PROMOTING OPEN SCIENCE WITH INSTITUTIONAL REPOSITORIES IN THE MALAYSIAN COMPREHENSIVE PUBLIC UNIVERSITIES

MAHFOOZ AHMED[1*], ROSLINA OTHMAN[2]

[12]Dept. of Library and Information Science, International Islamic University, Malaysia

**Corresponding author: almahfooz4real@gmail.com*

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ABSTRACT: This study examines the level of openness of the intellectual collections in the Malaysian Public Universities Repositories, towards promoting the practice of open science in the institutions. Open science stands for a new system in which researchers all over the globe can come together and contribute to all research processes and at the end of the processes allows for the sharing of the scientific findings that are beneficial to all humanities freely. Specifically, the main objectives of the study were to identify, to what extent were the intellectual contents in the Institutional Repositories (IR) of the comprehensive universities in Malaysia open to the general public and how the librarians and researchers from these universities promote open science through the IR. Mixed-method research was used to gather information from the respondents. A total of 255 responses were received for the quantitative method and a total of 6 librarians were interviewed for the qualitative method to complement the other and triangulation was done to aggregate the major findings, which show that the public universities in Malaysia were involved in OS through their institutional repositories. However, only 10% to 30% of the contents in these IR were available to the general public, while some institutions only provide the abstract to the public. Some recommended factors identified by the stakeholders to fully implement the OS practices were: the need for more enlightenment on the system, more of the modern digital facilities or infrastructure such as high-speed internet, and well-managed and secured databases.

KEY WORDS: *Open Science, Open Science Readiness, Open Access, Open Data, Institutional Repository, Open Science Policy.*

1. INTRODUCTION

Information and Communication Technology (ICT) has changed the ways research is being conducted in science and innovation to be more collaborative, more international, and more open to the world. These methods have presented a new scientific process based on cooperative work and new ways of disseminating knowledge using digital technologies and new collaborative tools known as open science (Mancini, Lardo, and De Angelis, 2020; Moedas, 2016). Open science has now created a system of knowledge dissemination using digital technologies and new collaborative tools that promote joint effort in sharing research processes and results of new knowledge as early and as widely as possible. The main objective of this method of scientific engagement is to include the broader communities in

addressing some universal challenges more effectively and to guarantee that science and research are fundamental to the innovation, growth, and development of any society (Martínez and Poveda, 2018).

Society is now requesting from the researchers and the innovators to make their knowledge more universal and visible to the public, but the question remains, are the researchers ready to make public their research or provide it on less formal platforms such as in the blogs, which could make them more visible to the public. This is also seen as an invitation and opportunity for early career researchers to think about social media as a publishing medium. But findings showed that most of the researchers were still in the opinion that they did not use social media channels for disseminating their research due to time constraints as they were busy writing papers for high impact factor journals because publishing in social media cannot give them any recognition (e.g. not admissible on their CVs). Other reasons were that they lacked the know-how while some journals forbade the authors to do so (Nicholas et al., 2017).

Thus, open science has introduced new ways through which research and education were being performed. It has created an avenue not only for researchers to publicize their studies, but also to collaborate, where knowledge can be shared so that everybody in the society can contribute to the scientific advancements through more effective use of research outputs. The open science movement was not only to enhance the educational sector but as the name implied, it would be a universal collaboration of research professionals all around the world trying to solve multiple challenges in many areas like food, water, energy, and health because these are universal challenges that can only be solved through international collaborations (Väänänen and Peltonen, 2016).

Likewise, various academic and research communities and publishers and their sponsors in places like Canada, United States, and the United Kingdom have introduced a new method, tools, services, and infrastructures for sharing their research output. Organizations such as the Social Sciences and Humanities Research Council of Canada (SSHRC), the National Sanitation Foundation (NSF International), the Canadian Institutes of Health Research (CIHR), the National Institutes of Health (NIH), the UK Medical Research Council the Wellcome Trust, and many other similar organizations have all been pioneers in this movement of open science. Each of these organizations has supported the establishment of PubMed Central as an open-access digital repository for all their funded research outputs (Lasthiotakis, Kretz, and Sá, 2015).

Research and academic institutions all around the globe are now trying to fully utilize the benefits attached to the internet technology, as many online platforms with which people could not only communicate and promote their research are being developed but through which they can also collaborate and work together simultaneously as a team. Some of these essential web-based tools for researchers range from social networking sites, scientific research support tools, labs and data management tools, and others (Crouzier, 2017). Likewise, these tools are now being used to support the acts of promoting excellent research, teaching, and learning as the goals in academic institutions (Brennan et al., 2019; Singh and Hurley, 2017).

The drastic change in academic publications and information communication mediums, which has introduced many academic institutions to now divert into more of being digital has also led to the birth of an institutional repository (Ebong, Nelson, and Afebende, 2017). Institutional repositories are mostly developed by libraries and research centers, universities, governments, multidisciplinary schools, and laboratories, mostly to preserve and communicate their intellectual properties both internally and externally (Adam and Kaur, 2019). While in the case of the libraries, the several economic downturns being experienced in its budgets during the past decades where the budget cutbacks have influenced the collection policies were among the reasons why these repositories are now being implemented globally (Saarti, 2018). This is why this study was also conducted to examine the level of openness of the intellectual collections in the Malaysian Public University Repositories, towards promoting open science initiatives. While specifically, the research answers the following research questions:

1. To what extent, were the comprehensive universities in Malaysia Institutional Repositories (IR) contents open to the general public?
2. How do the librarians from these universities promote open science through their IR?
3. How do the researchers from these universities participate in open science initiatives through their IR?

