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Managing the Preservation of Records for Digital Primary Data: A Case of Malaysia Institution

Alwi Mohd Yunus and Irwan Kamaruddin Abdul Kadir
Faculty of Information Management, Universiti Teknologi MARA
UiTM Selangor, Malaysia

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Abstract
Concerns raised about the lack of preservation initiatives and poor access to global scientific knowledge in the form of primary research data and records for research in the turn of the 20th century resulted in the development of a variety of ways to remedy the inadequacies associated with scholarly research data/products and dissemination of knowledge pertaining to research activities. The aim of the paper is to examine the needs for the surveyed social science research institutions in Malaysian government for the preservation of their digital primary research data. This paper presents the findings of the survey questionnaires of the existing practices on the preservation of primary research data in the selected Malaysian research institutions and related organizations. The questions asked in the survey were based on the elements of the generic preservation framework.
Keywords: Digital Data, Preservation, 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.

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).

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.

The aim of this paper is to examine the needs for the surveyed social science research institutions in Malaysian government for the preservation of their digital primary research data. This objective is achieved by means of investigating the following current practices on the preservation of primary research data which is based on the generic preservation framework elements of the CoP and UKDA.

2. Literature Review

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 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).

3. Methodology

A total of 31 questions were asked which required "Yes", "No" and "NA" (Not Aware) as answers. The questionnaires are divided into Part A, B and C. Part A was used to identify the name of the research institutions and the designation of therespondents to identify the total number of research institutions responding to the survey questionnaires and those responsible

for the task. This information was used to support the collection of qualitative data through face-to-face interviews in order to provide an in-depth exploration of the situation. Part B asked questions pertaining to the existing states of the creation, use, maintenance and disposition and preservation of research data and records based on the CoP recordkeeping system model. Part C asked questions pertaining to the existing states of the Data Creation; Data Analysis and Use; Data Output; Data Maintenance; Data Preservation; Data Distribution and Data Reuse by the research institutions. Analysis and interpretation of data began with Question 1 in Part B of the questionnaires.

4. Analysis Of Data And Findings

4.1 Manage the Framework for the CoP

Hill (1994) opined that policy is a plan or course of action designed to influence and determine decisions, actions and other matters; it is a guiding principle or procedure. Whereas Barata and Cain (1999) is the core direction chosen by an organization and the policy chosen will determine changes to legislation, which in turn will determine standards, codes of practice and so on. Within the context of the management of primary research data and records in the Malaysian public sector, the Malaysian federal government should formulate appropriate policy through the National Archives of Malaysia in consultation with the main stakeholders.In the Malaysian case, data in Table 1 on page 149 shows that there is evident of the availability of a specific written policy for the preservation of primary research data and records in the surveyed agencies, even though only 15% of the respondents believed so. While majority of the respondents 50% believed otherwise and 35% were unaware of the availability of the specific policy. When asked if they apply the policy as required, data in the same Table shows that out of 61 respondents who had recognized the existence of the policy, not all of them apply the policy as required as 20% out of the total 61 respondents answered 'No' and the rest 21% were unaware. The total of 61 respondents believed that they applied the policy by practice because all data and records were kept permanently as suggested by the qualitative data.

Table 1. Availability of Written Policy and Design Framework on Preservation of Primary Data and Records for Research Availability

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
1. Is there a specific written policy for the preservation of primary research data and records?	411	15	50	35
2. If there is a specific written policy for the preservation of primary research data and records in your agency, did you apply the policy as required?	61 who said "Yes"	59	20	21
3. Has your organisation developed a preservation program for primary research data and records in digital format?	411	64	21.4	14.3

Even though majority of the respondents believed that there was an absent of specific policy on the preservation of their data and records, when asked whether their organizations

has developed a preservation program for these data and records, majority of the respondents which is 64% believed so, 21.4% believed otherwise, while 14.3% answered they were unaware of the availability of the preservation program. This data will be verified during the face-to-face interviews whether there was actually a preservation programs being implemented in the surveyed organizations.

Recordkeeping System

An electronic records management system (ERMS) is a set of computer programs designed to track and store records, particularly but not exclusively electronic records. It is more than just an electronic filing cabinet; it can manage the tasks involved with creating and using documents; applying classification schemes and retention and disposal schedules; storing and retrieving records in a central or remote locations; and protecting the confidentiality of sensitive information (Azad, 2008). It provides a generic preservation framework that can be used by an organization, records centre, IR, archival institution or library to develop their own preservation strategies. These functional requirements in an ERMS address the issue of capturing and creating the records in its entirety through the activities of planning and developing a Record Making System, a Recordkeeping System and a Permanent Preservation System. This is to ensure the reliability, authenticity and integrity of born digital records with the intension of long-term preservation based on records management life cycle and continuum concepts.

