Assessing the Ecosystem for Open Science Advancement in Tanzania

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Abstract

This study aims to assess the favourable ecosystem for supporting OS in Tanzania and the factors hindering its adoption and implementation. Employing a cross-sectional research design, the study evaluates the enabling environment for Open Science adoption and practices within Tanzania. The study population comprises academicians, researchers, students, librarians, and science communicators. A total of 144 participants took part in the survey, predominantly early career researchers affiliated with both public and private institutions.

The findings underscore that to some extent several institutions within Tanzania provides some kind of support for open science practices. This support manifests through the provision of Institutional Repositories, online journal publishing systems, financial coverage for publishing processing charges, and the establishment of improved mechanisms for researchers to share their publications and data. Nonetheless, the results also highlight several challenges. These include a lack of awareness regarding OS practices, absence of institutional policies, inadequate budget allocation to cover article processing charges (APCs), and the high costs associated with publishing in prestigious Open Access (OA) journals.

Concerted efforts at both national and institutional levels to foster the widespread adoption of OS practices in Tanzania should be put in place. The efforts should focus on enhancing awareness, developing comprehensive policies, allocating adequate budgets to support APCs, and exploring strategies to mitigate the financial barriers associated with publishing in prestigious OA journals. By addressing these challenges proactively, Tanzania can pave the way for a more robust and inclusive research ecosystem aligned with the principles of Open Science.

Keywords: Open Science, Open Science Practices, Open Science Infrastructure, Open Access, Tanzania

Introduction

The concept of open science represents a recent development within the scholarly communication landscape. Open science is now reshaping the process of handling research from the way it is designed, performed, captured and assessed (Gong, 2022; Ignat et al., 2021). Scholarly communication is undergoing a transformation from "normal science" to "post-normal science" whereby the former refers to science in which scientific issues are discussed by scientists within the scientific community, the later widen the scope of science to involve the public domain in which, scientific issues become public science or open science (Gong, 2022). It is believed that "Open Science with its practice of responsible science will be a major contribution to address the dominant problems in science that we have analysed thus far, or at least will help to mitigate them" (Miedema, 2022).

Rafi., et al, (2020) the utilization of the online databases enhanced the productivity of the students in learning environment. Open science gained momentum in the early 2000s fuelled by the rapid advances of information and communication technologies that fosters collaboration, open sharing of data, information, and knowledge among researchers (Ramachandran et al., 2021). Open science is built on the notion of transparency in the entire research process which benefits not only the scientists but also the general public. The fact that most scientific researches are funded by tax payers' money from the government and donors means that the results should also be openly and freely accessible to the public and the impact of research must be felt by all citizens (Muneja, 2023). Open science initiative facilitates co-creation or collaboration and sharing of knowledge in much more transparent manner. This has been possible through several initiatives which are also known as "OS building blocks"

including open access, open-source software, open education resources, open peer review, citizen science, social media network and many more. Each of these building blocks are geared towards removing the barriers of knowledge creation, publishing and dissemination (Okafor et al., 2022).

What is Open science?

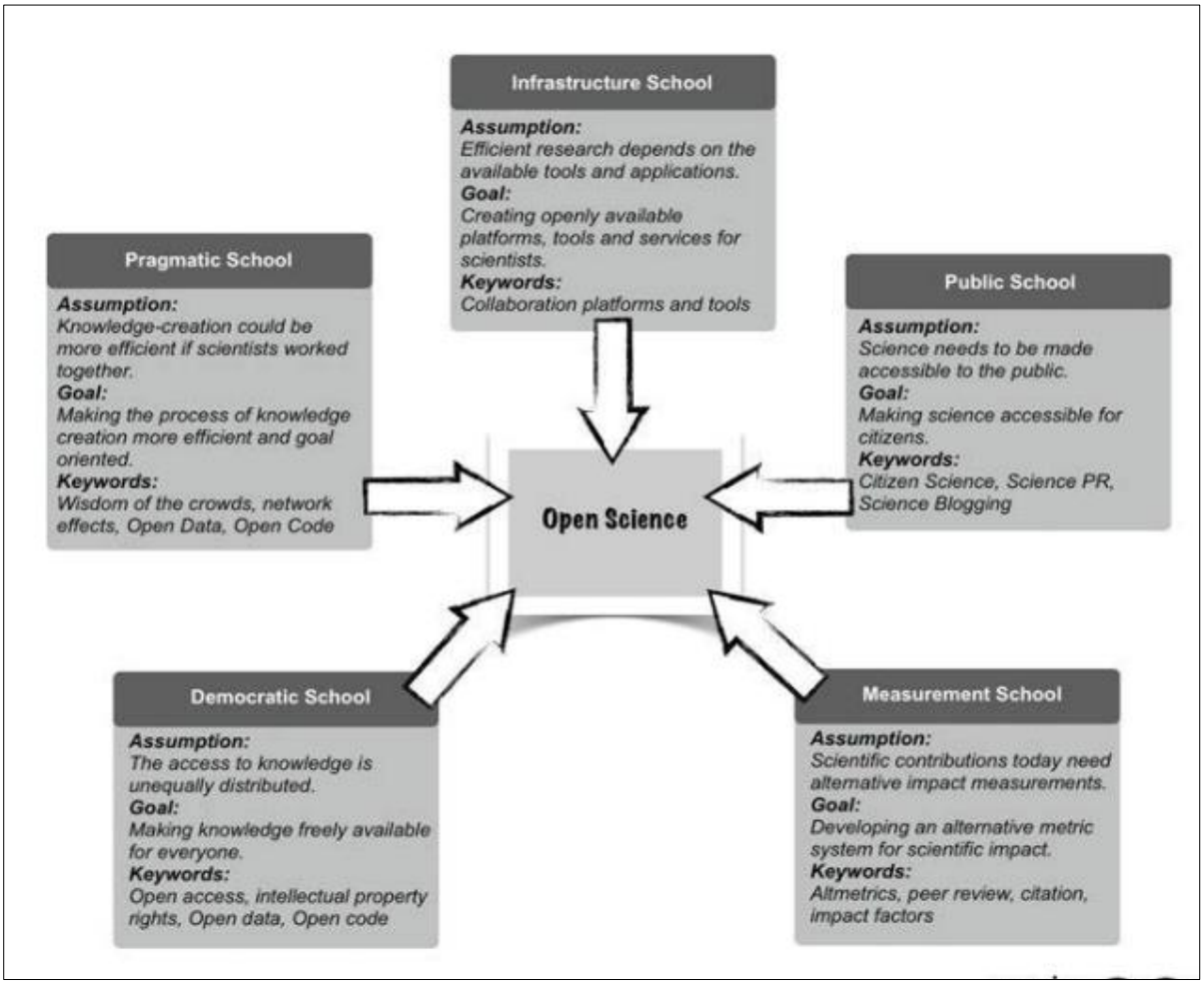
Open science "is a multifaceted, multipronged movement that seeks to increase access to research for all" (Harrington, 2019). The United Nations Educational, Scientific and Cultural Organization (UNESCO) broadly of defines OS as "an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community" (UNESCO, 2021).

