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Analytical study of open access health and medical repositories

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Abstract

Purpose – This study aims to assess open access (OA) repositories in the field of the health and medicine (H&M) available in the Directory of the Open Access Repositories (OpenDOAR) by analysing their various facets like geographical distribution, language diversity, collection size, content types, operational status, interoperability, updating policy and software used for content management.

Design/methodology/approach – To achieve the objectives of the study, the OpenDOAR was selected as a source for identifying the H&M repositories. The required data were manually collected from 1 to 30 April 2014 and analysed using various quantitative techniques to reveal the findings.

Findings – The results reveal that the OpenDOAR lists 254 repositories in the field of the H&M contributed by the 62 countries of the world, topped by the USA (15.4 per cent), followed by Japan (7.9 per cent) and the UK (7.5 per cent). The majority of the repositories are institutional (187, 73.6 per cent) in nature, having less than 5,000 items (161, 63.4 per cent) in the collection and mostly consisting of articles (76.0 per cent), theses (49.6 per cent), unpublished documents (33.1 per cent) and books (31.9 per cent). The linguistic assessment shows that the majority of the H&M repositories accept content written in English language (71.3 per cent), followed by Spanish (16.1 per cent) and Japanese (7.5 per cent). The updating policy of these repositories is not up to the mark, as only 67.0 per cent of the H&M repositories have been updated from 2008-2012, but the majority are still operational (91.7 per cent) and are compatible (67.3 per cent) with the Open Archive Initiative Protocol for Metadata Harvesting (OAI-PMH). About 30 software brands, both commercial and open source, have been used by administrators for creating these repositories and managing their content. DSpace is the most popular software used by 88 (34.7 per cent) repositories, followed by EPrints (43, 16.9 per cent) and Digital Commons (18, 7.1 per cent).

Research limitations/implications – The scope of this study is limited to the health and medical repositories listed in OpenDOAR, and hence the generalisation is to be cautioned.

Practical implications – This study is useful for library and information professionals and health and medical professionals across the globe.

Originality/value – This study is the first attempt to analyse the health and medical repositories in OA sites.

Keywords Open access, Health and medicine, Digital archives, Digital repositories, Medical information systems

Paper type Research paper

Introduction

Brand (1987) stated that "Information wants to be free", and Falk (2003) reported that virtually all scholars want free online access to the full text of information resources. Traditional publishing models have prevented information from being freely available;

however, with the development of open access (OA), more information is becoming freely available. OA has literally opened doors to scholarly information. The basic aim of OA is to make the intellectual output of researchers and their institutions more visible, accessible, harvestable, searchable and useable by any user. OA provides a barrier-free platform for accessing recorded knowledge. Although OA has been defined from different perspectives by different authors, they all stress that it provides a barrier-free access to scholarly content.

The Budapest Open Access Initiative (2002) described OA as:

[…] literature, freely available on the public Internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the Internet itself (Suber, 2013).

OA to scientific and medical literature allows anyone, anywhere, with a connection to the internet to find and read published research articles online, and to use their contents in the course of scholarship, teaching and personal inquiry (Public Library of Science, 2003). Presently, OA is a global endeavour to provide free online access to the scholarly research output in any form, format and language. It is a global platform for sharing research output freely from the east to the west, to the north and to the south (Fayaz and Rather, 2007).

There are two primary roads to OA: the "golden" road (publish in an OA journal) and the "green" road (publish in a non-OA journal and also self-archive in an OA repository [OAR]) (Harnad *et al.*, 2004). OA digital repositories (green road) have attracted great attention from academic and research communities worldwide over the past several years. According to Hayes (2005), "A digital repository is where digital contents and assets are stored and can be searched and retrieved for later use". The term "digital repository" represents an online archive of digital information which makes its contents freely and immediately available to information seekers without any restrictions. OARs have been created by almost all the leading academic institutes, research centres, government agencies, industrial organisations, documentation centres, libraries and information networks. Mellon (2006) identified various types of repositories, including institutional, government, disciplinary, publisher, document-specific and personal. Institutional repositories, administered by universities or research institutes for members of their community, are the fastest growing form of OA archives (Chan and Costa, 2005).

