



## TECHNICAL ASPECTS OF DIGITAL PRESERVATION OF BRAZILIAN JOURNALS IN INFORMATION SCIENCE

ASPECTOS TÉCNICOS DA PRESERVAÇÃO DIGITAL DE PERIÓDICOS BRASILEIROS EM CIÊNCIA DA INFORMAÇÃO

ASPECTOS TÉCNICOS DE LA PRESERVACIÓN DIGITAL DE REVISTAS BRASILEÑAS EN CIENCIAS DE LA INFORMACIÓN

Priscilla Mara Bermudes Araujo<sup>1</sup>  
Rosali Fernandez de Souza<sup>2</sup>

### ABSTRACT

The work emphasizes technical aspects of digital preservation of electronic journals in Information Science published in Brazil. It presents concepts and features of digital objects, models, internationally recognized standards and formats, in addition to strategies that can be used as important tools for digital preservation of electronic journals. International and national initiatives for digital preservation of electronic journals are identified, among them the Cariniana Network - the first Brazilian collective initiative. The empirical study analyzes the questionnaire sent to the editors of the journals selected for the survey. The results highlight the technical aspects of digital preservation of Brazilian electronic journals in Information Science, contributing to the importance of using such aspects to ensure the proper storage, integrity, usability and access to these publications.

**KEYWORDS:** Conservation techniques. Access to information. Information technology. Periodicals. Information Sciences.

### RESUMO

Ressalta aspectos técnicos da preservação digital dos periódicos científicos eletrônicos em Ciência da Informação publicados no Brasil. Apresenta conceituações e características de objetos digitais, modelos, padrões e formatos reconhecidos internacionalmente, além das estratégias que podem ser empregadas como importantes ferramentas para a preservação digital de periódicos eletrônicos. São identificadas iniciativas internacionais e nacionais de preservação digital de periódicos eletrônicos, entre elas, a Rede Cariniana - a primeira iniciativa coletiva brasileira. O estudo empírico analisa o questionário aplicado aos editores dos periódicos selecionados para a pesquisa. Como resultados são destacados os aspectos técnicos da preservação digital dos periódicos científicos eletrônicos brasileiros em Ciência da Informação, corroborando a importância da utilização de tais aspectos para garantir a guarda apropriada, a integridade, a usabilidade e o acesso a essas publicações.

**PALAVRAS-CHAVE:** Preservação de material. Acesso. Tecnologia da informação. Periódico. Ciência da Informação.

### RESUMEN

Hace hincapié en los aspectos técnicos de la preservación digital de las revistas científicas electrónicas en Ciencias de la Información publicadas en Brasil. Presenta conceptos y características de los objetos digitales, modelos, normas y formatos reconocidos internacionalmente, además de las estrategias que se pueden utilizar como herramientas importantes para la preservación digital de revistas electrónicas. Se identifican las iniciativas

<sup>1</sup> Mestre em Ciência da Informação (UFRJ/IBICT). Tecnologista Sênior do Instituto Brasileiro de Informação em Ciência e Tecnologia (IBICT). Brasília, DF. E-mail: [pris\\_bermudes@hotmail.com](mailto:pris_bermudes@hotmail.com). ORCID: <http://orcid.org/0000-0003-1076-0081>.

<sup>2</sup> Doutora em Ciência da Informação (Polytechnic of North London). Pesquisadora Sênior titular do Instituto Brasileiro de Informação em Ciência e Tecnologia (IBICT). Brasília, DF. E-mail: [rosalifs@gmail.com](mailto:rosalifs@gmail.com). ORCID: <http://orcid.org/0000-0002-0890-7999>.

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internacionales y nacionales para la preservación digital de revistas electrónicas, entre ellas la Red Cariniana - la primera iniciativa colectiva brasileña. El estudio empírico analiza el cuestionario a los editores de las revistas seleccionadas para la encuesta. Los resultados destacan los aspectos técnicos de la preservación digital de revistas electrónicas brasileñas en Ciencias de la Información, lo que corrobora la importancia de utilizar dichos aspectos para asegurar la adecuada custodia, integridad, facilidad de uso y el acceso a estas publicaciones.

**PALABRAS CLAVE:** Técnica de conservación. Acceso a la información. Tecnología de la información. Publicación periódica. Ciencias de la Información.

## 1 INTRODUCTION

The digital preservation is an activity that enables the registered information to be permanent, assuming a main role in the social, historical, cultural scientific and technological context, assuring a long-term access and the safeguard of the scientific and technological information.

The crescent production of digital objects, the renovation of the technologies and the temporality related to the digital contents become a challenge to the digital preservation. Therefore, the absence or an inadequate use of methodologies will compromise not only the long-term access to these objects, but also the scientific memory safeguard of the institutions.

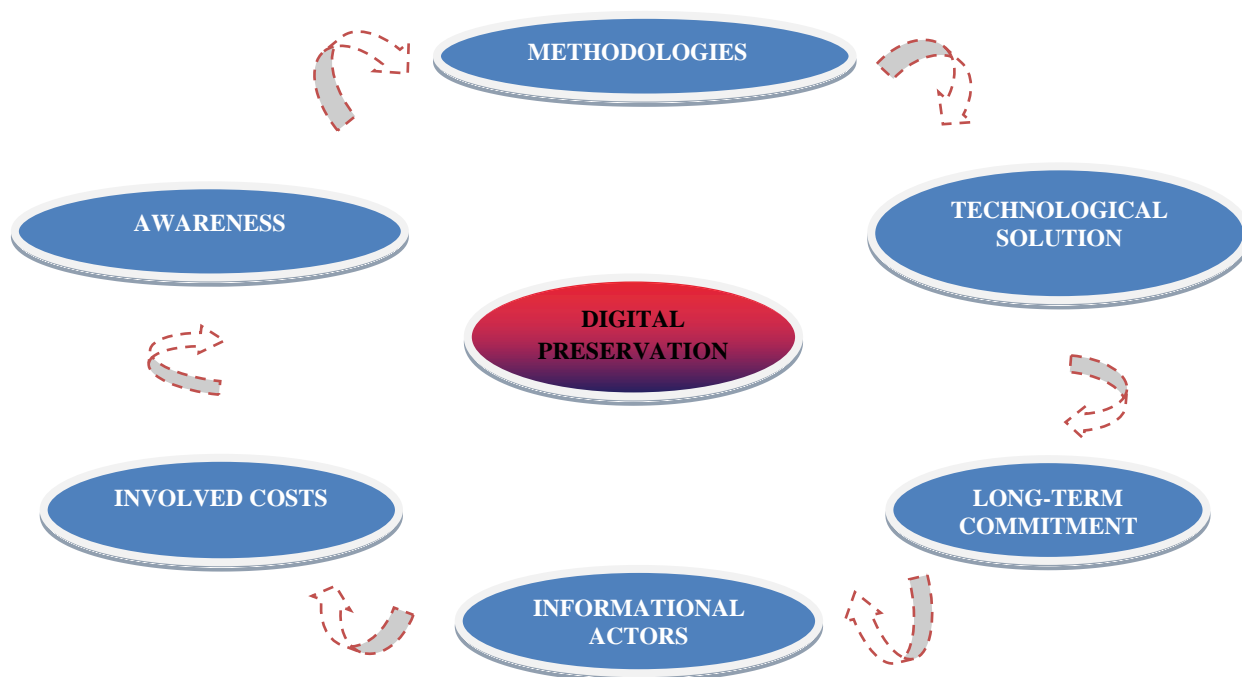
It is important to highlight the question of the used methodologies to keep the application of the digital contents, due to the innovations which are a result of the improvement of the Information and Communication Technologies (ICTs) in a shorter time, becomes primordial that the documentation of the used technology at the time in which the digital objects were created so they can be accessed and used. This way, planning and establishing appropriate strategies are necessary measurements to keep the digital contents in an appropriate and safe state of storage, as well as to safeguard a later use.