These initiatives can be grouped into five schools of thoughts which are supportive and complement each other to meet the core objective of removing or minimizing the barriers of access, sharing and utilization of scholarly materials. The schools of thought includes: Infrastructure school which based on supporting establishment of useful tools such as institutional repository software, Public school that advocate for making science accessible to the public, Measurement school which seeks for alternative research impact measurements,

Figure1: The Five Schools of Open Science by (Fecher & Friesike, 2014)

Why Open science?

The outcry of scientists and citizens in accessing knowledge which is mostly pay walled has transformed traditional ways of communicating science to open science. It has been argued by Nosek and Olson, (2020) that "the incentives for success in science have become rooted in the pursuit of publication rather than the pursuit of knowledge". Open science tends to provide opportunity for sharing knowledge by removing most of the barriers of accessing and sharing research output. Open science is built on four fundamental principles of scientific enterprise identified by Roberty Merton in mid-twentieth century, these are: communality (open sharing of information), universalism (merit-based evaluation of research), disinterestedness (selfless motivation), and organized scepticism (acceptance of critical scrutiny)" (Nosek & Olson, 2020). Open science as an import tool to foster innovations, transparency and collaboration in



Democratic schools that focuses on unequal distribution of knowledge, and Pragmatic schools which assumes that knowledge creation could be more efficient if scientists could work in collaboration see Figure 1.

scholarly communications (Msoffe and Buhomoli, 2023). Additionally, OS promotes the validation of findings, reproducibility and scrutiny of the research findings, and knowledge sharing. Also the OS makes research outputs to be available to a wider and diverse audience such as researchers, educators, policy makers and general public (Muneja, 2023; Tenopir et al., 2020). However, OS practices is largely facilitated by realizations of enabling environments. This involves the building capacity to key players, establishing relevant legal and regulatory frameworks, putting in place the appropriate open science supporting infrastructures as well as allocating enough fund for enhancing the practices.

Open Science global, regional and national initiatives

To date, OS practice is gradually gaining momentum in world-wide. There are global, regional, and national OS initiatives that aim at transforming the practice of scholarly communication. International organizations such as the European Union, Research Data Alliance, CODATA, UNESCO and others have laid down enabling environments for supporting OS in terms of policies and funding (Muneja, 2023). Ahmad, et al., (2024) in recent years, majority of the countries including those from global north and those which from the globe south, have been actively adopting these practices. In 2019, the European Union research funding organizations through Pan S agreed to support Open Access to published journal articles by 2020, backed up by 16 cOAlition S members, 13 national funders and three charitable organizations which was backed up by three major Chines science and technology institutions (Dal-Ré, 2019). Recently, UNESCO in recognition of the role of science in solving global challenges set "Recommendations on Open Science" guidelines during its 39th General Conference session held in 2017 (UNESCO, 2021). The goal of the recommendations is to provide a common international framework for open science policy and practise with respect to specific regional and disciplinary diversities and challenges. In its recommendation, UNESCO provides OS principles, shared values, and standards at the international level while proposing a set of actions to promote fair and equitable operationalization of open science. However, OS practices have not yet been fully adopted uniformly across institutions or disciplines even within the same country. One among the reasons for this, is poor enabling environment for the practices to be fully adopted and implemented (Muneja, 2023; Mwelwa et al., 2020). The establishment of the enabling environments for the open science practices in the country will support the standardization and harmonisation of the open science practices.

