Analysis of Institutional Repository Software for Knowledge Management in Universities

Análisis de repositorios institucionales latinoamericanos para la gestión del conocimiento

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Resumen

Introducción— Los Repositorios Institucionales (RI) son elementos de gran relevancia en los procesos de organización, difusión, investigación y preservación de la información. Dichos procesos se realizan de forma libre y gratuita siguiendo las premisas del movimiento Open Access (OA), que permitan aplicar elementos de interoperabilidad, acceso, y preservación a largo plazo el acceso universal a la información.

Objetivo— La investigación tiene un alcance descriptivo y será desarrollada mediante el uso del método analítico y comparativo. En la fase analítica se pretende realizar una recolección y revisión exhaustiva de información, lo cual permite caracterizar el uso del software, dicha información permitira acceder a la delimitación del uso de los diferentes DLMS a nivel mundial.

Metodología— Este estudio, enmarcado en una investigación descriptiva, da a conocer las principales características que presenta la usabilidad, uso de metadatos e interoperabilidad de los sistemas de gestión de bibliotecas digitales.

Resultados— En cuanto a los beneficios que se pueden determinar con la implementación de alguno de los dos DLMS evaluados, están, principalmente, mejorar la experiencia y satisfacción de los visitantes a los RI y lograr una mayor comunicación y feedback con el usuario, esto haciendo uso de los canales de comunicación que ofrezca el RI.

Conclusiones— Cualquier organización o institución puede utilizar los insumos y datos obtenidos de esta investigación como guía de referencia para determinar qué sistema es mejor para crear y mostrar sus colecciones digitales. La elección generalmente depende del tipo/formato del material, la distribución del material, la plataforma de software y el marco de tiempo para el establecimiento de la biblioteca digital.

Palabras clave— Repositorios Institucionales; gestión de información; productividad institucional; acceso abierto

Abstract

Introduction— Institutional Repositories (IR) are elements of great relevance in the processes of organization, dissemination, research and preservation of information. These processes are carried out freely and free of charge following the premises of the Open Access (OA) movement, which allows the application of elements of interoperability, access, and long-term preservation of universal access to information.

Objective— The research has a descriptive scope and will be developed through the use of the analytical and comparative method. In the analytical phase, it is intended to carry out an exhaustive collection and review of information, which allows characterizing the use of the software, such information will access to the delimit the use of the different DLMS worldwide.

Methodology— This study, framed in a descriptive investigation, reveals the main characteristics of usability, use of metadata and interoperability of digital library management systems.

Results— Regarding the benefits that can be determined with the implementation of one of the two DLMS evaluated, they are, mainly, to improve the experience and satisfaction of visitors to the IR and to achieve greater communication and feedback with the user, this by making use of communication channels offered by the IR.

Conclusions— Any organization or institution can use the inputs and data obtained from this research as a reference guide to determine which system is best to create and display their digital collections. The choice generally depends on the type/format of the material, the distribution of the material, the software platform and the time frame for the establishment of the digital library.

Keywords— Institutional Repositories; information management; institutional productivity; open access

I. Introduction

Information management changes over the years due, among other things, to the implementation of new technologies, which have made it possible to diversify the means of dissemination and access to knowledge. A few decades ago, knowledge was preserved in libraries, whose main purpose was focused on the acquisition, conservation, study and exhibition of books and documents [1]-[2]. However, over the years, libraries have been innovating, due to the implementation of communication technologies, giving rise to the so-called digital libraries. These allow taking advantage of the information resources available digitally, generating effective and easy communication between users and information sources.

Hence the emergence of Institutional Repositories (RI) as an element of great relevance in the processes of organization, dissemination, research, and preservation of information. These processes are carried out freely and free of charge following the premises of the Open Access (OA) movement, which allow applying elements of interoperability, access, and long-term preservation of universal access to information.

The higher education sector is a clear benchmark for the use of information tools and technologies, since it allows digitizing and preserving the resources produced to strengthen its value as a key actor in the development and advancement of knowledge. The institutional repository becomes an important mechanism to ensure its availability and instant accessibility [3]. Likewise, they complement traditional editorial channels and increase visibility and influence, especially in the scientific and academic works of researchers, teachers, and students.

Each institution works to develop its own standards for the interoperability of its systems, so it is necessary to design and implement solutions that facilitate access to information. However, to meet the objectives of the repositories, their content must be managed properly and should automatically provide open data access, interoperability and/or data sharing to facilitate retrieval by search engines and data collectors. Therefore, in order to take advantage of the different benefits that can be obtained from the repository, it is necessary to permanently monitor and evaluate it to analyze whether the objectives of dissemination and interoperability are met.