Starting by the safeguard of the scientific community production, the scientific journal is considered the main information tool, due to its own characteristics assure the credibility, the fast availability of scientific discoveries, the quality and the peer recognition of them published contents.

The production and the availability of scientific journals in the web allow new ways of access to its contents, in a faster, more dynamic and less expensive way, beyond the publication facilities, self-storage and the movement of the open access. However, as time goes by, the technological obsolescence, the physical degradation, a bigger facility in the falsification and plagiarism of the contents, the possible environment catastrophe and the access difficulties caused by scientific editors implicate in the establishment of effective actions in the preservation of digital documents to guarantee the access and the permanent integrity of the contents.

The digital preservation of the electronic journals involves organizational, technical

and legal aspects. This way, the necessary key elements to make a decision in relation to the preservation of these digital objects are presented below:



**Picture 1** – *Key elements involved in the activity of digital preservation*  
 Source: ARAUJO, 2015.

Picture 1 synthesizes the key elements that permeate the preservation of digital objects. The Methodologies involve the politics, guidelines, international standards and strategies which will be used to assure an adequate storage and a continuous access of what we intend to preserve. The Awareness means be aware that the information preservation must be firstly considered. The Technological Solution is related to the technology adoption to the digital preservation which will be used (and also if there will be participation of any collective initiative to digital preservation, use of patterns and formats, specially open). The Involved Costs are the continuous investments of the information actors for the durability of the activity of digital preservation. The Long-Term Commitment refers to the commitment of the information actors so that the preservation of digital objects will be continue, no matter which problems may appear; and, the Information Actors are the basis for the consolidation of the other key elements, because they permit, directly or indirectly, that the digital preservation actions are done.

Discussing this topic was a motivation because of the insipience of digital preservation actions in Brazil, lack of specific national literature about electronic scientific journals preservation, the importance of investigating the procedures related to the preservation of scientific journals in digital environment and to know the current state of the digital

preservation of electronic scientific journals in the country.

As it is impossible to include all knowledge areas, it was chosen to focus the empirical analysis in the area of Information Science, as it has a meaningful number of electronic scientific journals for an exploratory research and, because the studies related to the situation of the digital preservation of Brazilian electronic scientific journals in this area are not enough.

This work tried to identify in the literature, in analytical and exploratory studies, the procedure elements – specially the technical aspects – and the types of practice involved in the digital preservation of electronic scientific journals in the area of Information Science published in Brazil. Therefore, it was possible to get a wide view of the national situation of the digital preservation of journals in this area of knowledge.

## 2 DIGITAL OBJECTS

According to the literature, the digital object is a topic in development. A few studies about this topic indicate a lack of terminological and conceptual precision related to the digital objects.

According to Ferreira (2006, p. 70, own translation) the digital objects are:

Every and each information object which can be represented through a sequence of binary digits (*bitstream*). Text documents, digital photographs, vector diagrams, data basis, video and audio sequences, virtual reality models, web pages, and games or software apps are only a few examples of what can be considered a digital object.

This author considers that the main difference between digital objects and printed objects (books, journals and other documents registered in paper) is that in the printed ones the access to information is done directly in the object, and in digital objects, “layers” of technological interference are needed (*hardware/equipment* and *software/format*), and without these the information cannot be accessed and used. Besides that, as there is this dependence, the digital objects become very vulnerable to the technological obsolescence.

To Márdero Arellano (2004, p. 16) “a digital object is the one which was created in computer, and can be the original or a version after being converted (or digitalized).” And also, the author registers that “digital object: types of archives found in the digital environment, compounded by a set of bit sequences about information contents, metadata and identifiers.” (MÁRDERO ARELLANO, 2008, p. 355).

The Consultative Committee for Space Data Systems (2012, p. 21), says that digital object is: “an object composed by sequences of binary digits.”

By the described concepts and approaches, we can infer that an object can be considered digital if it was born in an environment in which its information and representation were created in bits (binary digits). And also, the digital object can also be created through scanning methodologies, which is converting a physical document to a digital one.

Talking about the preservation of digital objects it is important to register that “the preservation of the physical object and of the logical object is not a warranty of getting the conceptual object. It is necessary to preserve a way of translating the logical object to the conceptual one. Summing up, it is the **conceptual object** which must be **preserved**” (YAMAOKA; GAUTHIER, 2013, p. 85, own use of bold).

Araujo (2015, p. 32) has found that the conceptual object must be preserved due to the necessity of keeping the structural, appearance and content properties which are in the digital objects, so we can assure its accuracy, usability and accessibility for future generations.

Sayão (2010b) highlights that the digital objects, because they are susceptible to alterations (on purpose or not), and also to the media fragility when deteriorated or obsolete, can result in partial or total loss of information. Even the preservation actions can change the format or function of a digital object, so it is really important to document its characteristics, history, including the alterations they suffered.

For this study the electronic scientific journals are considered **digital objects**. The next section shows what is necessary to establish the methodologies that aim the implementation and management of the digital preservation of electronic scientific journals.

### 3 TECHNICAL ASPECTS IN THE MANAGEMENT OF THE DIGITAL PRESERVATION OF ELECTRONIC JOURNALS

The technical aspects refer to the resources which may be considered for the implementation and management of the digital preservation in conformity with the technological infrastructure, the storage management of digital objects, authenticity, usability and a long-term access.

We will firstly highlight the internationally recognized models, patterns and formats which can be used as important tools in the aids for the digital preservation of electronic journals. Afterwards, we will approach the strategies applied in the preservation of these digital objects.

