERNATIONAL PROJECTS ON DIGITAL PRESERVATION

DELOS (Digital Preservation Cluster) an international project on digital preservation is part of the European Union's Sixth Framework Program. Launched in 2004, DELOS aimed at establishing theory and methodology for digital preservation research. It is led by the Humanities Advanced Technology and Information Institute (HATII) at the University of Glasgow. DELOS network includes University of Bath, Technische Universitat Wien in Austria, Universita degli Studi di Urbino Carlo Bo in Italy, the National Archief Nederlands, the Phonogrammarchiv, Osterreichischen Akademie der Wissenshaften in Austria and the Universitat Zu Koln in Germany (Smith, 2005).

In 2001, the Humanities Advanced Technology and Information Institute (HATII); National Archie van Nederland; Instituto di Studi per la Tutela dei beni Atrchivistica e Librari, Italy; Schweizerisches Bundesarchiv, Switzerlandset a European consortium of Electronic Resource Preservation and Access Network (ERPANET) was established in (Ross, Greenan & McKinney, 2004). ERPANET aims to raise awareness among all types of users of digital preservation technologies, from software developers through institutions to individuals; to encourage research in digital preservation; and to support collaboration across all sectors with interests in this field, including government bodies, heritage institutions and commercial organizations in all industries (Ross & Hedstrom, 2005).

The most remarkable international collaboration on digital preservation is the International Research on Permanent Authentic Records in Electronic Systems (InterPARES) based at the University of British Columbia in Canada. The InterPARES Project aims at developing the knowledge essential to the long-term preservation of authentic records created and/or maintained in digital form. It has developed in three phases. The first phase was initiated in 1999 and concluded in 2001. It focused on the development of theory and methods ensuring the preservation of the authenticity of records created and/or maintained in databases and document management systems in the course of administrative activities, and took the perspective of the preserver. The second phase was initiated in 2002 and concluded in 2007. In addition to dealing with issues of authenticity, it delved into the issues of reliability and accuracy during the entire lifecycle of records, from creation to permanent preservation. It focused on records produced in complex digital environments in the course of artistic, scientific and governmental activities.

The third phase of the InterPARES was initiated in 2007 and continued through 2012. It builds upon the findings of InterPARES 1 and 2, as well as of other digital preservation projects worldwide. It aims to put theory into practice, working with small and medium-sized archives and archival/records units within organizations, and develop teaching modules for in-house training programs, continuing education and academic curricula. In addition to archivists, records creators, as well as records managers, members of InterPARES include information technology experts, research administrators, and lawyers from 15 countries in America, North

America, Europe, Asia and Africa (Duranti, 2011). A new InterPARES project was recently launched in 2013 called InterPARES-Trust focusing on digital preservation in cloud environment.

Table 1. Past and Present International Projects on Digital Preservation

Research Projects	Year of Commencement
Victorian E-Records Strategy (VERS)	1990s
Exemplars in Digital Archives (CEDARS)	1990s
Creative Archiving at Michigan and Leeds: emulating the old on the new (CAMiLEON)	1990s
University of Pittsburg project	1990s
University of Indiana project	1990s
University of Yale project	1990s
Preserving access to digital information (PADI)	1998
The Dutch Digitale Bewaring (Digital Preservation testbed) project	2002
Network Excellence on Digital Libraries (DELOS)	2004-2007
The Long-Term Preservation Metadata for E-Records (LMER)	2005
Minnesota Historical Society	2005 - 2007
Effective Strategic Model for the Preservation and Disposal of Institutional Digital Assets (ESPIDA)	2005 - 2007
Clever Recordkeeping Metadata Project (CRKM)	2007
Life-Cycle Information for E-Literature (LIFE)	2007
Investigating Significant Properties of Electronic Content (InSPECT) Project	2007 - 2008
Digital Archiving in Flemish Institutions and Administrations (DAVID)	2007/2008
Managing the Digital University Desktop (MDUD)	2007/2008
Co-operative Development of a Long-term Digital Information Archives (KOPAL)	2007/2008
Cultural, Artistic and Scientific Knowledge for Preservation, Access and Retrieval (CASPAR)	2007/2008
Securing a Hybrid Environment for Research Preservation and Access Development Partner (SHERPA DP2)	2007/2008
Repository for Preservation of Authentic Digital Records (RODA)	2007/2008
Service-Oriented Architecture for Preservation and Ingest of Digital objects (SOAPI)	2007–2008
Digital Repository Infrastructure Vision for European Research (DRIVER)	2009
Preservation E-print Services (PRESERV)	2009
Exploring Collaborations to Harness Objects in a Digital Environment for Preservation (ECHO Depository)	2009
Data Preservation Alliance for the Social Science (Data-PASS)	2009

Preservation and Long-term Access through Networked Services (PLANETS)	2009
Metadata Encoding and Transmission Standard (METS)	2009
Image Spatial Data Analysis Group (ISDA/Ip2Learn)	2009
Digital Preservation Europe (DPE)	2009
International Research Project on Permanent Authentic Records in Electronic Systems (InterPARES 1, 2 & 3)	1996 - 2012
InterPARES 4- Trust and Digital Records in an Increasingly Networked Society	2013