Open Science in Africa

The progress of Open Science practices in Africa is notably slowly but the pace of implementation vary across the continent (Mwelwa et al., 2020;Okafor et al., 2022). Despite the evidence of indicators of OS in Africa, efforts towards adoption and implementation are fragmented and limited to individual scientists, institutions and nations. Currently, only a few African countries have policies and guidelines for OS practices, these are South Africa and Ethiopia, and in some countries such as Nigeria, Côte d'Ivoire, and Uganda ratification is underway (UNESCO, 2022). Establishment of infrastructure such as Open access Institutional

Repositories (including the National repository portal hosted by the Tanzania Commission of Science and Technology), open data repositories, and open access journal publishing are some examples of OS initiatives in Tanzania (Muneja, 2023). In the context of Tanzania, there is still an existing gap that requires strong foundations of enabling environments for OS to be fully adopted. Several challenges have been cited as impending adoption and practice of OS at the continent level including lack of policies, unfavourable infrastructures, institutional frameworks, negative attitudes and misperception towards open access (Buhomoli & Muneja, 2023; David et al., 2022). These challenges have impeded the knowledge sharing, limiting knowledge validation, collaboration and ending with duplication of research efforts. These challenges hinder stakeholders from exploiting the benefits associated with open science. Moreover, the enabling factors for the adoption and implementation of open science in Tanzania have not yet been uncovered by studies that have been conducted in this area. Therefore, this study aimed at investigating the factors that enable OS practices in Tanzania so as to provide policy recommendations for promoting OS practices at institutional and national levels. The findings of this study provide a baseline for understanding the situation and informing the government agencies responsible for scientific research and education on the areas of intervention/support. To the best of our understanding, this is the first study to investigate institutional support for open science in Tanzania.

This study intends to answer the following questions: What are institutional supports for OS and infrastructure? What challenges hinder the adoption and practice of OS?

Methods

A cross-sectional research design was employed to evaluate the conducive environment for the adoption and implementation of Open Science practices in Tanzania. The study population encompassed academicians, researchers, students, librarians, and science communicators, selected due to their perceived relevant knowledge and expertise in the subject matter, facilitating the collection of pertinent data. The study utilized non-probability sampling, specifically convenience sampling, owing to the ease of access, geographical dispersion, and characteristics of the target population. Thus, a convenient sampling technique was applied, wherein an online survey was distributed to the aforementioned groups through institutional mailing lists, WhatsApp groups, and professional associations.

A total of 144 responses were gathered and subsequently exported as Google Sheets to Microsoft Excel for preliminary analysis. Data cleaning procedures were executed to eliminate unsuitable responses, including incomplete surveys and non-compliant submissions. Further analysis was carried out utilizing the Statistical Package for Social Sciences (SPSS) version 22. Microsoft Excel facilitated data formatting, and the extraction of figures, tables, and pie-charts for presentation.

Results

Demographic characteristic of respondents

This study involved 144 participants with a diverse research expertise, age, education and organization affiliation. The sample included 68.8% male and 30.6% while 1% of the respondents preferred not to disclose their gender see Table 1A. The majority (49.3%) of the responses were under the age group of 25 - 34 years old see Table 1B.

Table 1. Gender, Age, Role and Experience of Respondents

Table name	Category	Frequency	Percent
	Male	99	69
Table 1A: Gender	Female	44	31
	Prefer not to say	1	1
	Total	**144**	**100**
	25-34	71	49
	35-44	58	40
Table 1B: Age range	18-24	7	5
	45-54	7	5
	55-64	1	1
	Total	**144**	**100**
	Academician/Lecturer/Tutor	70	49
Table 1C: Role	Postgraduate student (masters, PhD or Postdoc)	32	22
	Researcher	26	18
	Technical personnel	12	8
	Undergraduate student	4	3
	Total	**144**	**100**
	Early career (0-5 years)	64	44.4
Table 1D: Experience	Mid-career (6-10 years)	53	36.8
	Senior (11+ years)	27	18.8
	Total	**144**	**100**

Academicians/researchers/tutors constituted a large number of participants followed by postgraduate students and researchers respectively see Table 1C. It was observed that majority of respondents were in their early stages of their research career (0-5 years) followed by mid-career and senior researchers see Table 1D.