Table 2. Availability of Specific Recordkeeping System

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
4. Is there a specific recordkeeping system used in your agency for the creation of primary research data and records for research?	411	89.5	9.2	1.2
5. Which software was used to create primary research data and records in your agency?				
(a) Microsoft Office		82.4	17.5	0
(b) Lotus Notes		72.7	27.2	0
(c) Open Office		51.6	39.4	9.0
(d) Other types of software		SPSS 75.6	-	-
		NUD*IST 94.1	-	-
		ATLAS.ti 73.9	-	-
		NVivo 87		

Of 411 respondents, 89.5% believed that they used a specific recordkeeping system to create their primary research data and records. However, 9.2% respondents believed that they did not use any specific recordkeeping system, whilst only 1.2% of them were not aware of the specific recordkeeping systems used to create their data and records. But intriguingly, answers

to question 5 provides evident to the recordkeeping systems believed by the respondents used to create data and records for research.

The intriguing results relate to the respondents' understanding or 'perception' of the term 'recordkeeping system'. The respondents answers may relate to their believed that the systems they used were recordkeeping systems. Pertaining to the IT officers answer to these questions, they have a significant role in developing systems that may include recordkeeping systems, and have an important role to play alongside records professionals and system users in support of electronic recordkeeping. Those respondents who answered 'No' to question 5 may well be due to their understanding of the term 'recordkeeping system' as suggested by the generic preservation framework. If the records managers in this case indicated 'No' to their answers to this question, this may indicated that they did not manage electronic records and therefore was not responsible for looking after them and they themselves did not use specific recordkeeping systems to create their organizational records.

The questions asked to elicit this data were close-ended questions, and may not have taken cognizance of the actual situation from the different types of respondents in accordance to their title. This data will be verified by the qualitative data from face-to-face interviews.

Like most operating systems provide for structured names for directories, sub-directories and files, naming conventions and document version controls. Data in Table 2 shows that majority of researchers 82.4% reported that they used Microsoft Office to create their research data and records, while 17.5% respondents who answered 'No' implies that they used different software to create their data and records.

Lotus Notes is another proprietary system used to create research data and records in the surveyed agencies. Majority of respondents 72.7% believed that their primary research data and records were created using Lotus Notes. This may suggests that the respondents may use Microsoft Office software in their PCs when they work in their officers and used Lotus Notes or other software programs in their Laptops. Since Open Office is another propriety software, this was also widely used by the respondents when 51.6% answered 'Yes' to question 5 (c). On the other hand 39.4% respondents who answered 'No' may have used other software packages with other respondents who answered 'Yes' and 'NA' which may include SPSS (75.6%); NUD*IST (94.1%); ATLAS.ti (73.9%); and NVivo (87%). This data may also relates to the findings of Question 4 and 5 where the respondents may interpret that Microsoft Office, Lotus Notes, Open Office, SPSS, NUD*IST, ATLAS.ti and NVivo as recordkeeping systems.

Table 3. Types of Databases Used to Create and Keep Primary Research Data and Records Types

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
6. Which database systems were used to create and keep primary research data and records in your agency?	411			
(a) MS SQL		60.3	30	9.7
(b) ORACLE		25.7	70.3	4
(c) MS ACCESS		70.3	29.7	0
(d) SYBASE		12.5	68.5	19
(e) Other types of data bases		INFORMIX 9.2	57.7	33.1
		BRAHMS 22.1	-	-
		STAR LIMS 18.7	-	-

Other than the various software packages used to create primary research data and records, surveyed organisations also create and keep their primary research data and record in different types of databases. Question 6 is to ascertain the types of databases used by the surveyed agencies to maintained and to a certain extent preserved their data and records. The most popular was MS ACCESS with 70.3% of the respondents answered 'Yes' and the least used was INFORMIX. Data in Table 3 suggests that surveyed organisations used different types of databases to create and maintained their data and records. For example relational databases may have been used to create and maintain office documents; object oriented databases may have been used to create and maintain design data and geographic/mapping data; flat file databases to create and maintain visual images and speech, video recordings, and sound recordings. Were these types of data and records in the various databases being preserved in an appropriate format as suggested by the CoP and UKDA generic elements? The following questions provide the answer to this question.

4.2 Managing the Creation of Records

4.2.1 Manage the Making of Records

Classification Scheme and Metadata

Prior to implementing any ERMS, the classification scheme must be developed; without the scheme, there would be computerised chaos in the ERMS repository. Normally, the classification scheme becomes the file folder structure used to file and store records in the ERMS. The top folder level should refer to the function and the next folder level to the activity. There may be another level for sub-activity, after which comes the records series level. It is at the records series level that the information or record is actually stored in the software together with the metadata.