Source: Irwan Kamaruddin (2014)

3.1 Digital Preservation In The Pacific Realm

One of the prominent digital preservation projects carried out in Australia is the PANDORA Digital Archiving System (PANDAS) in 2001. Undertaken by the National Library of Australia, PANDAS is a web-based tool to manage the archiving of web content(Australian Government, 2012). In New Zealand, the National Library was named as an international model for electronic heritage preservation by the Sun Microsystems centre of Excellence for Digital Futures in Libraries program. Through this project the government of New Zealand has established a nationwide Digital Strategy, a key plank of which is the National Content Strategy. The National Library is running the National Digital Heritage Archive (NDHA) scheme, which is a major contributor to the New Zealand government Digital Strategy (Knight, 2010).

3.2 Digital Preservation in the Asia Regions

In Malaysia, the national project was established called as the National Digital Cultural Heritage Repository Centre (NDCHR). NDCHR is developed with the collaboration efforts among the different types of cultural institution in Malaysia. The objective of the establishment of NDCHR is to improve accessibility, resource discovery, preservation and promotion of the nation's cultural heritage information would contribute toward restructuring some common grounds and thinking among the different types of cultural institutions with respect to effective approaches to managing and organizing the nation's digital cultural heritage information (Zuraidah, 2010). Similar to the IR in research institutions and universities (as mentioned in detail Chapter One), NDCHR does not fulfil the functions of a model for the preservation of primary data and records for research but rather to preserve secondary sources such as journal articles and similar information for open access at the national level.

According to Chen and Hsiang (2009), the National Taiwan University Repository (NTUR) project was run and established by one of the important universities in Taiwan. NTU has established the NTUR to be used in preserving the research outputs of academic organizations. The system design of NTUR was based on the open-source package Dspace. However, many of its functional modules are modified in order to fulfil the requirements of Chinese users. Sam (2009) in his article entitled "Towards a Standard Migration Procedure", South Korea rules and regulations regarding Records Management stated that all electronic documents must be kept to a records management system (RMS) after a specified time. As this Act had been introduced,

standards on migration of records to electronic form are needed as electronic systems are various. Thus, National Archives of Korea (NAK) has made various efforts to ensure the migration of records is according to established standards and procedures. The standard of ISO Digital Records Conversion and Migration Process is being developed that includes the ISO TC46/SC11 Migration Procedure and AHDS (The Arts and Humanities Data Services) Ingest Procedures Framework.

In Singapore on the other hand, electronic records preservation is launched due to wide adoption of internet digital technology of Websites for education purposes to the electronic government portals. Wu Horng-Jyh (2009) and Rodrigues & Pedron (2013) stated that SECI (Socialization, Externalization, Combination and Internalization) knowledge sharing process can be used to classify documents captured in blog, forum and wiki. However, SECI has its several limitations in capturing dynamic records. Thus, he is establishing WAWI (Web Annotation System) that will be an essential tool in Web preservation system in order to preserve the quality of Web-based records but not on primary data and records for research.

4. RESEARCH ON PRIMARY RESEARCH DATA

In 2003, the University of Northumbria, United Kingdom, conducted research on these specialized records. It studied the management of research records comprising of records of the process and its management, the outcomes or products as well as the primary and analysed research data, in one higher education institution (HEI). A particular emphasis was on electronic records. The project involved the different stakeholders in the research community, i.e., researchers, research directors, IT/systems staff and administrators. The results highlighted the complexity of the research functions. In summary, the project resulted in a number of practical lessons:

- records management guidelines and training, placed within an institutional framework of records management strategies and policies, are needed for all stakeholders and would be welcome;
- digital preservation can and needs to be addressed;
- it is possible to establish a virtual records centre/archives and, if it were to contain research outputs and management data, would constitute a rewarding learning tool for all stakeholders; and
- at the case study site, the undertaking of this research has increased awareness of the need for good records management practice and digital preservation strategies for research amongst the stakeholders staff involved in the project.

The National Archives survey on electronic records in the Malaysian public sector revealed that a large portion of their records resided on tapes that the various Ministries could no longer gain access to, due to technological obsolescence (McDonald, 2003; Rusnah, Alwi, Irwan Kamaruddin& Haslinda, 2009). These may include primary research data and records in the various research institutions and related organizations.

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Research on education and training needs in the field of electronic records management in Malaysian federal ministries and departments, including various research institutions and related organizations, reveals that research administrators, archivists, IT officers and records managers have failed in their responsibilities in regard to electronic records due to their lack of knowledge and skills. The Malaysian government may have already lost records of its activities, which may well include primary research data and records. Therefore, there is strong indication for the centralized collection and storage of records in the custody of a virtual records centre that would efficiently and effectively assist in the retention, preservation and sharing of these primary data and records for use as evidence material for various other studies, other than what it was originally intended for (Rusnah, 2011).

