Model Open Science Policy of Nigeria

March 2024

PREFACE

It is my privilege and with great anticipation that I introduce this Model Open Science (OS) policy to Nigerian Universities primarily and the larger Nigerian research and education community. Adopting progressive policies is imperative in an era of expanding knowledge boundaries, where academia plays a pivotal role in shaping the future. The policy outlines strategic directions to boost the capacity of Nigerian Universities to engage in research that grows a knowledge-based digital economy and society. The vision is to create a dynamic ecosystem driven by open science, fostering innovation, and enhancing societal trust in research and development. The overarching goal is to instil within our research community a culture of openness, collaboration, and knowledge-sharing for the ultimate benefit of society.

Chapter Two of the model policy articulates the objectives, emphasising the creation of enabling environments for open science, establishing and fortifying open science infrastructures, and developing human resources through capacity-building initiatives. These objectives are complemented by a commitment to reconsider research assessment methods, ensuring that openness and impact are appropriately rewarded and incentivised. Core values and guiding principles derived from the UNESCO Recommendation on Open Science underpin the policy. These principles, encompassing quality and integrity, collective benefit, equity and fairness, diversity, and inclusiveness, reflect our commitment to a global public good accessible to all.

Chapter Three delineates the policy's priority areas: establishing an enabling policy environment, fortifying open science infrastructures, investing in human resources, and fostering a culture of open science. These priorities collectively form a blueprint for a sustainable and inclusive approach to scientific advancement in Nigeria. The strategies detailed within provide a roadmap for translating these priorities into tangible actions. This includes policy statements, actionable strategies, and a call to integrate open science competencies into educational curricula, ensuring a holistic and enduring impact.

Finally, Chapter Four outlines vital implementation arrangements. It emphasises the development of a national guideline as a linchpin for executing the Open Science Policy, serving as a bridge between international recommendations, governmental perspectives, and the responsibilities of various stakeholders. The proposed implementation plan emphasises scalable governance, stakeholder engagement, and periodic reviews to adapt to evolving needs. In presenting this policy, we envision a transformative journey for Nigerian academia marked by openness, collaboration, and a profound commitment to the betterment of society. The success of this policy lies in the collective efforts of policymakers, institutions, researchers, and the wider community. Together, let us embark on this exciting venture to usher in a new era of scientific excellence and societal progress.

Prof Yakubu Ochefu, Secretary-General of the Committee of Vice-Chancellors of Nigerian Universities

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Open Science introduces a novel approach to the scientific method, emphasising collaborative efforts and the adoption of digital technologies and collaborative tools for disseminating knowledge. It advocates for the extension of openness principles throughout the entire research cycle, promoting early sharing and collaboration, thus instigating a systemic shift in the conduct of science and research.

1.2 Definition

"Open Science, a groundbreaking shift in research and innovation, diverges from conventional methods by prioritising collaboration, accessibility, and transparency across the entire scientific journey. This forward-looking approach aims to dismantle barriers, promoting the open exchange of data, methods, and results. Ultimately, it cultivates a more inclusive and dynamic scientific community. Open Science encompasses various movements, including open access to publications, research data, and collaborative efforts, all working together to accelerate discovery and champion a democratised approach to knowledge creation."

Open Science thus serves as a comprehensive term encompassing diverse movements that seek to eliminate obstacles to sharing various outputs, resources, methods, or tools at any stage of the research process. This includes open access to publications, open research data, open source software, open collaboration, open peer review, open notebooks, open educational resources, open monographs, citizen science, and research crowdfunding.

While the library and information domain often emphasises Open Research Data and Open Access to scientific publications, Open Science as a concept encapsulates a wide array of initiatives, which include Open Scientific knowledge, Open science infrastructures, Open engagement of social actors and Open dialogue with other knowledge systems (while applying the CARE principles) to incorporate rather than exclude other knowledge system regardless of the categorization, a particularly important matter for Africa and Nigerian indigenous knowledge systems. (UNESCO Recommendation on Open Science, 2021).