Figure 2A: Respondents' institution affiliations by type

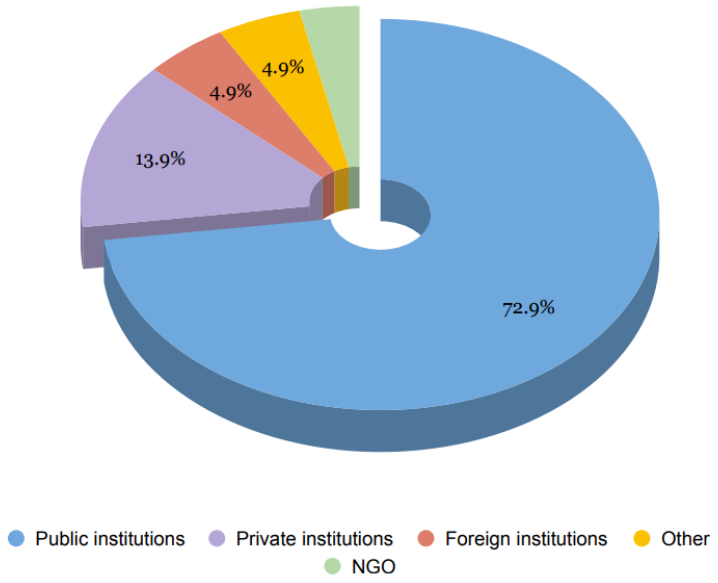


Figure 2B: Categories of respondents' institution affiliations

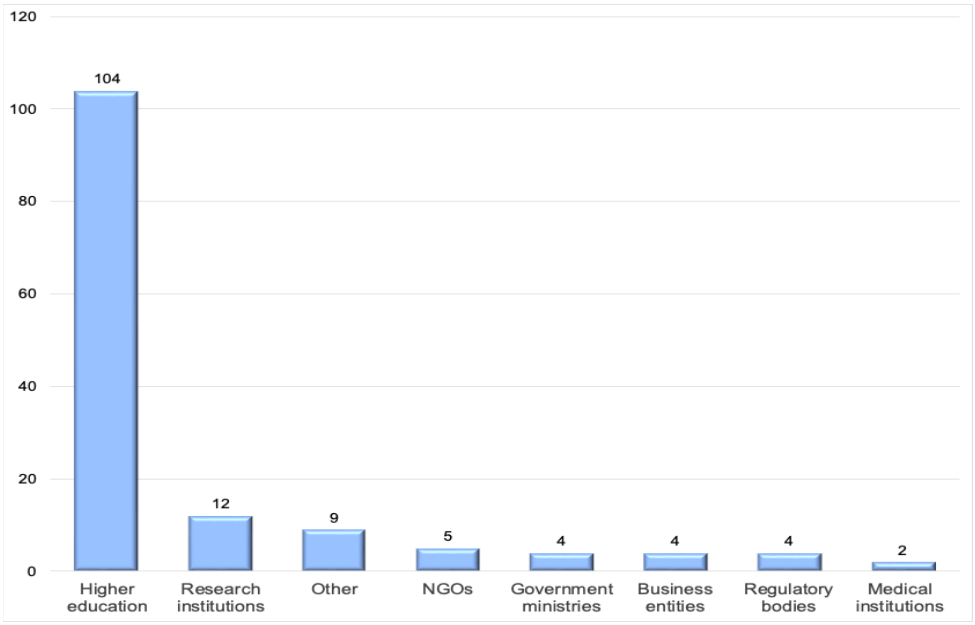
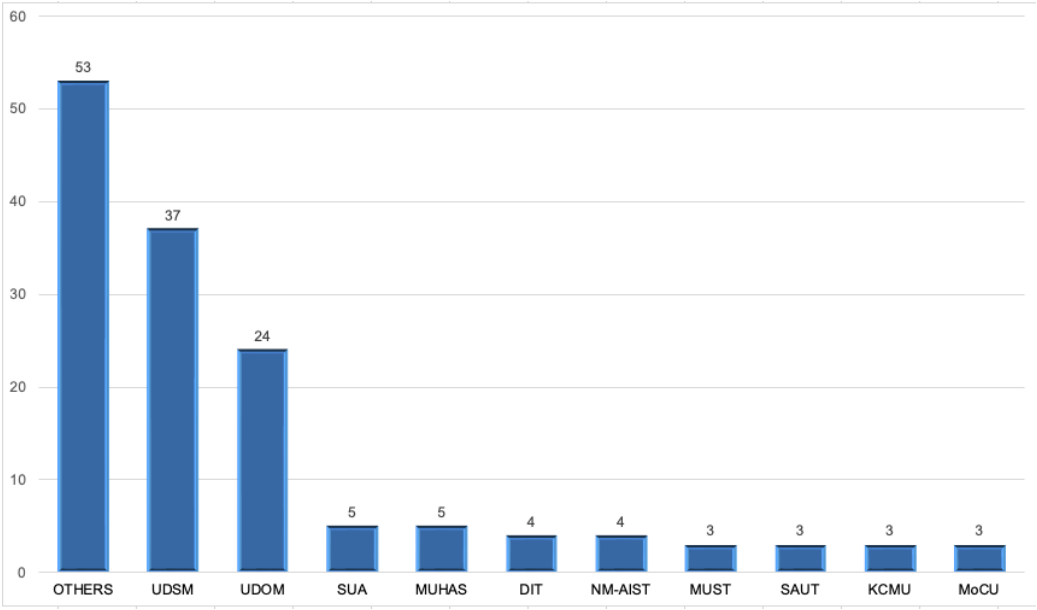


Figure 2C: Respondent's institution affiliation



Participants from different institutions ranging from academic, research, governmental and non-governmental organization were involved. It turned out that, most respondents were from higher learning and research institutions see Figure 2A. A large percentage of respondents (72.9%) were affiliated with public institutions see Figure 3B. University of Dar es Salaam and the University of Dodoma had higher number of respondents as indicated in Figure 2C.