According to Collins and Grogg (2011) a classification scheme is a hierarchical tool that can facilitate the capture, titling, retrieval, maintenance and disposal of records. The classification scheme is one of the important foundations for any electronic or paper records management program: it is the central tool used to describe, categorise and control records. Corrao, Robinson, Swiernik & Naeim (2010) explained that the classification scheme should process series or groups of records efficiently and effectively so that retention and disposition rules can be applied consistently. On the other hand Doering and Chilton (2008) stated that classification scheme allows for the comprehensive computerised search, retrieval and preservation of both the records and metadata.

Table 4. Classification Scheme and MetadataUsed for the Creation of Research Data and Records

Question	Total of Respondents	Yes (%)	No (%)	NA (%)
7. Is there a classification scheme embedded into the recordkeeping system in used for the creation of primary research data and record for research in your agency?	411	150 (36.5)	24 (5.8)	237 (57.7)
8. Is the metadata given to data and records in accordance to datasets convention?		(50)	(0)	(50)
9. Is there a metadata scheme embedded into the recordkeeping system in used for the creation of primary research data and records for research in your agency?		146 (35.5)	30 (7.2)	235 (57.1)
10. Are research data and records kept in your agency documented?		(84.9)	(0)	(15)

The analysis in Table 4 indicates that only 36.4% respondent believed that there was a classification scheme embedded into the recordkeeping system used to create research data and records. Contrary to this, 5.8% believed otherwise while the majority of 57.7% respondents were unaware of the situation. If the surveyed organizations used a record making system without a classification scheme records would not be able to be named in a consistent manner over time; difficult to retrieve all records relating to a particular function or activity; difficult in determining security protection and access appropriate for sets of records; difficult in allocating user permission for access to, or action on, particular groups of records; and difficult to determine appropriate retention periods and disposition actions for records.

Data on Table 4 shows that 50% respondents believed that metadata was created based on the datasets convention for research data and records while another 50% respondents indicated that they were not aware of the situation. From the observation made by the writer, it was noted that the creators of data and records used the research project name as the main metadata for each file title created and this was not in accordance to dataset convention.This situation in the surveyed Malaysian research institutions implies the lack of certain required elements of the UKDA and CoP models. The Data Archive's self-archiving repository (UKDA-store) provides a means for data creators to make available datasets and related information at a lower standard of documentation for the short to medium term. For CoP model, the record

capture process includes the registration and classification of the records as well as, if needed, the assignment of key words, so that the records are (uniquely) identifiable and searchable.

Table 4 shows the respondent on the availability of metadata scheme into recordkeeping system used to create and maintain primary data and records.

The term 'metadata' has become popular in discussions about the management of electronic records. In essence the word 'metadata' means 'data about data' which refers to information about information. The function of metadata is to provide the context for a piece of data or information so that the user of that information understands what he or she is using and how and why it came to be (Azad, 2008). Metadata is an important tool for preserving the authenticity and integrity of electronic records and there are best-known metadata schema and standards in place for records management. Recordkeeping metadata that is useful are 'terms and conditions metadata', 'structural metadata', 'content and use metadata'.

Data in Table 4 pertaining to the availability of metadata shows that majority of the respondents 57.1% were unaware of the availability of metadata, while only 35.5% answered 'Yes'. When question 10 was asked on the documentation of data and records, surprisingly 84.9% respondents answered 'Yes'. This data implies that majority of the respondents have no knowledge on metadata and may not understand the meaning of metadata. Even a proprietary system such as Microsoft software has a feature that allows users to capture metadata about document being created: the software will capture information such as author, title, keyword 'tags' and date. As creators of records, in this case the respondents need to be made aware of the importance of metadata through appropriate training programs.

Preservation of Data and Records at the Point of Creation

The CoP literature suggests that technology cannot determine the solution to the reliable and accurate creation of digital records or to their authentic preservation over the long term: organizational needs to define the problem and archival principles must establish the correctness and adequacy of each technical solution.Preservation is a continuous process that begins with records creation (Duranti, 2013). The process of preservation begins with saving electronic documents and it is important to define standard formats in which documents should be saved, particularly if many different software applications are in use or many people need to access and use records.

The objective of all questions under this section is to ascertain whether migration as one of the strategies for the preservation of digital resources is being considered and adopted by the surveyed respondents at their respective agencies at the creation points and maintenance of data and records as suggested by the CoP and UKDA. Managing the making of records encompassing migration strategy namely backward compatibility, interoperability, conversion to standard formats, and changing media. The most common types of primary research data and records created by any research institutions and related organizations suggested in the UKDA literature includes (1) Structured text/office documents; (2) Presentation graphics; (3) Design data; (4) Digital video recordings; (5) Speech and sound recordings; (6) Geographic/mapping data; (7) Interactive multimedia publication.