2. LITERATURE REVIEW

Although there has been quite some published work on open science and its related concepts in most developed countries, little has been written on this subject in Malaysia. This could be the fact that open science is either relatively new or is an emerging field of study. To achieve the objective set for this study, some previous and related studies were reviewed to explore more on the research objectives as found in existing works.

2.1. Concepts of Open Science

Open Science has introduced new socio-cultural and technological changes in how research is being carried out, based on openness and collaboration, on how it is being designed, achieved, captured, and assessed. In a nutshell, Open Science is a transparent and accessible knowledge that is developed and shared through collaborative platforms (Banks et al., 2019; Vicente-Sáez and Martínez-Fuentes, 2018).

Abd. Rahman (2019), and Gema Bueno de la Fuentes (2020) referred to the term, “Open Science” as a new system of knowledge collaboration and knowledge sharing in which research data and its underlying methods and processes are made available “freely” for reuse, redistribution, and reproduction by those other than the original researchers themselves. This is because making research data and knowledge publicly available is an important role in open science which can also help in building trust in research findings and could support public policies and further investments. Thus, open science encourages research work to grow, not only stay on shelves.

The Open Science Framework (OSF) and Center for Open Science (COS), is a web-platform that promotes open, centralized workflows that allow the different

features and process of the research life cycle, starting from developing a research idea, designing a study, storing and analyzing the data, and writing and publishing the reports. Defined Open Science as an open exchange of ideas to promote scientific progress towards solving most of humanity's problems, this is achieved through a platform in which the research is carried out with collaborative efforts towards solving universal challenges of mostly disease, education, poverty, social justice, and environment, which much time cannot be wasted on. The outcomes and findings of this system of research are always shared freely to allow reproducibility among experts (Foster and Deardorff, 2017). The Open Science Framework shall be a guideline that could accommodate local needs and local perceptions.

2.2 Open Science Repository (Infrastructure)

The fundamental objective of open science as mentioned is to openly make available scientific knowledge created by researchers as the result of publicly funded research projects for use and reuse. Likewise, to promote this system, many institutions around the world today most especially the research and academic institutions are implementing the Institutional repositories (IR) as a warehouse to host all their intellectual publications to easily present them to the public.

The institutional repository has been a tool for collecting, storing, and disseminating scholarly publications within and sometimes outside institutions. The IR provides a set of services ranging from management and dissemination of digital materials created by institutions and its community members to serve the interests of the people by collecting their intellectual outputs for long-term access (Prost and Schöpfel, 2014). Kayal et al. (2018) defined a repository as a tool for knowledge management in providing universal access to information and knowledge, especially in academic libraries and other related institutions. A repository refers to as digital collections of scholarly articles that are self-archived by their authors.

Hwang et al. (2020) defined repositories as a group of services that make an open-access digital archive of the institution's scholarly work and communication created by the college, administration, and students. While Gibbons (2009) identified the features for an institutional repository (IR) as follows: digital, community-driven, and focused, institutionally supported, durable and permanent, and accessible. This makes Demetres et al. (2020) defined IR as a perfect platform for presenting and publicizing scholarly output that may not be suitable for publication during a peer-reviewed journal or that has got to meet open access requirements. This could include but is not limited to, student work, presentations, working papers, conference papers, newsletters, electronic theses and dissertations, journals with limited distribution, or electronic archival materials.

One of the most essential components in many institutions today is the repository where their intellectual contents were being collected and managed. This can be why there has been a large implementation of diverse data repositories worldwide to support the open science movement (Arlitsch and Grant, 2018). The Institutional Repository has been remarked by different names over time, like data centers, data archives, or scientific databases, Abd. Rahman (2019) categorized the various varieties of repositories into three main categories as follows:

1. **Institutional Repositories (IRs):** which are mostly affiliated with institutions such as the IIUM Repository.

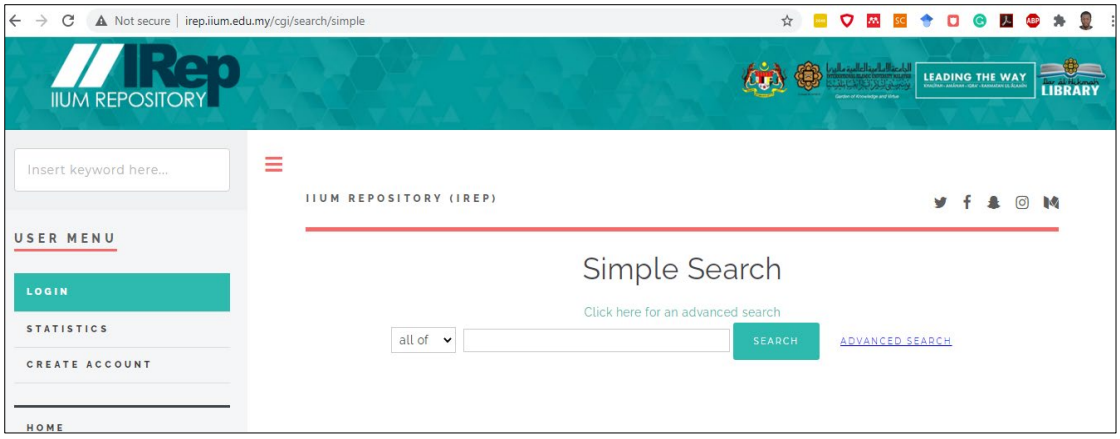

Fig. 1. Institutional Repositories (IRs)

