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The Use of Application Profiles and Metadata Schemas by Digital Repositories: Findings from a Survey

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Abstract

Shows the results of a survey by questionnaire sent to the managers of 2, 165 digital repositories registered at OpenDOAR. Its purpose was to identify the existence and the use of application profiles and related metadata schemas. Of this total, 431 questionnaires were filled. The survey enabled the identification of metadata application profiles, as well as schemas and metadata elements/properties used within these repositories. According to the results, the number of repositories that use or provide metadata application profiles is 13, which we consider as very low. The Dublin Core remains as the most commonly used metadata schema, followed by MARC 21, METS and MODS. The dataset that resulted from the survey is openly available at RepositóriUM, the institutional repository of the University of Minho

Keywords: application profile; metadata schema; scientific digital repositories

1. Introduction

Metadata or data about data (National Information Standards, 2004, pp. 1) may be associated with a wide range of information and be adopted for different purposes. Based on its content and purposes, a DR may have metadata elements/properties drawn from a single or from several metadata schemas simultaneously, which leads us to the concept of Metadata Application Profile (MAP) (Heery & Anderson, 2005, Heery & Patel, 2000).

The concept of MAP has been evolving through the years. It started as a specification of a "mix and match" of metadata elements drawn from several metadata schemas (Heery & Patel, 2000), to a more complex construct as defined by the Singapore Framework for Application Profiles (Nilsson, Baker, & Johnston, 2008). For this study, we used the concept as described by (National Information Standards Organization- NISO (2007) which states that a MAP specifies how elements from one or more metadata schemas combine and fit to describe a particular set of resources, stipulating what and how the elements are adopted for description. By favoring the understanding of an application metadata model and relating it to existing schemas and encoding schemes, MAPs favor interoperability especially if they are encoded in a widely used linked data language such as the Resource Description Framework (RDF).

According to Curado Malta & Baptista (2014), various communities are defining and using MAPs. As an example there is the Scholarly Work Application Profile (SWAP), developed in 2008 to provide a method for describing scholarly works, research papers or scholarly research texts in Eprints UK (DCMI Usage Board, 2009). Another example is the RIO XX, also targeted to the UK institutional repositories ("RIOXX…", 2014). Other MAPs have been developed for specific domains or for specific institutions. An example is The Virtual Open Access Agriculture & Aquaculture Repository (VOA3R) MAP from the Food and Agriculture Organization (FAO) (Diamantopoulos et al. 2011). In the context of digital libraries there is the DC-Library Application Profile, developed by the Dublin Core Metadata Initiative (DCMI) (Guenther, 2000).

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In what regards metadata, DRs have at least one thing in common: the OAI-PMH protocol. This protocol uses the simple Dublin Core (DC) metadata schema, which implementation is known in the community as OAI-DC. Although simple DC is a very good cross-domain metadata schema, there is an increasing need for domain-specific metadata elements in order to provide means for better relationships among resources and more accurate searches and results at a global level (Bruce & Hillmann, 2004, Chan, 2005, Clayphan & Oldroyd, 2005, Heery & Anderson, 2005, Hillmann & Phipps, 2007). It is reasonable to expect that some of the existing DRs already use more metadata elements than the ones provided by OAI-DC, or even have MAPs clearly defined, but there are not up-to-date studies about this reality (Park & Tosaka, 2010).

The main goal of this study is to identify the current panorama of DRs in what regards the use of metadata elements, their schemas and the definition of MAPs. Therefore, this study is proposed to: a) check if the repositories have clearly defined application profiles and which; b) identify the adopted metadata schemas and elements; and c) relate adopted metadata schemas and elements with the type of DR.

2. Methodology

This research adopted the survey by questionnaire for which we used Survey Monkey. The sample was restricted to the DRs registered at The Directory of Open Access Repositories (OpenDOAR - http://www.opendoar.org/) until September 4, 2014. The data collection was performed from September 2014 until November 2014. We selected only repositories with registered email addresses, regardless of type and geographical location, which corresponded to 2,165 repositories, out of a total of 2,720. OpenDOAR was selected because it has been widely used by the DRs community and European projects and initiatives, such as the Digital Repository Infrastructure Vision for European Research (DRIVER), the Surf Foundation and the Sherpa Services.

The questionnaire was structured in three sections, with and a total of 11 questions. The first section aimed at the DR identification of the repository; the second section aimed at the verification of the existence of a MAP; and the third section aimed at the identification of schemas and metadata elements used by the DRs. For the sake of clarification, and to avoid misunderstandings, all the metadata related terms used in questions were properly defined before they were used.

In section 1, after the repository's name and/or acronym (question number 1 - Q1), we requested its type (question number 2 - Q2). Based on literature, we consider that an Institutional Repository (IR) stores the intellectual production of a research institution; a Thematic Repository (TR) stores domain-specific research results; an Organizational Repository (OR) stores documents/artifacts of an organization whose main aim is not related to research (e.g., the DR of the Brazilian Federal Court); a Learning Object Repository (LOR) stores only educational materials; and an e-Thesis Repository (TDR) stores only thesis and dissertations (Armbruster & Romary, 2010, Darby et al., 2009; Heery, 2009, Semple, 2006)). Question 3 (Q3) required the identification of the types of resources stored, i.e., books, papers, journal articles.

In section 2, where we sought to assess the use of international recommendations and MAPs by the DR, two questions were formulated: Q4) whether the repository adopts some sort of international recommendation – although not directly related to MAPs, its intention is to try to envision if the DRs community is open to the adoption of new recommendations and standards; and Q5) whether it adopts a MAP.