To monitor the mushrooming growth of OARs across disciplines worldwide, the Registry of Open Access Repositories was developed by Tim Brody at the University of Southampton (UK), while the Directory of Open Access Repositories (OpenDOAR) was initiated by the University of Nottingham (UK). The OpenDOAR is an authoritative directory of OARs, presently having over 2,600 repositories. This service has been awarded the SPARC Europe Award for Outstanding Achievements in Scholarly Communications, as it maintains a comprehensive and authoritative list of institutional- and subject-based repositories. It also encompasses archives set up by funding agencies, such as the National Institutes of Health (USA) and the Wellcome Trust (UK and Europe). Funding agencies include the Open Society Institute (OSI); Joint Information Systems Committee (JISC); Consortium of Research Libraries; and SPARC Europe, an alliance of European research libraries, library organisations and research institutions

(OpenDOAR, 2014). Keeping in mind the importance of OA, many health and medical repositories were established by higher academic institutes, research centres and governmental and non-governmental organisations at national and international levels.

Open access in health and medicine
The idea of OA to information was active in the minds of scholars before the Budapest Open Access Initiative, as a few documents, especially journals, were available under the title of freely accessible journals. A small, but lively, meeting convened in Budapest organised by the Soros-funded OSI on 1-2 December 2001 and was known as the "Budapest Open Access Initiative"; its recommendations were made public in February 2002 (Bailey, 2006). The Budapest Open Access Initiative stimulated the movement which opened the path for the green and gold roads of OA. In the USA and the UK, legislators and government agencies advocated for OA to publications that resulted from government-funded research (Falk, 2004). The Public Access to Science Act passed by the 108th US Congress in 2003 was another sign of changes ahead. The Act sought an exemption from copyright protection for the results of federally funded scientific research (Banks, 2004). In response to the Public Access to Science Act, the National Institutes of Health (NIH) initiated the Public Access Policy as a landmark step for the development of OA in the health and medical fields. According to the policy, every scientist is required to submit the final peer-reviewed journal manuscripts that arise from NIH funds to the digital archive, PubMed Central (PMC), immediately upon acceptance for publication (Palmer, 2014). PMC is a free, full-text archive of biomedical and life sciences journal literature at the US NIH's National Library of Medicine (www. ncbi.nlm.nih.gov/pmc/). Approximately 60 per cent of NIH-funded articles in PMC are deposited in the form of a final peer-reviewed manuscript and the remaining 40 per cent come from publishers who supply the final published version of the article to PMC directly (European Science Foundation, 2012). Further, PMC International (PMCI) is a collaborative effort between the NIH and organisations in other countries to create a network of digital archives. UKPMC and PMC Canada are similar collaborative centres (European Science Foundation, 2012).

Along with the NIH from the USA, the Wellcome Trust in the UK also strongly advocated for OA to biomedical research. The Trust supported open and unrestricted access to research findings and wanted to see the scientific research funded by the Trust become available to all people (Chesler, 2004). Gradually, many leading research associations in Germany, France, Switzerland, Norway and Hungary, as well as others throughout Europe, signed the "Berlin Declaration" calling for free access to research findings (Falk, 2004). There is a high pressure from funding agencies and international organisations, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), to deposit the articles in repositories that can be freely available (European Science Foundation, 2012).

Reputed academicians and researchers worldwide also joined the OA movement. Michael Eisen of the Public Library of Science (PLOS) declared that OA was "morally superior" to other forms of publishing. In August 2004, 25 Nobel Prize-winning scientists called for the US Government to make all taxpayer-funded research papers freely available. Paul Ginsparg of arXiv estimated that converting all scientific information to an OA model could save US$5bn worldwide (Falk, 2004). *The Economist*

reported on 5 August 2004, that every year around 1.2 million articles are published in about 16,000 scientific journals.