2. **Domain-specific or Disciplinary Repositories (DRs):** are Subject Repository or discipline-specific and usually operated by a professional organization, a consortium of researchers, or a similar group, such as CiteSeerx which is a scientific literature digital library and search engine that focused primarily on the literature in computer and information science.

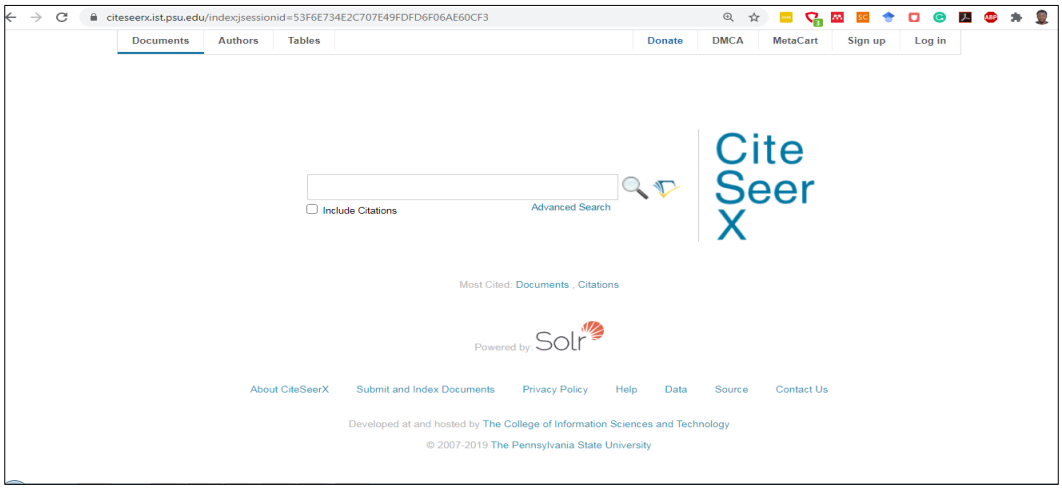

Fig. 2. Domain-specific or Disciplinary Repositories (DRs)

3. **General-purpose or Open Repositories (ORs)**: which allow researchers to deposit and make their data available regardless of disciplinary or institutional affiliation, such as Research Gate which is a global and open repository available to users on the internet.

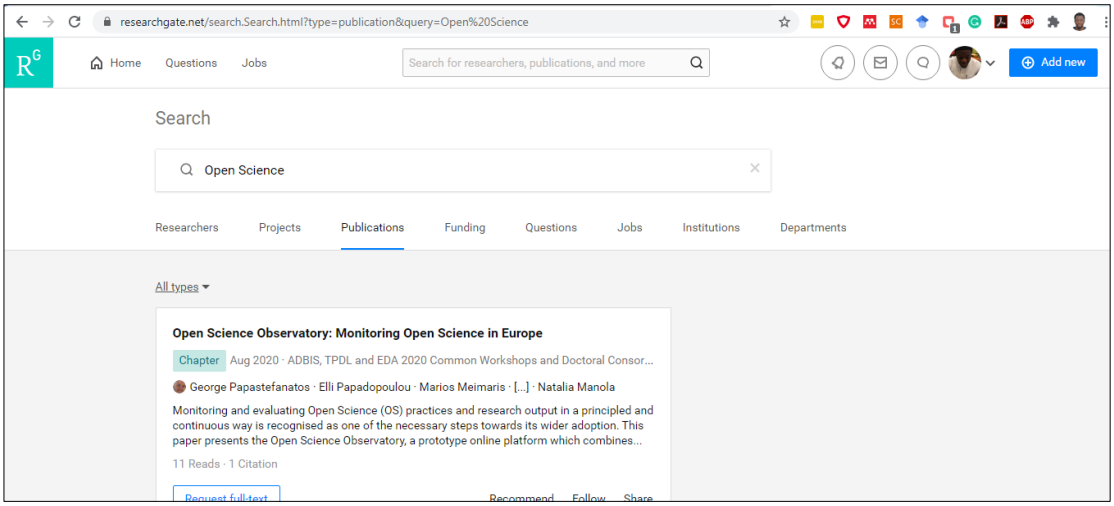

Fig. 3. General-purpose or Open Repositories (ORs)

Mancini et al. (2020) stated that the success of open research processes will be based on the availability of an information system infrastructure, such as informatics platforms where efficient web interfaces should be developed to easily record and share open data.

The term “Open Science” as mentioned earlier could encompass different practices, usually encompasses areas like open access to publications, open access to research data, open-source software, open workflows, open educational resources, citizen science, and substitute methods for research evaluation as well as open peer review.