In section 3, we investigated which metadata schemas and elements are used by DRs. Therefore, we sought to determine: in Q6, which metadata schemas are adopted; in Q7-Q9, which DC, LOM and MODS elements, are adopted; and in Q10 which other schemas and elements are adopted. That way, we are able to draw an overview of what is being used and make relations, as well as achieve a parameter for future projects related to the definition of MAPs for DRs.

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The questionnaire and its results may be accessed at the RepositóriUM, the Institutional Repository of the University of Minho (http://repositorium.sdum.uminho.pt/) by following the handle http://hdl.handle.net/1822/35527.

3. Results and Discussion

From 2,165 emails sent to the DRs' managers with a link to the questionnaire, 66 (3.1%) emails returned (wrong email address, not existent, et cetera). From the remaining (N= 2.165), 431 questionnaires were answered, corresponding to 19.9% of the total delivered.

The first question is about type of repository, 401 questions were answered and 30 were ignored. Of the total (n=401), 69 respondents (17.20%) identified their repository as being of more than one type. From these, 9 are indicated as OR and IR. We believe that, in this case, respondents might not have fully understood the differences between OR and IR. Therefore, we sought OpenDOAR in order to decide to which typology each of these 9 repositories should be assigned. After this exercise we verified that, from the total (n=401), the IR are prevalent (358, or 89.27%), followed by the TDR (52, or 13%), TR (36, or 9%), OR (25, or 6.23%) and LOR, (15, or 3.74%).

Four hundred and fourteen (n=414) DR managers answered Q3, while 17 left it blank. Scientific articles are identified as the most stored type of resource (350, or 84.54%), followed by books/chapters (320, or 77.29%) and theses and dissertations (318, or 76.81%). Respondents also informed about the storage of: datasets, media appearances, administrative and technical documents, blogging academics, curricula and other grey literature. Additionally, it was mentioned the use of metadata of journal of articles. Informal conversations with DRs managers at conferences and other events made it clear that some of them consider that a platform that only has metadata (and not contents) should not be considered a DR.

Comparing the types of repositories and the types of resources stored, it is clear that DRs are storing several types of resources, regardless of their pre-defined typology as answered in Q2 (Figure 1). Also, the results show that not all kinds of resources are subject to a quality control process such as peer review, which confirms Heery's claims (2009, pp. 13).

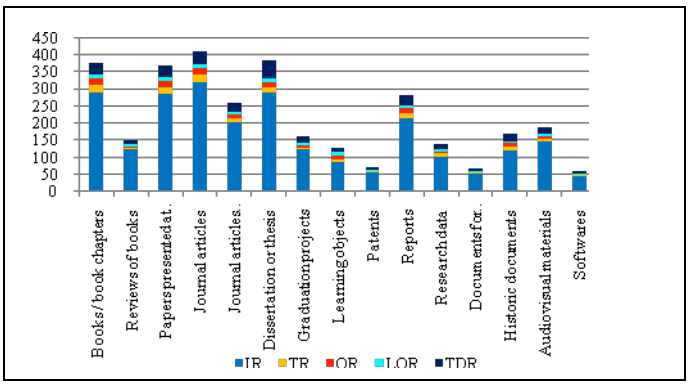

FIG. 1. Type of resources mostly stored by Digital Repositories

As to Q4, section 2, 376 questions were answered and 55 left blank. From total (n=376), some respondents claim to use DCMI recommendations (314, or 85.51%) and the OAI-PMH protocol (308, or 81.91%). A relatively low number of DR adopts SKOS (7, or 1.9%) and OWL (7, or 1.9%). It is noted, however, a greater number of those using RDF specifications. In accordance with results, the OAI-ORE standard has on IRs their biggest supporters (30, or 93.75%).

On the "other options", the respondents also quoted the Digital Repository Infrastructure Vision for European Research (DRIVER) recommendations. In the same field the respondents mentioned the use of other supporting documentation, not all classifiable as recommendations. These include specific APs, metadata schemas, data models, encoding/markup languages, file

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formats, frameworks to create and use self-defined metadata formats, as follows: Guidelines SNRD Del Ministerio de Ciencia, Tecnología e Innovación productive -Argentina; RIOXX, European Semantic Elements 3.4.1- ESE and European Data Model 5.2.6-EDM, JSIC-Eprints Metadata Model; EThOS UKETD-DC; VOA3R; XMetadiss, XMetaDissPlus; Open Language Archives Community-OLAC-DC; Component Meta Data Initiative–CMDI, MarcXml; Encoded Archival Description Document-EAD; TagSuite NLM DTD; NISO Z39.96-2012; JATS XML; Google scholar metadata tags; OpenAire; bibtex; schema.org; Digital Commons Metadata; MODS+ORE, Open Archives Initiative Static repository.

The answers to Q5 indicate that the number of repositories having defined APs is still very low. Overall, 342 questions were answered and 89 were ignored. From the total answered, two hundred and ninety-two (292, or 85.38%) respondents stated that their repositories do not adopt MAPs and 50 (14.62%) responded that their do. From these 50, 46 (13.5% of n=342) signaled "YES" (has MAP) and 4 (1.1% of n=342) signaled "Yes" and used the comment box to express their doubts as to what would be a MAP. Additionally, from the 46 affirmative answers, it was not possible to confirm the existence of a MAP for 25 (7.31% of n=342), even by following the URI that 6 of them provided; the existence of MAPs was confirmed only for 13 (3.8% of n=342) by using the URI they provided (Table 1). These results were obtained after we have analyzed each of the repositories on which there was an indication of the existence of MAPs and only the MAPs that fit NISO (2007) definition were taken into account. Table 1 presents the URIs of the 13 identified MAPs that are being used by these 13 DRs. It is worth mentioning that from the 89 that did not answer this question, 10 (11.2% of n=89) stated that they did not know what a MAP was. Summing these 10 with the above 4 in the same conditions, there was an overall of 14 respondents that claimed to not know the meaning of Application Profile. Although this number is very low (3.25% of n=431), it is reasonable to suppose that more respondents could have this doubt despite the definition was available just before the question.