### 3.1 Reference model OAIS

The Consultative Committee for Space Data Systems (CCSDS) published in 2002, and recently a new version in 2012, the reference model OAIS (Open Archival Information System) that guides the digital preservation initiatives in its actions of preservation and maintenance of the access to digital information in a long-term period with warranty and reliability. In 2003, this reference model became an international standard, regulated by ISO 14721:2003.

Thomaz and Soares (2004), say the environment OAIS is composed by four entities, which are: a) Producers: people who give the information which will be preserved; b) Customers: people who are interested in using the preserved information; c) Administration: the responsible for the politics of the model; d) Archive itself: refers to the information to be preserved, and can also be called “information object”, composed by the “given object” which represents the original digital object and the “information representation” which contains the descriptive information, this is, the metadata which describe the “given object” with its preservation characteristics.

Besides these entities, Grácio (2012) registers that there are six functional entities which manage the information flow among the entities of the environment OAIS which are: a) Reception which is responsible for the acceptance and treatment of the Submission Information Package (SIPs) of the producers and for the addressing of the Information Archiving Package (IAP) for the storage and of the metadata for the data management, according to the formatting and the determined patterns; b) Storage which deals with the storage, maintenance and recovery of the IAPs, using already defined criteria; c) Data management which keeps and accesses the descriptive metadata and the administrative data used to manage them; d) System administration is responsible for the archive operation as a whole; e) Preservation planning is responsible for the monitoring of the OAIS environment and designs recommendations to assure that the preserved information will be accessed by the future generations, independent of the obsolescence of the original technological environment; f) Access is responsible for the Customers necessities attendance by discussion, results and storage information requests in the OAIS environment.

Souza *et al.* (2012) highlight that the reference model OAIS is essential for the development of digital preservation initiatives and confirm the importance of the stipulated criteria for this model so a digital preservation solution can be successful, because the model OAIS not only stipulates preservation criteria but also provides a simple understanding model to help in the construction and initiative organization in this area.

### 3.2 Patterns and Formats



Many authors emphasize besides the importance of the reference models using, the use of patterns and formats internationally recognized for the establishment of politics, strategies and digital preservation actions.

Sharing this premise, the thought of Bodê (2008, p. 35, own use of bold) when he informs that:

A crucial point about Archive Formats and that is directly connected to the problems with its preservation refer to the fact that it is a proprietary format or not. The **open archive formats** (those in which the public has the access to the technical details) are more adequate for the **future preservation**, because the possibilities of **comprehending** the meaning of its bits structure are bigger.

Other studies mention Márdero Arellano (2008) highlighting that the worldwide projects and initiatives emphasizes the imminence necessity in the adoption of metadata patterns recognized for the use of open formats, because they provide the future comprehension and facilitate the conversion to after formats which came from new communication and information technologies.

This way, we can conclude that the conversion to patterned and interoperable formats which are supported by companies or open initiatives must be considered when talking about digital preservation of electronic journals, because they can assure the access and usability permanent of the digital objects which use this format.

Grácio (2012) adds that in the strategies for digital preservation of electronic journals as in the migration strategy it is necessary to create converters so the digital objects can be migrated without information loss, as well as the development of maintainable archives extensions. This involves not only the hardware and software but also the digital objects format in which:

[...] many initiatives indicate the use of open formats, so even after the obsolescence, the institutions can understand in the future the obsolete format and create tools that convert them to a new format. The use of proprietary formats, in which the description technology of a digital object is unknown, can lead to this digital object loss in case of discontinuity of this format (GRÁCIO, 2012, p. 139-140).

Besides that, the use of these open technologies allows an experience exchange among the organizations, as well as it helps in the uniformity of digital objects management to be preserved, says Grácio.

These ideas corroborate so that models, patterns and formats must be developed in a democratic and clear way, so they are available to be analysed and used by everybody. It means to fulfil the objectives of digital preservation, that is, the appropriate and safe storage of digital objects, the authenticity warranty and reliability of its contents and to assure the

continuous access of these objects.

### 3.2.1 PDF/A

A promising example of open formats initiative which is being largely used for the digital preservation of electronic journals is the PDF/A.

The *Portable Document Format/Archiving* (PDF/A) is a format of open archive for the preservation or storage of digital objects in a long-term period, based in the original format *Portable Document Format* (PDF) of the company *Adobe Systems*.

In September of 2005, after many studies, the working group led by public and private institutions, among them the *Library of Congress*, the *National Archives and Records Administration* (NARA), the *Adobe* and the *Xerox* has chosen a new format for the preservation of electronic documents over time, which was regulated as ISO 19005-1: the PDF/A-1.

Mortara says that PDF/A:

[...] was the first pattern ISO which approaches a growing necessity of keeping the information stored in electronic documents for a long period of time. The PDF/A is a derivative of the company's specification, the PDF, with restrictions and some few additions which make a PDF reliable and adequate for the storage and reading for long periods of time (MORTARA, 2011).

As mentioned above, the PDF/A format was developed aiming at take advantage of the benefits of the PDF format and to incorporate specific benefits to be used in the scope of digital preservation of digital objects.

In the studies of Bodê (2008) there are seven essential characteristics which describe and consolidate the PDF/A as an appropriate format for digital storage of electronic journals: 1. Device Independence, that is, being an independent format of any software or hardware platform used for its reading or printing; 2. Self Content, that is, being self-sufficient, because what is necessary to visualize or print a PDF/A-1 is in the archive. This way, Bodê stresses that a diagnosed problem is the lack of incorporation of the sources archives, that is, the types of number, characters, text characters and other symbols; 3. Self Description, as it describes all the information which is the metadata of the archive; 4. Clearness means that the text contents can be extracted and read no matter the device or specific app which allows the archive reading in this format, allowing its easy use; 5. Accessibility, as it does not have protection mechanisms and access restrictions – prohibition of encryption resources use and protection passwords – it promotes a free access to the content of digital objects in PDF/A, as well as it facilitates its future use independent of the technology at the time, it is also important to mention that the digital signature is accepted in this format, since the used source is in the PDF/A; 6. Specification Opening refers to the legal authorization for a public use of the technical information of the archive format; 7. Adoption means that the



characteristics of the PDF/A allows that this format is largely available in the Market, allowing its growing and general use. Besides that, Bodê informs that the more the format is flexible and popular, the more the possibilities of the digital objects preservation grow for the future generations.

Therefore, we can conclude that the PDF/A is an appropriate format for the electronic journals provide its articles, because it is an open format and has characteristics which allow their digital preservation.

### 3.2.2 Digital Object Identifier (DOI)

Another important technical aspect to be considered in the topic of digital preservation of electronic journals is the use of persistent and permanent identifying systems that is a name used for a digital resource keep the same forever, independent of its localization. This way, “the use of a persistent identifier assures that, even when a document is removed, or its property is transferred, people can still use their links” (SAYÃO, 2007, p. 68).