2.3 Open Access (OA)

Open access here simply refers to free and unrestricted online access to research findings such as in journal articles, books, book chapters, and other related. OA contents are usually open for everyone, with no access fees. According to Suber (2010), open access refers to any digital literature online, peer-reviewed scholarly publications, which are mostly made available to be read for free, with limited or no copyright and licensing restrictions. Different terminologies were used for the term ‘Open Access’ in different platforms, according to Robinson-Garcia et al. (2020), the main 3 types of access to publications are gold, green and hybrid access, as listed and indicated below.

i. **Gold Open Access** is any digital scholarly publications made available free to read by journal publication.
ii. **Green Open Access** is any digital scholarly publication made available or delivered by a repository.
iii. **Hybrid Open Access** or Toll access is also known as close access journals that make specific publications open and accessible to the public after the author pays some fee, which will serve as a recovery for the publishers from what they will have gotten from the subscription fees.

Such standards of open access can be applied based on the readiness of both authors who were researchers and librarians who provided the in-house collections.

Lastly, the Bronze Open Access which was first introduced by Piwowar et al. (2018) and refers to free to read articles that are made available by the publishers, without clearly mentioning its OA license.

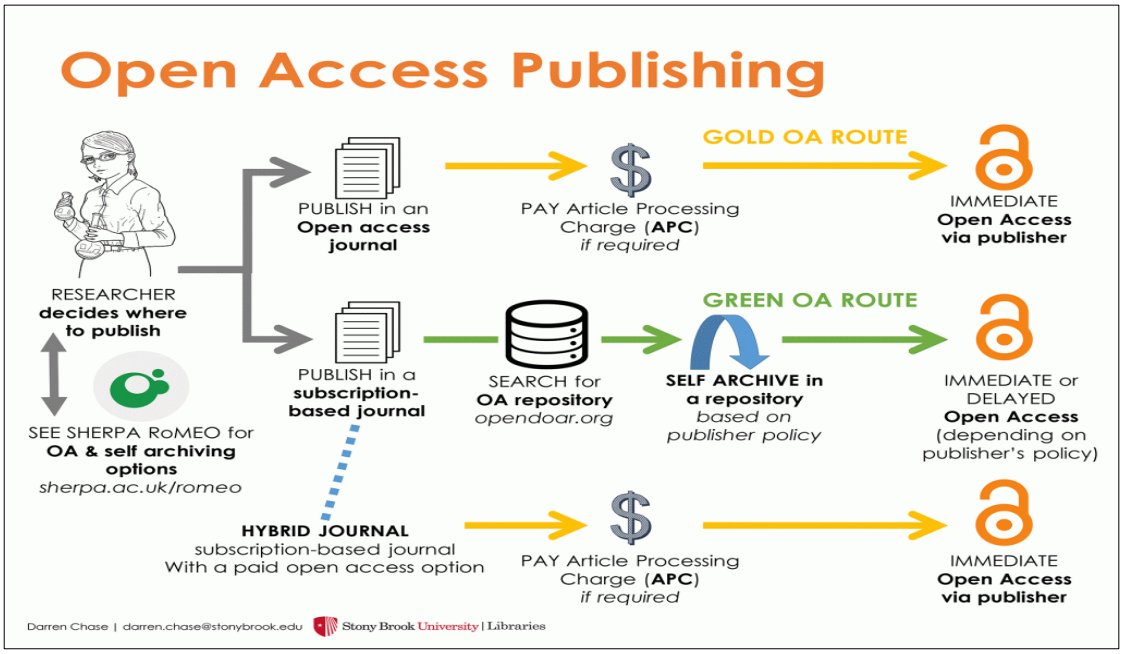

Fig. 4. Types of Open Access Publishing, source: https://library.stonybrook.edu/

According to Pontika et al. (2015), the first official recognition of open access can be dated back to 2002, when the Budapest Open Access Initiative declared OA not only as a term but also as a policy that will support the rise within the amount of free, accessible, and reusable research publications. Since then, the open scholarly communications agenda has grown, and currently, more terms are embedded in it such as open data, open-source, and open reproducible research. Therefore, open access can be thought to be a vital characteristic of open science.

Björk (2019) studied open-access journal publishing within the Nordic countries. Through alternate data sources for identification and manual verification of 437 scholarly open access journals published from 5 Nordic countries (Denmark, Norway, Sweden, Iceland, and Finland), and a few key characteristics were studied, of which only 184 of those journals were indexed in DOAJ. While most of the journals were published by other scholarly societies or universities, humanities and social sciences were the dominant topics, and only a few of the journals charge publication fees. National or university-specific Open Journal System portals have played a significant role in enabling open publishing. Around a 3rd of the Nordic scholarly journals are currently open access. Thus, open access has its records of achievements and growth.

Robinson-Garcia et al. (2020) also presented a universal view of the state of open access uptake at the institutional level. They identified all universities that appeared in the 2019th edition of the Leiden Ranking; all their publications were retrieved from Web of Science and they categorized their access type into the following four types based on their experiments: gold, green, hybrid, and bronze. Overall, their results showed that around 41% of all publications contained in their data set are openly accessible. Green OA is the most common type of OA (77%),

followed by Gold OA (33%). Differences between countries and continents are also observed in the study, with Europe leading on OA penetration, followed by North America, and Asia and Africa behind. However, it also yields many differences between universities from the same region, with only universities from Oceania and South America showing similar ratios of OA presence. Thus, there was a need to explore the readiness for open science initiatives from the researchers' views and librarians' perspectives.