4.1 Digital Preservation Models On Primary Research Data And Records In Practice

The above discussions on the literature is supported by a number of case studies on the preservation on primary data and records in the social science research which provide a synthesis of existing best practice modelsand pragmatic examples, policies and implementation strategies in the developed countries. They introduced a range of stakeholders and organizational roles in the creation, management and preservation of digital resources including that of primary data and records for research. These are data banks, 'digitisers', funding and other agencies, institutional archives, academic data archives and legal deposit libraries.

4.1.1 Data Banks

These are made up of university computing services, perform large-scale data storage functions for a broad constituent community (Snell, 2014). According to Stafford and Flatley (2014) they are contract data services whose core function is to act as 'safety deposit box' in which data creators deposit their data for safe keeping under some form of agreement, and from which depositors again may recall their data at some point in the future. Utulu and Akadri (2014) argue that the data bank ensures that deposited data are available on contemporary storage media and leaves depositors to worry about whether they can be represented on and meaningfully accessed with contemporary hardware and software.

Lauridsen (2014) opined that in some cases, the data bank may also contract with a depositor to take on certain functions which are more closely associated with an institutional or academic data archive, though these may be said to be additions to their core services. McLeod and Child (2003) illustrate few examples of data banks which include the Oxford University Computing Services (OUCS), which provides an archive for the electronic assets of the University of Oxford, and the University of London Computing Centre (ULCC), which acts as a data bank for a variety of depositors and offers a data bank facility for the Computer Readable Data Archive of the UK National Archives.

4.1.2 'Digitisers'

'Digitisers' create data resources, or build collections of resources which are either created or acquired from third parties, for a variety of different but always very specific

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purposes. According to Stieglitz (2014), space missions which install satellites for the purposes of transmitting digital images of space, archaeologists who build a simulated town plan of Pompeii, art curators who hang a virtual exhibition, librarians and archivists who digitise images of printed books and manuscripts or documents are all 'digitisers'. They exercise a substantial degree of control over the data creation process and their use of the framework is influenced by their focus on the particular purposes to which their data collections are to be placed.

Alemneh and Hartsock (2014) grouped the digitisers into three broad categories which reflect their roles and their intentions in the data creation process namely:

- Research-oriented agencies and individuals create or acquire data resources in the course of (or as an output from) specific investigations.
- Library, archive and cultural heritage organizations have existing collections made up predominant of non-digital information objects. Their data creation and acquisition activities are guided by collection policies which govern the institution's curational work generally and focus on five main areas: collection management and accountability (e.g. through the creation of computer catalogues); collection development (e.g. by acquiring access to third-party data resources as a means of appropriately extending the institution's 'holdings'); access to the collections (e.g. through the creation and network delivery of digital surrogates for objects within the collection); preservation (e.g. through the creation of digital surrogates for at-risk objects within the collection); repair (e.g. through the creation of digital surrogates for fragile objects within the collection).
- Publishers produce primary and secondary data for commercial purposes. They are increasingly interested in exploiting the value of their back files.

Examples of digitisers include: among the research organizations, the Space Data Centre (SDC) at the Rutherford Appleton Laboratory; and, among the cultural heritage organizations and libraries, the British Film Institute (BFI), the National Museum of Science and Industry, and the Victoria and Albert Museum (V&A).

4.1.3 Funding and Other Agencies

Cissne (2014), Catani (2014) and Snell (2014) described these agencies as those invest in the creation of digital information resources and sometimes exercise some strategic influence over the financial, business, and legal environments within which such resources are created. Positioned to determine how and why data resources are created, these agencies may have a determining role in whether, how, and what cost data resources will be managed over the long-term, and made accessible for re-use. Their use of the framework may help to extend their influence over data resources throughout each stage of their life-cycle. Examples include the Natural Environment Research Council (NERC) and the Scottish Cultural Resources Access Network (SCRAN) (Krueger, 2014).

4.1.4 Institutional Archives

These are government or business archives, selectively build and manage unique electronic records which are generated by an organization and retained by that organization to document its activities. They will also make deposited records available as required by the record-generating organization. Institutional archives' use of the preservation model is governed by their involvement with unique records, their interest in those records' long-term retention, their influence, through the record-generating organization, over the behaviour of data creators, and their reliance upon mandated deposit by those creators as a source of collection development. Shu-Fen and Hsueh-Hua (2014) illustrate two examples of institutional archives which are the National Archives of UK and the Centre for Electronic Records (CER) of the National Archives and Records Administration of the United States (NARA).

4.1.5 Academic Data Archives

These are selectively developed, maintain, and encourage re-use of unique data resources which are of interest to particular end-using communities. The resources themselves are drawn from a wide variety of depositors, though once deposited, they typically become the curatorial responsibility of the academic data archives (McLeod & Child, 2003; Utulu & Akadri, 2014; Chen-Gaffey, 2014). The archives' use of the preservation model is influence by their focus on secondary analysis, by their service to a specialist user community, by that user community's information requirements, and their reliance upon voluntary or non-exclusive deposit as a means of collection development. McLeod and Child (2003) illustrate two examples which include Data Archives at the University of Essex, and the Arts and Humanities Data Services (AHDS).