Sayão (2007) points that the most important schemes of persistent identifiers are: *DOI*, *URN*, *PURL*, *Handle System* and *Open URL*. However, among these permanent identifiers mentioned, the *Digital Object Identifier (DOI)* Works as the main mechanism of a link for a complete text, for the scientific editors, especially for scientific journals.

DOI is a system for the identification of documents in the internet which localizes and accesses permanently materials in the digital environment, facilitating the document authentication, especially the journals and the writings protected by copyright.

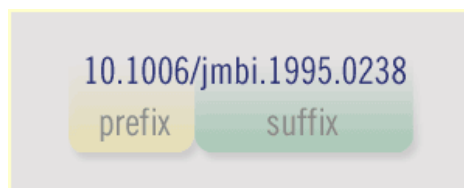
The DOI system was originated in 1997, since a joint initiative of three professional association in the editorial industry (*International Publishers Association; International Association of Scientific, Technical and Medical Publishers; Association of American Publishers*). Even from a textual publishing, the *DOI* was planned as a generic structure for the content identifying management in digital web, recognizing the tendency for a digital convergence and multimedia availability.

The DOI Organization<sup>3</sup> (2014) also informs that in 1997 was created to develop and manage the DOI system, the *International DOI® Foundation (IDF)* and since its creation the IDF continues working with the *Corporation for National Research Initiatives (CNRI)* as a technical partner, using the Handle system developed by CNRI as a component of digital web of the DOI system.

<sup>3</sup> Available at: <<http://www.doi.org/index.html>>. Accessed on: Dec.16, 2014.

The first application of the DOI system was in 2000 by the CrossRef register agency in electronic articles. In the same year, the syntax of the DOI was standardized by the National Information Standards Organization (NISO) and in 2010, the DOI system was approved as an international standard, regulated by the ISO 26324, with its most recent publication in 2012.

The persistent identifier DOI is composed by two components, one prefix and one suffix, separated from a bar, as shown in the picture:



**Picture 2 – DOI Structure**

**Source:** CROSSREF, 2013.

Picture 2 shows the composition of DOI, in which all prefixes start with a "10" to differ DOI from other implementations of the Handle System, followed by a number of four digits or chain (the prefix can be longer, if necessary). In general, each member has a prefix but it is possible for members to have many prefixes (for example, a prefix for each journal title). The suffix is determined by the editor, according to the creation of a suffix system stipulated by the DOI. Besides that, the DOI does not differ capital letters and small letters (for example, 10.1006/abc is the same as 10.1006/ABC) and the suffix must be the only one inside a prefix. The prefix/root DOI is named by the IDF (International DOI Foundation), which assures that each root is unique. The books or articles published in journals, for example, will probably use as a suffix the number in the ISBN or ISSN.

Weber (2012, p. 6) highlights that “a DOI syntax is an identifier (not a place) of an entity in digital web. It can be used to identify digital or not digital objects.” In this way, the author says that the access is persistent, even if the information about an object change with time, the DOI syntax will not change the URL, the e-mail address, other identifiers and other descriptive metadata.

Continuing with the studies of Weber, the four main types of DOI syntax users are: editors; agencies/affiliates (including agents and platforms of magazines accommodation), counting on more than three thousand intercrossed publishers; libraries; and, individual researchers.

With the DOI in the electronic journals we can get information about the localization of its articles, ensuring the permanent access in case the transference of these digital objects is necessary. It corroborates to what ARAUJO (2015, p. 54-55) says that “for the digital preservation the use of persistent identifiers is safe and reliable, and it also allows the

articulation between the service of descriptive metadata providers, as: article title, key words, summary, references and citations.”

Paula and Oliveira (2014) inform that the procedure to get a DOI prefix is made through the site<sup>4</sup> and, for journals the register agency must be CrossRef<sup>5</sup>, and only filling a form is needed and the communications will be done by e-mail. It is necessary to print and send the initial pages by the mail. When all of this is accomplished, you have the DOI prefix and the passwords to use CrossRef as a member and also put the references together with the journals metadata.

Nowadays this identifying system counts on one hundred million registers all over the world. However, in Brazil, this identifying persistent system is new, being applied in some Brazilian electronic scientific journals in many knowledge areas, as the Revista Digital de Biblioteconomia e Ciência da Informação, Revista Eletrônica de Comunicação, Informação e Inovação em Saúde, Transinformação, among others. Moreover, the DOI is also being used in the *Lattes* Platform of the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), as a manner of digital certification of bibliographic productions registered by the researchers in their curriculum *lattes*.

It is necessary to emphasize that no matter the persistent identification system chosen, it will only be useful if there is a continuation. Sayão (2007) recommends that if the digital object is removed, the new location must be associated to the permanent identifier, no matter what the system is, because no system makes this alteration automatically.

### 3.3 Strategies applied for digital preservation of electronic journals

The strategies for the digital preservation aim at taking actions that assure the usability and accessibility of the digital objects, so they can be visualized, executed or interpreted by the software or by the adopted format, made to preserve the integrity and the authenticity, that is, they consist in does not change the content and/or the physical structure of these objects and if there are legitimate alterations, they must be documented.

To Thomaz and Soares (2004) methodologies and strategies must be established in the context of digital preservation, in which the main types of strategies are the *structural and the operational ones*. The structural strategies imply in initial investments by the institutions, so they can implement any digital preservation process in their environment. The operational strategies are the activities themselves applied to the digital objects aiming at digital preservation.

<sup>4</sup> Available in: <[http://www.crossref.org/01company/15doi\\_info.html](http://www.crossref.org/01company/15doi_info.html)>. Accessed on: Dec.15, 2014.

<sup>5</sup> *Crossref*: System of database which connects the resources to their respective identifiers DOI for an effective intercrossed between electronic journals by the referencial links, according to Sayão (2007).

Next, we mention the structural and operational strategies that may be applied for the digital preservation of electronic journals, based in the studies of Márdero Arellano (2004), Thomaz and Soares (2004) and Ferreira (2006):

a) Structural Strategies

▪ Standard adoption

It recommends the preferential use of standard and archive formats of open data, as the PDF/A largely used to assure the continuous use of electronic journals because there is a growing stability tendency and support for a long-term period. This strategy can be related to the preservation of metadata strategy also necessary when talking about preservation of digital objects.

▪ Elaboration of guides, manuals and reports

Organizations from Europe, Australia and North America are being successful in the development of better practices and functional requirements to deal with questions about digital preservation register their findings in guides, manuals and reports for the digital preservation of digital objects, for example: *A Guide to Best Practices for Editors of Library and Information Science Journals*, published by the Library & Information Science Editors, EUA, 2010, *Preservation, Trust and Continuing Access for E-Journals*, published by the *Digital Preservation Coalition (DPC)*, England, 2013.

▪ Formation of collaborative networks and partnerships

Involvement and commitment of the institutions, corporations, consortium and alliances aiming at establishing the digital preservation for a long-term period.