2.4 Open Data

Open data as the name implies from the open data handbook means any facts or statistics collected for reference or analysis, which anyone can freely access, use, modify, and share for any purpose. Open data and content can always be freely used, modified, and shared by anyone for any purpose (OKF, 2014). Such openness could enable the re-use and repeatability of a research instrument and shed new light on the same data. Such data could also be re-visited for a different scenario and interpretation.

As open data encompasses a future to be shared and reuse anywhere globally for later use and also the movement is growing rapidly and becoming widely accepted as publicly funded agencies are mandating that researchers open their research data for sharing and reuse. While there are abundant advantages to the utilization of open data, like facilitating accountability and transparency, although, Chauvette et al. (2019) in their study on open data in qualitative research, stated that not all data are created equally which reusing data in qualitative research may present some epistemological, methodological, legal, and ethical issues that must be addressed within the movement toward open data. This is often because qualitative research mostly obtains in-depth information on a couple of phenomena of interest. Because it provides a novel engagement between the participants, and the researcher in generating the info, which is usually rich and contextual. This was often true when perceptions and analysis became felt.

2.5 Open Source

Open source refers to something people can modify and share because its design is publicly accessible (Ma et al., 2019). Open source is mostly related to open-source software, which is a computer application or program source code (initial part of the software) provided for the public freely to inspect, modify, and enhance (Pontika et al., 2015). An example of a library management open-source software is KOHA. Open-source software can be accessed online for free, with a source code license that allows its use, creation of derivatives, and distribution. The major advantage of open-source software is its strong community support.

Ab Yajid (2020) examined the factors that are affecting the adoption of open-source software adaptation in Malaysian organizations. In which he adopted a survey approach to determine these factors. A total of 200 questionnaires were distributed to different company's CEO and I.T. staff ranging from insurance, banking, government, education, and information technology. His findings indicated that Malaysia is still in the early stage in the implementation and use of OSS and suggested that, the government of Malaysia should enhance the open-source in programs and events of ICT and the government of Malaysia should enable and give increments to the development of open-source via promotions and private and civil sector adaptations. Because in countries such as France and Germany, open

source is very popular, and they are even at the top of the world in the adoption of open source. Thus, this research also aimed to understand the readiness from the views of researchers and perceptions of librarians.

2.6 Open Reproducible Research

Open reproducible research is exactly almost like the final term “open science” itself, within which research data that are being collected, or data being generated, and sometimes the procedures implemented during a research paper were made available unengaged to the public for re-use. Reproducibility of research findings will give the flexibility to repeat experimental procedures and ensure the previously found results of any research. Martínez and Poveda (2018) explained it as providing access to the results (open access), to the method (open data), and to the methodology and other features of the research process that creates it possible to know how the results were achieved and to permit the research work to be replicated and reproduced. In a null shell, open reproducible research is the act of practicing open science to enable the independent reproducibility of the research results (Nüst et al., 2016; Pontika et al., 2015).

This research learned another characteristic of open science that is reproducibility indicating that research work is challenged. By implementing open reproducible or transparent research practices, authors have the chance to present and showcase work that is more reproducible, easier to make upon, and more credible. Scientists again by making their work easier to share and maintain within their laboratories, and therefore the scientific community gains by making underlying data or research materials more available for confirmation or making discoveries. Sullivan et al. (2019) gave the detailed procedures for creating a more open and reproducible research workflow using the free and open-source Open Science Framework (OSF) shown in Fig. 5, to form an information management plan, preregister a study, use version control, share data and other research materials, or post a preprint for quick and straightforward dissemination. A hunt work that is receptive arguments would have more citations and revisits by other different researchers.

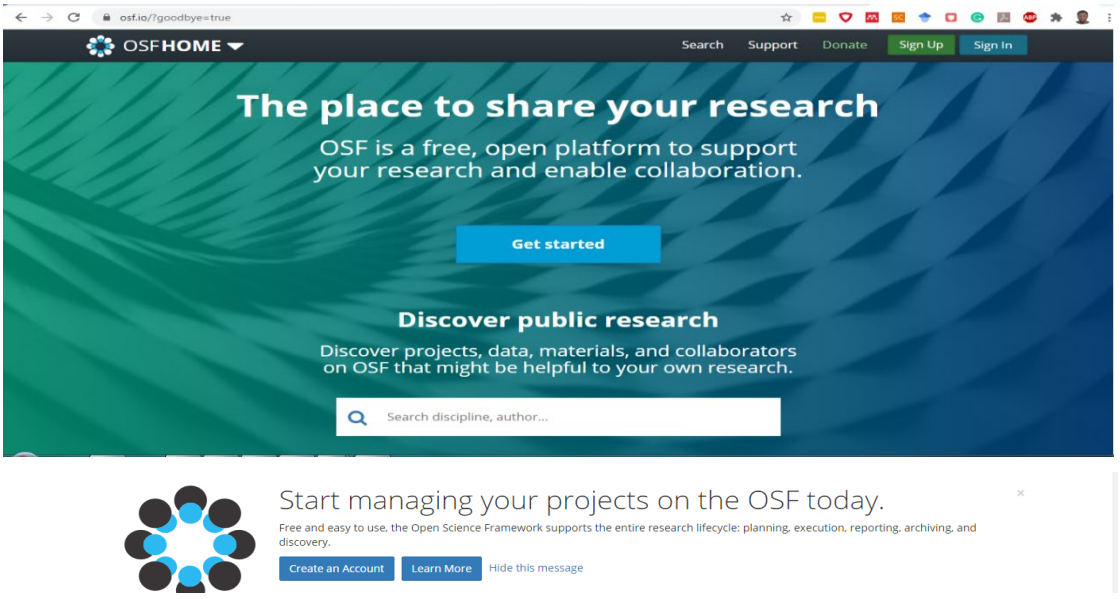

Fig. 5. Open science web interface (https://osf.io/)