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Creation of Structured Text/Office Documents

The literature on UKDA suggests that structured text and office documents mainly consisted of literary texts; formal documents; corporate publications; commercial publications; web pages; sets of digital documents; digitised paper images; links/bundles created via office suites; groupware; and HTML. Data types may include alphanumerical data; data set; bibliographic data; tags to other data types (raster and vector graphics).

Table 5. Format Used for Structured Text/Office Documents

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
11. In which formats does your organization create and maintain structured text/office documents pertaining to primary research data and records?	411	MS-Word 81.3	18.7	0
		PDF 72.5	27.5	0
		RTF 29.2	35.7	35.1
		PostScript 15.4	28.2	56.4
		Lotus Notes Pro 44.5	19.5	36
		GOE 8	54.3	37.7

Table 5 shows the most popular word processing packages i.e. the MS-Word (Microsoft Word) software which has the *backward compatibility* as preservation strategy was being used to create and maintain research data and records in the form of structured text and office documents.The data indicates that majority of respondents 81.3% believed that MS-Word packages were used in creating and maintaining their research data and records. However, this analysis shows that not all the respondents used the same software packages in creating and maintaining their data and records in text formats and office documents across agencies. Evidently, those respondents who answered 'No' may have used many other software packages such as Lotus Word Pro and Open Office systems.

Further analysis of data in Table 5 shows that conversion to standard format PDF (Portable Document Format) as part of migration strategy for long-term storage has been considered and undertaken by the creators of data and records – believed to be practiced by 75.5% respondents. It is reasonable to assume that majority of the research project administrators, IT officers and records managers involved in this survey also used PDF format in saving and maintaining their administrative documents in the form of structured and plain text.

As shown in Table 5, RTF (Rich Text Format) is also one of the standard formats used to save and maintain research data and records among 29.2% respondents. However, 35.7% of the respondents thought otherwise, while 35.1% were unaware whether RTF was used to create and maintain the structured text and office documents in their respective agency. Data in Table 5.4 on page 153also showed that other standard formats were also mentioned by the respondents with 15.4% mentioning PostScript; 44.5% mentioning Lotus Notes Pro, while 8% mentioning GOE (Generic Office Environment of the EG systems) which is one of the Malaysian EG applications.

Creation of Data and Records in Graphic Formats

Presentation graphics of research data and records may consist of business presentations and formal courseware. Data types in the presentation graphics include vector/raster graphics; moving graphics; alphanumeric data; full motion video; interleaved audio and video. The digital information strategy suggested by the UKDA comprise of combination of backward compatibility and conversion to standard formats and changing media. Standard formatted forms suggested include PostScript; Adobe PDF and TIFF.

Table 6. Format Used for Presentation Graphics ormat used for presentation graphics

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
12. In which formats does your organization create and maintain presentation graphics of primary research data and records?	411	PDF 55.2	34.8	10
		TIFF 36.9	39	24.1
		MPEG 38.1	40.5	21.4
		AVI 29.3	49.8	20.9
		MOV 17.2	47.9	34.9
		GDI 13.1	58.4	28.5
		PostScript 9	57.2	33.8

Data in Table 6 shows that majority of the respondents believed that PDF format was being used to create, maintained and preserved their primary data and records with 55.2% answered ‘Yes’. While MPEG format scores second highest with 38.1% respondents. On the other hand, 36.9% respondents believed that TIFF format was used and AVI format with 29.3%. Other types of standard formats written by the respondents include MOV with 17.2%, GDI with 13.1% and PostScript with 9%.

Creation of Design Data

Design data are made up of many data types which include vector graphics (computer aided design); raster graphics (old manual drawings); and alphanumeric data (text documents plus attribute data in databases). They may be held in two and three-dimensional formats. The UKDA recommends the digital information strategy and make use of a combination of backward compatibility, interoperability and conversion to standard formats. For interchange they tend to rely on the de facto DXF format or Initial Graphics Exchange Specification (IGES) for two and three dimensional vector graphics. Standard formatted forms include HPGL; Encapsulated PostScript and TIFF.

Table 7. Format for Design Data Format for design data

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
13. In which formats does your organization create and maintain design data?	411	IGES 23.1	25.9	51
		HPGL 18.5	36.5	45
		TIFF 17.9	41.1	41
		PostScript 9	57.2	33.8
		DXF 3	61.6	35.4

In the Malaysian case, data in Table 7 suggests that the highest score goes to standard format IGES with 23.1%; second highest goes to HPGL with 18.5% and TIFF format with 17.9%. Other formats suggested by respondents are PostScript with 9% and DXF with 3%.