4.1.6 Legal Deposit Libraries

McPeck (2014) described legal deposit libraries as institutions with obligations to maintain and provide access to non-unique information objects whose deposit is legally prescribed and enforced upon producers of certain classes of those objects. Legal deposit libraries according to McPeck may supplement these core holdings through voluntary deposit and, funding permitted, through acquisition of objects either through subscription or purchase. Their use of the preservation model is governed by their reliance upon mandated deposit, their lack of influence over depositor's behaviour; and their orientation toward long-term preservation and secondary use. Examples include most national libraries.

4.2 Centralized Data Archives

In many developed countries, through the various digital preservation projects (as mentioned in the above sections), models on the preservation of primary research data and records appropriate for archiving had been identified. In this context the concept of digital preservation in the form of virtual records centre, data banks, digitisers, academic data archives, information repositories, institutional archives and legal deposit libraries had been extended to the virtual archives models, giving birth to the national and institutional social science data archives. The following section of this chapter discusses the various examples of

Social Science Data Archives (SSDA) which preserved primary research data in some developed countries.

4.3 European Data Archives

The Council of European Social Science Data Archives (CESSDA) promotes the acquisition, archiving, distribution and preservation of electronic data for social science teaching and research in Europe. It encourages the exchange of data and technology and fosters the development of new organizations in sympathy with its aims. It associates and cooperates with other international organizations sharing similar objectives. The CESSDA's model home pages allow easy access to the catalogues of member organizations and provide a central news forum about its activities and other relevant information based on the digital preservation concepts. Users can be helped to locate and acquire data from other archives within Europe and worldwide. Data for several key international series can be found and requested via a Data Catalogue search. At the same time, users can also search for data at other archives via the clickable maps provided in the webpage. Additionally users are able to search seamlessly via the CESSDA Data Portal to locate data and variables within a selection of datasets preserved at a number of European social science data archives. In this case, research data are made available for reuse and re-purposing by third parties, accessible either from the institution that carried out the research, from the Council's own archives or from the national archives and at the same time preservation of data and records are ensured [http:www.cessda.org. (Accessed 20 June 2013)].

CESSDA is made up of 20 data archives in 17 partner countries, which include the national data archives in Australia, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom. The 20 European data archives are: Sociological Data Archives (SDA), Prague; Wiener Institut fur Sozialwisserachaftliche Dokumentation and Metodik (WISDOM), Vienna; Romanian Social Data Archive (RODA), Bucharest; Social Research Informatics Centre (TARKI), Budapest; Greek Social Data Bank (GSDB-EKKE), Athens; Archiv Druzboslovnih Podatkov (ADP) Ljubliana; Archiv Druzboslovnih PodatkovSociodata Service(ADPSS), Milan; Swiss Foundation for Research in Social Sciences (FORS), Lausanne; Reseau Quetelet, Paris; Archivo de Estudios Sociales (ARCES), Madrid; CEPS/INSTEAD, Luxembourg; German Social Science Infrastructure Services (GESIS); Irish Social Science Data Archive (ISSDA), Dublin; UK Data Archive (UKDA), Essex; Data Archiving and Networked Services (DANS), The Hague; Danish Data Archives (DDA), Odense; Norwegian Social Science Data Services (NSD), Bergen; Swedish National Data Service (SND), Goteborg; Finish Social Science Data Services (FSD), Tempere; and Estonian Social Science Data Archive (ESSDA), Tartu (Murakas & Rammer, 2010).

In the United Kingdom, the Economic and Social Data Service (ESDS), which came into operation in January 2003, provides a national data archiving and dissemination service. The service is a jointly-funded initiative sponsored by the Economic and Social Research Council (ESRC) and the Joint Information Systems Committee (JISC). The ESDS is a distributed service, based on collaboration between four key centers of expertise, which are: United Kingdom Data Archive (UKDA), University of Essex; Institute for Social and Economic Research (ISER),

University of Essex; Manchester Information and Associated Services (MIMAS), University of Manchester; and Cathie Marsh centre for Census and Survey Research (CCSR), University of Manchester. These centres work collaboratively to provide preservation, dissemination, user support and training for an extensive range of key economic and social data, both quantitative and qualitative, spanning many disciplines and themes. The ESDS provides an integrated service offering enhanced support for the secondary use of data across the research, learning and teaching communities. The Economic and Social Research Council (ESRC) has a Datasets Policy that aims to preserve and share high quality social science data generated as a result of ESRC-funded research. All ESRC award holders are under contractual obligation to offer their research data for archiving [http:www.esrc.ac.uk/ESRCInfoCentre/ (accessed 20 June 2013)].