2.7 Open Science Policy

By policy here we mean “a set of ideas or a plan of what to be done in a particular situation which has been agreed to officially by a group of people or organization” (adapted from the Cambridge dictionary definition). Specifically, open science policy here means laws passed by the parliament, and Research Plans/Roadmaps, Concordats/Agreements between multiple influential parties, and Codes of Research Practice/Integrity/Ethics, etc. (Digital Curation Center and SPARC Europe 2019). These policies were mostly established by research institutions, research funders, government officials, or publishers. A policy in place might facilitate the viewed readiness of researchers and the perceived readiness of librarians.

Seeing the implementation of policies could advance the implementation of open science practice and need also to be conveyed by some indicators that will allow monitoring the acceptance of the policies and their potential effects on research publishing and sharing practices (Robinson-Garcia et al., 2020). Indicators might be incorporated into the policies and operationalized for the researchers and librarians.

Gwen et al. (2019) stated several questions, challenges, and customary misconceptions about open science policy in their handbook, titled the Open Science Training Handbook. The most common question asked by researchers on open science policies is how they will accomplish all the wants without losing any freedom on determining where to publish, for example, when given all the available options because normally, open science policies provide a variety of options. Another question often raised is what happens if researchers do not fulfill the necessities. During this case, they will run samples of projects monitored by funders or warnings received by researchers. Perhaps, a sharing session openly revealing data would pose a good challenge to researchers.

A common misconception regarding research data policy is that researchers should share all data openly and to attain this, they must understand all different excerpts within the text of the policy where there are explanations about which is the data suffering from the policy and when it must be shared. All the opt-out choices that the policies included should even be noticed.

When planning policy is vital to grasp what one needs to achieve or solve. Sometimes policies are created following other initiatives doltishly if there's a requirement for an additional one and if your new policy will overlap with other existing ones. The most challenge when creating a policy is to align it with other initiatives and to avoid contradictions with the laws and regulations (Gwen et al., 2019). This is often a challenge, particularly, when it involves copyright issues.

2.8 Open Science Tools

A tool can be any item that is used to achieve a goal (adapted from the Cambridge dictionary definition). Open science tools here can also be referred to as any item that is used in achieving the open science objectives. Neylon and Wu (2009) put it as what makes the sharing of research material practical. Dr. Nancy Pontika, the Open Access Aggregation Officer at CORE, one of the largest databases for open access research publication, did list some qualities to look out for in every open science tools and platforms.

a. Must be free to use,
b. Must be open source,
c. Must enable customization,
d. Must enable sharing of information, and
e. Must be interoperable.

The above open science tools and platforms might have been missed in the researchers' views and librarians' perceptions of open science.

Kramer and Bosman (2018) presented a comprehensive example of 17 open science tools and practices that can be used by any researcher throughout the research workflow as shown in Fig. 6 and was titled the Rainbow of open science practices.

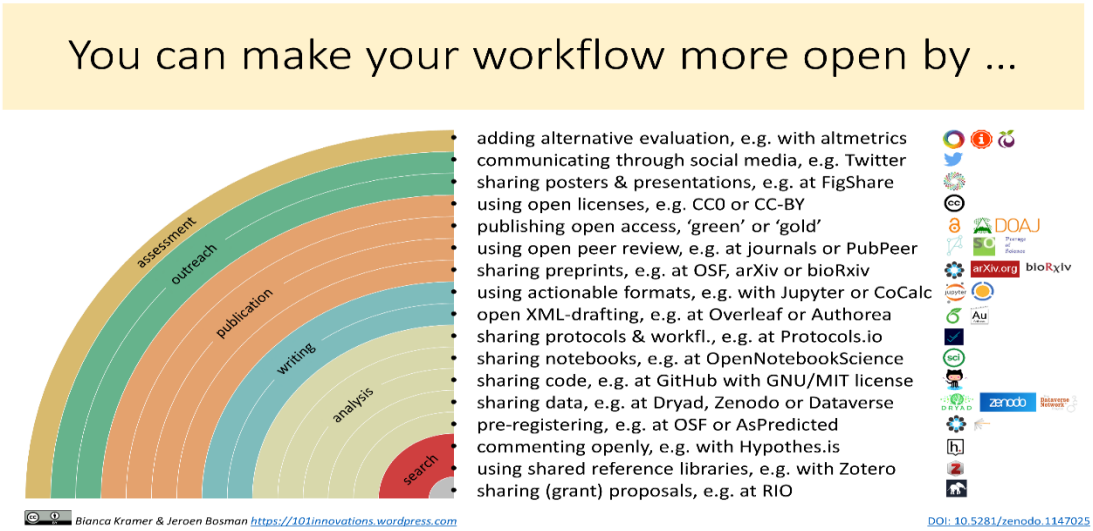

Fig. 6. The rainbow of open science practices (Kramer and Bosman, 2018)