▪ Setting up of infrastructure

Appropriate adoption of hardware and software infrastructure, and human resources by the institution which is committed to the preservation of electronic journals in a long-term period.

b) Operational strategies

▪ Migration

It is considered the most used strategy by the institutions for the digital preservation of electronic journals. They are a set of procedures and techniques to copy, convert or transfer, periodically, the digital information which is in a determined technology generation for future generations. The migration preserves the physical presence and the content of the digital object, but it may not preserve the presentation, the functionality and the context. The migration can happen by the conversion, refreshment and reformatting techniques:



- Conversion

Migration technique that can happen in different ways: a) data conversion: format changing, that is, a digital object which is in an obsolete format converts into a more current or standardized format (e.g., *Microsoft Word* into *ASCII*); b) computer system conversion, that is, conversion of a hardware/software platform in a discontinuity process into another (for example, *WINDOWS NT* into *LINUX*).

- Refreshment or updating

Migration technique which consists in copying the data from one support to another, without changing its codification, avoiding data loss from the support damage, that is, it consists in the transference of a digital object which is becoming obsolete or physically damaged to a newer one (for example, a copy of a rigid disk to a CD-ROM).

- Reformatting

Migration technique which consists in the change of the presentation form of a document made to access or preserve the data. For example, the printing or transformation of digital documents to microfilm – COM technology, or the transference of documents from a computer system to a moving media – COLD technology.

▪ Replication

Strategy which starts from the concept of the existence of many copies of the preserved content, geographically distributed, in different places, that is, it is the replication of the digital object in many places. In case of damage or copy loss, other institutions which have these copies, will assure the access to replacement or restoration. The adoption of the automatic replication for the electronic journal archiving needs the use of technologies of the preservation copies systems derived from Peer-to-Peer (P2P) networks.

The P2P networks refer to a distributed architecture style which contrasts with the client/server: distributed systems completely decentralized, in which all the nodes are equivalent in terms of functionality and chores they execute. Besides that, the P2P systems are defined as distributed systems that consist in interconnected nodes capable of self-organize themselves in overlay topology aiming at sharing resources like content (music, videos, documents etc.), CPU cycles, storage and bandwidth, capable of adapting to the transient population of nodes while keeping an acceptable connectivity and performance, with no necessity of intermediation or support of a central entity, Barcellos and Gasparly mentioned (2006).

Other scholars highlight the advantages and disadvantages about the replication use:

The replication can be a viable solution which increases the reliability, availability, tolerance and failures (of hardware and software) and the system performance,

without considering that the hardware/software cost is fairly low. The main replication disadvantage is that the copies creation increases the use of storage device and makes the safety and data update more difficult (CASTRO *et al.*, 2009, p. 291).

This way, we can infer that as it has a low cost, is less susceptible to failure and allows the participants access reliable preserved data through a connection restrict to a group, the replication becomes a viable strategy for the digital preservation of electronic scientific journals. However, with this big number of copies shared from electronic journals the use of technological equipment is intensified, and it can cause a slowdown in safety and data update. Besides that, we highlight that this strategy does not include the technological obsolescence overcoming, and it must be used as a complementary strategy.

A practical example of the replication strategy use and distributed digital preservation is the initiative Lots of Copies Keep Stuff Safe (LOCKSS).

#### ▪ Emulation

Digital preservation strategy that is based in the creation of a new software which imitates an old hardware and/or software way of working to make a current technology Works with the characteristics of an obsolete technology. Then, not only the physical presence and the content are preserved, but also the digital objects can present the original characteristics (for example, layout) and the available functionality in the previous software. The emulation techniques are related to the digital object preservation in its original format.

The initiative of the National Library of the Netherlands (Koninklijke Bibliotheek - KB) and the National Archief of the Netherlands recognize the importance of emulation, because this strategy assures the authenticity, the integrity, and the originality of electronic journals.

#### ▪ Technology preservation

It suggests that the technology which has created the digital objects must be kept available. This way of preserving the content, allowing that in the future the digital objects can be visualized in their original format (layout and functionality), implies in very high costs. The creation of “museums” of hardware and software requires almost impossible space terms and technical support. This is a valuable strategy for private cases or software and hardware historic, and also for its utility for the museums community.

Summing up, the technology preservation strategies, emulation and refreshments allow the preservation of the digital objects in their original form, without modifications in their structures.

▪ Encapsulation

This strategy aims at keeping the digital object unchanged until its access is necessary, and the objective is the future development of converters, viewers and emulators for the storage of big data that maybe in current time it is not interesting to access them but in the future, if there is interest, can be accessed.

▪ Metadata of digital preservation

There are at least three reasons that justify the use of metadata to better describe the digital objects: “1) facilitate the research and the identification of its information sources; 2) manage its flow in the processes; and, 3) represent its structures to enable the access” (THOMAZ; SOARES, 2004).

Sayão (2010b) characterizes the metadata in three categories:

**Descriptive metadata:** it is the most well-known face of the metadata, they describe a resource to discover and identify; they can include elements as title, author, summary, key words and persistent identifier. **Structural metadata:** they are information that document how the complex resources, composed by many elements, must be recomposed and ordered. For example, as the pages of a book, digitalized apart, are connected and ordered to form a chapter. **Administrative metadata:** they provide information that support the processes of information resources life cycle management. They include, as an example, information about how and when the resource was created and why [...] (SAYÃO, 2010b, p. 5, author's stress).

This metadata categorization clarifies the type of information in the digital objects, allowing its detailed description so they can be localized, managed and used more easily. It means that the preservation metadata are a joint of descriptive, structural and administrative metadata because they include elements of these three categories.

The use of preservation metadata facilitates the interoperability among the objects they describe, and they must be used by the digital objects developers and the managers of these collections, no matter the chosen digital preservation technique or methodology, because its use favours the digital objects accessibility.

As shown in literature, the preservation metadata are important for the digital preservation, because they present the necessary information for the search, representation and access to the digital objects. So, the creation and management of this type of metadata must be careful and supported by internationally recognized tools and standards.

#### **4 INITIATIVES OF ELECTRONIC JOURNALS DIGITAL PRESERVATION**

With a growing technological revolution new and effective possibilities of safeguard and access to electronic publications have appeared, as the digital repositories that, together

with libraries, act like guardians of the registered, printed or electronic knowledge, and aims are assuring a safe digital storage, as well as the access to the electronic contents in a long-term period.

The digital preservation has provoked an engagement of many organizations in creating methodologies to assure the longevity and the permanent access to the digital objects contents, favouring the appearance of digital preservation collective initiatives. This way, it is important to register that the initiatives must favour a joint collaboration instead of unique and specific collaborations, because the collective actions offer mechanisms and facilities which contribute in an effective, safe and everlasting way for the preservation of digital objects.