Institutional Repositories can preserve and establish the identity of the institution, help control and understand the productivity (lectures, articles, conferences, audiovisual materials, etc.) generated by researchers attached to the institution [4]. Likewise, they allow generating analyzes on the most consulted topics or areas, and even detect the strengths of the most consulted authors and researchers, among other aspects. The importance of RIs is evidenced by the boom in the use of RIs, as can be seen in directories such as the Open Access Repository Registry (ROAR) where, by 2020, there are more than 4 500 registered repositories [5] and the Directory of Open Access Repositories (OpenDOAR) which has more than 5600 records [6].

Hundreds of repositories in the world are supported by different technological platforms, most of them open source, such as DSpace, EPrints, WEKO, OPUS, and Fedora, among others. Given the relevance and global growth of IRs, it is necessary for institutions to have an input that facilitates decision-making when implementing a platform for managing their repositories, considering essential characteristics such as interoperability, visibility, and availability. of the information.

Given the relevance and global growth of institutional repositories, it is necessary for institutions to have an input that facilitates decision-making when implementing a platform for managing their repositories, considering essential characteristics such as interoperability, visibility, and information availability. That is why the objective of this research is to carry out a comparative analysis of open-source platforms for the management of institutional repositories.

To know the different approaches and results that have been worked on this topic, the referents on the topic are presented. One of these works is the "*Guide for the evaluation of repositories*" proposed by FECYT [7]. The Guide is used for the organization and creation of the

evaluative model for Metadata and Usability. It is conceived as an internal audit instrument to improve the quality of the repositories, facilitate their indexing process in RECOLECTA and their adaptation to the new standards established by OpenAIRE (Open Access Infrastructure for Research in Europe).

On the other hand, UNESCO in the work of "*Institutional Repository Software Comparison*" analyzes the features of the major platforms and is intended to help libraries focus on the features that will help facilitate the success of their repository [8]. The study of this comparison allows the creation of evaluation criteria considering the information available in it, despite the fact that the focus is mainly given to the implemented IRs, the success of an IR is related to the possibility of the DLMS to develop said criteria.

The research has a descriptive scope and will be developed using the analytical and comparative method. In the analytical phase, it is intended to carry out an exhaustive collection and review of information, which allows characterizing the use of the software, this information will access to delimit the use of the different DLMS worldwide. The information present in the open access web directories, the Open Access Repositories Registry and the Open Access Repositories directory will be used [7]-[8].

Once the software has been characterized, it is necessary to create a selection of evaluation criteria determined by the software quality standards and institutional repositories. Subsequently, an evaluation phase of the selected platforms is carried out for a detailed analysis of the benefits, advantages, and disadvantages of the use of the selected platforms.

II. Methodology

This study, framed in a descriptive investigation, reveals the main characteristics of usability, use of metadata and interoperability of digital library management systems. It is complemented by a mixed design since, in its development, defined in different phases, mixed strategies were addressed, to redirect the purposes according to the information that was being obtained.

In an analytical phase, an exhaustive collection and review was carried out that allowed characterizing the use of digital library management systems from a technical and statistical point of view, which allowed delimiting the different software to be evaluated, using the technical and statistical data present. in the worldwide open access web directories (Registry of Open Access Repositories and the Directory of Open Access Repositories).

Next, a review of international guide standards, studies and research related to software usability was carried out to determine the categories to be evaluated with a series of criteria defined from the information found. Each criterion was determined with a weighting, obtaining a qualitative evaluation in relation to the information obtained in each criterion.

Based on the evaluation of the selected digital library management systems, an analysis was generated that will be used as input for decision-making in the implementation of an institutional repository management platform.

III. Results

A. *Platform Characterization*

The characterization of the software used by the IRs was made taking as a reference the guidelines established by the "*A Study report on the Open Source Digital Library Software's: Special Reference to DSpace, EPrints and Greenstone*" [9]. Applying a series of methodological and conceptual criteria, a documentary review was made for the analysis of the DSpace, EPrints and Greenstone platforms (Table 1).

TABLE 1.
CHARACTERIZATION OF THE PLATFORMS USED BY THE ROAR AND OPENDOAR DIRECTORIES.