Generally, it could be noticed from all the different interpretations of open science from the different studies that, the main goal of open science can be summarized into the following objectives as presented by Giulia Ajmone Marsan the directorate for Science, Technology, and Innovation, in the policies to promote open science: evidence from the Organization for Economic Co-operation and Development (OECD) countries.

a. To increase transparency and quality of science and research,
b. To speed the transfer of knowledge,
c. To promotes competition and collaboration on research ideas,
d. To increase knowledge spillover not only in science but also in the economy and society at large,
e. To address global challenges more effectively, and
f. To promote citizens' engagement in science.

The last point of the above goals could exist in the researchers' views of open science.

As an umbrella term, open science has enabled the concept of vase openness in knowledge and learning, which also involved the different stages human can follow in solving many of life challenging problems, ranging from having open

access to scientific publications and sharing of knowledge to collaborating between different players on creating and building upon the shared knowledge. This will not only serve as a problem-solving means but will also make society and the world at large a better place. This is because humans are created to always solve problems and the best ways to deal with any challenges is to work with others in overcoming them or to learn from the past available documented experience, open science offered experiences that could be learned by others.

3. METHODOLOGY

This research examined the level of openness in the intellectual collections of the Malaysian Comprehensive Universities Repositories, towards promoting open science initiatives. A mixed-method approach to research was applied, as the study shared both qualitative and quantitative approaches to acquire a better and common understanding regarding both the nature of the knowledge and the conduct of social and behavioral research (Creswell and Creswell, 2017).

The quantitative method was used to solicit data from the academic researchers and the librarians from the selected comprehensive universities in Malaysia (see Fig. 7). After which the heads of the selected university libraries, together with their branches were contacted for a semi-structured interview to complement the survey. The methodology suggested was a sequential mixed design, in which the quantitative and qualitative study was done in a chronological phase, in which the questions from the latter was built on the previous strand, the research questions were interrelated and evolved during the early study (Schoonenboom and Johnson, 2017).

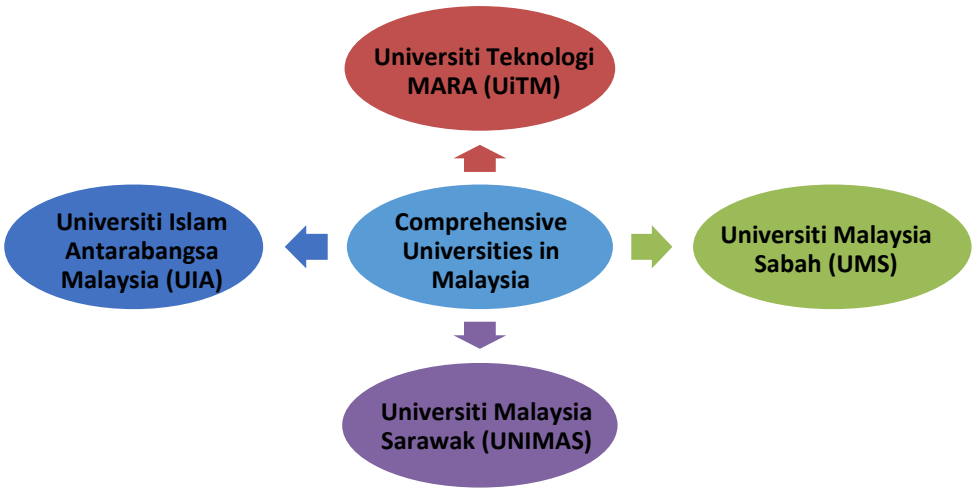

Fig. 7. The four (4) Comprehensive Universities in Malaysia

Source: https://www.mohe.gov.my/institusi/universiti-awam/kategori-ua

Out of the 1,300 distributed surveys through the respondents' email addresses, which only consist of the academicians and librarians from the 4 selected universities, a total of 255 responses were received as indicated in Table 1, with a response rate of 25% after several follow-ups. However, a low response rate is

likely to be expected since the study implemented an online survey in which the questionnaires were sent through the respondents' email addresses (Dillman, 2011).

The numbers of responses for the sampled institutions with their designations were tabulated below, which shows the highest number of responses obtained from UIAM with 94 (37%) of the entire response rate, followed by UNIMAS with 65 (25%), UiTM with 56 (22%) and lastly from UMS with 40 (16%).