Although there are over 2,000 publishers in the scientific, technological and medical publishing business, "scientific publishing has to change rapidly to respond to growing pressure for free access to published research" (Guerrero and Piqueras, 2004). The response from the publishers was sharp. *Elsevier*, the largest publisher of scientific journals, was one of the first commercial publishers to announce new concessions to OA. *Elsevier* authors are allowed to post their own articles in institutional repositories maintained by their institutions. *Springer*, the world's second largest academic publisher, initiated publication fees or article processing charges for offering OA to scientific research, and authors under these systems were allowed to place their own preprint version in their institutional repository (Falk, 2004). A JISC survey of the SHERPA/RoMEO project showed that 93 per cent of 8,630 journals agreed to allow authors to archive published papers in their institute's archive (Chan *et al.*, 2005). This is one of the great achievements of the worldwide OA movement to persuade non-OA journals to let their authors deposit the peer-reviewed versions of their work in OARs. In a nutshell, the OA movement received considerable support from academics, Nobel laureates and scientists, especially in the West, and this support led to the Budapest, Berlin and Bethesda (3B) initiatives. Thanks to such OA initiatives, many digital repositories and archives were established in all disciplines, especially health and medicine (H&M), which provide the latest knowledge to information seekers worldwide and help to bridge the knowledge gap.

Literature review

OARs have become vibrant platforms for sharing information in a timely manner and are free of cost. Universities and research institutions worldwide are investigating, piloting and developing systems for building collections of digital resources and learning materials in the shape of OA institutional repositories (Rothery and Bell, 2007). Abrizah *et al.* (2010) emphasised that the OA self-archiving movement was initiated to facilitate access to scholarly communication. Therefore, OARs have mushroomed worldwide and almost all countries have established a mechanism to make the research output of the leading higher educational institutes available to the research and academic community at a global level. The main reason universities have institutional repositories is to enhance the visibility, retrievability and impact of the research output of the university (Suber, 2007). Zaki and Dollah (2012) revealed that OA was intended to break the hold of commercial publishers on the intellectual output of universities and research institutions. They further suggested that rather than giving published research to private companies, universities and other research institutes should publish their research findings themselves on freely available, public domain websites.

Wang and Su (2007) stated that, although OA started with developed countries, it is appealing to developing countries and is spreading rapidly throughout the world. Cullen and Chawner (2009) reported that institutional repositories are now established in all continents, with the largest repositories being found in Europe, North and South America, Japan, India and Australia. Subsequently, Roy *et al.* (2012) revealed that, although all the continents are now maintaining OARs, Asia emerges as the third largest contributor. Loan (2014) further noted that Asia is the third largest region in terms of the number of OARs in the world after Europe and North America, contributing

400 (17.4 per cent) repositories out of the total of 2,299. The highest number of repositories in Asia is contributed by Japan (138, 34.5 per cent), followed by both India and Taiwan (58, 14.5 per cent). Most of these repositories are multidisciplinary (268, 67.0 per cent), whereas 10 per cent are related exclusively to technology (43, 10.8 per cent) and health/medical sciences (42, 10.5 per cent). These repositories archive various types of materials, with articles accounting for 81.5 per cent, followed by theses (52.5 per cent), conference proceedings (35.4 per cent) and books (26.5 per cent). Lone *et al.* (2008) revealed that India shares the 10th position with Spain and Sweden in OpenDOAR in terms of the number of repositories in the world, whereas it is second in Asia after Japan. Subject-specific repositories in India make up 66 per cent, with only 34 per cent being multidisciplinary. The subject-specific repositories are mostly related to science and technology, rather than social sciences and humanities. Most of India's repositories in the OpenDOAR archive a variety of information sources, such as articles, conference papers, theses, books, patents and many other formats, whereas some repositories are document specific, that is, archiving only one type of document, such as theses.

There is a sizeable amount of literature on OARs. The results of earlier studies revealed that OARs were mostly established by developed countries and in all subject areas. However, OA digital repositories in H&M are a relatively unexplored area of research which needs to be studied. The present study is a step forward to fill this gap.