Characteristic	ContentDM	DSpace	eprints	hal	OPUS
Year of creation	2009	2002	2000	2001	1998
User authentication	NEITHER.	LDAP Authentication, Shibboleth Authentication.	LDAP authentication.	CCSD's Central Authentication Service.	NEITHER.
Statistical reports	Full record count.	Full record count.	Full record count.	Full record count.	Full record count.
Software platforms	Windows Server, Linux, or Solaris.	Linux, Unix, Solaris, Windows.	Linux, Unix, Windows.	NEITHER.	Linux distributions Ubuntu 10.04, Ubuntu 10.10 and OpenSuSE 11.3.
Databases	NEITHER.	Oracle, PostgreSQL.	MySQL, Oracle, PostgreSQL, Cloud.	NEITHER.	mysql.
Programming language	NEITHER.	Java & JSPs.	Pearl.	NEITHER.	PHP, XSLT, Java, JavaScript.
Machine-to-machine interoperability	OAI-PMH.	OAI-MHP, OAI -ORE, SWORD, SWAP.	OAI-MHP, OAI -ORE, SWORD, SWAP, RDF.	OAI-PMH.	OAI-PMH.
License	SaaS.	GNU.	bsd.	NEITHER.	GNU.
Services	Service through third party service providers.	Service through third party service providers.	Training, consulting, site visits.	Service through third party service providers.	Service through third party service providers.
resource identifier	NCRI Handles.	NCRI Handles.	NCRI Handles.	NCRI Handles.	NCRI Handles.
OAI-PMH	YES.	YES.	YES.	YES.	YES.
Supported Item Types (Storage and Playback)	You can store and manage all kinds of content.	You can store and manage all kinds of content.	You can store and manage all kinds of content.	You can store and manage all kinds of content.	You can store and manage all kinds of content.
Metadata formats	Dublin Core, METS.	Dublin Core, Qualified DC, METS.	Dublin Core, METS. Dublin.	Dublin Core.	Dublin Core.
Thumbnail preview	NEITHER.	Images.	Images, audio, video.	NEITHER.	NEITHER.
Search capabilities	Field specific, boolean logic, sort options.	Field specific, boolean logic, sort options.	Field specific, boolean logic, sort options.	Field specific, boolean logic, sort options.	Total number of documents, newly published documents by month, documents by document type, and documents by institute.
Navigation options	Navigation can be done using any field.	By author, title, subject and collection navigation.	Navigation can be done using any field.	Navigation can be done using any field.	Navigation can be done using any field.

Source: Based on [9].

IV. Evaluation criteria based on software quality standards and institutional repositories

The evaluation categories are the result of a documentary analysis of International Standards, Research and Guides. Among those selected are:

A. *Usability*

In the case of DSpace and EPrints, the evaluation conditions are governed by basic utilities, these softwares have the particularity of being open source and easy to use, according to what is presented in the article called "*A novel framework for measuring software quality-in-use based on semantic similarity and sentiment analysis of software reviews*", the effectiveness metric evaluates whether the tasks performed by users achieve specific objectives with precision and completeness in a specific context of use, however, as these tasks have been fulfilled, it is necessary to calculate the effectiveness submetrics, task completion and error rate [14]. All these submetrics require a manual invocation by the user to calculate the proportion of goals successfully achieved.

Based on A Guide to institutional Repository Software, the DLMS [10] comparison institutional Repository Software Comparison [11], the DLMS A Study on the Open Source Digital Library Software's [9], the article Comparison of 10 software [12], and bibliographic resources obtained from the documentation of each Software, the Usability evaluation proposal is prepared, as presented in Table 2.

Table 2.
Software Usability evaluation model.

	Evaluation criteria	Description
1.1	GUI Modification	Allows modifications in the graphical user interface by the institutions for the creation of IRs .
1.2	Inclusion and use of languages	It allows the inclusion of multiple languages in the RI, for writing methods, display of site content and user interaction.
1.3	Usability in disabled users	It offers the possibility of making changes to usability parameters, allowing access to IR for people with hearing and/or visual disabilities.
1.4	Support for discussion forums	Allows the creation and management of forums within the IRs .
1.5	Message or alert mechanism	It offers a mechanism of messages and alerts for the different users of the IRs .
1.6	Email notification for senders	Sends an email notification to a user regarding the status of a content submission (for example, that the item has been approved for inclusion in the repository or has been returned to the submitter).
1.7	Email notification for content managers	Sends an email notification to a content manager (for example, reviewer, approver, etc.) when a submission has been sent to them for review, approval, etc.
1.8	View pending content submissions	Allows users to see all the content they have submitted to the repository.
1.9	View approved content	Users can manage unfinished content submissions (ie, content submissions that have been started, but not completed for some reason).
1.10	View pending content management tasks	Allows content managers (eg reviewers, editors, approvers, etc.) to review submissions awaiting processing.
1.11	System generated usage statistics and reports	Allows repository administrators to track repository usage and adoption. This facilitates system capacity planning and supports internal resource allocation and budgeting.
1.12	Defining data types used by sections	There is clarity in the types of data the user must enter in each section of the Software.
1.13	Faceted navigation	It allows access to information organized according to a faceted classification system, allowing users to explore a collection of information by applying different filters.
1.14	Authentication methods	There are one or more authentication methods like LDAP, Shibboleth Authentication, CCSD's, RDBMS.
1.15	Password authentication	Registers and authenticates users who are authorized to submit and/or manage content in the repository, as distinct from the worldwide audience of anonymous users who can access content that is publicly accessible.