Sayão (2010a), Térmens (2013) and The Keepers Registry (2014), indicate well-known international initiatives for the digital preservation of electronic journals. Some of them are: *Archaeology Data Service (ADS)*; *British Library*; *CLOCKSS Archive*; *HathiTrust*; *Koninklijke Bibliotheek e-Depot (KB e-Depot)*; *Kooperativer Aufbau eines Langzeitarchivs Digitaler Informationen (kopal/DDB)*; *Library of Congress*; *LOCKSS Network*; *Los Alamos National Laboratory (LANL)/ Research Library (RL)*; *National Library of Australia Pandora (NLA Pandora)*; *National Science Library, Chinese Academy of Sciences*; *OCLC Electronic Collection Online (OCLC ECO)*; *OhioLINK Electronic Journal Center (OhioLINK EJC)*; *Portico*; *PubMed Central (PMC)* and *Scholars Portal*.

In Brazil, in January of 2013, the Instituto Brasileiro de Informação em Ciência e Tecnologia (IBICT), with the support of Financiadora de Estudos e Projetos (FINEP), joined in the program LOCKSS creating the Rede Brasileira de Serviços de Preservação Digital – Cariniana Network, first Brazilian collective initiative of digital preservation of electronic journals.

The Cariniana Network is an initiative without profit purpose based in a decentralized infrastructure which uses distributed computer resources, as a distributed digital preservation we. In this way, it counts with the participation of institutions which have the digital documents and with its infrastructure, in a standardized and safe environment which assures the permanent access and the monitored storage of documents. (IBICT, 2014).

The participation of Cariniana Network in the Alliance LOCKSS, the oldest and the biggest digital preservation web in the world, represents an advance and a significant contribution for the scientific information in Brazil, because it allows the preservation of Brazilian electronic publications contents in international collaborative institutions which take part in the initiative LOCKSS.

### 3 METHODOLOGICAL APPROACH



The empirical analysis of the panorama of the digital preservation of electronic scientific journals in Science Information which was published in Brazil was realized since the bibliographic research of the scientific production about digital objects and technical aspects of the digital preservation of electronic journals, in which articles, thesis, dissertations events annals and books were selected from 1996 to 2015 in national and international data base of the Science Information (IS) and of related areas.

The data base construction of the analysed journals was realized by the collection, treatment and analysis of the data related to the empirical research of Brazilian electronic journals in Information Science. This construction was divided in the following steps:

### 1) Searching of electronic scientific journals in Science Information in Brazil

This step identified the current electronic scientific journals in Information Science in Brazil. The search was done through three lists: a) List of electronic magazines in Information Science, available in the site of Associação Nacional de Pesquisa e Pós-Graduação em Ciência da Informação (ANCIB); b) List of electronic journals in IS listed by the Base de Dados Referencial de Artigos de Periódicos (BRAPCI); c) List of electronic journals in Applied Social Science available in the data base *Scientific Electronic Library Online (SciELO)*, which affirm that scientific papers in the area of IS are published.

### 2) Description of the electronic journals in Information Science published in Brazil

This step consisted in the identification of the metadata obtained in the electronic addresses of the journals identified in the previous step. The current electronic journals metadata in the area of Information Science allowed to characterize them as scientific and related to this referred area.

### 3) Selection of electronic scientific journals in Information Science in Brazil

We selected Brazilian electronic journals characterized as scientific in the area of Information Science for analysis some criteria: being current, peer evaluated, present editorial committee and scientific committee.

The definition criteria for the characterization as journals in the Information Science area were: a) having the term Information Science in the title or subtitle; or, b) inform in its scope that scientific papers in the area of Information Science are published; and, c) being classified by the Coordenação de Aperfeiçoamento de Pessoal de Ensino Superior (CAPES) in the area of Applied Social Science I (except the journals which were first published in 2014 because they were not classified by *WebQualis/CAPES*).

The application of the questionnaire about digital preservation sent by e-mail to the

editors of the selected *corpus* from electronic scientific journals in Information Science published in Brazil, was accomplished according to the criteria previously specified and listed in Box 1.

The direct observation was accomplished in the sites The-Keepers (digital archival agencies) and from the Cariniana Network for information complements about the Brazilian electronic scientific journals in IS, aiming at identifying the initiative(s) which take(s) part in digital preservation.

The situation diagnoses made was based in the theoretical referential analysis about digital preservation of electronic journals, in the presentation of the characteristics of the scientific journals in the IS area, in the contemplated items on the questionnaire and in the information added by the direct observation in the indicated sites. This way, it was possible to present the current state of digital preservation of the Brazilian electronic scientific journals in IS, which are summarized as followed.

#### 4 ANALYSIS AND RESULTS

23 electronic scientific journals in Information Science published in Brazil were identified, according to Box 1:

**Box 1 – Brazilian Electronic Scientific Journals in Information Science.**

|                             |  |
|-----------------------------|--|
| 1. A. to. Z.                | 13. Informação & Tecnologia  |
| 2. Biblionline              | 14. Journal of Information Systems and Technology Management (JISTEM)  |
| 3. Biblos                   | 15. Liinc em Revista   |
| 4. BRAJIS                   | 16. Múltiplos Olhares em Ciência da Informação                         |
| 5. Ciência da Informação    | 17. Perspectivas em Ciência da Informação                              |
| 6. Comunicação e Informação | 18. PontodeAcesso  |
| 7. DataGramaZero            | 19. Revista ACB  |
| 8. Em Questão               | 20. Revista Digital de Biblioteconomia e Ciência da Informação (RDBCI) |
| 9. Encontros Bibli          | 21. RIC1   |
| 10. InCID                   | 22. Tendências da Pesquisa Brasileira em Ciência da Informação         |
| 11. Informação & Informação | 23. Transinformação  |
| 12. Informação & Sociedade  |  |

**Source:** Self creation. Collected data on: July 06, 2015.

The presented analysis is shown in the results of a survey done with Brazilian scientific journals in Information Science editors and is a results of the direct observation in the The Keepers and the Cariniana Network sites.

#### 4.1 Results of the survey done with Brazilian scientific journals in Information Science editors

Among 23 questionnaires sent to editors, 14 (66%) were answered. In Box 2, the 14 journals are shown in alphabetic order:

**Box 2** – Brazilian electronic scientific journals in IS who answered the questionnaire.

|   |  |
|---|--|
| 1. A. to. Z.: novas práticas em informação e conhecimento           | 8. Informação & Tecnologia   |
| 2. Biblionline  | 9. Journal of Information Systems and Technology Management (JISTEM)   |
| 3. Biblos: revista do Instituto de Ciências Humanas e da Informação | 10. Revista ACB: Biblioteconomia em Santa Catarina                     |
| 4. Ciência da Informação  | 11. Revista Digital de Biblioteconomia e Ciência da Informação (RDBCI) |
| 5. Comunicação e Informação   | 12. Revista Ibero-americana de Ciência da Informação (RICI)            |
| 6. Em Questão: comunicação e informação                             | 13. Tendências da Pesquisa Brasileira em Ciência da Informação         |
| 7. Informação & Sociedade: estudos                                  | 14. Transinformação  |

**Source:** Self creation. Collected data on: July 06, 2015.

Next, the answers are presented and analysed, according to the questions in the questionnaire. The questions were created according to the technical aspects of the digital preservation of the electronic scientific journals and aimed at diagnosing the used actions and practices.