Statement of the problem

H&M have remained areas of active inquiry for continuous development and for which a tremendous quantity of literature is produced every day. To ensure the visibility, preservation and usage of scholarly communication in this field, OA is essential. Pat Brown of Stanford University, one of the initiators of the PLOS, (Velterop, 2003, p. 167) said:

> Anyone who has an interest in the results of scientific inquiry, or who believes in making the latest advances in medical knowledge available to physicians and patients around the world, can recognize the importance of more equitable access to the scientific literature.

He then offers a few examples:

> When a woman learns she has breast cancer, she deserves to be able to read the results of research about her treatment options that her own tax dollars have funded. A physician in a public clinic in Uganda ought to have the same access to the latest discoveries about AIDS prevention as a professor at Harvard Medical School. And a precocious high school student in Gary, Indiana, who wants to read about the latest discoveries from NIH-sponsored research in cell biology should not have to pay thousands of dollars for journal subscriptions.

Keeping in mind the importance of the health and medical sciences, Velterop (2003) fully, logically and legally advocated for breaking the financial chains of OA research for the betterment of society as a whole; the world is now witness to the fact that a portion of the health and medical knowledge is openly available in OA journals and repositories. The current study is an attempt to analyse the status of the H&M repositories in OpenDOAR (an authoritative directory of academic OARs) by looking at different aspects – such as geographic contributions, disciplinary scope, language diversity, operational status and harvesting trends – in an effort to help stakeholders to improve OARs in the field of H&M.

Research design
Objectives
The study assesses OARs in the field of H&M sciences available in the OpenDOAR based on research aims which are as follows:

- to discover the geographic contributions of the H&M OARs;
- to examine the disciplinary nature and scope of the H&M repositories;
- to identify the various types of these repositories;
- to determine their language diversity;
- to find out the size of repositories in terms of collections;
- to identify the core content types of H&M repositories;
- to discover the operational status of these repositories;
- to learn about their review/updating policies;
- to identify various software used in the creation and operation of H&M repositories; and
- to review the Open Archive Initiative/Protocol for Metadata Harvesting (OAI-PMH) compatibility of these repositories.

Scope and methodology
The scope of the study is confined to H&M repositories indexed in the "Directory of Open Access Repositories", popularly known as OpenDOAR. To achieve the objectives of the study, the OpenDOAR was selected as the source for identifying and analysing the H&M repositories. The OpenDOAR listed 254 H&M repositories during the period of study (1-30 April 2014). The requisite data about these repositories were collected manually and transferred to a Microsoft Excel file for tabulation and other purposes.

Data analysis
Geographical distribution
OpenDOAR lists 254 repositories in the field of the H&M contributed by 62 countries worldwide. The maximum number of repositories are contributed by the USA (39, 15.35 per cent), followed by Japan (20, 7.88 per cent) and the UK (19, 7.48 per cent). India shares the sixth position with Brazil and Italy, contributing eight repositories each (8, 3.15 per cent) (Table I).

Repository types
There are different types of repositories available in an OA mode. In the case of H&M, the major share of repositories consists of institutional (created and maintained by higher education institutions) (187, 73.6 per cent), followed by disciplinary (designed by organisations/associations of H&M disciplines) (38, 15.0 per cent), aggregated (created by individual units after joining and sharing responsibilities) (23, 9.1 per cent) and governmental (created and maintained by governmental departments) (6, 2.4 per cent) (Table II).

Language diversity
H&M repositories archive contents in 30 languages. Contents in English are stored by 181 repositories, followed by Spanish by 41, Japanese by 19, French by 16, Portuguese

Rank	Country	No.	(%)
1	USA	39	15.4
2	Japan	20	7.9
3	UK	19	7.5
4	France	13	5.1
5	Germany	12	4.7
6	Italy	8	3.2
6	Brazil	8	3.2
6	India	8	3.2
7	Spain	7	2.8
8	Korea	6	2.4
8	Venezuela	6	2.4
8	Portugal	6	2.4
9	Norway	5	2.0
9	Argentina	5	2.0
10	Australia	4	1.6
10	Peru	4	1.6
10	Canada	4	1.6
10	Ireland	4	1.6
10	Indonesia	4	1.6
43 Other countries		72	28.4
Total		254	100

Table I.
Geographical distribution of H&M OARs

Repository types	No.	(%)
Institutional	187	73.6
Disciplinary	38	15.0
Aggregated	23	9.1
Governmental	6	2.4
Total	254	100

Table II.
Type of H&M OARs

by 15 and German by 12. However, contents in the Hindi language are preserved by only one repository (Table III).