	Evaluation criteria	Description
1.16	Password management	Provides a secure process by which users who have forgotten their passwords can select a new password without human intervention. Normally, the system uses the user's email address to manage the new password.
1.17	Access limit according to user type	Allows the repository administrator to have limited access to certain content based on the user's authorization level. This could be used, for example, to limit access to the working documents of an academic department for faculty members of that department.
1.18	SSL transport layer security	It implements cryptographic protocols that provide privacy and integrity in communication, guaranteeing that the information transmitted cannot be intercepted or modified by unauthorized elements, only legitimate senders and receivers are the ones who have access to the communication in its entirety.
1.19	Control of access restriction levels	Allows the repository administrator to apply levels of access restrictions to submitted items based on user type. For example, most elements would be globally accessible to all users; some elements may be available through an IP address to a university community; and other items may be limited to ID/password access to a relatively small group of users.
1.20	User self-registration service	It allows users to register in the IR in their own way, without the interference of an external regulatory entity that needs to approve each of the registrations.
1.21	Management of access rights to the digital document	There is the possibility of managing the access rights that the digital document has.
1.22	Management of rights of use of the digital document	There is the possibility of managing the rights of use that the digital document has.
1.23	Distinction of rights granted	The software distinguishes the rights granted to the following four types of users: administrator, metadata producer, digital document producer, simple user.
1.24	Third-party tools for the analysis of web access	The software offers support for the use of third-party tools for web access analysis. Tools such as : Google Analytics, Piwik, AWStats, Yandex Metrica, OWA (Open Web Analytics), Segment.
1.25	Management of document collections	The collection management policy is a normative document that provides useful information to guide library staff in making decisions that lead to the construction and maintenance of collections. The collections can be used by the users of the community and are a basic tool for its normal operation.
1.26	Submitted items can include multiple files	Allows a user to submit multiple files and/or file types as part of a single repository. This allows, for example, a user to submit a research paper along with its supporting dataset or a conference paper along with the overhead presentation given at the conference.
1.27	Approved file format function	This feature allows the system administrator to limit the submission of content to approved format types. This allows the repository to indicate which digital formats it is willing to accept (from a policy perspective) as opposed to which formats the system is capable of accommodating (from a technical perspective). This can help support repository policies designed to ensure continued access and preservation of repository contents.
1.28	Ingested File Formats	What digital formats the system is capable of ingesting. Based on it allows the institution to define multiple content collections and/or user groups within a system installation. Collections can be defined in various ways, including by topic, content type or purpose, audience, and so on. (for example, a series of working documents or a collection of curriculum support materials). User groups may represent academic departments, schools, research institutes, administrative departments (eg museums, hospitals, etc.), as needed to address the needs of the implementing institution.
1.29	Full text search capability	Full text search capability through the use of: Boolean logic, truncation/ wildcards, word stemming.
1.30	Find all descriptive metadata	Find all descriptive metadata through the use of: Boolean logic, truncation/ wildcards, word stemming.
1.31	Find selected metadata fields	Allows a user to search for selected metadata fields. For example, search only for the "title" or "author" fields.
1.32	Navigation	It allows browsing through these denominations: by author, by title, by publication date, by subject term, by collection.

Source: Authors.

V. Metadata

The evaluation model proposed to verify if the Software has the capacity to implement these elements and manage aspects related to the use and implementation of metadata, is built based on the "*Guide for the evaluation of repositories*" [7], the DLMS [10], "*Institutional Repository Software Comparison*" [8], [11], the DLMS "*A Study on the Open Source Digital Library Software's*" [9], the article on "*Comparison of 10 software*" [12], complemented with the bibliographic resources obtained from the documentation of each Software (Table 3).

Table 3.
Software Metadata Evaluation Model

	Evaluation criteria	Description
2.1	Supported metadata schema	Refers to the extent to which a system can store metadata related to a content submission and make that metadata searchable through a user interface. Schemes such as: Dublin Core, Qualified DC, METS.
2.2	Metadata review support	For metadata collection to be effective, the repository must establish quality control procedures and quality thresholds for metadata stored in the system. This is especially true for repositories that claim to allow authors to archive their articles and provide their own metadata. This feature supports the metadata approval process through which metadata can be reviewed, corrected, enhanced, and/or approved before it is made available through the system.
23	Metadata export	It allows an institution to export repository metadata, in XML or some other structured format, to facilitate migration to a later system.
2.4	Do not allow metadata harvesting	Allows the system administrator to "turn off" the OAI harvester's ability to harvest repository metadata in general. This would effectively disable repository interoperability.
2.5	Add/remove metadata fields	It allows metadata management in terms of modification, addition or deletion. This can create a knowledge base according to the needs of the organization, and even present different standards for the correct use of metadata.
2.6	Set default values for metadata	Allows the repository system administrator to set default values for metadata fields to simply enter metadata. For example, you can set the institution field to the default value of the host institution (for example, Institution = "Universidad Pedagogica y Tecnologica de Colombia").
2.7	Supports Unicode characters for metadata	It makes use of the character encoding system used by computer equipment to store and exchange data in text format. Assign a unique number (code point) to each character in the world's major writing systems. It also includes technical symbols and punctuation marks, as well as many other characters used to write text.
2.8	All records contain a title field	Free text containing the official name of the resource. The original name, order, and spelling of the resource title should be preserved. Use only capital letters for distinguished names. Subtitles must be separated from the title with a colon.
2.9	All records contain description field	A summary of the publication must be included, but more information can be provided, as long as it is not used to represent information corresponding to other fields.
2.10	All records contain an authorship field	In this field, record the primary entity or natural person responsible for creating the content of the resource.
2.11	There is a specific field to indicate the description of the collaboration	Entities or persons responsible for coordinating, correcting, commenting or contributing to the development of resources in any other way have been registered in this field.
2.12	Includes a reference to identify funded research projects	The reference of the funding agency and the project is collected in a standardized way.
2.13	The identifier field is unique	All records contain an identifier field that is generated by the system itself.
2.14	Records may contain alternate identifiers	It is recommended to include identifiers other than the main identifier, which should be applied to the resources according to the formal identification system. Examples of formal identification systems include the Uniform Resource Locator (URL), the Digital Object Identifier (DOI), or the ISBN.