- Which strategy(s) of digital preservation is used in the journal?

In this multiple choice question it was possible to choose more than one alternative, and aimed at identifying the operational strategies used for the digital preservation of electronic journals.

The answers revealed that the migration and replication strategy are used by 100% of the journals and the digitization by 25%.

Comparing the answers, we verify that the migration appears as the most used strategy for the digital preservation of electronic journals, corroborating the explored literature related to the digital preservation operational strategies. This statement can be related because the migration preserves the physical presence and the content of the digital object, even though it may not preserve the presentation, the functionality and the context.

We highlight that the replication strategy is also used by everyone who answered, what probably happens because this strategy is a viable solution with low cost, less susceptible to failure and allows the access to reliable preserved data through a connection

restricted to a group.

We perceive that besides the dispersion among the mentioned strategies used, all the journals claimed that they adopt concomitant strategies. This is a positive fact, as this complementation contributes to the permanent access and to these journal use.

These inferences lead to question the reason why the adoption of identified strategies were established in this study. What leads to the next question.

- Which digital preservation initiative(s) does the journal take(s) part?

The results indicated that the analysed journals took part in the following initiatives: CLOCKSS – 17%; LOCKSS - 75%; Cariniana Network- 67%; Other initiatives - 9%. The LOCKSS initiative has a high percentage of Brazilian electronic scientific journals in IS preserved. It can be a reflection to the fact that this initiative is considered the oldest and the biggest digital preservation network, according to the explored literature.

The Cariniana Network also concentrates a significant percentage of preserved journals. This fact can be explained due to this initiative act as the Rede Brasileira de Serviços de Preservação Digital. We have verified that the CLOCKSS initiative preserves a small number of the journals which answered. And, in relation to the initiatives that were not indicated here, only one journal highlights that takes part in the Lepidus Tecnologia initiative, through a service called Periódicos em Nuvens, that works with scientific editors of electronic journals and has the Sistema Eletrônico de Editoração de Revistas (SEER) plataforma as a basis – translated and customized version from Open Journal System (OJS).

The following questions were created with the purpose of investigating the involvement of the Editorial team, revealing the quantity, the academic formation and the description of the activities of the members involved in the digital preservation of their journal. Therefore, with the respective open questions, we got the following answers:

- How many members of the Editorial team are involved in the digital journal preservation?

08 (66%) journals out of the 12 who answered inform that they have less than 03 members of the editorial team involved in the digital preservation activity, and 02 (17%) journals mentioned that there are not members involved in these activities, because the managers of these journals are the responsible professionals who deal with all the digital preservation process. Paradoxically, also 17% of the journals registered that they have from 08 to 09 members of the editorial team who take part in the digital preservation activities.

The results show that there is not a linearity in the journals when talking about the

allocation of their members to develop the digital preservation activity. However, there is a worry in a big number of journals about choosing at least 01 member in the team to develop any activity related to digital preservation of the journal.

- Show the academic formation of the Editorial Team members involved in the digital preservation of the journal.

The answers indicated that there is a heterogeneity in the academic formation (Information Science, Library Science, Computer Science, Communication etc.) of the involved members. Besides that, we highlight 70% of the members have academic formation in the Information Science area, what shows the importance of this area professionals knowledge in the activities related to digital preservation.

- Describe the activities of the Editorial Team members involved in the digital preservation of the journal.

Talking about the activities of the Editorial Team members in the digital preservation, we diagnosed three types of activities: technical activities (75%), reflexive activities (12,5%) and operative activities (12,5%). The technical activities comprehend the activities operationalization, that is, refer to the content replication, meetings participation, interface with the Cariniana Network and authorization with the authors for the digital preservation. The reflexive and operative activities are related to the memorial achievement of each published fascicle and to the decision in the choice of which digital preservation initiative the journal will be preserved.

The next questions looked for information about the knowledge of the first collective initiative of digital preservation in Brazil.

- Are you aware of the Cariniana Network?

Only 02 (14%) of the editors informed that did not know the Cariniana Network. Therefore, the answers indicated the big majority of the ones who answered (12 editors, 86%) know the Cariniana Network. This result can be considered significant, as this Network is significant for the safeguard and access to scientific and technological information in Brazil.

- In case of affirmative answer, indicate how you heard about this Network:

This question consisted in detecting the information channels which contributed for the dissemination of the Cariniana Network to the editors. For this item, with multiple choice options it was possible to choose more than one alternative.

In a unanimous way, the 12 (100%) editors informed that they knew the Cariniana

Network, they said they knew about the Network through seminars/presentations in events (Congresses, Seminars, Meetings etc.) and through the IBICT site. Other information channels indicated were the LOCKSS site, corresponding to 03 (21,5%) editors and for scientific articles only 01 (7%) editor. It shows that the Cariniana Network is largely spread, allowing the editors to know the role and importance of this Network for the digital preservation of Brazilian electronic journals.

#### *4.2 Results of the direct observation in The Keepers and in the Cariniana Network sites<sup>6</sup>*

The investigation in the The Keepers and in the Cariniana Network sites aimed at collecting information about digital preservation of electronic scientific journals in IS in Brazil which did not answered the questionnaire, and according to the case, complement essential data for the journals which answered the questionnaire, when talking about technical aspects in the digital preservation.

05 (22%) out of 23 journals appear as preserved in The Keepers registers, and 04 (17%) are in processing.

The fact that the Brazilian electronic scientific journals appear in The Keepers registers reveals that these journals are being preserved in internationally recognized digital preservation initiatives. As a consequence, they adopt the necessary methodologies to keep the digital contents in safe conditions of storage, trying to assure a long-term access and the usability of these digital objects. It is important to remember that the adherence of the Brazilian electronic scientific journals in Information Science to CLOCKSS – stored in the SciELO basis – was not concluded yet and this register refers only to the connectivity test phase in The Keepers.

The observation results in the Cariniana Network site refer to the situation of the digital preservation of electronic scientific journals in IS published in Brazil in this Network. This way, the electronic journals preserved in it are also part of the LOCKSS, because as it was mentioned before the Cariniana Network is a member of this initiative.

In the Cariniana Network, 11 (48%) out of the 23 journals appear preserved, and the situation of the majority of these collections indicates that their contents are fully preserved. Moreover, these journals can have editions which are in process for their preservation, as the example of the first editions of the Biblos journal.

