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## Making research data discoverable: an outreach activity of Datacite

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# **Making research data discoverable: an outreach activity of Datacite**

## **Abstract**

### **Objective**

The enormous growth in research data generated today has highlighted the value of data management (RDM) to make research FAIR (Findable, Accessible, Interconnected and Reusable). Appropriate data instructs researchers to use and reuse that data within appropriate citations and attribute it to the author. And Data citation refers to the process of presenting a reference to data in the same way as a bibliographic reference to printed resources is regularly provided by researchers. In this regard, the objective of this paper is to investigate the activities of the Datacite website in managing research data.

### **Methodology**

The study approached the Datacite website, a non-profit organization that provides analysis with persistent identifiers (DOIs). The research examines the Statistics systems and other critical resources. Registrations by the Collective group and most involved repositories are included in the statistical approaches. The basic resources include top executives, OAI-PMH, DataCite Public Roadmap, DataCite Commons, DataCite/ORCID Auto-update and Service Providers. The outcomes were analysed by MS Excel.

### **Results**

It is noted that there were 293 members of the registry from different countries. The USA was at the top of the 137 members according to registration, while at least one was located in India, Finland, Spain, etc. Germany was listed as the top member and most of the repository holding companies. Datafirst is the only server found in an Indian context. DataCite Commons found as a discovery tool which allows simple searches by works, individuals and organisations, while providing users with a detailed overview of the relationships between the entities in the research setting. Using the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), the DataCite service exposes metadata stored in the DataCite Metadata Store (MDS). Datacite Auto-update unambiguously categorises researchers and provides tools to automate the link between researchers and their creative work.

**Keywords:** Research Data, Data citation, Digital Object Identifier

### **Introduction:**

DataCite is a global international non-profit organisation that was founded in London in December 2009. DataCite is a platform for researchers and librarians to discover knowledge on data citations and to keep up with new data citation innovations. Librarians can be called upon to work in e-science and data

management to help a researcher locate a particular dataset and help that researcher correctly cite that dataset. A librarian may also be invited to assist a researcher in generating a citation for their dataset or assigning a Digital Object Identifier (DOI) so that others can identify and use the correctly assigned dataset. DataCite serves as a platform that provides a format for data citation and assigns datasets to DOIs.

DataCite also provides a metadata schema for librarians that describe what information, along with recommended usage instructions, should be included in a dataset for citation and retrieval purposes. In data management preparation, this schema can aid, as it offers simple examples of the types of descriptors required to define a dataset.

The task of DataCite to provide data citations and permanent attribution identifiers is critical because universities such as Columbia are now adding the data of a researcher as a production that can count against his or her tenure or promotion. Librarians should also allow their researchers to correctly cite data and to ensure that their own data is correctly cited so that their data can be properly credited and obtained.

### **History**

The German National Library of Science and Technology (TIB) allocated its first DOI names to scientific data in the summer of 2004 in order to make scientific databases available for study. This was carried out within the context of a project initiated by the German Research Foundation (DFG). Five years later, on 1 December 2009, TIB's work led to DataCite being funded as a multinational consortium focused on assigning research data and other scientific outcomes with citation references and DOI names. DataCite is an example of an effective cooperative initiative that established early ideas into an international organisation focused on scientific workflow (Brase, Sens&Lautenschlager, 2015).

### **Literature Review**

**Robinson- Garcia et. al. (2017)** studied DataCite as a novel bibliometric source. In order to evaluate its potential as a new source of bibliometric data for the study of open data development, the study aimed to explore the characteristics of datacite. The analysis was focused on primary data and the DataCite website was accessed to collect the information. The analysis was found to be divided into three sections. The first section explains the numerous access points that Datacitehas accessible and the advantages and disadvantages of using one or the other. In the second part of the research, the data set downloaded from Datacite's public OAI-PMH collects and describes the information given by datacite as to its structure, description of data record fields and information. Study systematically analyses documents downloaded from the OAI API of the datacite and establish a set of recommendations about the use of

this source for open data bibliometric research. The study highlighted the problems related to the incompleteness of metadata and emphasized the importance and ability of datacite to become one of the key sources of data metrics creation.