4.3.1 UK Data Archives (UKDA)

The UKDA is funded jointly by the University of Essex, the Economic and Social Research Council (ESRC) and the Joint Information Systems Committee (JISC). It has been the primary repository for digitised social science research data in the UK since 1967. As a 'national data collection service' the UKDA, originally called the Data Bank, was created by the forward-thinking Social Science Research Council, now the Economic and Social Research Council (ESRC), to bring together 'social survey research materials for storage, retrieval and secondary analysis of the information in them'. For over three decades, preservation of these collections has been a core function of this enterprise. Over recent years the remit of the UKDA has been extended with the addition of new services such as the AHDS History Service, the Census Registration Service and an extensive program of research and development projects in relevant areas such as multi-lingual thesaurus development, software for data publishing and browsing, research into the preservation and grid-enabling of social science data and collaborations with research councils, including the Medical Research Council (MRC) and the Natural Environment Research Council (NERC).

The UKDA continues to facilitate secondary analysis in the scholarly community by contributing to projects to produce teaching and learning material for students and by preserving and sharing research material that may have served its immediate purpose but has continuing value for re-use. By taking a strategic approach to long-term digital preservation, the UKDA ensures that it is at the leading edge of technical advances by monitoring hardware and software developments and migrating its collections accordingly. The UKDA is committed to using its resources wisely, and adding value to data collections where it will most benefit the user community.

Since January 2003, the UKDA has managed core activities and provided dedicated services for the ESRC under the banner of the Economic and Social Data Service (ESDS). The ESDS is dedicated to supporting users of social and economic datasets for secondary analysis for research and teaching, from the novice researcher to the experienced data analyst. ESDS provides preservation, dissemination and user training for an extensive range of key economic and social data, both quantitative and qualitative, spanning many disciplines and themes. ESDS provides an integrated service offering enhanced support for the secondary use of data across the research, learning and teaching communities, covering a collection of several thousand

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datasets. Examples of data acquisitioned by the ESDS include the General Household Survey, the Labour Force Survey, National Statistics Time Series Data, British Household Panel Survey (BHPS) and the National Child Development Survey (NCDS).

Under the ESDS Qualidata Service, the acquisition of qualitative data is encouraged and the UKDA has a policy of identifying and ensuring that large paper collections of qualitative material are archived in suitable repositories. AHDS History is also based at the UKDA. The AHDS History (formerly the History Data Service) is one of five Subject Centres of the Arts and Humanities Data Service (AHDS) and is a national data archiving service jointly funded by the Joint Information Systems Committee and the Arts and Humanities Research Board.

The Census Registration Service, also sited at the UKDA, was established to facilitate access to the four Census Data Support Units for UK higher and further education users (see below). These four units have all been funded by the ESRC and JISC to supply value-added census data. UKDA has developed its own data lifecycle model for social science data archive. It has become a reference and practice on how data management is implemented in UKDA.

4.4 North American Data Archives

Similar to the European Data Archives, the North American Data Archives encompasses a range of service models, which include centralized collections, geographically distributed collections, and descriptive catalogues or gateways. Grid technology offers a mechanism for providing access to such research archives. It provides seamless access to large datasets. The software is able to analyse the data irrespective of the location of the computer holding the information. With the use of Web resources the data archives can be connected worldwide. North American Data Archives are made up of 14 institutional data archives: Harvard Data Centre, Massachusetts; Roper Centre, Connecticut; Princeton University Data Library, New Jersey; Colombia University Electronic Data Services, New York; Geospatial and Statistical (Geostat) Data centre, Virginia; the Inter-University Consortium for Political and Social Science Research (ICPSR); San Diego Social Science Data Centre, California; Social Science Data Archives UC, Irvine, California; Data and Program Library Service (DPLS) Wisconsin; The University of British Columbia (UBC) Data Library, Vancouver; University of Alberta Data Library, Edmonton; Data Resource Centre University of Guelph, Guelph; Social Science Network and Data Services University of West Ontario, London, Canada; and Carlton University Data Centre,Ottawa[http://cndls.georgetown.edu.gussda/archivenorthamerica.html(accessed 20 June 2013)].

4.5 Other Data Archives Worldwide

Other data archives worldwide that are reachable via the UK Data Archives portal are: Banco de Datos,Unidad de Informaci (UISDP) Montevideo; South African Data Archives (SADA), Pretoria; Israel Social Science Data Archive (SSDA), Jerusalem; Social Science Data Archives (SSDA), Canberra; and New Zealand Social Science Data Service (NZSSDS), Auckland.

Therefore, the literature suggests that, within the Asia and Southeast Asian region, centralized data archives are yet to be established. Through the UK Data Archives web portal it is clearly suggested that the primary research data in the various Asian and Southeast Asian

countries are being kept, managed and preserved by the individual creating agencies. Thus research is critical to be carried out in Asia and Southeast Asian countries to ascertain whether preservation for primary research data is being undertaken.