	Evaluation criteria	Description
2.15	Records contain a copyright field	Information about the rights contained in the resource. Generally, the authority element will contain authority management statements to access or use objects or references to services that provide such information. Rights information generally includes intellectual property rights, copyrights, and other proprietary rights. It's best to refer to a permissions service that uses a URL to explain reuse permissions to the end user. For example, the Creative Commons organization.
2.16	All records contain access rights information	It refers to the categorization of the access rights with which the repository has been loaded.
2.17	The access rights field is in accordance with the established vocabulary	Information on access rights must be based on the COAR vocabulary [43]of access rights.
2.18	All records contain a publication date field	This element will be associated with the publication of the resource.
2.19	The publication date field is in accordance with the established format	The best practice for encoding the date value is defined in the ISO 8601 profile and follows the format YYYY-MM-DD, where MM and DD are optional.
2.20	All records contain a language field	Language of the intellectual content of the resource
2.21	The language field is in accordance with the established vocabulary.	For this field it is established as ISO 639-x vocabulary, where x can be 1,2 or 3. The use of ISO 639-3 is recommended. For documents to which the language field cannot be applied (for example: images, maps, music...), the code zxx can be used .
2.22	There is a specific field to indicate the publisher	The entity responsible for making the resource available is recorded in this field. It can be a person, an organization or a service. Normally, the name of a publisher should be used to indicate the entity.
2.23	All records contain the research result type field	In this field, the type of scientific achievement whose resource is its manifestation is recorded. The type of document or knowledge content that describes the resource. It is used to explain to the user the type of resource they are looking at.
2.24	COAR resource type vocabulary	COAR resource type vocabulary [13]. A controlled vocabulary is used as an organized structure of words and phrases used to index content and/or to retrieve content through browsing or searching. It includes preferred terms and their variants and describes a specific domain or has a specific scope.
2.25	All records contain a format field	The digital manifestation of the resource is recorded in this field.
2.26	The format field is assigned according to the established vocabulary	IANA Registered List of Internet Media Types (MIME Types) is used to select a term.
2.27	There is a specific field to indicate the location of the file	This field records the location of the files associated with the resource, for example, URL of the PDF file containing the full text. The property needs to be repeated for each associated file.
2.28	All records contain a resource version field	The status of the publication process must be indicated in this field.
2.29	The resource version field is in accordance with the COAR vocabulary	COAR resource type vocabulary [13]. A controlled vocabulary is used as an organized structure of words and phrases used to index content and/or to retrieve content through browsing or searching. It includes preferred terms and their variants and describes a specific domain or has a specific scope.
2.30	Some standardized classification system is applied	It is recommended to have one or several standardized classification systems such as CDU, JEL, UNESCO, etc. This is very helpful for selective collection by aggregators and can greatly facilitate the creation of value-added services.
2.31	The repository performs some metadata curation activity	The repository team should perform routine data quality and control activities (eg, descriptive metadata enrichment, metadata editing, access control, verifier report analysis, intellectual property management, etc.).
2.32	Persistent identifier tags	It is good practice to include the persistent identifiers of all those entities, objects and people that are described in the metadata records of the repositories. Identifiers like: DOI, Handle, URN, ORCID, etc.

Source: Authors [13].

VI. Interoperability

The interoperability category examines how each platform integrates with other products through OAI-PMH, discovery services, researcher profiles, and other repositories hosted on the same platform. Considering the "*Guide for the evaluation of repositories*" [7], the DLMS [10], "*Institutional Repository Software Comparison*" [8], [11], the DLMS "*A Study on the Open Source Digital Library Software's*" [9], the article on "*Comparison of 10 software*" [12], and the bibliographic resources obtained from the documentation of each Software, the Interoperability evaluation proposal is made (Table 4).

Table 4.
Software Interoperability Evaluation Model.