Language interface
Most of the repositories (173, 68 per cent) have a monolingual interface, 73 (29 per cent) repositories have bilingual interfaces and a very limited number of repositories (7, 3 per cent) have interfaces available in more than two languages (Figure 1).

Collection development
The majority of the repositories (161, 63.4 per cent) have fewer than 5,000 items, 34 (13.4 per cent) repositories contain 5,000-10,000 items, while only 11 (4.3 per cent) repositories have more than 50,000 items in their collection (Table IV).

Content types
OA H&M repositories archive up to 12 types of content, depending upon the policy of repositories. The highest number of repositories (193, 76.0 per cent) store articles,

Language interface	No.
English	181
Spanish	41
Japanese	19
French	16
Portuguese	15
German	12
Italian	8
Chinese	7
Korean	5
Norwegian	5
Arabic	4
Persian	3
Dutch	3
Ukrainian	3
Catalan	2
Croatian	2
Swedish	2
Hungarian	2
Finnish	2
Indonesian	2
Polish	1
Danish	1
Czech	1
Bulgarian	1
Hindi	1
Icelandic	1
Lithuanian	1
Serbian	1
Russian	1
Basque	1
ND (not defined)	1
Total languages	30

Table III.
Language diversity
of H&M OARs

followed by theses (126, 49.6 per cent), unpublished documents (84, 33.1 per cent) and books (81, 31.9 per cent). Data sets and patents are preserved by nine repositories (3.5 per cent) and only one repository preserves software (Table V).

Open Archive Initiative/Protocol for Metadata Harvesting compatibility
Metadata harvesting is essential for interoperability and searching for information through search engines. Out of 254 repositories, a large number (171, 67.3 per cent) are compatible with the OAI-PMH. Oddly, 83 (32.7 per cent) repositories do not provide any information regarding their OAI-PMH policies (Figure 2).

Software use
Software is an essential component for constructing repositories, and 30 different open source and commercial software are used by H&M repositories to manage their content. DSpace is the most popular software used by 88 (34.7 per cent) repositories, followed by
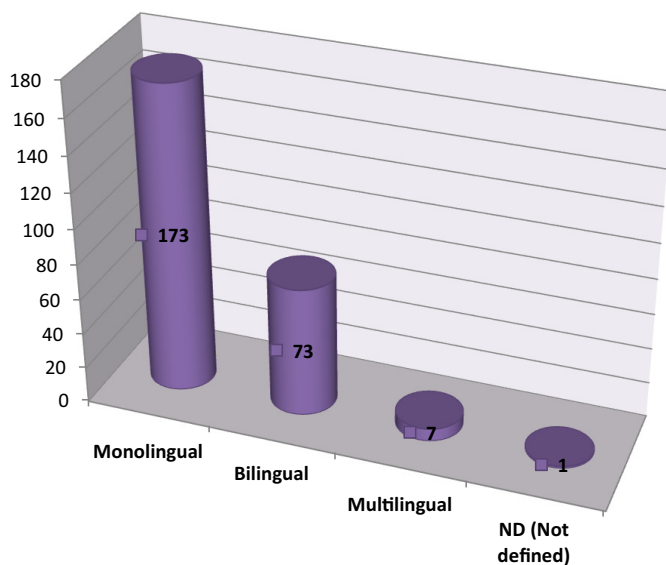
Figure 1.
Language diversity
of H&M OARs

Size	No.	(%)
<5,000	161	63.4
5,000-10,000	34	13.4
10,000-15,000	12	4.7
15,000-20,000	3	1.2
20,000-25,000	6	2.4
25,000-30,000	6	2.4
30,000-35,000	3	1.2
35,000-40,000	4	1.6
40,000-45,000	1	0.4
45,000-50,000	1	0.4
Above 50,000	11	4.3
ND (not defined)	12	4.7
Total	254	100

Table IV.
H&M OARs by size
of collection

EPrints (43, 16.9 per cent) and Digital Commons (18, 7.1 per cent). In total, 27 other
software brands are used by 75 repositories (29.5 per cent), and 30 repositories (11.8 per
cent) do not provide any information about the software used by them for managing
their contents (Table VI).