Creation of Digital Video Recordings

Digital video recordings, another specialised area, involve one main data type – motion video or moving image data. Increasingly, digital video resources contain interleaved audio and video data may also be held and managed in a database. Where practical, the UKDA have adopted the digital information migration strategy, especially conversion to standard format. The Motion Picture Experts Group (MPEG) standards provide several standards for the compression of full motion video. This is an area where early digital video material was created on proprietary applications and held in proprietary formats. Where the applications are now obsolete, a technology preservation or technology emulation strategy may be needed as a temporary measure to preserve the data. Applications used to create/manage/distribute video

recordings include digital video frames stored as bitmaps; audio files; audio/video interleaved; compression systems; relational and flat file databases.

Table 8. Format for Digital Video Recordings of Primary Research Data and Records

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
14. In which formats does your organization create and maintain digital video recordings of primary research data and records?	411	MPEG 38.1	39	22.9
		AVI 29.2	41.8	29
		MOV 17.3	27	55.7
		WMV 9	29.9	62
		DAT 5	46.7	48.3
		AXF 2	83	15

Data in Table 8 shows that MPEG is the most popularly standard format used for the creation and maintaining digital video recordings of data and records for research activities with 38.1% respondents. Followed by AVI with 29.2%; MOV with 17.3%; WMV with 9%. While other formats suggested by the respondents are DAT (5%) and AXF (2%).

Creation of Speech and Sound Recordings

Speech and sound recordings contain audio data; MIDI; and metadata. These are created by speech processing; audio recording and playback; symbolic music recording; relational and flat files databases. These may include music libraries; sound effects, radio broadcasts; sound recordings and media. According to UKDA, for these types of research data and records, the digital migration strategy is suitable, using a combination of backward compatibility, conversion to standard formats and changing media. Digital speech processing can be divided up into three areas: speech coding (the analogue-to-digital conversion of speech signals or waveforms, the compression of the digital signals, and the reverse digital-to-analogue conversion for play back purpose); speech synthesis (the translation by computers of a coded description of a message into speech, i.e. computers 'talking'); and speech recognition and understanding, which facilitate people 'talking' to computers, dictating text or issuing commands. Sound coding involves the analogue-to-digital conversion of sound signals, the compression and/or storage of the digital signal, and the reverse digital-to-analogue conversion for play back purposes. Any sound, including speech and music, can be recorded in this way. Music can also be described in a symbolic way - printed music scores have been used for

centuries. For computer systems the Musical Instruments Digital Interface (MIDI) standard defines how to code all the elements of musical scores, including notes, timing conditions, and the instruments to play each note. The sound files which are to be preserved will generally contain sound data coded either as a digitised analogue sound signal or as notes for a MIDI instrument.

Table 9. Format for Speech and Sound Recordings of Data and Records Format for speech and sound recordings of data and records

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
15. In which formats does your organization create and maintain speech and sound recordings of primary research data and records?	411	WAV 35.3	29.8	35
		AIFF 24.8	40	35.2
		AU 7.2	44.8	48
		MIDI 2.6	38.4	56

Data in Table 9 shows that there is evident of migration strategy for primary data and records for research in the form of speech and sound recordings. Majority of the respondents 35.3% of them believed that WAV (Microsoft Windows Audio File Format) was used. On the other hand, 24.8% used AIFF (Audio Interchanged File Format), 7.2% believed AU (Sun Microsystem's Audio File Format) was used and only 2.6% thought that MIDI was used.

Creation of Geographic/Mapping Data

The literature on UKDA implies that geographical or mapping data can cover almost all data types, including raster graphics (base mapping data), vector graphics, and alphanumerical data held in databases. Geographical data can be held in two and three-dimensional formats. Cartographic software packages range in sophistication and functionality from atlases and route planners up to full geographical information systems (GIS). For this category of digital resource the digital information migration strategy is recommended, using a combination of backward compatibility, interoperability and conversion to standard formats as appropriate, with changing media as a back-up option.

Table 10. Format for the Preservation of Geographic/Mapping Data Format for the preservation of geographic/ mapping data

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
16. In which formats does your organization create and maintain speech and sound recordings of primary research data and records?	411	PDF 19.2	28.8	52
		RTF 17.6	19	63.4
		HTML 11.6	14.2	74.2
		XML 6.8	24.1	69.1
		SGML 3.4	19.4	77.2
		RDF 1.2	24.3	74.5

Table 10 shows data pertaining to the respondents rating on formats used for the creation and maintaining geographic or mapping data created by the research institutions and related organizations. PDF was the most used as believed by 19.2% respondents, with 17.6% respondents believed that RTF was used. HTML with 11.6%, XML with 6.8%, SGML with 3.4% and the least is RDF with 1.2%.