	Evaluation criteria	Description
3.1	Alert services	When an unexpected event occurs that requires the user to operate immediately, it will be displayed on the graphical user interface. Blocked application alert dialogs are considered poorly designed solutions for usability professionals because they are prone to pattern errors. Also, when used as error dialogs, they have proven ineffective at notifying users of error conditions or protecting them from destructive operations.
3.2	Functions implemented with web services	A set of protocols and standards are used to exchange data between applications.
3.3	Semantic Web (RDF)	RDF is used allowing users to find answers to their questions more quickly and easily, allowing users to delegate more specific search tasks in the software.
3.4	Export of bibliographic references	Users are allowed an editor that allows bibliographic references to be exported, organized according to predefined bibliographic standards and models such as: APA, Harvard, Vancouver, OSCOLA, MLA, IEEE, Turabian, AMA, ACS, NLM, AAA, APSA.
3.5	Queries Z39-50	The system supporting information retrieval services based on International Standard ISO 23950 defines the information retrieval application service and specifies the information retrieval application protocol.
3.6	SRU / SRW Queries	Queries are governed by the ISO 20775:2009 standard designed to be used as a schema in responses to queries, which specifies a schema designed to cover holdings of all types of resources, physical and electronic, all types of resource format, such as printed text, visual images, sound recordings, videos, electronic media, and once published or broadcast resources, such as monographs or those published in series or in part.
3.7	Diffusion mechanisms	JSON, Web Service, Social Networks, RDF, Online Journal.
3.8	Integration with discovery platforms	There is the possibility of integrating the repository with discovery platforms, such as directories and collectors.
3.9	Identification of research resources in the repository	Research resources are identified, either through an OAI-PMH server dedicated to research, or through one or several sets when the repository contains heterogeneous materials, such as endowments.
3.10	Deleted records are marked	Deleted records must be marked for at least a period of time sufficient to allow collectors to identify and remove them from their databases. Otherwise, there is a risk that records deleted by the data provider will still exist in the collectors.
3.11	Resume token lifetime is a minimum of twenty-four hours	Resumption tokens are used on incomplete responses from the OAI-PMH server so that the client can resume downloading at a later time. The definition of until when it can be resumed must be defined by each repository, but in no case can it be less than twenty-four hours.
3.12	The delivery of records through the protocols is progressive through batches	The Software runs without the direct control or supervision of the Designated User. The characteristic of this type of program is that its execution does not require any type of interaction with the user.
3.13	Batch size for log delivery is in the range of 100-500 logs	It has been proven in practice that a number of elements included within this range speeds up the collection processes and avoids overloading the repositories.
3.14	Integration with other information systems of the institution	The repository offers the possibility to import/export metadata and/or full text of its contents from and to: other digital libraries, Current Research Information Systems (CRIS), publishing support platforms, e-learning platforms, library catalogue, etc.

	Evaluation criteria	Description
3.15	Inclusion of <meta...> tags in HTML headers	The HTML headers of the web pages that link to the files available in the repository incorporate the metadata of said file using the <meta ...> tag. The use of the Dublin Core metadata schema is recommended, accompanied by at least one of the following: Highwire Press, EPrints, Bepress, or PRISM.
3.16	Implements Schema. org to facilitate structured access to its metadata	Labeling of bibliographic data on web pages using the Schema.org markup model is contemplated, to facilitate its structured retrieval. Schema.org is widely used by commercial search engines such as Google and increasingly by repository aggregators, for example Data Cite, so its implementation facilitates the discovery and accessibility of repository content.
3.17	Supports other protocols and APIs to share metadata and/ or content	Other protocols, apart from the basic OAI- PMH, are contemplated to facilitate the retrieval of metadata and repository contents. In recent years, new standards have emerged that facilitate interoperability between repositories and other related infrastructures. These standards fall within the so-called “new generation of repositories” services and allow, among other functions, the ingestion of content (SWORD and API REST) and the synchronization of changes associated with metadata and files (ResourceSync).
3.18	Widespread use of persistent identifiers	It is good practice to include the persistent identifiers of all those entities, objects and people that are described in the metadata records of the repositories. Identifiers like: DOI, Handle, URN, ORCID, etc.
3.19	Use controlled vocabularies or ontologies whose concepts are endowed with persistent identifiers	The controlled vocabularies used in the repository use, for their unique identification, persistent identifiers such as the vocabularies proposed by COAR [13]. Identifiers like: PURL, DOI, URN.
3.20	Volume import for objects	It allows an institution to import existing digital libraries and other digital material.
3.21	Import of data volume	Allows a repository to import metadata for existing digital collections.
3.22	Volume export / content portability	An explicit expectation for an institutional repository is that the content managed by the system will outlast the system itself and be able to migrate as new technologies evolve. This feature refers to the way content can be exported from the system.
3.23	Analytics Integration	The software allows the integration of Google Analytics tools, which show the keywords that users need the most and a list of keywords that increase visitor traffic. Useful function to improve search engine positioning and increase traffic.

Source: Authors [13].