**Simons (2012)** implemented DOIs for research data. The purpose of the study was to explore the DOI solution for the management of large quantities of research data. The research was based on a review of literature and accessed the DataCite website to observe their services. Study found that worldwide, huge volumes of research data were produced, largely born digital and activated by vast advances in computing power. And the incredibly challenging challenge of finding a way to store and handle data in a format that promotes discoverability, usability and reuse has been addressed by research institutions. The study found that a growing momentum for an international data citation culture using the DOI scheme was part of a global initiative to increase access to research data. Research also found that the growing culture of data citation for scientific content was encouraged by the Datacite website. The study concluded that DOIs had several advantages and posed question of governance common to other organisations that facilitated discussions and partnerships.

**Rueda, Fenner and Cruse (2016)** studied on persistent identifiers for research data management. The aim of the research was to identify the kinds of different actions and the lessons learned by Datacite. The analysis was based on the datacite website. The study found that datacite integratd with many members to deliver its services. The participation of three stakeholders had been established, i.e. IT specialists and creators, librarians and information scientists, and designers of user interface. Datacite offered persistent identifiers that allow independent platforms to interoperate and share information. Crossref, Datacite & ORCID worked on updating ORCID records to keep researchers' records up-to-date with minimal effort. Metadata from Datacite also allowed researchers to search for and locate their data. Datacite had worked on networking services for their acceptance of services such as datacite participates in several conferences tailored to this community to meet the librarian stakeholder's community. The research concluded that the role of persisting identifiers simplifies the road, but still required careful growth, harmonized integrations and services, and a study effort to communicate benefits and best practices.

**Dudek, Mongeon and Bergmans (2019)** observed Datacite as a potential source for open data indicators. The goal of the study was to investigate the performance and impact indicators of datasets described in datacite. The research was focused on the Datacite website particularly a datacenter from the ocean sciences. Research found that the most citations from all ocean science datacenters were obtained by IFREMER, and it was found to be the most influential association with 133 authors. The results also

showed that the metadata obtained from datacite for the metrics considered were constrained in accuracy and completeness and did not allow for a facilitated comparison of data sets. Significant and detailed insights were not easily produced as a result. From a copyright perspective, permission was necessary for the reuse of datasets. The research also noted the difficulty of a lack of control of metadata. The study concluded that datacite was not completely approached to the standards of FAIR and that additional source, i.e. reusability, had to be added to fill this void. The study proposed a more advanced approach to calculating the reuse of datasets.

### **Study Scope:**

The research approached Datacite website to observe and collect the data. This website is selected for various reasons. These reasons are: It is a leading global non-profit organization that provides for research data and other research outputs with persistent identifiers (DOIs). DataCite is an active participant in the research community and through community-building efforts and outreach programs facilitates data exchange and citation. Its services support usage and data citation analytics. Its goal is to be the world's leading supplier of persistent research identifiers. Its motto is to provide the means by which work can be developed, found, referenced, linked and used. Several publishers reference this DataCite service in their editorial policies as the best resource for finding the most suitable repository of data. DataCite gathers metadata for any DOI that is assigned to an entity. It also seeks value creation and the development of community-driven, innovative, open, integrated, usable and sustainable research services.

### **Study Objectives**

- i.To identify out the top country.
- ii.To the top country with the highest repository listed.
- iii.To find out the top members.
- iv.To identifying the top members according to total DOI registration.
- v.To explore the DataCite Metadata schema.
- vi.To clarify the DataCite Public Roadmap.
- vii.To describe the DataCite Service Provider.
- viii.To understand the DataCite Commons.
- ix.To understand the Auto-update function of DataCite

## **Methodology**

The DataCite website is chosen for the compilation, presentation and analysis of the findings. The research addressed programmes related to Statistics and other basic services. The approaches to statistics include registrations by group of the Community and most active repositories. The basic resources include top executives, OAI-PMH, DataCite Public Roadmap, DataCite Commons, DataCite Auto update, and Service Providers. MS Excel analyzed the results.