TABLE 1. Application profiles used by Digital Repositories

REPOSITORY IDENTIFICATION	URI OF IDENTIFIED MAPs
Edinburgh ResearchArchive (ERA)	http://ethostoolkit.cranfield.ac.uk/tiki-index.php?page=The +EThOS+ UKETD_DC+application+profile
Kagoshima University Repository	http://www.nii.ac.jp/irp/en/archive/pdf/junii2_en_20090213.pdf
Rutgers University Community Repository	https://rucore.libraries.rutgers.edu/collab/reference.php?group=ALL&auth=ALL&type=ap&submit=Search
BibliotecaValenciana Digital	EDM 5.2.4 and EUROPEANA
ScienceCentral	http://www.e-sciencecentral.org/pub/pubinfo/
University of Oslo Open Res.Archive	https://www.cristin.no/openaccess/Dokumenter/Metadata_handbok_final.pdf
Biblioteca Digital de Castilla y León	http://www.digibis.com/software/digibib.html
BRAGE HihmHøgskoleniHedmark	http://brage.bibsys.no/xmlui/handle/11250/92963
UOC Repositori Institutional	http://openaccess.uoc.edu/webapps/o2/bitstream/10609/8055/6/GRISET_metadadesUOC_2010_cat.pdf
REDICCES	http://www.redicces.org.sv/jspui/bitstream/10972/1763/1/guia_metadatos.pdf
Alaskas Digital Archives	https://scholarworks.alaska.edu/page/policy
DSpace at Rice University	https://digitalriceprojects.pbworks.com/w/page/89346902/Research%20Data%20Management%20Application%20Profile
Europe PubMed Central	http://dtd.nlm.nih.gov/2.0/xsd/archivearticle.xsd

Although we could not find similar studies, we found others that resemble in some way. Park & Tosaka (2010), for instance, obtained results that indicate a high percentage of MAPs usage within Digital Repositories + Digital Collections. Smith-Yoshimura & Cellentani (2007) found a low level of adoption of MAPs in digital libraries. None of these results can be directly compared to ours, once the objects are quite different. A study by Curado Malta & Baptista (2014) only found 10 MAPs specifically built for libraries and DRs and 31 for Learning Objects applications, that although not directly comparable to ours, corroborates its main finding: the low level of adoption of MAPs in the DRs community... Furthermore, both Park & Tosaka (2010) and Curado

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Malta & Baptista (2014) report difficulties in accessing MAP related documentation, that in the case of Curado Malta & Baptista was partly solved by making direct contact with the MAP managers.

With regard to metadata schemas adopted (Q6, section 3), the prevalence is the Dublin Core Metadata Element Set (DCMES - reported by some respondents as simple DC) (269, or 83.80%), followed by Open Archives Initiative-Dublin Core (OAI-DC) (131, or 40.81%), Metadata Encoding and Transmission Standard (METS) (43, or 13.40%) and Machine-Readable Cataloguing (MARC) (39, or 12.15%), Metadata Object Description Schema (MODS) (36, or 11,21%), Electronic Thesis and Dissertation Metadata Standard (ETDMS) (30, or 9.35%), Learning Object Metadata (LOM) (13, or 4.05%), DSPACE intermediate metadata (DIM) (11, or 3.48%), Multimedia Content Description Interface (MPEG-21) (7, or 2.18%) and Academic Metadata Format (AMF) (2, or 0,62%).The Open Digital Rights Language (ODRL) and Metadata schemas for exchanging business cards (vCard) were not used by any of the DR (Figure 1). Here it is worth clarifying two aspects. The first is what was termed the DC Simplified and Qualified by the respondents. Many people still calls DC qualified (expression fallen into disuse within the DCMI community) to the set of DC elements plus its refinement elements (now all included in the DC Metadata Terms vocabulary - http://www.dublincore.org/documents/dcmi-terms/). It should be noted that the DSpace platform includes the so-called "DC Qualified" metadata elements, some of them not belonging to DC Terms and that were set as part of the development of this platform. The second aspect relates to the DC and OAI-DC: OAI-DC is the way the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) calls the 15 elements of the Dublin Core Metadata Element Set. Therefore, we combined these results considering that OAI-DC, DCMES and Simple DC are, in fact, referring to the same vocabulary/schema.

In the field "Others", the respondents also indicated the use of the following schemas: unofficial Croatian metadata scheme (based on CROSBI); XMetaDiss; Date Document Initiative (DDI 3.2); Directory Interchange Format (DIF); CIF core dictionary; MTD2-BR; hal.fr; Digital Item Declaration Language (DIDL); Component Metadata Infrastructure (CMDI); Darwin Core for the Virtual Herbarium collection; Text Encoding Initiative (TEI); Registry Interchange Format – Collections and Services (RIF-CS); Research Document Information Format (ReDIF). However, as in Q4, some answers do not really correspond to metadata schemas: Document Object Model (DOM), GNU Eprints, Collex.org; World Bank-specific taxonomies, and Google Scholar Metadata, and the already mentioned OLAC, ESE, EDM; ORE; JATS DTD.