Open science places a strong emphasis on addressing open problems and involving citizen science, a rather alien concept to mainstream research perspectives in Nigeria. Its role in enhancing science and innovation across countries, disciplines, and technological sectors is crucial. By fostering collaboration and transparency, open science optimises the utilisation of limited resources while also reinforcing the reliability and replicability of scientific inquiries. The open, dynamic, and transparent practices in knowledge production contribute to the swift dissemination of information and encourage citizen science participation.

Internationally agreed scope of Open Science

(UNESCO Recommendation on Open Science, 2021).

"The concept of 'accessibility' refers to the availability of scientific inquiry in online/digital formats at minimal costs, with a focus on being inclusive for individuals with disabilities. Meanwhile, 'open data' involves making data accessible for reuse and redistribution, achieved through data connection, integration, and the provision of comprehensive metadata. This effort should also

ensure the prompt publication of research data, ideally upon its generation or as early as practically feasible.

Open Science, a transformative paradigm in the realm of research and innovation, represents a departure from traditional methodologies by emphasising collaboration, accessibility, and transparency throughout the entire scientific process. This forward-thinking approach seeks to break down barriers, encouraging the open sharing of data, methods, and outcomes, ultimately fostering a more inclusive and dynamic scientific community. Open Science spans various movements, encompassing open access to publications, open research data, and collaborative endeavours, collectively aiming to accelerate the pace of discovery and promote a democratised approach to knowledge creation.

1.3 Open Science in Nigeria

Nigerian researchers' attitudes toward open data, open access and Open Science like most African researchers are in tandem with global perspectives. OS promises to promote access for the advancement of scientific research and the development of the next generation of scientists in Africa. However, limitations exist for the prospect of institutionalisation and practices of OS in Nigeria, highlighted by the global resurgence of discussions around open science due to the COVID-19 pandemic. Therefore, in deploying the policy, the geopolitical peculiarity and other relevant factors must be considered and recognized in its implementation across various levels, avoiding a one-size-fit-all approach.

The Open Science concept transcends all aspects of society dealing with the inputs, outputs and applications of research and research related endeavours. Nigeria alongside other African governments and institutions must embrace the open science principles and build research infrastructures that align with the global open science movement. Hence, appropriate OS policy frameworks must evolve to guide policymakers and all other stakeholders; who must re-evaluate their positions relative to the Open Science concept and integrate its practices across Nigeria and the rest of Africa. As with the policy, deliberate efforts must ensue to eliminate barriers and foster a supportive environment for open science to thrive on the continent.

A key grey area is that of the concept of 'accessibility' among the FAIR principles. Implying availability of scientific inquiry in online/digital formats at minimal costs, with a focus on being inclusive for all categories of individuals, its practical feasibility in Nigeria and by extension, Africa is one that must receive conceited attention if the OS policy must work.

CHAPTER TWO: POLICY DIRECTIONS

2.1. Vision

A vibrant knowledge-based digital economy and society driven by open science.

2.2 Policy Goal

The Policy goal is to enhance the efficiency, effectiveness and impact of science and research, increase innovation capacity, improve the trust of society in science, foster a culture of openness, collaboration and knowledge sharing for the benefit of the society in Nigeria.

2.3 Policy Outcomes

The desired Policy outcomes are:

i.   Enable legal, policy and regulatory environments at national and institutional levels, and embedded open science practices across research activities.

ii.   Enable the set up and strengthening of Open science infrastructures and services

iii. Promote the availability of human resources for Open science through capacity building, in awareness and comprehension, contextualization and enrichment of Open science ethos and skill sets and resources for researchers.

iv.   Promote research assessment reformation to reward and incentivise quality, impact and openness.