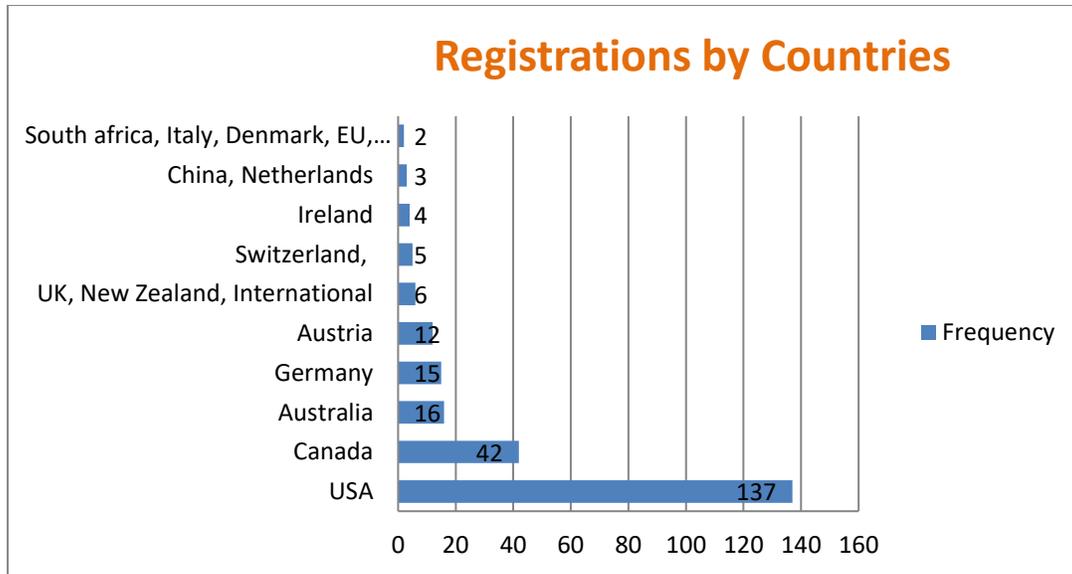
## **Results and Discussion:**

### **1. Registrations by Countries:**

Registration statistics apply to data sets that were submitted and a DataCite DOI was provided, while resolution statistics provide information about how a DOI was used to access a dataset. Data found that there were 293 registration members from various countries. Within 137 members, The USA was on top position followed by Canada and Australia whereas India, Finland, Spain etc. found as least one. The only Datafirst server found from an Indian context.

<b>Ranking</b>	<b>Countries</b>	<b>Members</b>
1	USA	137
2	Canada	42
3	Australia	19
4	Germany	15
5	Austria	14
6	UK, New Zealand, International	6
7	Switzerland	5
8	Ireland	4
9	China, Netherlands	3
10	South Africa, Italy, Denmark, EU, Singapore	2

**Table 1. Registrations by Countries**



**Figure 1. Registrations by Countries**

Datacite is a global association that promotes DOI and access to these facilities are responsibility of all countries. But it is found that only few countries are active in this participation such as Datafirst server found only one from an Indian context. However, the highest member who is more involved in this involvement is kept by the USA.

## 2. Registration of Repositories

Results found 294 approx. repositories from around 40 types of countries. The study observed that Germany was at the top of 387 repositories followed by Germany and Russia, while many countries found within only 1 repository was kept, such as Sweden, India and France, etc. China is the only one to take 4th position in Asia.

Ranking	Country	Repositories
1	Germany	387
2	Russia	215
3	USA	212
4	China	116
5	UK	116
6	International	82
7	Canada	57
8	Italy	51

9	Poland	46
10	Netherlands	35

**Table 2. Registration of Repositories**



**Figure 2: Registration of Repositories**

Many countries are constantly using services of datasets to obtain identifiers. But very few of them are active. In this context, the contribution of many countries like India, Norway, Spain is less, while major contributed by Germany, Russia and USA.