Creation of Interactive Multimedia Publications

By definition multimedia publications involve at least three data types. Most contain motion video with audio data interleaved; many comprise animation with interleaved audio data; and many will also involve some still images, graphics and alphanumeric data. Most early multimedia publications were produced on one of the compact disk (CD) formats and will have been authored and edited using proprietary multimedia editing and authoring packages. They will be accessed via proprietary access software. A strategy of technology preservation or technology emulation may be the best way to preserve the data until a practical migration strategy is developed. It may prove difficult to migrate the data in future without the loss of considerable data.

Table 11. Format for Interactive Multimedia Publications of Primary Research Data and Records
Format for interactive multimedia publications of primary research data and records

Questions	Total of Respondents	Yes (%)	No (%)	NA (%)
17. In which formats does your organization create and maintain primary research data and records of interactive multimedia publications?	411	JPEG 59.3	18	22.7
		MPEG 51.1	23.9	25
		WAV 45.9	33.4	20.7
		AVI 31.6	36.3	32.1
		MOV 21.8	48	20.7
		PNG 15.1	40.1	44.8
		AIFF 10.2	41.4	48.4
		DGI 3.4	68.4	28.2

Data in Table 11 shows that JPEG (Joint Photographic Experts Group) is the most used format with 59.3% respondents believed that their interactive multimedia publications was created and maintained in this standard format. Next is MPEG (Moving Picture Experts Group) with 51.1%; WAV (Microsoft Windows Audio File Format) with 45.9%; AVI (Audio Video Interleaved) with 31.6%; MOV (Movie File Format) with 21.8%. Four types of formats were suggested by the respondents as other types of formats used for their interactive multimedia publications of research products. These are: PNG (Portable Network Graphic) with 15.1%; AIFF (Audio Interchange File Format) with 10.2% and the least is GDI (Graphical Device Interface) with 3.4% respondents.

4.2.2 Select and Preserve Records

Appraise Records for Permanent Preservation

In the CoP and UKDA models, primary research data (and where possible/relevant specimens, samples, questionnaires, audiotapes, etc) must be appraised and retained in their original form within the research establishment that generated them for a minimum of ten years from completion of the project (JISC Infonet, 2007). Research found that research data centres like UKDA are highly valued by their users (http://www.ukdataservice.ac.uk). Benefits appear to be particularly strong around improving research efficiency, especially access to data. CoPpreservation framework adopted the perspective or viewpoint of the records creator for

preserve reliable and authentic digital records. As is widely recognized, digital records must be carefully managed throughout their entire existence to ensure that they are accessible and readable over time with their form, content and relationships intact to the extent necessary for their continuing trustworthiness as records (Eastwood, Hofman & Preston, 2008).

Table 12. Appraise Records for Permanent Preservation Appraise records for permanent preservation

Question	Total of Respondents	Yes (%)	No (%)	NA (%)
25. Are data and records appraised for their value for permanent preservation purpose?	411	35.7	0	64.3

The findings in Table 12 shows that there was activity on records appraisal as suggested by 35.7% respondents who believed such practice was undertaken in their respective agencies. However majority of the respondents 64.3% were unaware of the appraisal activity. This data will be verified with the qualitative data from face-to-face interviews to ascertain whether it is true that appraisal process was undertaken by surveyed organizations as suggested by 35.7% respondents.

Acquisition of Selected Records

UKDA ensure best use of resources by providing a framework for managing the preservation procedures with the aim to develop and maintain systems of low-cost storage, with appropriate location and with regular review and optimize the use of the Archive's space for storage purposes of permanent preservation of selected data and records of value for future research. Adequate storage capacity for all holdings is maintained by UKDA (UKDA, 2014). The CoPpreservation framework does not specify on specific technology to store data for selected data and records, but the digital components of the creator's records, and their metadata is stored in a storage system on digital media which already existed and allocated by preserver (Eastwood, Hofman & Preston, 2008).

Table 13. Acquisition of Selected Records Acquisition of Selected Records

Question	Total of Respondents	Yes (%)	No (%)	NA (%)
26. Is accruals of selected data and records for permanent preservation being practiced in your organizations?	411	14.3	14.3	71.4

The exploration of data in Table 13 shows that only 14.3% respondents believed that selected data and records were acquired for permanent preservation. While 14.3% respondents

believed this practice was not carried out. It is not surprising that majority of the respondents, 71.4% of them were unaware. This may be due to the fact that all data and records were being kept by the researchers themselves and only published data and records in the forms of reports and journal articles were being transferred to the organizational libraries to provide access by internal users only.