Operational status
A dead repository is essentially not a repository. Out of the 254 H&M repositories, 233
(91.7 per cent) were operational at the time of the study, whereas a small proportion of
repositories (21, 8.3 per cent) were non-functional. The most prominent reasons of
non-functional repositories were server problems, website error and similar issues
(Figure 3).

Rank	Content types	No.	(%)
1	Articles	193	76.0
2	Theses	126	49.6
3	Unpublished documents	84	33.1
4	Books	81	31.9
5	Conferences	78	30.7
6	Multimedia	45	17.7
7	References	45	17.7
8	Learning objects	36	14.2
9	Special	29	11.4
10	Data sets	9	3.5
11	Patents	9	3.5
12	Software	1	0.0

Table V.
Content type in H&M OARs

32.68

67.32

Yes
No
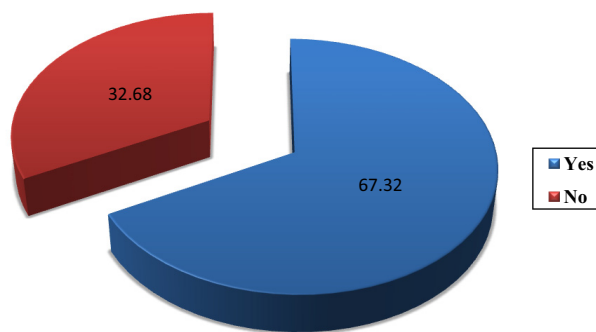
Figure 2.
OAI-PMH compatibility

Software types	No.	(%)
Dspace	88	34.7
EPrints	43	16.9
Digital commons	18	7.1
SciELO	15	5.9
Open repository	12	4.7
Greenstone	9	3.5
Fedora	4	1.6
HAL	4	1.6
XooNIps	3	1.2
PMC	3	1.2
ND (not defined	30	11.8
20 Other software	25	9.8
Total	254	100

Table VI.
Software used by H&M OARs

Updated status

A policy for updating the repository is indispensable in view of rapid technological development, as it keeps the repository accessible by new Web tools, increases persistence and the user base, and thus leads to the active growth of the repository. The data reveal that 69 (27.2 per cent) of the H&M repositories have been updated from 2008 to 2011, whereas 102 repositories (40.2 per cent) were updated in 2012, 62 (24.4 per cent) in 2013 and 21 (8.3 per cent) in 2014 (Table VII).

Discussion

OpenDOAR registered more than 250 repositories in the field of H&M. Further, 62 countries had repositories with the highest share coming from developed countries, including the USA, Japan, UK, France, Germany, Brazil and Italy. The majority of these repositories were established by academic/research institutions and governmental organisations whose primary aim is to conduct research in the health and medical fields and make their research output freely available in a timely manner to the global academic, research and medical communities. This timely availability of medical information is indispensable for the development of health-care systems worldwide in general and for developing and under-developing countries in particular. Timely availability can bridge the information gap between the information-rich countries (information haves) and information-poor countries (information have-nots) in the field of health and medical sciences. It is also generally necessary to ensure dissemination of information to the neighbouring countries, to combat similar health problems in the region.
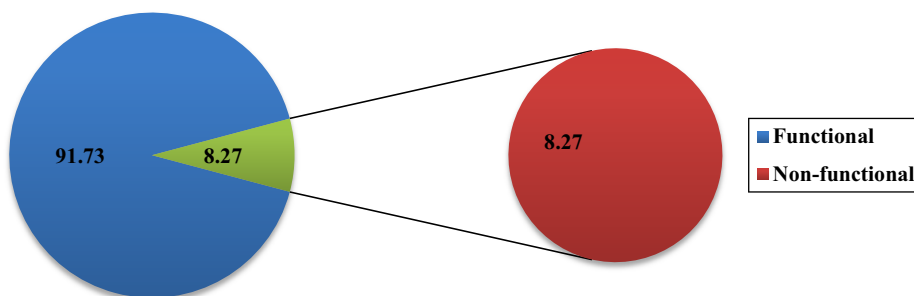