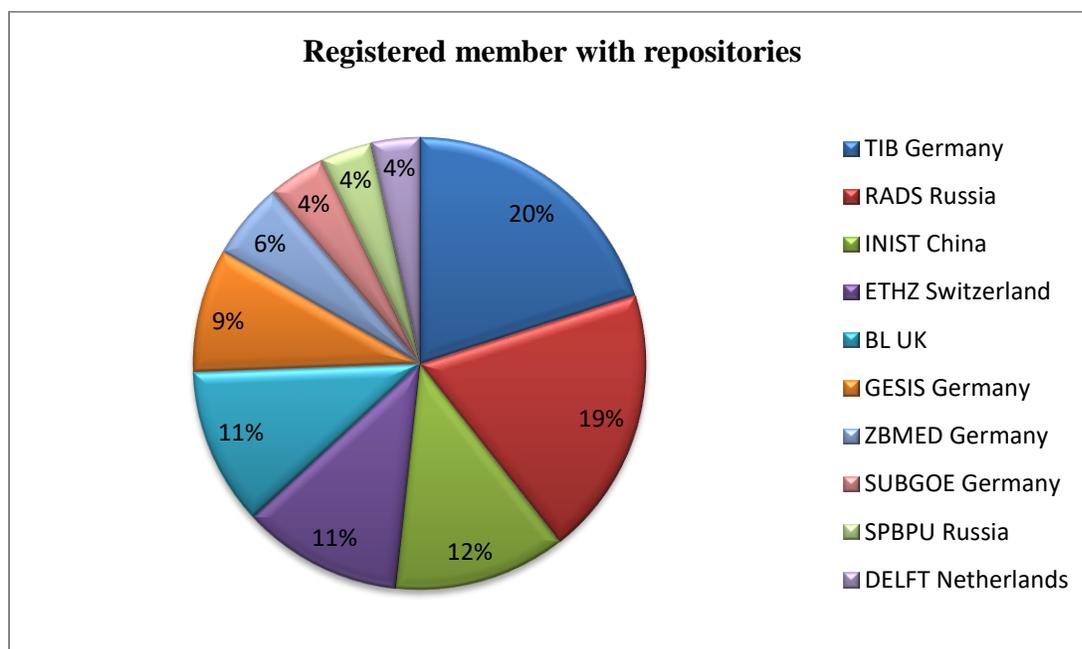
### 3. Registered member with repositories:

The analysis found that among 40 countries, TIB, i.e. Germany's German National Library of Science and Technology has a maximum number of repositories (186 repositories) whereas, from several countries such as Sweden, India, etc., the least was found. China is the only Asian country in the 3rd position.

Code	Member type	Country type	Repositor ies
TIB	German National Library of Science and Technology	Germany	186
RADS	Russian Agency for Digital Standardization	Russia	179
INIST	Institute for Scientific and Technical Information	China	114

ETHZ	ETH Zurich	Switzerland	106
BL	The British Library	UK	104
GESIS	GESIS Leibniz Institute for the Social Sciences	Germany	82
ZBME D	Deutsche Zentralbibliothek für Medizin – Informationszentrum Lebenswissenschaften	Germany	51
SUBG OE	Niedersächsische Staats- und Universitätsbibliothek Göttingen	Germany	38
SPBPU	Peter the Great Polytechnic University	Russia	34
DELFT	TU Delft Library	Netherlands	32