Open Science Enabling Environment

The first of objective of this research intended to establish enabling environments for Open science in different institutions in Tanzania such as infrastructure, policies, guidelines, trainings and others.

Open science infrastructure

Respondents were asked to give their insights of whether their institutions provide support open science practices, the majority 94(65.3%) agreed that their institutions provide supports. However, about 4.9% had no clue of whether their institutions do support OS or not. In addition, 4.9% said no support is offered by their respective institutions see Figure 4.

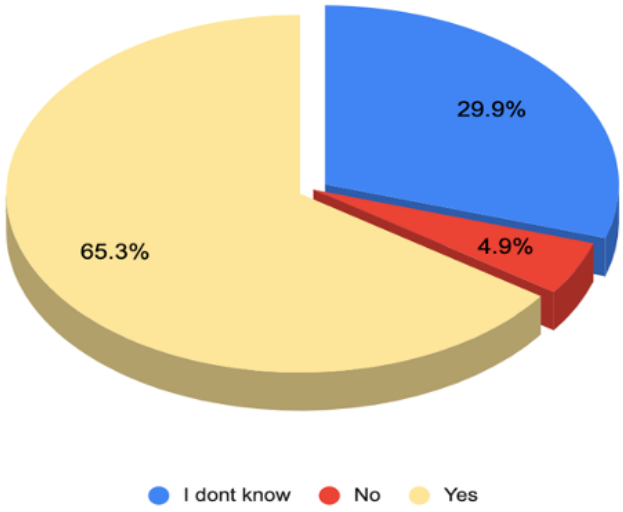


Figure 4: Institutional support for open science

Ways in which Institutions support Open science.

Respondents were asked to indicate way their institutions support OS. About 95(69%) of 144 responded to this question. The majority mentioned Institutional Repository followed by encouragement to share research data online and financial assistance for Article Processing Charges (APCs). Furthermore, installation of Open Journal Systems (OJS) for publishing Open access journals was mentioned by slightly a quarter of the respondents. The kind of support which were less popular included changing local journals into Open Access, sharing lab notes and having policy mandates of Open Science. Nevertheless, 5% of respondents indicated mentioned other kind of support see Table 2.

Table 2: Institutional activities to support open science

How does your institution support OS? N=95	Frequency	Percentage
My institution has created an open access IR	50	53
Researchers are encouraged to share their research data	41	44
The management support its researchers through paying APCs	25	27
My institution has established an OJS	13	14
The management supports changing local journals on OA journals	12	13
Scientists are sharing lab notes with collaborators for validation of research findings	10	11
My institution has passed a policy mandate for Open science	9	10

Other kind of supports mentioned by respondents included allowing staff to publish in OA local journals, creating portal for data and information sharing, and sharing data freely through its website.

Open Science Support Received by Individual Researchers

Respondents were further asked whether they have received institutional support for open science in the course of OS practice. It was revealed that 72(50%) had received and 72(50%) have never received any kind of support in their course of practicing Open science. For those who agreed to have received direct support from their parent institutions, slight majority indicated to have received training, and access to the Institutional Repositories respectively. Furthermore, other indicated to have supported to pay their APCs for publishing their articles, establishment of collaboration systems, guidance on appropriate OA journals for publishing their manuscripts. A small number of respondents said, the articles they published through OA journals were accepted for promotion see Table 2.

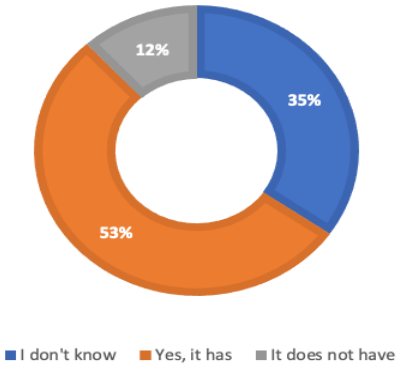
Table 3: The type of OS support received by individuals from their institutions or libraries.

The type of support received by individuals for OS N=77	Frequency	Percentage
Offered training for me on principles of Open science	26	34
Facilitated access and use of OA-IR	26	34
It has paid my APCs for publishing my articles	20	26
It has supported my research by establishing collaboration systems	20	26
Directed me to choose the appropriate OA journals for publishing my articles	20	26
The articles I published through OA journals was accepted for promotion	7	9

Availability of Open Science Infrastructure

We investigated the availability of the necessary infrastructure to facilitate adoption and practice of OS in institutions in Tanzania see Figure 6.

Figure 5: Does your institution have the necessary infrastructure to support OS?