5. STANDARDS RELATED TO THE PRESERVATION OF DIGITAL PRIMARY RESEARCH DATA AND RECORDS

A few projects carried out by the American Consultative Committee for Space Data Systems have developed several standards on digital preservation namely Open Archival Information System (OAIS), XML Formatted Data Unit (XFDU) which is a document modelling format for the preservation of digital records (Becker, Kulovits, Guttenbrunner, Strodl, Rauber & Hofman, 2009). The Open Archival Information System (OAIS) Reference Model, an approved ISO standard and considered the benchmark for digital preservation systems, is a high-level model that defines the base functional components of a long-term preservation system and the key internal and external interfaces, and characterizes the information objects managed in the system. It addresses all aspects of long-term preservation of digital information: ingest archival storage, data management, access, dissemination, and migration to new media and forms. The goal of an OAIS is to preserve information for a designated community over an indefinite period of time (CCSDS, 2002). Digital preservation initiatives have adopted, adapted, or referenced the OAIS model since its inception as the foundation upon which to build, as has the preservation section of the CoP model. It can be considered a good model for the information ecosystem as it serves as a framework around which a coherent set of standards can be developed to address the many different issues associated with this complex issue (Pearce-Moses & Davis, 2008).

Following the work on OAIS, a working group on preservation of metadata called PREservation Metadata: Implementation Strategies (PREMIS) have developed a data dictionary and a report providing guidance about what information a responsible archives must know about its content and must be able to supply to partners as required (PREMIS Editorial Committee, 2011). Meanwhile the American Digital Library Federation through its research project has developed a significant Metadata Encoding and Transmission Standard (METS). METS has evolved from a format primarily designed to drive display applications for multipart objects into a full-featured archiving package (Library of Congress, 2014).Likewise, the United States Department of Defense through its metadata project developed a Sharable Content Object Reference Model (SCORM) intended for use in a courseware or training environment (Day, 2011).

6. CONCLUSION

The review of the literature in this paper indicates that the specific issues on the preservation of primary research data and records in social science has a strong foundation in the developed countries like Australia, Europe, UK and USA. The writer has proven that the concepts of the UKDA, European Data Archives, North American Data Archives and other similar data archives model in Australia, Jerusalem and New Zealand identified are very significant models for the preservation of these specialized records for the purpose of reuse for invention and innovation through an open access model.

However, works specifically on the preservation of primary research data and records in the Asian region are still rare. The literature suggested that most of the research undertaken in Malaysia was researching generic records management and electronic records management and none of their concerned on the preservation of primary research data and records. This implies that the issue on the preservation of primary research data and records is still at the very initial stage even though it can be considered much overdue by comparison to the developed nations as discussed in the review thus far.Therefore, the literature suggests that there is a significant gap in the subject under study within the Asia and Southeast Asian region, centralized data archives are yet to be established. Therefore, this research is critical to be carried out to ascertain whether preservation for primary research data and records in the social science disciplines are being undertaken in research institutions and related organizations in Malaysia.

References

Alemneh, D.G. & Hartsock, R. (2014). Theses and dissertations from print to ETD: The nuances of preserving and accessing those in music. In J.M. Krueger (Ed.). *Electronic Records and Resource Management Implementation in Diverse Environments* (pp 41-60). Hershey PA: IGI.

Ismail, A. & Manaf, Z.A. (2010). Malaysian cultural heritage at risk?: A case study of digitisation projects. *Library Review,59*(2), 107 – 116. Retrieved December 11, 2014,from http://dx.doi.org/10.1108/00242531011023862

Mohktar, A. (2008). Polisi pengurusan rekod elektronik dalam sektor awam di Malaysia. *Jurnal Teknologi Maklumat & Multimedia **7**(2008),* 51 – 67.

Mohammed, A. Ghazali (2011). *Development of competency profile for records managers in the Malaysian federal ministries* (Doctoral dissertation). Universiti Teknologi MARA.

Arvidson, A. & Lettenström, F. (1998)**.** The kulturarw project-the swedish royal web archive. *Electronic Library, 16*(2), 105–108.

Aronson, B. & Glover, S. (2005). Journal access initiatives: Where are they? Why the World health organization? and What is HINARI? *Serials Review*, *31*(4), 279-283.

Isa, A.M. (2010). *Strategic management of records and risks for the sustainability of organizations* (Unpublished Doctoral dissertation). University of Glasgow,United Kingdom.

Ball, A., Day, M. & Patel, M. (2008). The fifth international conference on preservation of digital objects (iPRES 2008). *International Journal of Digital Curation*, *3*(2), 89-102.

Beagrie N. & Greenstein, D. (1998). A strategic policy framework for creating and preserving digital collections: A report to the Digital Archiving Working Group. Arts and Humanities Data Service. *Internet Scout Review*, *5*(2).

Becker, C., Kulovits, H., Guttenbrunner, M., Strodl, S., Rauber, A. & Hofman, H. (2009). Systematic planning for digital preservation: evaluating potential strategies and building preservation plans. *International Journal on Digital Libraries*, *10*(4), 133-157.

Bennett, J. C. (1997). A framework of data types and formats, and issues affecting the long term preservation of digital material. *British Library Research and Innovation* Report 50. London: British Library.