**Table 3. Registered member with repositories**



**Figure 3. Registered member with repositories**

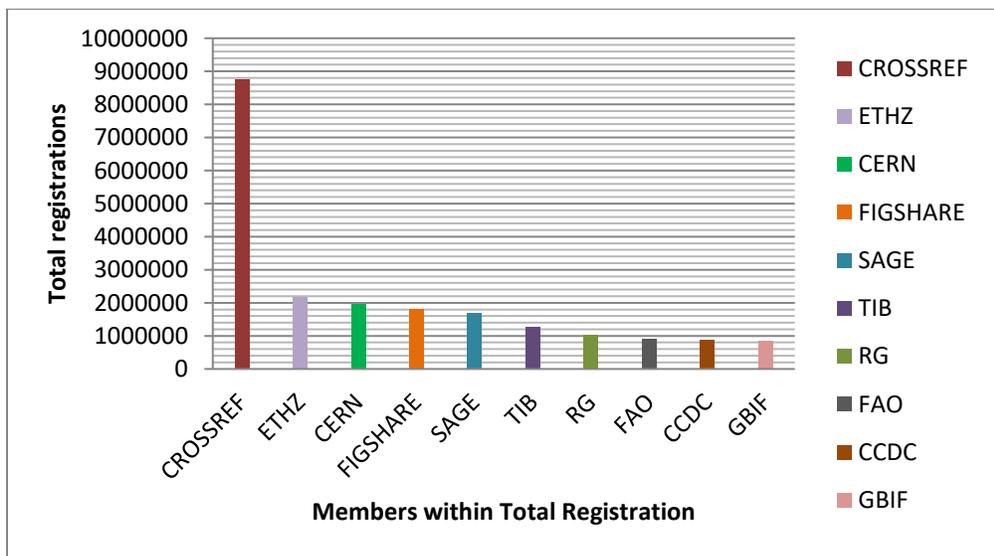
Many contests receive datasite services, of which only a few countries are active and from some countries, only a few DOI centers or members are active. In this regard, the result was found to be a lower contribution of DELFT from the Netherlands, while a larger contribution by TIB, Germany.

#### 4. Members within Total Registration

Within 31153061 total DOI registrations, the Crossref is located at the top place within 8770543 records. It is the International DOI Foundation's official Digital Object Identifier (DOI) Registration Agency. It is registered in New York, USA, as the Publishers International Linking Organization, Inc. (PILA). Several registration agencies find only within 1 DOI are CADD (Computer-Aided Drug Design), CLARINER (Clarín), FMLV (Joint Nature Conservation Committee) etc.

Ranking	Code	Members	Total
1	CROSSREF	Crossref	8770543
2	ETHZ	ETH Zurich	2175325
3	CERN	CERN - European Organization for Nuclear Research	1975726
4	FIGSHARE	Figshare	1809482
5	SAGE	SAGE Publishing	1707204
6	TIB	German National Library of Science and Technology	1273146
7	RG	ResearchGate	1017427
8	FAO	FAO	925751
9	CCDC	The Cambridge Crystallographic Data Centre	866821
10	GBIF	Global Biodiversity Information Facility	847002

**Table 4. Members within Total Registration**



#### **Figure 4. Members within Total Registration**

Within 294 members, updates to their records have been found to be different from each other. In this regard, CADD is found to have at least one member who carries only one type of result followed by CLARINER (CLARIN), FMLV (Joint Nature Conservation Committee), etc. Whereas CROSSREF was found in the top position. DataFirst is listed with 393 total registrations.

#### **5. DataCite Metadata**

OAI-PMH is a protocol developed for harvesting metadata descriptions of records. Every implementation of OAI-PMH supports representing metadata in Dublin Core, but DataCite's service also supports OAI DataCite and the original DataCite Metadata Schema used to deposit the record. The DataCite Metadata Schema is a list of core metadata properties chosen for citation and retrieval purposes to accurately and reliably classify data, along with suggested use instructions. In support of DataCite's broader objectives, this metadata schema can serve many main functions. These are primarily:

- Recommending a standard dataset quotation format based on a limited number of properties needed for registration of identifiers;
- Provision of a basis for interoperability with other systems for data management;
- Promoting the discovery of datasets with optional properties that allow the resource to be represented flexibly, including its relationship with other resources;
- And, laying the groundwork for future services (e.g., discovery) by using both a DataCite vocabulary and external vocabulary regulated words when appropriate. The vocabulary of DataCite will be managed by the Metadata Supervisor of DataCite, who will define and publicise procedures for the submission of changes
- The DataCite Service Provider OAI-PMH is able to disseminate records in the formats i.e. OAI Dublin Core OAI Dublin Core (oai\_dc), OAI DataCite (oai\_datacite), DataCite Direct (datacite).

#### **6. DataCite Public Roadmap**

Public Roadmap is a publicly available website where users can find what shipped recently, what are currently working on, and some suggestions about what should be doing next. More significantly, users will voice their opinion and vote for the functionality they most desperately want to see introduced. Datacite's roadmap contains three type of headings I.e. under consideration, In Progress and Launched.