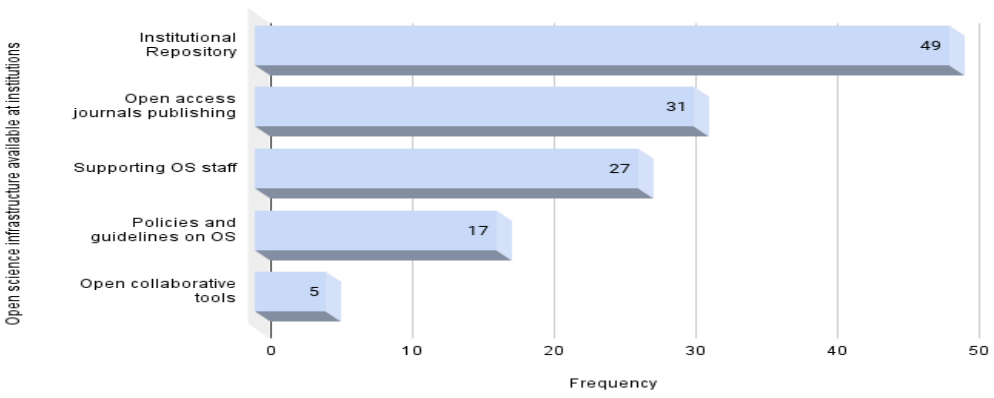


Data in Figure 5 shows that, majority (53.5%) of the respondents indicated that their institutions had the necessary infrastructure to support open science. Surprisingly, a sizable portion of the respondents (34.7%) said they did not know whether the supporting infrastructure exists at their respective institutions. Also, the study registered 11.8% respondents who said no OS infrastructure existed in their institutions.

The type of Open Science Infrastructure that exists

A follow up question to respondents who said the supporting infrastructure existed in their institution determined the type of infrastructure present. Here also, most cited available infrastructure was related to open access. Availability of institutional repositories was reported by 49(38) while presence of systems for publishing on open access journals was cited 31(24%). Other respondents said their institutions had human resources to support open science 31(21%) and clear policy frameworks for open science practice 17(14%). Only a small fraction 5(4%) said open collaborative tools were in place, see Figure 6.

Figure 6. Availability of open science infrastructure at institutions



Limiting factors for Open Science practice

We asked the respondents to rank the limiting factors for Open Science, the responses were recorded and arranged according to their orders of importance as follows:

i. Lack of proper knowledge about Open Science among researchers and institutional leaders.
ii. Myth about the quality of Open Access/Poor perception
iii. Negative perceptions towards OS/Researchers' willingness/Attitude towards OS
iv. Lack of financial support for APCs/limited budget
v. Lack of national policies and frameworks on Open Science
vi. Concern related to copyrights
vii. Legal and ethical issues
viii. High cost of publishing in Open Access Journals
ix. Some OA journals are not recognized by the country's regulatory bodies
x. Lack of funds for Postgraduate students to publish in OA Journals
xi. Insufficient management support
xii. Collaboration related barriers
xiii. Institutional related barriers
xiv. Unreliable ICT infrastructure including internet

The major challenges for OS include lack of proper knowledge on this initiative, if institutions manager will have the necessary knowledge on the practice and benefits of OS, they will embark on implementation including creating policies, providing financial support such publishing processing charges, establishment of publishing systems etc.

Discussion

As Ahmad et al., (2019). the technological trends changes the fundmentatl services of the libraries and information resources This study investigated the availability of supporting environment and infrastructure for open science in Tanzania. It also provide insights the available support and infrastructure for open science in the academic, research both government and non-governmental organizations in the country. The study reveals the extent to which institutions are actively facilitating these OS initiatives and how institutions play role in advancing Open Science.

Open Science Institutional support

The findings reveal a significant number of the respondents reported that their institutions support open science practices see Figure 4. This indicates a positive trend, suggesting that a considerable number of institutions in Tanzania recognize the importance of OS and are gradually adopting it in scholarly communication. However, it is important to note

that a notable percentage of respondents as indicated in Figure 4 reported uncertainty regarding whether their institutions support open science practices as they don't know whether their institution have or don't have any kind of OS support such as Institutional Repositories (IRs), Open Journal Systems (OJS), policies, financial assistance for APCs etc. This uncertainty might be attributed by lack of awareness or clarity regarding institutional plans and strategies, policies or initiatives geared towards OS practices (David et al., 2022). The findings suggest a need for strengthening sensitization programme on OS among researchers to ensure that they are aware of the available support and resources for open science. The fact that a small number of respondents, indicated that their institutions did not have support on open science practices, calls for more effort to promote open science and encourage wider institutional participation. Efforts should be directed towards engaging these institutions, addressing any concerns or misconceptions they may have, and emphasising on the positive impact of open science in research outcomes, collaboration, and knowledge dissemination.

Institutional Repositories are type of support offered by institutions which seem to be popular as several academic institutions have installed IR for the purpose of collecting, preserving, archiving, and sharing publications and research data online see a list of Institutional Repositories in Tanzania https://v2.sherpa.ac.uk/opendoar/ . IR being mentioned by most of the respondents shows the recognition of the ICT infrastructures as one of the key enabling environments for the open science practices to take place aligning with findings by Buhomoli and Muneja (2023).