Preserve Acquired Records

The aim of question number 27, 28 and 29 is to ascertain the existence of mechanisms available in the surveyed organizations pertaining to the preservation of their research data and records. These may include the availability of ICT infrastructures, systems, networking, policies, procedures, standard operating procedures, work processes, rules and regulation with regards to the management of research data preservation program. Policies, strategies and standards are to ensure the longevity of digital records and the ability of users to trust the authenticity of those records. InterPARES has developed a number analytical instruments and tools aimed at helping both individuals and organizations manage the creation, maintenance and long-term preservation of authentic digital records (Preston, 2007 p.2). For example, the Baseline Requirements consists of the requirements that support the production of authentic copies of digital records transferred to the custody of the preserver and maintained within the preserver's preservation system. Plus, without establishment of guidelines on preservation of electronic records, it prevents the agencies from doing the right thing regarding to the preservation processes and activities (Rusnah, 2006 p. 240).

Table 14. Preserve Acquired Records Preserve acquired records

Question	Total of Respondents	Yes (%)	No (%)	NA (%)
27.Does your organization have specific mechanisms for keeping and preserving research data?	411	50	28.6	21.4
28. Are there agreed process of appropriate storage method for printed and electronic format?		42.9	0	57.1
29. Is there an agreed policy on the length of time to keep research data and records (duration)?		14.3	35.7	50

From the survey data in Table 14 illustrates that half of the respondents which is 50% of them believed that their organization has specific mechanisms by which research data were kept and being preserved in the organization. However, 28.6% of them did not believe so by answering 'No'. While the rest 21.4% of the respondents were unaware of the availability of the mechanisms. From the survey findings, it can be concluded that there was some kind of mechanism to regularly preserve primary research data in the research institutions in Malaysia as suggested by 50% respondents. This was due to the fact that it was important for the researchers in all fields to manage, maintain, generate and analyse research data effectively and efficiently.

The strategy employed by UKDA and CoP preservation framework is to deal with the obsolescence of file formats through the different types of migration strategy. In UKDA, the environmental parameters which control the storage media are tightly controlled to reduce the vulnerability of these media. Additionally, the strategy to reduce the risk of obsolescence is based on storing multiple copies on different storage media as well. These are reviewed regularly and data are copied onto new media when appropriate (http//www.ukdataservice.ac.uk). When the format of a type of digital components is obsolete, CoP model suggested the use of a targeted preservation strategy to migrate these digital components to the chosen current standard formats, and associate with this group of digital components documentation of the actual migration.

The analysis of data in Table 14 shows that only 42.9% respondents indicates the availability agreed process of appropriate storage method for printed and electronic form of research data and records, while majority of them 57.1% were unaware of the availability of such practice. Since majority of the respondents are consisted of researchers, this data implies that in actual practice there was an absent of agreed processes as all data and records were being kept personally by the researchers themselves without complying to any best practice procedures.

In a standard best practice procedure, research data and records must be properly stored accordingly to achieve what was highlighted in the UKDA data management lifecycle requirement elements and CoP framework. In the case of the CoP model, a situation of optimum resources is assumed to allow users to picture the ideal towards which, in any given real situation, they may work. Various tools, such as information technology and other equipment and supplies, will be needed to manage the lifecycle of records, as will physical facilities and infrastructure. In a real situation, lack of these resources obviously constrains what can be done (Eastwood, Hofman &Preston, 2008).

The findings of question number 29 in Table 14 shows that out of 411 respondents, only 14.3% believed that there was an agreed policy on the length of time to keep research data and records. In managing research records and organizational records, appraisal is the key element in ensuring records is well kept and managed. With small number of “Yes”, its lead to majority of 50% respondents who were unaware of the situation, while 35.7% stated that the agreed policy was not available. Duration of keeping research data/records enable the organization to know which records is current, semi-current and non-current. In research, up-to-date data is needed by the researchers to have collection of reliable and authentic data and records. Without a proper policy of the length of time and duration to keep research data, it is quite impossible that the reliability and authenticity of the data stored and retrieved by the users could be ensured. As determined by the creator’s retention schedule, the final recordkeeping system activity in CoP model provides an overall control and co-ordination of records disposition activities in accordance with disposition activity directives and disposition rules, procedures and strategies (Eastwood, Hofman& Preston, 2008).