<b>Under consideration</b>	Fabrica	<ul style="list-style-type: none"> <li>• <b>Authentication by individuals:</b> One can only sign with a single organizational account into DataCite services right now. But considering services that allow individuals to login, and organizations may manage the groups of individuals who have permissions for that organization.</li> <li>• <b>Batch update for DOI</b> Such as the Most add DOIs to a list of uploaded metadata change the URL for all DOIs, pass DOIs based on the results of the search</li> <li>• Allow the ability, based on the search results, to move DOIs between clients. Example: Move all DOIs from one client account to another published by "My New Repository."</li> </ul>
	Metadata	The DataCite metadata schema is a set of core metadata properties chosen to define a resource correctly and reliably for citation and retrieval purposes, along with suggested guidelines for use. The secret to making data citable, searchable and usable is to equip metadata datasets – definitions of, details and data figures – that follow basic requirements and conform to a simple, structured scheme. The most recent update is 4.3.
	Other Services	<ul style="list-style-type: none"> <li>• <b>Enhanced integration of ORCID:</b> it updates the author's ORCID profile by sending alerts to those who do not subscribe to the Auto-Update service through the ORCID Inbox.</li> <li>• <b>Email alert service:</b> it provides the author with daily emails with their DOI registration reports (e.g. number of DOIs registered last month or year) and their relation checker reports (e.g. which DOIs do not correctly resolve and should be updated);</li> <li>• Advance query-search system</li> <li>• Content identification service to classify the files associated with a dataset in a specific and permanent way.</li> </ul>
<b>In Progress</b>	<ul style="list-style-type: none"> <li>• <b>Support all metadata fields in the DOI registration form:</b> At present the DOI registration form in DOI Fabrica only supports the mandatory metadata fields and the optional description field. They will update the form to include all</li> </ul>	

	<p>the required and optional areas, too.</p> <ul style="list-style-type: none"> <li>• <b>Integrate crossref DOIs into the datacitegraphQLAPI:</b> Crossref DOIs are being introduced to the DataCiteGraphQL API, starting with those associated identifiers in the DataCite DOI metadata</li> <li>• <b>Common DOI search:</b> A DOI search portal from more than one registration agency (e.g. for simultaneous DataCite DOIs and Crossref DOIs).</li> </ul>
<b>Launched</b>	<ul style="list-style-type: none"> <li>• Searching by ORCID in event data</li> <li>• Information on provenance in REST API</li> <li>• Use of DOIs stats in DataCite search</li> <li>• Upgrade DOI Registration</li> <li>• Portal of Migration stats to solrelasticsearch</li> <li>• Schema 4.2</li> <li>• Schema 4.2 HTML Version</li> <li>• Submission and display of the Member information</li> <li>• Variation schema 4.3</li> <li>• Replacement OAI-PMH</li> <li>• Citation stats of DOIs searched for datacite</li> <li>• MVP Research Profile</li> <li>• Data Matrics MVP badge</li> <li>• Expanding finder repository</li> <li>• GraphQL API release initial production</li> <li>• MVP Frontend PID services registry</li> </ul>

**Table 5. DataCite Public Roadmap**

Three forms are listed in the public roadmap referred to above. The first is under consideration, which involves a DOI batch update, datacite metadata schema, email alert services, etc. The second is in progress, which contains services such as general DOI search that are in progress. The last form is launched services that contain data matrices for upgrading DOI registration, etc.

### 7. DataCite Service Provider

A DataCite Registered Service Provider is an organization that has integrated with one of the DataCite APIs in order to allow existing DataCite Members to register DOIs using that Member's own

log-in credentials. A CRIS or a repository platform are both examples of a Service Provider. There are four members who provide data-based services, which are:

<b>S.N.</b>	<b>Members</b>	<b>Description</b>
<b>1</b>	<b>Atmire</b>	Atmire is a privately owned company with offices in Belgium (EU) and New York (USA) launched in 2016. It is a service provider registered with DuraSpace i.e. is a manager of archive. Atmire provides remote application support and maintenance services on demand, such as day-to-day support for repository administrators and IT and changes in configuration and customizations. It also offers recommendations based on knowledge with over 200 repository projects around the world
<b>2</b>	<b>Figshare</b>	Figshare is a repository where users can make all their research output available in a charitable, shareable and searchable way. Its purpose is to help organize research and provide its much greater impact without wasting time and effort. It provides 20 GB of free private space, Unlimited public space, DOI and accessible it anywhere. Anyone can upload their files up to 5 GB in any format here and is very useful for sharing private links with colleagues.
<b>3</b>	<b>Haplo Services</b>	Haplo offers a centralized repository for all research, allowing simultaneous storing and retrieval of all research results relevant to a project. It uses versatile schema, allowing various types of outputs to be handled in the same repository (including the research data). It also imports metadata and compatibility with legacy EPrints repositories and supports standard protocol, OAI-PMH metadata, ORCID incorporation, DOI minting, multiple per-file embargo, and web profiles for study.
<b>4</b>	<b>The Library Code GmbH</b>	The Library Code was founded by Pascal-Nicolas Becker who has over 10 years of digital repository experience. The Library Code is a service provider with DSpace. It provides consulting services such as stated various repository use cases, creation of open source applications, related data, open access and analysis data, Dspace design services, support and training services etc.

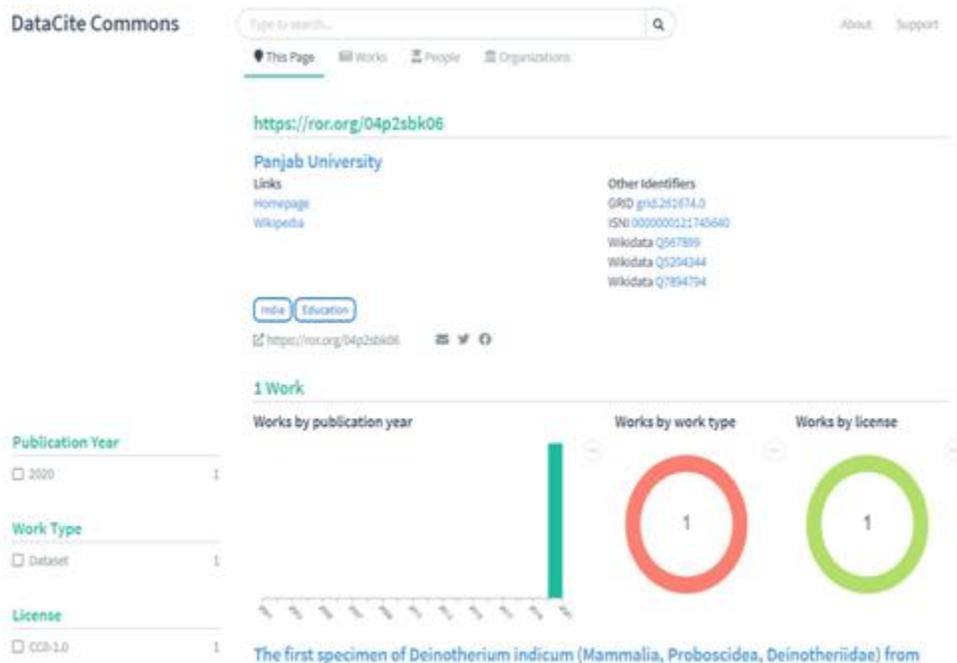
**Table 6. DataCite Service Providers**

In order to be listed as a Registered Service Provider, an organization must apply and meet the essential requirements. In this case, Datacite facilitates many advantages to Service providers such as they will be part of the Service Provider managed list that users can pick when updating their repository metadata in Fabrica. A special registered Service Provider badge will be issued to registered service providers to be

displayed on their website. Registered service providers will have their own mailing list from which DataCite will provide them with daily updates. To receive support and provide feedback, licenced service providers will have daily contacts with DataCite employees.