Catani, S. (2014). The preservation of electronic records: Decision acts signed by the department head. In J.M. Krueger (Ed.). *Electronic Records and Resource Management Implementation in Diverse Environments* (pp 318-333). Hershey PA: IGI.

Chen-Gaffey, A. (2014). Managing vendor records for monographic e-collection at a medium-sized academic library. In J.M. Krueger (Ed.). *Electronic Records and Resource Management Implementation in Diverse Environments* (pp 22-40). Hershey PA: IGI.

Chen, K. H. & Hsiang, J. (2009). The unique approach to institutional repository: practice of National Taiwan University*. Electronic Library, 27*(2), 204-221.

Cissne, K. (2014). NARA: A digitization case study. In J.M. Krueger (Ed.). *Electronic Records and Resource Management Implementation in Diverse Environments* (pp 306-317). Hershey PA: IGI.

Covey, D. T. (2010). Usage and usability assessment: Library practices and concerns, usage studies of electronic resources.*Council on Library and Information Resources.* Retrieved on January 20, 2012, from http://www.clir.org/pubs/reports/pub105/contents.html

Currall, J., Johnson, C. & McKinney, P. (2005). The organ grinder and the monkey: Making a business case for sustainable digital preservation.*EU DLM Forum Conference*, Budapest, Hungary.

Day, R. (2011).*How to write and publish a scientific paper*. (7th ed.). Oxford: Greenwood.

Digital Curation Centre (UK) & Digital Preservation Europe (DPE). (2007). *Digital preservation, archival science and methodological foundations for digital libraries.* Retrieved June 1, 201, from http://www.gallbladder-research.org/media/media_113621_en.pdf

Duranti, L. (2011). Continuity and transformation in the role of the archivist. *Paper presented atInterPARES International Symposium*. 15 – 18 June, Kuching Sarawak, Malaysia.

Duranti, L. (2013). Trust in digital records: An increasingly cloudy legal area. *Computer Law & Security Review* 10/2013, *28*(5), 522-531.

Erwin, T. & Singer, J.S. (2009). The natural geospatial digital archives: A collaborative project to archive geospatial data. *Journal of Map & Geography Libraries: Advances in Geospatial Information, Collection & Archives,* 6(1),6-25.

Fresco, M. (1996). Long term preservation of electronic materials.*Report of a JISC/British Library Workshop as part of the electronic libraries programme (eLib)*, organized by UKOLN, 27-28 November 1995, University of Warwick. British Library R&D Report 6328. London: British Library.

Guercio, M. (2009). Keeping and preserving email. *Proceedings of InterPARES 3 Symposium*. 4-6 June, pp 143-195. Seoul: National Archives of Korea.

Gustavsen, I. (2009). The challenges of migration as a long-term preservation strategy: the findings of TEAM Norway and LongRec. *Proceedings ofInterPARES 3 Symposium*. 4-6 June, pp 279-300. Seoul: National Archives of Korea.

Haynes, D., Streatfield, D., Jowett, T. & Blake, M. (1997). *Responsibility for digital archiving and long term access to digital data*. British Library Research and Innovation Report 67. London: The British Library.

Hendley, T. (1998).*Comparison of methods and costs of digital preservation*. British Library Research and Innovation Report 106. London: The British Library.

Higgins, S. (2011). Digital curation: The emergence of a new discipline. *International Journal of Digital Curation*, *6*(2), 78-88.

Holdsworth, D. (2006). Strategies for digital preservation. *Digital preservation*, *64*(4), 32.

Kadir, I.K.A (2014). *Electronic records management (ERM) practices at the Malaysian federal ministries: Exploring the fundamental organizational and professional issues* (Doctoral dissertation). UiTM.

Knight, S. (2010). Early learnings from the national library of New Zealand's national digital heritage archive project. *Program: electronic library and information systems*, *44*(2), 85-97.

Kruse, F. & Thestrup, J. B. (2013). Research libraries' new role in research data management, current trends and visions in Denmark. *LIBER Quarterly*, *22*.

Krueger, J. (2014). Building a digital repository for accreditation through courseware. In J.M. Krueger (Ed.).*Electronic Records and Resource Management Implementation in Diverse Environments* (pp 150-163). Hershey PA: IGI

Lauridsen, L. (2014). Topaz Japanese-American relocation center digital collection: A case study. In J.M. Krueger (Ed.).*Electronic Records and Resource Management Implementation in Diverse Environments* (pp 117-129). Hershey PA: IGI.

Lee, C. A., Kirschenbaum, M., Chassanoff, A., Olsen, P. & Woods, K. (2012). BitCurator: Tools and techniques for digital forensics in collecting institutions.*D-Lib Magazine*, *18*(5/6), 14-21.

McKemmish, S. & Gilliland, A. (2013). Archival and recordkeeping research-past, present and future. *Research methods: information systems, and contexts*, 79-112.

McLeod, J. & Child, S. (2003). *Managing primary research data and records for research in HE institutions* (Unpublished report). United Kingdom: Northumbria University.