Data Distribution and Reuse

As highlighted in the CoP model and UKDA elements, as data and record are systematically selected and kept, the output of data and records of value should find their way to external end-users or other researchers for other purpose such as to produce new knowledge and inventions. Considering the practices of Economic Social Research Council (ESRC), the development of data sharing in the UKDA is far more advanced and matured while there are much room of development in the case of research institution in Malaysia. The ESRC Data Management Plan considers few systematic processes for data management while such data management plan is not available in the surveyed research institutions in Malaysia. ESRC Data Management Plan includes data sharing and archiving in their process. When the data was not shared and archived, as in the case of surveyed research organizations in Malaysia, it depicted the problem of access and reuse to the data because it was not ready for such things. Despite of the research data kept within the holdings by the research organizations.

Table 15. Data Distribution and Reuse Data distribution and reuse

Question	Total of Respondents	Yes (%)	No (%)	NA (%)
30. Is open access to research data and records being practiced in your organization for the purpose of data reuse by external users?	411	64.3	0	35.7
31. Is online access to primary research data and records make available to external users?		35.7	28.6	35.7
32. Are copies of research data and records supplied to external users?		28.6	35.7	35.7

With regard to open accessibility of research data and records for use and reuse, data in Table 15 shows that majority of the respondents 64.3% altogether agreed that open access facility was being provided for external users. However, 35.7% were unaware of the open access practice. Analysis of data in Table 15 shows on matters pertaining to online access of data and records shows that 35.7% respondents believed that online access of data and records was available for external users. But 28.6% respondents believed otherwise and the rest 35.7% were unaware of the practice. This implies that some of the research institutions did not provide online means for data distribution. This data will be verified through the interview data in the next phase of the study. This is practiced in the CoP model and UKDA elements, where the records are distributed to the end-users or researchers by any means as appropriate. The UKDA's HTTP-based download service provides a quick and reliable means of gaining access to the most heavily used collections held at the UKDA (Beedham, Missen, Palmer and Russalepp, 2005). The UKDA also provides online access to data that have been enhanced and published via the Nesstar system. A minority of data are mounted in the Nesstar system for online browsing and visualization of the data, including tabulation, graphing, book marking, sub-setting, filtering and downloading which is based on the DDI standard. This approach has

enabled the UKDA to remain at the forefront of technological developments for searching and browsing datasets and in the development of tools for both users and data archivists (Beedham, Missen, Palmer and Russalepp, 2005)

Data in Table 15 indicates that only 28.6% respondents believed that copies of research data and records are supplied to users whereas 35.7% respondents responded otherwise and another same percentage were unaware of the practice. This implies that data sharing was not fully practice by the surveyed research institutions. Without data sharing, this may result in redundancy of research and at the same time hampering the reuse of data for the purpose of invention and innovation activities. In the webinar presentation given during Open Access Week at University of Exeter on November 8, 2012, which indicates that:

"*Publicly funded research data are a public good, produced in the public interest, that should be made openly available with as few restrictions as possible in a timely and responsible manner that does not harm intellectual property*" (Research Councils UK Common Principles of Data Policy, 2012).

6. Conclusion

The objective of the quantitative data gathered by means of the survey questionnaires was to investigate the current practices on the preservation of primary research data. The questions asked were based on the elements of the generic preservation framework of the CoP and UKDA in order to set the questions into context with the overall aim of the study which is to develop a preservation framework for the preservation of primary research data and records created by the public sector of the Malaysian federal government. The main concern of the survey questionnaire is to ascertain whether migration as one of the strategies for the preservation of digital resources is being considered and adopted by the surveyed respondents at their respective agencies at the creation points and maintenance of data and records. Based on the generic preservation framework elements, migration is not optional – it is an essential operation, given the fact that the computer operating environments of digital archives will inevitably change over time. There are a variety of migration strategies, appropriate to different formats of digital materials. InterPARES and UKDA make the point that no single strategy applies to all formats and none of the current preservation methods is entirely satisfactory. Migration strategy includes backward compatibility, interoperability, conversion to standard formats and changing media.

Significant evident of the survey findings point to the creation of different types of research data and records of research activity outputs by the Malaysian research institutions and related organizations. These are data sets; structured texts; office documents; design data; presentation graphics; visual images; speech and sound recordings; video recordings; geographic/mapping data and interactive multimedia publications of research products. Data types created by the key players of research programs include alphanumerical data; mark-up data; raster and vector graphics; moving graphics; audio data; metadata; event data, administrative data; attribute data; bibliographic data etc. It is evident from the survey data that a specific ERMS or recordkeeping was not used to create research data and records. Therefore in most cases data were not appraised for their values as there was significant

evident that records retention schedules and plan was not in place in the surveyed research institution and related organizations.

However the findings of the survey questionnaires could not ascertain whether the identified primary research data and records were being transferred and preserved in a centralized repository or data archives even though the data suggests that there was a provision for open accessed of primary research data and records to a certain extend to internal and external users.

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