These results show that: a) a great number of repositories store different types of resources (398, or 99.25%), which means that elements drawn from one or more metadata schemas could probably be used as a complement to DC, in order to enhance the description of those resources. Some of these repositories, however, only use DC; b) some repositories use metadata elements drawn from two or more schemas. In this case it could be advisable to define a MAP; c) the usage of LOM elements is more visible in IRs than in LORs, prevailing the use of DC in all of them.

The prevalence of the use of DC might be justified with the results of Q4 that show the data collection is based on the OAI-PMH protocol, which uses only DC be default. There are metadata schemas designed for specific and detailed descriptions, potentially enabling resources' "find ability" and more relevant and precise search results (Heery & Anderson, 2005, Vogel, 2014). Organizations such as DCMI and W3C offer recommendations for "mixing and matching" these elements into a coherent whole and in a machine-readable and interoperable way. By using different metadata schemas repositories' managers can optimize the information exchange between the various information services. In addition to MAPs, it is worth noting the recent W3C developments on the Shapes Constraint Language (SHACL), which is an RDF vocabulary to identify RDF graphs' "predicates and their associated cardinalities, data types and other constraints" (Knublauch, et al., 2015). A Draft version was recently published that contains use cases and requirements (Steyskal & Coyle, 2015)

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The results of Q7 show that most of the 15 DC elements are highly used by DRs (Figure 2). In addition to the 15 elements, the respondents also indicated the use of the following DC Terms elements: alternative (1, or 0.32%), bibliographicCitation (1, or 0.32%), isPartOf (1, or 0.32%) and audience (1, or 0.32%). Respondents also informed about elements that are not part of DCTerms, that were added by DSpace [sic]: placeOfPublication (1, or 0.32%), root (1, or 0.32%), series (1, or 0.32%), number, edition, volume; level of audience; dc.contributor.author; dc.subject.other (1, or 0.32%); author contact (1, or 0.32%); editor contact (1, or 0.32%); date available (1, or 0.32%); date accessioned (1, or 0.32%); start page (1, or 0.32%); end page (1, or 0.32%); ispartofname (1, or 0.32%); ispartofnumber (1, or 0.32%); ispartoftitle (1, or 0.32%); ispartofvolume (1, or 0.32%), level of audience (1, or 0.32%); open access (1, or 0.32%), embargo (1, 0,32%). One respondent informed that he "incorporated other metadata elements in records for ETDs". Another respondent extended DC in order to include information about "media of materials and number of pieces and NBN identifier". This is an old practice that was already identified by Heery e Patel (2000) who have claimed that implementers use metadata schemas pragmatically and that this procedure in the past started with the use of MARC, when implementers introduced their own fields, instead of adopting the concept of "mixing and matching schemas".

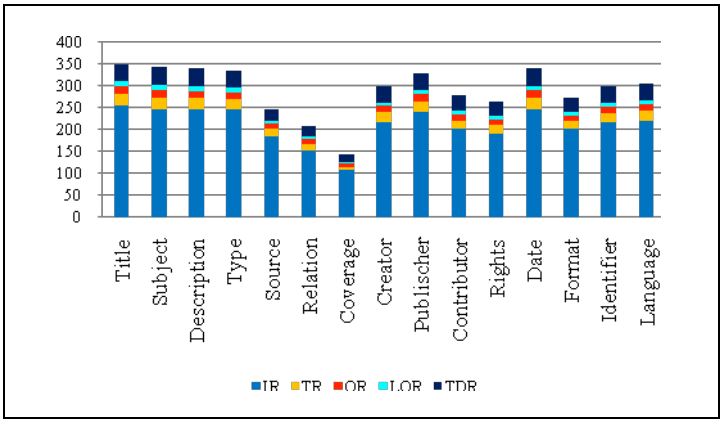

FIG. 2. DC elements used by Digital Repositories

As for LOM, the categories most frequently used were General and Educational (Figures 3 and 4). Some elements were used only by just one repository.