#### *4.3 Panorama of the digital preservation of Brazilian electronic journals in Information*

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<sup>6</sup> Collected data on: July 18, 2015.

Science

We will present a panorama of the digital preservation of Brazilian electronic journals in IS, through elements essential to the technical aspects of digital preservation identified in the answers and the analysis of the questionnaire answered by the editors, and also the diagnosed results in The Keepers and in the Cariniana Network sites.

The Box 3, synthesizes the situation of digital preservation of electronic scientific journals in IS published in Brazil:

**Box 3** – Panorama of the digital preservation of Brazilian electronic journals in Information Science

| Title   | Preserved         |       |   |  |
|---|-------------------|-------|---|--|
|   | Technical aspects |       |   |  |
|   | DOI               | PDF/A | Initiative(s)                             | Strategy(s)                            |
| 1. A. to. Z.                                    | -                 | -     | LOCKSS                                    | Migration<br>Replication               |
| 2. Biblionline                                  | -                 | -     | LOCKSS<br>Cariniana<br>Network            | Migration<br>Replication               |
| 3. Biblos                                       |                   | X     | LOCKSS<br>Cariniana<br>Network            | Migration<br>Replication               |
| 4. Ciência da<br>Informação                     | -                 | -     | CLOCKSS<br>LOCKSS<br>Cariniana<br>Network | Migration<br>Digitizing<br>Replication |
| 5. Em Questão                                   | -                 | -     | LOCKSS<br>Cariniana<br>Network            | Migration<br>Replication               |
| 6. Encontros Bibli                              | X                 | X     | E-Depot                                   | -                                      |
| 7. Informação &<br>Informação                   | X                 |       | LOCKSS<br>Cariniana<br>Network            | Migration<br>Replication               |
| 8. Informação &<br>Sociedade                    | -                 | -     | LOCKSS<br>Cariniana<br>Network            | Migration<br>Replication               |
| 9. Informação &<br>Tecnologia                   | -                 | -     | LOCKSS<br>Cariniana<br>Network            | Migration<br>Replication               |
| 10. JISTEM                                      | X                 | -     | CLOCKSS                                   | Migration<br>Digitizing<br>Replication |
| 11. Liinc em Revista                            | -                 | -     | LOCKSS<br>Cariniana<br>Network            | Migration<br>Replication               |
| 12. Perspectivas em<br>Ciência da<br>Informação | X                 | -     | CLOCKSS                                   | Migration<br>Replication               |
| 13. PontodeAcesso                               | -                 | -     | LOCKSS<br>Cariniana                       | Migration<br>Replication               |

|                     |   |   |                          |                                  |
|---------------------|---|---|--------------------------|----------------------------------|
|                     |   |   | Network                  |                                  |
| 14. Revista ACB     | - | - | Lepidus Tecnologia       | Migration Replication            |
| 15. RDBCI           | - | - | LOCKSS Cariniana Network | Migration Replication            |
| 16. RICI            | - | - | LOCKSS Cariniana Network | Migration Replication            |
| 17. Transinformação | X | - | CLOCKSS                  | Migration Digitizing Replication |

Source: Self creation

The results obtained reveal that out of the 23 Brazilian electronic scientific journals in IS identified in this survey, the biggest majority of these journals, 17 (74%) have digital preservation. Of these, 06 (36%) adopt standards and formats for the digital preservation, but 05 (30%) of them have the persistent identifier DOI, only 01 (6%) uses the open format PDF/A and concomitantly have DOI and use PDF/A, only 01 (6%).

Among the initiatives for the digital preservation of electronic journals, about the identified preserved journals, we have: 12 (71%) journals which take part in the LOCKSS initiative, 11 (65%) journals from the Cariniana Network, 04 (24%) journals from CLOCKSS, 01 (6%) journal from the E-Depot and 01 (6%) journal from Lepidus Tecnologia. We have also verified that 11 journals take part in more than one initiative, being these 11 journals preserved in two initiatives - LOCKSS and Cariniana Network - and, 01 (6%) journals in three initiatives LOCKSS, Cariniana Network and CLOCKSS.

Another technical aspect is related to the strategies used for the digital preservation of electronic journals, in which the migration and replication strategies are used by 16 (95%) of the journals, the digitizing by 03 (18%) journals and also 03 (18%) journals use these three strategies concomitantly. In only 01 (6%) journal it was not possible to detect which strategies were applied in the digital preservation.

## 5 IN THE GUISE OF CONCLUSION

The coming of ICTs has been providing a fast production, register and dissemination of information in heterogeneous supports and digital formats. However, it is necessary to establish actions to assure the guard, the use and the access to the digital objects for the future generations.

In relation to the analysis and results from the questionnaire answers end from the observation in The Keepers and in the Cariniana Network sites it is possible to visualize that



from the journals identified for this study, the most part 17 (74%) have digital preservation, what represents a favourable situation to assure the access in a long-term period and the use of these digital objects.

Talking about the technical aspects in the proposition and management of digital preservation of electronic journals the adoption of the reference model OAIS, international standards and open formats, like the PDF/A must be considered. The importance of persistent identifiers, as the DOI, so these objects, no matter the local change, can always be localized and accessed and the applying of appropriate strategies of digital preservation, as they aim at keeping the authenticity, the integrity, the reliability of the electronic journals, allowing their access by the time.

The results also indicate that all the preserved journals take part in one ou more digital preservation initiative, what is positive by the fact that these initiatives act together to offer mechanisms and bigger facilities which contribute in a more effective, safe and everlasting way for the preservation of electronic journals.

We highlight the important role of the Cariniana Network for the preservation of the national scientific production, being largely spread and a significant number 11 (65%) of the preserved electronic scientific journals in IS published in Brazil take part in this Network.

We found that among the digital preservation strategies, the migration and the replication are the most used ones, what probably happens because they are the most used by the identified initiatives. We suggest that the replication must be used as a viable complementary strategy for the digital preservation of electronic scientific journals, as this strategy does not contemplate the advance and the obsolescence technological. Besides that, other strategies which were not diagnosed in the preserved journals are also important, as the technology preservation and emulation, even though, they require higher financial and technical investments.

The majority 11 (64%) of the identified preserved journals does not adopt important complementary alternatives to the digital preservation, as the DOI neither the open format PDF/A. For the journals which do not adopt any digital preservation yet, they can adopt the PDF/A as it is less expensive, assuring that the journal can be preserved and always accessed. This way, we confirm the importance of using complementary tools to the strategies of digital preservation of the Brazilian electronic journals.

To conclude, we highlight that the electronic scientific journals are digital objects of an unquestionable scientific and historical value, therefore it is essential to adopt effective actions for their digital preservation, to keep their contents and their structure, assuring the use and permanent access.

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