VII. Weighting for Evaluation Criteria

The evaluation of each of the criteria defined in the selected categories is carried out through a documentary analysis. The qualification of each criterion will be subject to two aspects, a qualitative evaluation of the fulfillment of each criterion, transformed into a percentage value, which will refer to the score that the criterion will contribute to the evaluation. In Table 5, the qualitative values expressed as “Compliance” are arranged in relation to the percentage of score defined for each one.

Table 5.
Proposal for weighing criteria.

Compliance	Qualification	Score Percentage
Not Fulfilled	0-1	0%
Unacceptably	1-2	30%
Acceptably	23	60%
Correctly	3-4	80%
Totally	4-5	100%

Source: Authors.

To determine the maximum amount of score that each criterion will have within the classifications, the following formula was used (1):

$$\text{Maximum score} = \frac{\text{Number of criteria to evaluate}}{100} \qquad (1)$$

The maximum score refers to the maximum value that can score each criterion within the category. The number of criteria to be evaluated refers to all the criteria defined within the category in question. The value of 100 is taken as the maximum score that the DLMS in question can obtain. The sum of the score obtained in each criterion will be the total score that the DLMS will obtain in the evaluation category in question.

VIII. Evaluation of Institutional Repository Management Platforms

After the detailed review of each platform, the results shown in Fig. 1 were obtained, specifying the benefits, advantages, and disadvantages of the correct use of these systems.

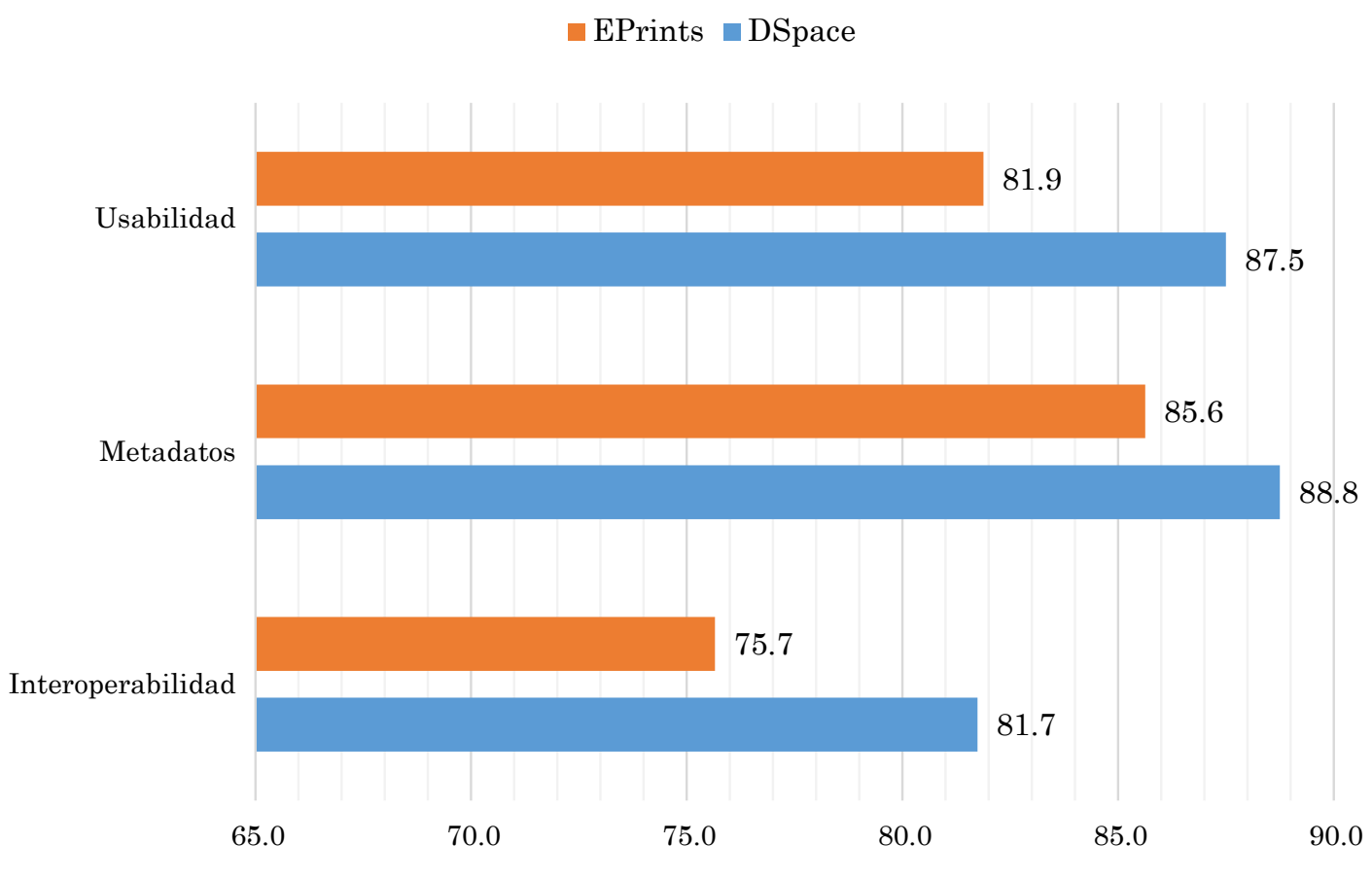

Fig. 1. Score Evaluation.
Source: Authors.