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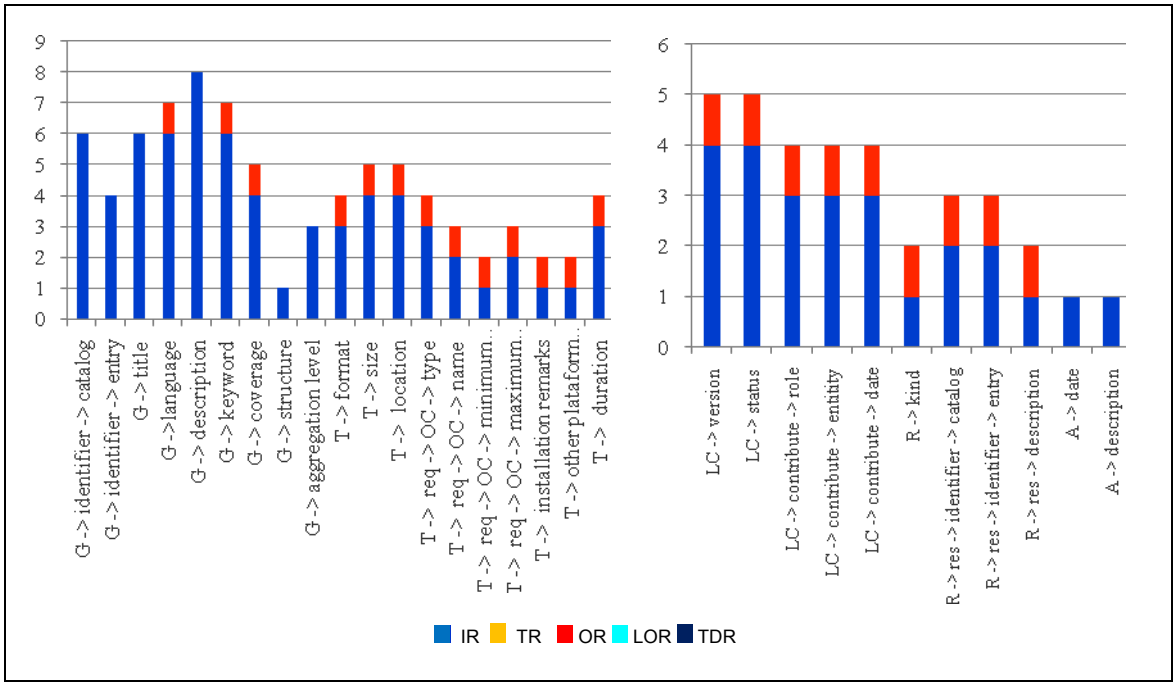
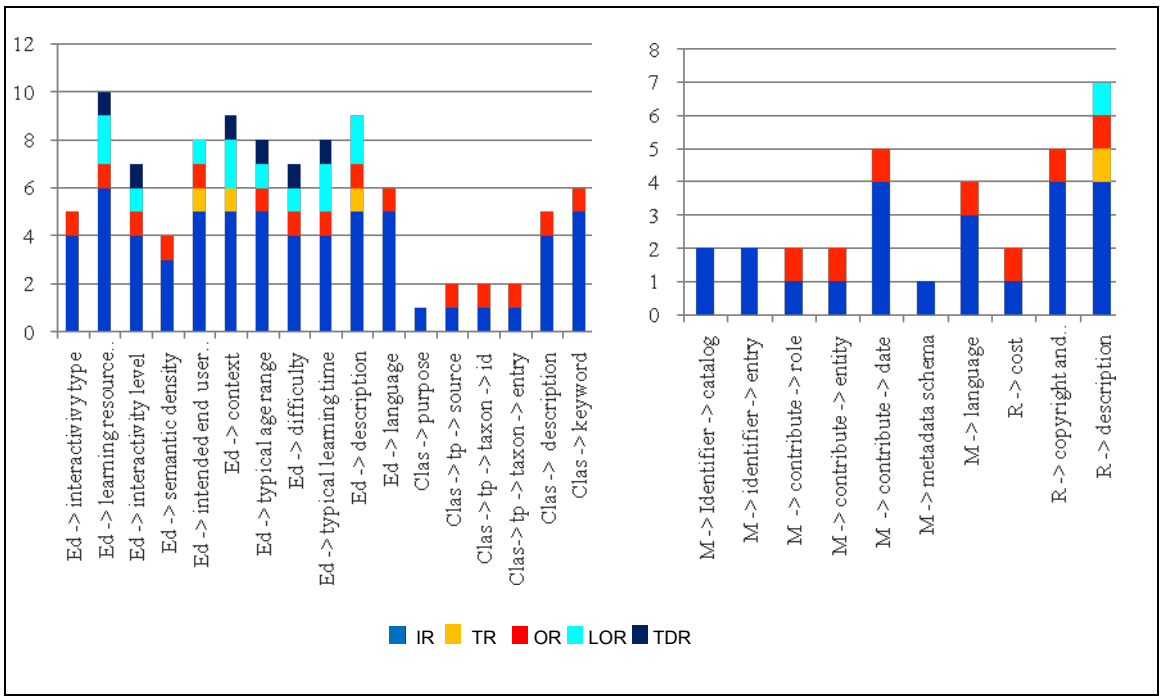


Legend: G – General, T- Technical, req – requirements, OC – OrComposite, LC – Life Cycle, R – Relations, res – resource, A – Annotation

FIG. 3. LOM elements used by Digital Repositories (General, Technical, Life Cycle, Relations categories)



Legend: Ed – Educational; Clas – Classification; tp – taxon path; M – Meta-metadata; R- Rights

FIG. 4. LOM elements used by Digital Repositories (Educational, Classification, Meta-Metadata e Rights categories)

MODS elements were adopted by (29, or 6.72%) DRs. The IRs use more MODS elements than any other type of repository (Figures 5 and 6). This fact maybe related to its compatibility with MARC 21, which is widely used in the libraries' domains (Assumpção & da Costa, 2013). The fact that MODS was developed for the description of bibliographic resources, considering the

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libraries domain ("Metadata Object Description Schema", n.d.), contributes for its adoption by information professionals.