Table 1: Profile of the respondents

		Name of Universities				
		UIAM	UiTM	UMS	UNIMAS	Total
Position/Role in the Universities	Professor	10	2	0	6	18
	Associate Professor	27	16	4	20	67
	Assistant Professor	26	25	25	32	108
	Lecturer	4	2	3	4	13
	Academic Fellow	4	0	2	1	7
	Librarian	12	2	4	0	18
	Senior Librarian	8	4	0	2	14
	Library Assistant	3	5	2	0	10
Total		94	56	40	65	255

4. FINDINGS

The section presents the findings of the study, which were based on the responses collected through the survey questionnaire distributed through the respondents' official email addresses and the transcribed semi-structured interviews conducted with the chief librarians of the selected institutions together with their deputy librarians. The findings were presented as follows:

1. The findings indicated that the public universities in Malaysia are aware of open science, but not all are involved in its practices, while the only means through which they practice it has been, through open access to their scientific journals and other open educational resources in the Institutional Repositories.
2. Many of the respondents 122 (48%) also agreed that the current open science practices are beneficial to the scientists and the other relevant stakeholders in both private and public universities in Malaysia. But they also indicated that issues of copyright, crowdsourcing, open data, and citizen science are other aspects of open science that need to be taken into consideration.
3. Many of the respondents 171 (67%) indicated that their institutions own research repositories, and the types of materials in most of them are journaled articles, book chapters/sections, book, conference papers, and posters. While some of the institutions are in the planning stage to also start collecting research data, such as methodologies and workflow, slides, artifacts, specimens, samples, questionnaires, and computer software source codes in their repositories.

4. The majority of the respondents 217 (85%) indicated Faculty/Institutional depository and 20 (6%) indicated public domain and shared hard drive as the places where they currently deposit their research data in their institutions. However, the respondents also identify high-speed internet, well managed and secured repositories, and capacity building as some infrastructures needed to fully implement open science in their institutions.
5. The findings also indicated that 122 (48%) of the respondents acknowledge that their universities provide training on research data management. While 77 (30%) of the respondents are not aware of whether their institutions provide any training or not. But they are all familiar with open access to publication in open access journals and proceedings elements of open science.
6. Lastly, some of the challenges listed by the respondents to reaching the national consensus on open science are general awareness by the stakeholders on the benefits of open science, lack of financial support for the system, and lack of secure and reliable platforms and policy to support the system.

It was also noticed from the interviews with the heads of the selected libraries that most of the universities are partially practicing open science. Though most of their repository collections are only fully utilized by the local members of the universities as quoted below:

P1; *"…only authors have the full access to the full contents of their collections in our repository…"* **P3;** *"…our digital repository is within the vicinity of the campus only."* **P5;** *"The collections are only open for our members."* **P6:** *"The contents in the repositories are completely open to the general public, except for the thesis, student projects and I think entrepreneurship projects."*

While among the objectives of open science are to enable the free exchange of ideas to accelerate scientific progress towards solving humanity's most persistent problems, with collaborative efforts towards solving some global challenges (OSF Website, 2020; OECD, 2015). But in these cases, only part of these collections can be accessed by the general public, as stated by the respondents.

P1; *"The collections in our repository are open to at least 30 presents to the general public."* **P3;** *"…but the public can have access to the abstract of the content only…"* **P4;** *"Our digital contents allow up to 24 pages per document for public view."*

However, the respective authorities may have been conscious of the global copyright issues. As the universities allowed the public to visit or contact the relevant authorities in the respective universities for the full contents of these research contents as mentioned by the participants.

P1; "…*But In case they have an interest in any document from the repository they can visit or contact the library or the authors for the complete record."* **P3;** "…*but if they need the full text, they have to come down to the universities for request.*"

However, adequate support and training on copyright will also encourage the researchers to deposit their research items with research data in the open platforms to promote open science practices. This is because the more open their works are, the more protected they become as they will already be known and acknowledged

by a wide range of users, which makes it difficult for others to claim. Likewise, implementing some of the contemporary research tools such as the open researcher and contributor ID (ORCID) and the official digital object identifier such as (Crossref) will likely reassure the safety of the researchers' work.

Some of these institutions are also currently proposing research data repositories to enable them to collect their researchers' data in a single place in other to promote the transparency and accessibility of their research data and to allow the reproducibility and replicability of their findings as reported by the participants.

5. CONCLUSION AND RECOMMENDATION

From the findings of this research, it could be concluded that the public universities in Malaysia are aware of open science, and the popular means through which they practice it has been, through open access to their scientific journals and other open educational resources in the institutional repositories. Some key features mentioned by the respondents to further support the implementation of open science in their institutions are, to provide more modern infrastructures that support open science with relevant experts and to also enlighten the participants more on the system. This is as the result of some challenges listed by the respondents to reaching the national consensus on open science, which include general awareness for the stakeholders on the benefits, financial support for the system, and secure and reliable platforms and policy to support the system.

Based on the findings of this research and the conclusion reached, the following recommendations were made.

That there is the need for:

1. The stakeholders which comprise the researchers and the librarians from these institutions, to be enlightened more on what the full open science practices and benefits comprise.
2. They should be familiarized with some of the available open platforms they can integrate into different stages of their research practices and activities.
3. The library management in these institutions should also participate in promoting the available national and international academic social network platforms to the participants such as MyCite, MyUniNet, and the likes in the case of Malaysia.
4. The authorities in the institutions should also provide more contemporary digital infrastructures to fully support open science practices.
5. The participants should be encouraged and motivated to contribute all types of their research materials, methodologies, findings, and their final published reports to the open system.
6. The authorities should provide training on the modern research content management system to the participants, most especially the researchers.
7. Highly skilled professionals should be involved in implementing open science projects in the institutions.

Lastly, more financial supports and research grants should be provided for the researchers and the institutions, by the governments and the other relevant bodies.

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