Figure 3.
Operational status of
H&M repositories

Updated status (year)	No.	(%)
2014	21	8.3
2013	62	24.4
2012	102	40.2
2011	24	9.5
2010	20	7.9
2009	14	5.5
2008	11	4.3
Total	254	100

Table VII.
Updated status of
H&M OARs

H&M repositories archive various types of contents, both published and unpublished, including articles, conference papers, books, patents, theses, dissertations and many other formats, depending upon their respective policy. Sources include both digital versions of print sources or born digital sources. The collections of these health and medical repositories are in the budding phase, as repositories have only limited collections, with the highest having 63 per cent of all possible articles (>5,000). This may also be the result of poor academic participation. Digital illiteracy, technophobia, copyright issues, fear of plagiarism and invisible author benefits are some of the factors responsible for poor participation. There is a need to motivate the academic community to deposit their research output in these H&M repositories and to provide proactive support for greater participation. Author awareness programmes, such as workshops and short-term training courses, are of great importance to address these issues. The low level of author participation reduces public access to knowledge and undermines career-enhancing opportunities. Archiving of contents in these H&M repositories is suitable for future searching, mining and interoperability with other archives that not only helps to provide a wider circulation of knowledge but also helps in increasing citations and impact. Medical librarians have to take more responsibility to make H&M repositories more vibrant. These repositories should not become graveyards of less qualitative and unpublished material, but should become proactive information dissemination centres. All the research output of the institution published in any form (print or electronic) and in any mode (OA or commercial) must be preserved in these repositories for use by present and future generations. Reputable commercial publishers, such as *Elsevier*, have allowed authors, in most instances, to deposit their research papers in their institutional repositories. Now institutions need to take steps to make it compulsory for academicians and medical professionals to deposit publications, including theses and dissertations, in H&M repositories. These repositories should act as the "brain of the institution/profession" in a real sense where the intellectual output is to be stored for posterity and the prosperity of social health and mental hygiene.

To make these H&M repositories more useful, metadata harvesting is essential. Metadata is the information that describes the material deposited in the repository and enables end users to search, find and retrieve information from the repository easily and effectively. Fortunately, a large number of repositories are compatible with the OAI-PMH. As mentioned previously, the OAI-PMH is a protocol developed by the OAI used to harvest (or collect) the metadata descriptions of the records in an archive so that services can be built using metadata from many archives. An implementation of OAI-PMH must support representing metadata in Dublin Core, but may also support additional representations (Breeding, 2002). The OAI-PMH allows search engines to harvest the data from these repositories and makes interoperability possible, enabling users to find relevant information from various search engines. The information available in these repositories can be retrieved through both general (Google) and specific (Healthfinder) search engines. These repositories need to be listed in health and medical directories on the internet, such as MedLinePlus, HealthWeb, MedWeb and Health Compass. This process is necessary for increasing their visibility and popularity among academicians, medical professionals and other users worldwide. Matsuura (2008) reported that Japan has a single Web portal called Japanese Institutional Repositories Online for accessing the contents of all digital repositories. The World Health Organization (WHO) could establish such a portal to increase the use of H&M

repositories. Another alternative is to create a common world health repository under the umbrella of the WHO for archiving, preserving and accessing digital content in the field of H&M. It could also maximise the use of the H&M repositories, and subsequently help increase the h-index of the institution *vis-à-vis* the institution's scholarly reputation.

The majority of H&M repositories (92 per cent) were found to be functional. Prominent reasons for non-functional repositories were server problems and website errors. Administrators need to have high-configuration servers for the repositories with better electricity backup to overcome these problems. Additionally, the updating policy for repositories is indispensable in view of rapid technological development, as it keeps the repository available to be searched by the ever evolving Web tools. Almost 67 per cent of H&M repositories have been updated as long ago as the 2008-2012 time frame; therefore, it is recommended that these repositories be updated at more regular intervals to keep them operational.