Financial assistance for Article Processing Charges (APCs) is another important kind of OS support that has been mentioned by respondents due to the fact that most researchers now prefer publishing on OA Diamond journals that charges a certain amount of money to cater for processing and maintaining the published articles. The APC is normally charged to individual authors, but it is normally paid by institution or donors through funded research project funds. The findings relate with those of Ng'eno and Mutula, (2018) that indicate funding as one of the enabling environments for the open science to take place. Therefore, this is call for institutional and national funding agencies to support the open access by allocating financial resources for the endeavor. Moreover, several public institutions in Tanzania runs donor funded research projects which provides budged for APCs as they require researchers to share their results through OA journals and self-archive the same into IRs. Although, the Installation of Online

Journal Systems (OJS) mentioned by slightly quarter of the respondents among OS support, this is among key infrastructure of OS, only a fewacademic and research institutions have installed it, The University of Dar es Salaam for example has an OJS that publishes 24 journals hosted by different departments of the University see https://journals.udsm.ac.tz/.

Other kind of OS support that were mentioned by fewer respondents included changing regular journals into Open Access, sharing lab notes and having policy mandates of Open Science. Changing regular journals into Open Access also known as Journal flipping is becoming popular nowadays due to the fact that many scholars are now embracing Open access as their "new normal" in scholarly communication (Lane JN & Lifshitz-Assaf H, 2022).
Some studies such as Bautista-Puig et al., (2020) has attached OA flipping with increased value of journals' Impact Factors which impliedly show an increased citation of the journal. Some journals published by the University of Dar es Salaam have actually flipped from traditional publishing to Diamond OA that means they do not charge the author to publish an article to the journal and once published the article become freely accessed and used by users, see for example the journals with their OA polices in the Africa Journal Online (AJOL) https://www.ajol.info/index.php/ajol/browseBy/country?countryId=208.

Another key supportive environment is having institutional and national OA mandates. Open science policy mandate is a key to ensuring that researchers in a particular institution align with an institutional strategies.OA mandate has been shown to increase the production and citation of articles published in OA journals (Bryan & Ozcan, 2021; Probst et al., 2023). Other see OA mandate as the motive towards the growth of content in the Institutional Repositories (Kennan, 2011).

Further, respondent mentioned other type of support for OS include encouraging researchers to publish in OA local journals and creating a portals for sharing research data. In most research and higher learning institutions in Tanzania, researchers are encouraged to publish in prestigious journals so as to increase the reputation of their institutions due to presumed high quality of those journals (Brembs, 2018), usually measured by the impact factor. The Minister for Education Science and Technology of Tanzania in 2022 announced that researchers who will publish in journals with high Impact Factor will be awarded monetarily of about $20,000 (MoE, 2023). In simple terms, this announcement somehow indicate a low regard for local journals, making them the less preferred medium for publishing science. On

the other hand, data portals are less popular in Tanzania, although there are few examples such as that hosted by the Ifakara Health Institute (IHI) at https://data.ihi.or.tz/ . Data portal is among key infrastructure for capturing, archiving and dissemination of data for validation and re-use.

The low number of participants indicating policy framework as one of the enabling environments established by their institutions suggests an oversight in the open science practices in Tanzania. The findings are contrary to studies by Buhomoli and Muneja, (2023) and Ng'eno (2018) who asserted that open science policies and other regulatory frameworks play an important role in shaping the open science practices including establishing open science organizational culture, organizational structure, standards and compliances through their studies which were conducted in Tanzania and Kenya respectively. These findings show a greater need for establishing policy and regulatory frameworks to guide effective adoption of open science in the country..

Our findings also indicate that support for open science to individuals is common practice. Fifty-nine percent confirmed to have received individual support for OS while fourty-one percent did not receive. This higher number of participants who have received the individual support reflects the enabling environments created by their institutions to provide personalized open science practices support (Chiware & Skelly, 2022).

The two prefered types of supports received by individuals were training on OS principles and facilitation to accessing IR resources (Chiware & Skelly, 2022; David et al., 2022; Lyon et al., 2012). Training is an important aspect of building capacity of researchers on OS and can cover topics such ass scholarly communication, open access principles, self-archiving and publishing including how to avoid predatory journals. Other type of support received include payment of APCs for publishing manuscripts in OA journals, which is normally paid by parent institution or donors through donor funded research projects. Establishment of research collaboration system is another type of support received this is mainly done through working together in different projects, and guidance on choosing the appropriate OA journal which is provided through policies and trainings. The type of support which had the least response is acceptance of articles published in OA journals for promotion. The findings suggest that while institutions may support open science practices to some extent, the formal implementation of comprehensive policies specifically targeting open science is

relatively low. This indicate that open access publishing is a key focus area for institutions supporting open science in Tanzania.

Open Science infrastructure

The results indicate the majority of respondents have the necessary infrastructure to support OS. This suggests a positive trend towards the availability of infrastructure that enables and promotes open science initiatives. However, it is noteworthy that a considerable proportion of respondents (34.7%) reported uncertainty regarding the existence of supporting infrastructure at their institutions. This response suggests lack of adequate knowledge of OA practices and the enabling environment. There is an unfilled knowledge gap that needs a close attention that hinders researchers' ability to take fully take advantage of available resources for open science. It is crucial to address this knowledge gap and enhance the accessibility and visibility of open science infrastructure within Tanzania institutions. Furthermore, (11.8%) reported that the necessary infrastructure for open science did not exist in their institutions. This finding highlights the need for increased investment and attention to developing and implementing appropriate infrastructure to support open science practices. Institutions should prioritise the establishment of infrastructure that enables open access publishing, data sharing, and collaboration, as which are key building blocks of open science.