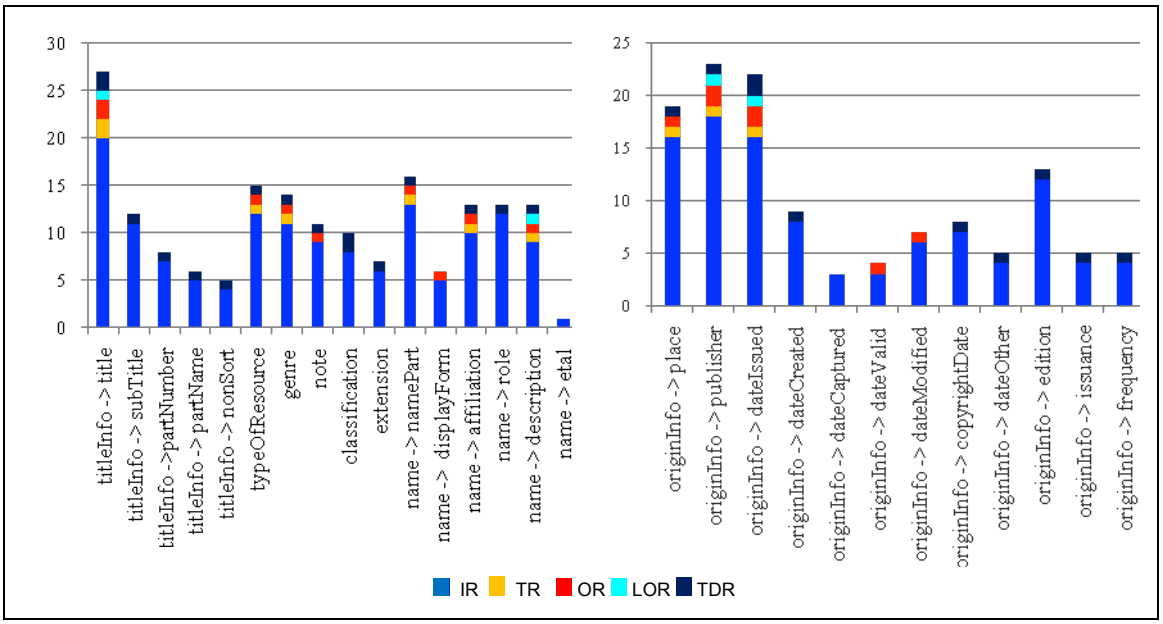
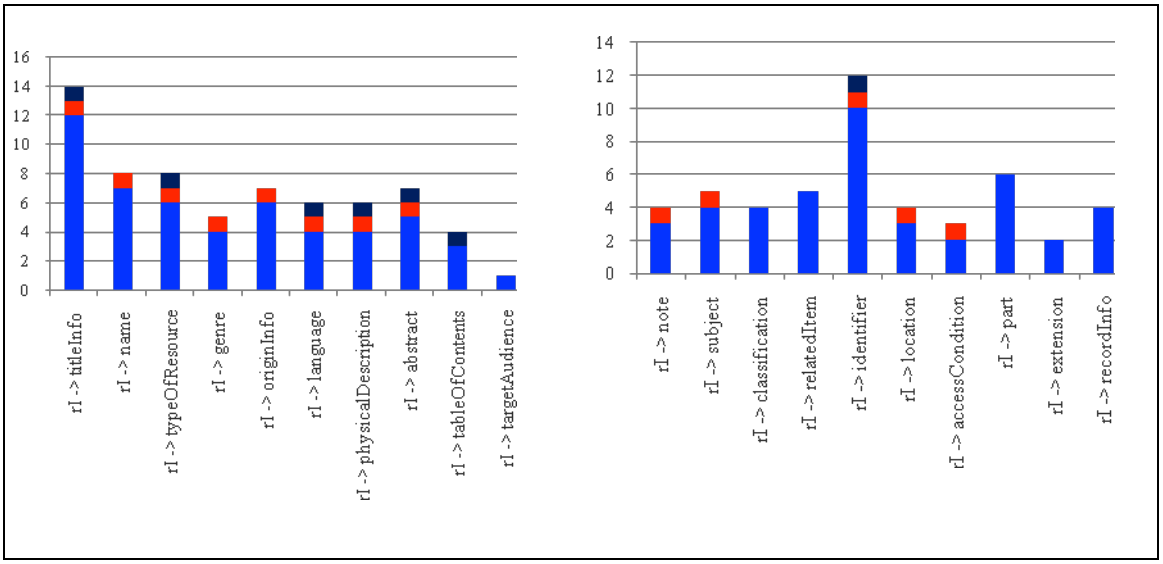


FIG. 5. MODS elements and subelements used by Digital Repository (titleInfo, typeOfResource, genre, note, classification, extension, name, originInfo Elements)