As for the benefits that can be determined with the implementation of one of the two DLMS evaluated, they are:

- Improve the experience and satisfaction of visitors to IRs.
- Achieve greater communication and feedback with the user, making use of the communication channels offered by the IR.
- Getting more traffic, the positioning of the IRs is related to the usability capacity that they have, this in relation to a correct construction of the repository makes the user traffic high, offering disclosure of the institutions responsible for the repositories.
- Increasing the duration of the visits, the amount of time that users remain in the IR is a factor to take into account to measure the disclosure and name that institutions take regarding their academic content.

- Decrease bounce rate. The bounce rate is the percentage of sessions that visit only and exclusively one page of the website when the number of events received by Google Analytics exceeds the number of events with which you interacted. To better understand it, bounce refers to any visitor that comes and goes without visiting any other page of the same website or clicking any button or link.
- Build user loyalty, getting them to visit the IR again. The loyalty of the users allows to maintain a constant flow of access, its importance lies directly in the number of people who will be able to access the academic contents arranged in the RI, in this way other measures that positively affect the institution are promoted, such as the name of the institution, the traceability of its products, the increase in bibliographic citations, making it easier for users to recommend the IR, and the dissemination of knowledge.
- Make the user familiar with the IR beforehand and make its handling easy and intuitive. The familiarity with which a user perceives a repository directly impacts the benefits of proper usability development.
- Improve the dissemination of academic content from the institution on the network.
- Receive international recognition in evaluations that measure the level of Usability, Metadata and implementation of the interoperability of the academic content provided in the RI.
- It allows the storage of various files, including unpublished files (articles, monographs, chapters of monographs, activity exchanges, papers, academic papers, data sets, videos, etc.) and various formats.
- Collect and disseminate the scientific and academic achievements of the institution to the world.
- It allows the publication of documents of research results, thus fulfilling the tasks (of the funding organization).
- More visibility and influence, more appointments.
- Guarantees the correct management of copyright.
- Protect the future of the author's work and the intellectual activities of the university.
- Acquire knowledge for the whole society and reuse it for the benefit of all.
- It can make public investment in research visible and accountable for it.
- The gap in access to information between institutions and countries is reduced.
- Permanent access to work through permanent link. Promote the use of data to participate in the evaluation.
- Increase the visibility of the organization through the work of the author and improve its positioning in search engines of the network.

Regarding the disadvantages that can be determined with the implementation of one of the two DLMS evaluated, it is important to mention that, in terms of favoring and complying with the open access movement, the disadvantages are very few, among which are:

- Internet access and a good connection are required.
- Institutions must allocate resources for the creation and maintenance of repositories.
- Most of the repositories are in English. Europe and North America represent a high percentage of the distribution of repositories.
- Published materials may be copied without citation.

IX. Conclusions

The RI directories play a fundamental role in the collection of information and the functionality they offer as a means of centralizing it. The correct selection of software platforms is delimited by the correct collection of technical and statistical information, which could be consulted quickly thanks to the study of these directories.

The creation of the evaluation models was subject to extensive documentary review, based on international standards, repository evaluation guides and studies related to existing DLMS . It was possible to build a generalized evaluation model, focused on aspects for compliance with the policies and standards established by the open access to information movement. Usability studies make it possible to guarantee the proper functioning of systems and services in the digital environment, as well as user satisfaction. Metadata management involves aspects of access to academic information, in addition to enabling collection and distribution processes. The interoperability of academic information systems is a fundamental piece to comply with the open access movement of information, its correct implementation means the success or failure of the institutions in complying with these policies.

The digital library management software provides a customizable and easy-to-use framework to create institutional repositories, which allows and facilitates that the different research products, manuscripts or any other digital resource can be disseminated in order to preserve and disseminate digital projects. that contributes to the advancement of knowledge in this global age.

It is pertinent to highlight that in the three evaluation categories DSpace has obtained better results, considering that the amount of information available in bibliographic resources about this software has been greater than that available for EPrints, however, both platforms have a large amount of documentary resources so that its implementation does not bring with it inconveniences. This software provides different services and architectures, so it is difficult and complex to propose a specific DLMS system as the most suitable method for all situations.

Any organization or institution can use the inputs and data obtained from this research as a reference guide to determine which system is best to create and display their digital collections. The choice generally depends on the type/format of the material, the distribution of the material, the software platform and the time frame for the establishment of the digital library.

The benefits, advantages and disadvantages of the correct selection of a DLMS and the creation of the institutional repositories mentioned, effectively delimit the scope to which any institution aspires, taking these aspects into consideration contributes satisfactorily in the promulgation of trends for the correct implementation of these systems and the existence of institutional repositories.

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