The results have revealed that, infrastructure such as Open Access Institutional Repositories, and OA publishing journals systems are given much weight in supporting OS. Other kind of support include OS supporting staff, policies and guidelines for OS publishing and research collaborative systems (see Figure 6). Institutional Repositories are key to ensuring freely sharing of locally published research materials including journal articles, conference proceedings, theses and dissertation etc. Several institutions have already installed Institutional Repositories to capture, disseminate and preserve intellectual output (Muneja, 2023). Likewise, most academic institutions are hosting and publishing their own journals, most of which are free access, publishing in Diamond open access model. See for example the list of journals published by the University of Dar es Salaam departments https://journals.udsm.ac.tz/ using the Online Journal System (OJS). The findings also indicate the recognition of the importance of skilled individuals who can facilitate and guide researchers in adopting open science practices effectively. Moreover, availability of clear policy frameworks that provides guidance in promoting the culture of openness is a key factor in ensuring the practice of open science.

A relatively small number of respondents (3.88%) reported the existence of open collaborative tools in their institutions. This suggests that while infrastructure related to open access publishing and policy frameworks may be more prevalent, there is room for improvement in terms of providing platforms and tools that facilitate collaboration and cooperation among researchers.

Factors hindering OS practice

Respondents were requested to indicate the factors that hinder OS practice, this was an open-ended question that highlighted several factors. The prominent barriers of OS were revealed to be lack of proper knowledge about Open Science and its benefits in scholarly communication among researchers and institutional leaders, negative perceptions towards OS that makes scientists unwilling to practice OS associated with the myth that OS leads to low quality scholarly content, and lack of OS policies and frameworks at national level. Other factors including concerns related to intellectual property rights, especially that comes with the notion that scholars will have their scholarly materials misused and their their copyrights violated, lack of financial support for paying Article Processing Charges (APCs) to publish in OA journals due to high cost which is unaffordable by institutions with limited budgets, lack of funds for postgraduate students to publish in OA journals, Insufficient management support and lack of collaborative tools, and unreliable ICT infrastructure including internet

Scholars have proposed several factors to create an enabling environment for OS adoption and practice. Firstly, establishing national and institutional policy frameworks on various areas of OS application such as data use, sharing and access has been repeatedly stated. (Chiware & Skelly, 2022; De Filippo & Sastrón-Toledo, 2023; Muneja, 2023; Mwelwa et al., 2020). These studies emphasizes that OS policies should be an integral part of promoting OS and factor in aspects that impact OS adoption. At an individual level, existing systems of reward in academia and research institutions have been shown to be a strong enabling or limiting factor on the ability of scientists, especially early career researchers (ECRs), to practise OS (Zečević *et al.*, 2021). Although at an individual level scientists may embrace OS, if systemic frameworks are not supportive of OS, progress will continue to be limited, which may be the case in Tanzania too. In our previous study we found out that in Tanzania, OS is dominated mainly by OS practices driven by individual incentives and efforts rather than institutions (David et al., 2022) and thus achieving limited momentum and impact.

Conclusion

This study delves into the institutional support structures facilitating the adoption of Open Science (OS) practices within Tanzanian institutions. It scrutinizes the essential infrastructural prerequisites essential for effective OS implementation. The findings underscore the criticality of institutional support for fostering OS practices, irrespective of researchers' awareness levels regarding OS principles. Predominantly, the support mechanisms for researchers to engage in OS practices center around Institutional Repositories, coverage of Article Processing Charges (APCs), and the facilitation of streamlined avenues for sharing research outputs, encompassing publications and data. Notably, researchers place significant emphasis on institutional support in the form of training opportunities, facilitation of access to resources, utilization of open-access Institutional Repositories, and recognition of Open Access (OA) publications for career advancement. While a considerable proportion of researchers acknowledge the presence of necessary infrastructural support within their institutions for OS endeavors, the study identifies only a limited array of readily available infrastructures, notably Institutional Repositories, OA publishing systems, and associated policies. However, addressing the existing gap necessitates concerted efforts to combat the lack of awareness regarding OS, dispel myths surrounding open access, secure financial backing, establish national OS policies, and alleviate the financial barriers associated with publishing in prestigious OA journals. Despite researchers' overall perception of institutional support for OS practice, enhancing awareness and fostering clarity regarding OS principles among both researchers and institutional management remains imperative.

Recommendations

Further endeavors should be directed towards engaging institutions that currently do not endorse open science practices. Additionally, increased investment is imperative to establish supportive infrastructure for open science, encompassing tools such as open collaborative platforms and the formulation of supportive policies. Addressing the factors impeding the adoption of open science necessitates active engagement and commitment from both researchers and institutions. By mitigating these barriers, the open science landscape in Tanzania can be substantially enriched, fostering collaboration, knowledge dissemination, and research impact. Consequently, institutions can cultivate a more inclusive and supportive research environment that promotes transparency in research, facilitates data sharing, and

encourages collaboration. Embedding open science principles within institutional strategic plans can facilitate this transition.

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