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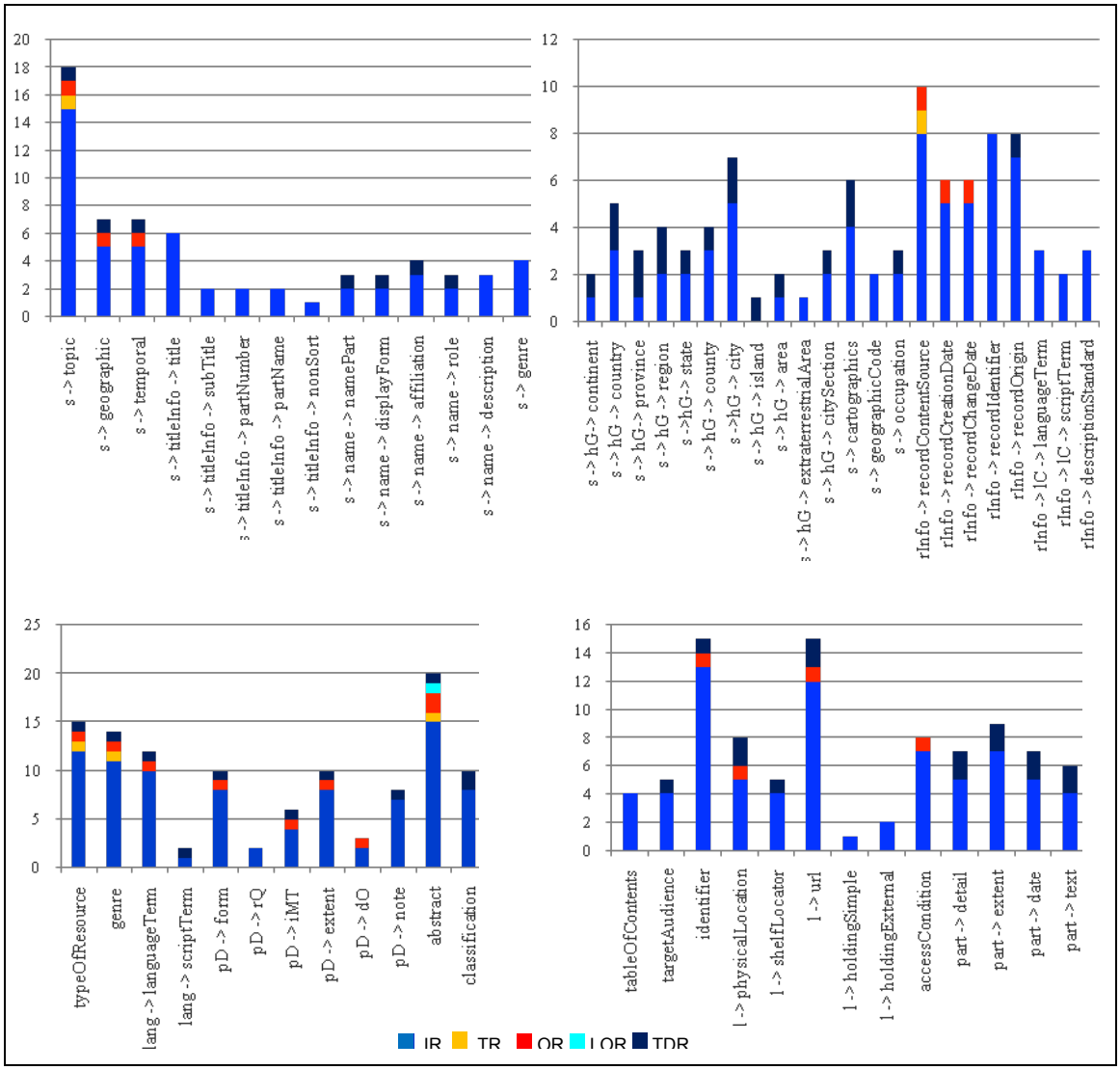

Legend: lang – language; pD – physicalDescription; l – location; rQ – reformattingQuality; iMT- internetMediaTypes; d-O, digitalOrigin; rI – relatedItem; s – subject; rInfo – recordInfo, lC – languageOfCataloging

FIG. 6. MODS elements and subelements used by Digital Repository (relatedItem, subject, recordInfo, typeOfResource, genre, language, physicalDescription, tableOfContents, targetAudience, identifier, location, accessCondition, part Elements).

Q10 is open: the respondents could inform about other schemas and elements being used and that were not previously mentioned in the questionnaire. The results are presented in Table 2.

TABLE 2. Other metadata schemas and elements used by Digital Repositories

Type of DR	Metadata Schema	Metadata Elements	
IR / TDR	ETD-MS (NDLTD)	thesis.degree.level thesis.degree.name	etd.degree.discipline etd.degree.grantor etd.degree.level etd.degree.name etd.thesis.degree title, director, advisor)
	Elements used to better capture resources by Google Scholar (	citation_title citation_author	

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		citation_online_date citation_pdf_url
IR / TDR	https://rucore.libraries.rutgers.edu/rutgers-lib/30699/record/	rulib:descriptiveEvent->type rulib:descriptiveEvent->dateTime rulib:descriptiveEvent->detail rulib:descriptiveEvent->associatedEntity rulib:descriptiveEvent->associatedObjectand similar events in sourceMD, techMD, and rightsMD
IR / OR	elementsdevelopedinternally	utb.event.state utb.faculty utb.source utb.identifier.wok utb.identifier.scopus utb.identifier.obdid utb.identifier.rivid

The results presented in Table 2 are related to three different situations: a) Two DRs use metadata elements drawn from other schemas or created by them, but they do not have MAPs explicitly created; b) One DR has a MAP and makes it publicly available; and c) One respondent claimed his repository had a MAP, but it is not accessible.

Conclusion

The data collected shows that:

- the number of repositories that define APs, is very low, regardless of their typology, contrasting with DCMI recommendations that recommend the use of MAPs in order to optimize semantic interoperability. The lack of knowledge by managers about the advantages and the definition of APs might be one of the factors that inhibit its adoption;
- IR is the type of repository using a greater variety of metadata schemas and using them more. However, we realize that while others follow the trend of the IR, LOR and TDR do not exploit so much the metadata schemas that have been developed for their predominant resource types;
- Dublin Core Element Set is the most adopted metadata schema. Other schemas quite used are METS and MARC 21. This result may be justified by: a) the simplicity of DC and by the fact that it is the schema used by default by OAI-PMH; b) METS simplicity, extensibility and modularity; and 3) the history of MARC 21 in the information science discipline.
  The five most used elements in a) DC: title, author, description, date and type; b) LOM: General -> description, General -> identifier -> catalog, General -> title, General -> language, Educational -> learning resource type; 3) MODS: titleInfo -> title, originInfo-> publisher, abstract , originInfo ->dateIssued and subject -> topic;
- The respondents show a lack of knowledge about MAPs and its adoption.

Limitations and future study

The main limitations of the study are:

- limited number of answers. Although we have achieved a considerable number of respondents (431 out of 2,165), many questionnaires were not completely answered (111, or 25.8%), and many questions were left blank. The questionnaire was quite dense and some questions, such as the ones related to MAPs, might be considered complex for some DR managers. The contributions of other agents that participate in DRs'management might have been useful although it is our belief that the MAP concept is not well disseminated in the DRs community.
- lack of knowledge by the respondents about some concepts touched on some questions, despite of the almost totality of questions have been explained as to their meaning. This is a situation that deserves repositories' specialists and managers

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attention, once the lack of knowledge of some themes inhibits the progress of the actions that can strengthen and optimize the use of the open access through RDs, the semantic interoperability and the adoption of Linked Data guidelines.