## 8. DataCite Commons

DataCite Commons is a discovery tool that allows simple searches by works, individuals and organisation, while providing users with a detailed overview of the relations in the research environment between the entities. It gives Easier access to information about the use of their DOIs and can detect and monitor relations between their DOIs and other entities such as Scopus Author ID, Loop Profile, ResearcherID etc. One of the most significant features is the ability to scan all DOIs, regardless of whether they are registered with DataCite, Crossref or any of the other DOI registration agencies. In addition to having much more material to search for, DataCite Commons also reveals the relations between DOIs in the form of citations, versions, and collections. DataCite Commons also shows the ties between DOI content and individuals, research organisations, and funders within the PID Graph of scholarly tools defined by persistent identifiers (PIDs) and linked in standard ways. Example:



**Figure 5. DataCite Commons**

There are three types of choices available in Datacite Commons, i.e. works, individuals and organisations. And in the above, the researcher addressed the organisational example, i.e. Panjab University. The results

show the organisation's homepage and other identification choices, such as GRID, ISNI and wikidata. The findings also discuss the possibility to share the findings such as on email, twitter and facebook. Three forms of graph are also shown by DataCite Commons, first for publication year with count and its language, second for dataset and third for copyright licences.

#### 9. DataCite/ORCID Auto-update

In automating the workflow of connecting ORCID identifiers and DOI names, Auto-update is a milestone. Its purpose was to classify researchers unambiguously and provide instruments to automate the link between researchers and their creative works. This is the first official agreement and near partnership between ORCID, CrossRef and DataCite by the three organizations. This collaboration automatically updates ORCID records when a new research output gets assigned a DOI. This integration provides an easy way to keep all the main services up to date and helps propagate the metadata further. In this way, researchers can also keep their publication lists up to date with minimal effort (Rueda & Fenner, 2016). A new Auto-Update service that automatically moves metadata to ORCID when newly registered DOI names contain an ORCID identifier.

#### **To make it work, there are a few steps:**

- There are two things that researchers need to do: (1) use ORCID iD when uploading a document or dataset, and (2) allow Crossref and DataCite to update ORCID records.
- **Publishers and Centers of Data.** These organisations also have two things to do: (1) during the submission workflow, collect ORCID identifiers using a method involving authentication (not a type-in field!), and (2) embed the iD in the published paper and use the iD when sending information to Crossref or DataCite.
- **Crossref and DataCite.** Upon receipt of data from a publisher or data center with a valid identifier, Crossref or DataCite can automatically push that information to the researcher's ORCID record.

#### **Discussion**

Evidence from the investigation of the DataCite website addressed in this study indicates that developing countries are inactive in properly referencing support for RDM. The study increases the level of explaining the nuances of RDM operations to librarians and other stakeholders. Results show that due to lack of understanding and proper information, developing countries have a few repositories and representatives to work with data organizations. The current research will fill these gaps and allow librarians and research scholars to better handle their data within the correct citation. The findings could not find registry data by option "registration of repository" because it was listed as too big data.

Researchers were virtually unable to locate registration of client data. Future studies should take into account the active involvement of representatives of research centers and libraries in particular.

### **Conclusions and recommendations**

The research shows that Datacite plays a key role in supplying research with data citations and persistent identifiers. In particular, it identifies registration by countries, registration of repositories, Top registered members with highest repositories, Top 10 Total Registration members, DataCite Metadata, DataCite Public Roadmap, DataCite Service Provider, and DataCite Commons.

The study concludes that the largest number of DOI registration members belongs exclusively to the United States (137), where the highest number of repositories (387) comes from Germany. China is the only one with the highest repositories and a registered member of the Asia Continent in the top 5 ranks. Whereas the Datafirst repository only from an Indian context. DataCite uses its Metadata i.e. Datacite metadata to organize the entity of Data. Under datacite public roadmap, there are three types of services are mentioned i.e. under consideration which is in consideration, in progress which services are in progress and launched which are successfully working. The research explains briefly about 4 service providers i.e. Atmire, figshare, Haplo Services, the library code GmbH. Datacite commons is the latest service to provide a detailed overview of the relations in the research environment between the entities through three options i.e. works, individuals, and organizations. Based on the research findings, the study recommends the following measures to strengthen and develop datacite practices in a sustainable manner:

1. All countries need to participate on Datacite website to receive persistent identifiers (DOIs) for research data and other research outputs.
2. There is a need to aware to the research scholars also to become their outputs more discoverable and associated with metadata available to the community.
3. There is a need to the registration of repositories with datacite platform to become their data more discoverable.

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