To manage H&M repositories, administrators have mostly selected the open source software DSpace. DSpace has a number of noteworthy features, such as flexibility, customisability, interoperability, greater visibility, searchability and free availability, which make it more suitable for administrators. There are many other commercial and open source software brands used by repository managers. The medical library and information managers and other involved persons need to be trained in operating the software and keeping their knowledge and skills up-to-date when new versions are released to effectively implement them. However, there is a need to tap the experiences of various professionals for upgrading the software and making these more user-friendly. Information and technology experts and computer scientists should provide a helping hand in this direction (Loan, 2014).

Language is the heart of communication. The language barrier has an adverse effect on the free flow of information among scholars speaking, reading, writing and understanding different languages. Health and medical information in these repositories is available in 30 different languages, and most of the information is available in English, followed by Spanish and Japanese. There are 7,106 living languages in the world spoken by 6,295,712,191 people among which Chinese is spoken in 33 countries by 1,197 million people, Spanish in 31 countries by 414 million people, English in 99 countries by 335 million people, Hindi in four countries by 260 million people and Arabic in 60 countries by 237 million (Ethnologue, 2014). These statistics indicate that there is a visible language barrier between users and information which results in poor understanding and misunderstanding of information. There is a need to promote multilingualism worldwide in the form of publications, conferences, symposiums, seminars and so forth to allow the information to be communicated in as many languages as possible. These repositories also need to archive materials in all publishing languages for optimum utilisation. English can serve as a "lifeline" in the scholarly communication cycle, as it is being used in 99 countries. It has become a global language for scholarly communication, especially in the fields of natural sciences and technology. In addition to English, Chinese, Spanish, Hindi and Arabic languages can also prove to be the most useful for the free flow of information. All the contents available in H&M repositories in various languages need to be preceded by abstracts in all of the most influential languages of the world so that the maximum amount of the population can benefit. Hindi is the fourth most spoken language globally, but only one repository archives materials in this language. The health and medical repositories in India need to archive

content written in all local languages, including Hindi, for use by their own nationals. The translation services of various national and international organisations, such as Index Translationum of UNESCO, could also prove helpful in this regard. It is also evident that most of these repositories have a monolingual interface, whereas some repositories have bilingual interface, and a very limited number of repositories have interfaces available in more than two languages. Translation software, such as Machine Translation and Memory Translation, and the translation services of Web software, including Google Translation Service, could also be used to help overcome this problem. Again, there is a need to promote multilingual culture and create websites, Web pages and weblogs for these repositories in all of the most prominent languages for the maximum exploitation of the information contained in the H&M repositories.

Conclusions

OA health and medical repositories have emerged in every corner of the world and help bridge the knowledge gap between information-rich and information-poor countries and institutions. These repositories serve as valuable resources for health and medical sciences professionals in developing and underdeveloped countries and smaller or less wealthy institutions. Repositories have made a portion of health and medical information available to the worldwide medical community free of cost, and this will help dedicated medical professionals, such as doctors and nurses, in providing qualitative health services to patients, as well as researchers, scholars, students, policy planners and other interested amateurs in making more informed decisions on health and medical issues.

OARs have revolutionised the scholarly information transfer in the field of H&M. These repositories have broken down the financial barriers between medical professionals and needed information to a great extent. With the availability of the literature in these repositories, there will be dramatic and striking gains in the circulation of knowledge, citations of sources, indexing of authors and impact factors of journals. However, poor academic participation, language barriers and non-operating repositories are some concerns that need to be addressed. Academicians and researchers should be actively engaged with H&M repositories to fulfil OA mandates. International organisations, such as WHO, and national organisations should join together and provide strong support to the OA movement to strengthen health and medical services across the globe.

Future research

The current research is based on a quantitative analysis of H&M repositories. In future research, the focus should be on qualitative research to judge the quality of contents archived in these repositories by a selected set of parameters, such as authors and their affiliations, h-indexes, publishing bodies and their reputation, their currency and obsolescence and copyright and plagiarism, to name the most promising areas.

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