Future studies could focus in identifying which metadata schemas and elements are being used by different resource types in DRs. In addition, future studies could include the usage of interactive tools as the wiki.

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References

Armbruster, C., & Romary, L. (2010). Comparing repository types. Retrieved from http://arxiv.org/ftp/arxiv/papers/1005/1005.0839.pdf

Assumpção, F. S., & da Costa, P. L. V. A. (2013). Metadata Authority Description Schema (MADS): uma alternativa à utilização do formato MARC 21 para dados de autoridade; Metadata Authority Description Schema (MADS): una alternativa al uso del formato MARC 21 para datos de autoridad. *Informação & Informação*, *18*(1), 106–126.

Bruce, T. R., & Hillmann, D. I. (2004). The continuum of metadata quality: defining, expressing, exploiting. Retrieved from http://www.ecommons.cornell.edu/handle/1813/7895

Chan, L. M. (n.d.). Metadata Interoperability: A Study of Methodology. Retrieved July 15, 2015, from http://www.white-clouds.com/iclc/cliej/cl19chan.htm

Clayphan, R., & Oldroyd, B. (2005). Using Dublin Core application profiles to manage diverse metadata dDevelopments. In *International Conference on Dublin Core and Metadata Applications* (pp.–23). Retrieved from http://dcpapers.dublincore.org/index.php/pubs/article/view/800

Curado Malta, & Baptista, A. A. (2014). A panoramic view on metadata application profiles of the last decade. *International Journal of Metadata, Semantics and Ontologies*, *9*(1), 58. http://doi.org/10.1504/IJMSO.2014.059124

Darby, R. M., Jones, C. M., Gilbert, L. D., & Lambert, S. C. (2009). Increasing the Productivity of Interactions Between Subject and Institutional Repositories. *New Review of Information Networking*, *14*(2), 117–135. http://doi.org/10.1080/13614570903359381

DCMI Usage Board. (2009, March 2). DCMI Usage Board Review of Scholarly Works Application Profile. DCMI. Retrieved from http://dublincore.org/usage/reviews/2009/swap/

Diamantopoulos, N., Sgouropoulou, C., Kastrantas, K., & Manouselis, N. (2011). Developing a Metadata Application Profile for Sharing Agricultural Scientific and Scholarly Research Resources. In *Metadata and Semantic Research* (pp. 453–466). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-24731-6_45

Guenther, R. (2000, August 6). DC-Library Application Profile (DC-LAP). Retrieved from http://dublincore.org/documents/2001/08/08/library-application-profile/

Heery, R. (2009). Digital Repositories Roadmap Review: towards a vision for research and learning in 2013. Retrieved from http://kennison.name/files/zopestore/uploads/libraries/documents/reproadmapreviewfinal.pdf

Heery, R., & Anderson, S. (2005). Digital repositories review. Retrieved from http://opus.bath.ac.uk/23566/2/digital-repositories-review-2005.pdf

Heery, R., & Patel, M. (2000). Application profiles: mixing and matching metadata schemas. *Ariadne*, *25*, 27–31.

https://doi.org/10.23106/dcmi.952137093

Hillmann, D. I., & Phipps, J. (2007). Application profiles: exposing and enforcing metadata quality. Retrieved from https://ecommons.library.cornell.edu/handle/1813/9371

Knublauch, H., TopQuadrant, Inc., Prud'hommeaux, E., & W3C/MIT. (2015, April 2). Shapes Constraint Language (SHACL). W3C Editor. Retrieved from https://w3c.github.io/data-shapes/shacl/

Metadata Object Description Schema: MODS (Library of Congress). (n.d.). Retrieved July 27, 2015, from http://www.loc.gov/standards/mods/

National Information Standards, N. (2004). Understanding metadata. *National Information Standards*, 20.

National Information Standards Organization. (2007). *A framework of guidance for building good digital collections*. Bathesda: NISO.

Nilsson, M., Baker, T., & Johnston, P. (2008, January 14). The Singapore Framework for Dublin Core Application Profiles. Retrieved from http://dublincore.org/documents/singapore-framework/

Park, J.-R., & Tosaka, Y. (2010). Metadata creation practices in digital repositories and collections: schemata, selection criteria, and interoperability. *Inf. Technol. Libr*, *29*(3), 104–116.

RIOXX the RIOXX metadata profile and guidelines. (2014). Retrieved March 24, 2015, from http://rioxx.net/v2-0-final/

Semple, N. (2006). Digital Repositories. Retrieved July 16, 2015, from http://www.dcc.ac.uk/resources/briefing-papers/introduction-curation/digital-repositories

Smith-Yoshimura, K., & Cellentani, D. (2007). *RLG Programs Descriptive Metadata Practices Survey Results: Data Supplement*. OCLC Programs and Research. Retrieved from http://www.wip.oclc.org/content/dam/research/publications/library/2007/2007-04.pdf

Steyskal, S., & Coyle, K. (2015, July 16). SHACL Use Cases and Requirements. Retrieved July 22, 2015, from https://w3c.github.io/data-shapes/data-shapes-ucr/

Vogel, D. M. (2014). Qualified Dublin Core and the Scholarly Works Application Profile: A Practical Comparison. Retrieved from http://digitalcommons.unl.edu/libphilprac/1085/

https://doi.org/10.23106/dcmi.952137093