McLeod, J., Hare, C.& Rusnah Johare (2004). Education and training for records management in the electronic environment- the (re)search for an appropriate model. *Information Research, 9*(3), 179.

McPeck, T.L. (2014). Electronic resources and next generation public library catalogs. In In J.M. Krueger (Ed.).*Electronic Records and Resource Management Implementation in Diverse Environments* (pp 1-21). Hershey PA: IGI

Murakas, R. & Rämmer, A. (2010). Social science data archiving and needs of the public sector: The case of Estonia. Estonian Social Science Data Archive (ESSDA).

Hussin, N. (2013). *Functional requirements for the management of electronic court records in the Superior Court of Malaysia* (Doctoral dissertation). UiTM.

Pearce-Moses, R.& Davis, S. E. (2008). New skills for a digital era. In *Proceedings of a Colloquium sponsored by the National Archives and Records Administration, Society of American Archivists and the Arizona State Library, Archives and Public Records* (Vol. 31).

Ras, M. (2009). The KB e-depot: Building and managing a safe place for e-journals. *Liber Quarterly*, *19*(1), 44-53.

Rodrigues, P. & Pedron, C. D. (2013). Knowledge management on the implementation of a CRM project in a subsidiary company: A case study.*10th International Conference on*

Information Systems and Technology Management – CONTECSI. 12 – 14 June 2013. São Paulo, Brazil.

Ross, S. (2012). Digital preservation, archival science and methodological foundations for digital libraries. *New Review of Information Networking*, *17*(1), 43-68.

Ross, S.& Gow, A. (1998). *Post-hoc rescue of digital materials. Digital archaeology? Rescuing neglected or damaged digital resources*. British Library Research and Innovation Report 108. London: The British Library.

Ross, S. & Hedstrom, M. (2005). Preservation research and sustainable digital libraries. *International Journal of Digital Libraries*, *5*(4), 317-325.

Royal Library of Sweden (2005). *Swedish websites.* Retrieved June 20, 2013, from http://www.kb.se/english/find/internet/websites/

Johare, R., Yunus,A.M., Irwan Kadir, I.K.A. & Mohamed, H. (2009). Managing primary research data and records for research in research institution and related organizations: Examples from the team Malaysia case studies. *Proceedings of theInterPARES 3 International Symposium*. Seoul, South Korea.

Johare, R. (2011). Case study 03-A study on digital preservation policy of PUSTAKA Negeri Sarawak. *Paper presented atInterPARES 3 Summit & Symposium*. 16-18 June. Kuching,Sarawak.

Sam, G. O. (2009). Toward developing a standard migration procedure. *Proceedings of InterPARES 3 Symposium*, 4-6 June, pp 19-54. Seoul: National Archives of Korea.

Shu-Fen, H.L. & Hsueh-Hua, C. (2014). Construction of a culture-rich database system for indigenous documentary records: Conceptual model, flexible classification, and methodology. In J.M. Krueger (Ed.).*Electronic Records and Resource Management Implementation in Diverse Environments* (pp 61-93). Hershey PA: IGI.

Smith, M. (2005). Exploring variety in digital collections and the implications for digital preservation. *Library Trends*, *54*(1), 6-15.

Snell, C. (2014). ERMS druthers. In J.M. Krueger (Ed.).*Electronic Records and Resource Management Implementation in Diverse Environments*(pp 181-192). Hershey PA: IGI.

Stafford, D. & Flatley, R. (2014). Choosing and implementing an open source ERMS. In J.M. Krueger (Ed.).*Electronic Records and Resource Management Implementation in Diverse Environments* (pp 164-180). Hershey PA: IGI.

Stieglitz, S. (2014). The American memory project. In J.M. Krueger (Ed.), *Electronic Records and Resource Management Implementation in Diverse Environments*(pp 106-116). Hershey PA: IGI.

Utulu, S.C.A. & Akadri, A.A. (2014). A case of Redeemer's University adoption of instructional repository using the principles of electronic information management systems. In J.M. Krueger (Ed.).*Electronic Records and Resource Management Implementation in Diverse Environments (*pp 130-149). Hershey PA: IGI.

Voutssas, J. (2012). Long-term digital information preservation: Challenges in Latin America. *Aslib Proceedings, 64*(1), 83 – 96.

Wang, J. (2009). Challenges and strategies for managing digital records in a public organization: Findings from the TEAM China case study. *Proceedings ofInterPARES 3 Symposium*. 4-6 June, pp 243-278. Seoul, South Korea: National Archives of Korea.

Wu, P. H. J. (2009). Towards preservation, description and arrangement of web records: A case study of archiving professional seminar e-learning space.*Proceedings of the InterPARES 3 International Symposium*. Seoul, South Korea: Sungkyunkwan University.

Yusof, Z.W. (1999). *Records management in the business community in Malaysia: A study of the understanding of concepts and practice and the development of a model*. University of Wales Aberystwyth, UK.

Manaf, Z.A. (2010). *A case study on the preservation of digital cultural heritage in Malaysia* (Unpublished Doctoral dissertation). UiTM.