2.4. Specific Policy Objectives

The specific Policy objectives are:

i.   Put in place an enabling policy environment for open science, including legislative initiatives where appropriate;

ii.   Set up and strengthen open science infrastructures and services;

iii. Invest in human resources and capacity building for open science;

iv.   Foster a culture of open science among researchers and provide incentives and rewards for open science practice at all levels (assessment of institutions, research projects and individual researchers);

2.5 Core values and guiding principles

The Policy is based on the **core values** of OS listed in the UNESCO Recommendation on Open Science and include that:

i.   **Quality and integrity**: OS will respect academic freedom and human rights and support high-quality research by bringing together multiple sources of knowledge and making

research methods and outputs widely available for rigorous review and scrutiny, and transparent evaluation processes that reward and incentivise the conduct of open science.

ii. **Collective benefit:** as a global public good, OS benefits humanity as a whole. To this end, scientific knowledge should be openly available and its benefits universally shared. The practice of science should be inclusive, sustainable and equitable, also in opportunities for scientific education and capacity development.

iii. **Equity and fairness**: open science should play a significant role in ensuring equity among researchers, enabling fair and reciprocal sharing of scientific inputs and outputs and equal access to scientific knowledge to both producers and consumers of knowledge regardless of location, nationality, race, age, gender, income, socio-economic circumstances, career stage, discipline, language, religion, disability, ethnicity or migratory status, or any other grounds.

iv. **Diversity and inclusiveness**: open science should embrace a diversity of knowledge, practices, workflows, languages, research outputs and research topics; as well as diversity of research communities as well as the wider public and knowledge holders beyond the traditional scientific community, including indigenous peoples and local communities.

The following **guiding principles for open science,** listed in the UNESCO Recommendation on Open Science, provide a framework for enabling conditions and practices of this Policy:

i. **Transparency, scrutiny, critique and reproducibility**: increased openness should be promoted in all stages of the scientific endeavour, with the view to reinforcing the strength and rigour of scientific results, enhancing the societal impact of science and increasing the capacity of society as a whole to solve complex interconnected problems. Increased openness leads to increased transparency and trust in scientific information and reinforces the fundamental feature of science as a distinct form of knowledge based on evidence and tested against reality, logic and the scrutiny of scientific peers.

ii. **Equality of opportunities**: all scientists and other open science actors and stakeholders, regardless of location, nationality, race, age, gender, income, socio-economic circumstances, career stage, discipline, language, religion, disability, ethnicity or migratory status, or any other grounds, have an equal opportunity to access, and contribute to and benefit from open science.

iii. **Responsibility, respect and accountability**: with greater openness comes greater responsibility for all open science actors, which, together with public accountability, sensitivity to conflicts of interest, vigilance as to possible social and ecological consequences of research activities, research integrity and respect for ethical principles and implications pertaining to research, should form the basis for good governance of open science.

iv. **Collaboration, participation and inclusion**: collaborations at all levels of the scientific process, beyond the boundaries of geography, language, generations and resources, should become the norm, and collaboration between disciplines should be promoted, together with the full and effective participation of societal actors and inclusion of knowledge from marginalised communities in solving problems of social importance.

v. **Flexibility**: due to the diversity of science systems, actors and capacities, as well as the evolving nature of supporting information and communication technologies, there is no one-size-fits-all way of practising open science. Different pathways of transition to and practice of open science need to be encouraged while upholding the above-mentioned core values and maximising adherence to the other principles hereby presented.

vi. **Sustainability**: to be as efficient and impactful as possible, open science should build on long-term practices, services, infrastructures and funding models that ensure the equal participation of scientific producers from less privileged institutions. Open science infrastructures should be organised and financed upon an essentially not-for-profit and long-term vision, which enhances open science practices and guarantee permanent and unrestricted access to all, to the largest extent possible.

CHAPTER THREE: POLICY PRIORITY AREAS

The Policy has the following four priority areas:

1. Enabling policy environment for open science;

2. Open science infrastructures and services;

3. Human resources and capacity building for open science;

4. A culture of open science among researchers and incentives and rewards for open science practice at all levels (assessment of institutions, research projects and individual researchers);

3.1 Priority Area 1: Enabling policy environment for open science

i. Policy Statement
The Policy will put in place an enabling policy environment for open science, including legislative initiatives where appropriate.

ii. Strategies
Government, universities and research institutions will
1. Implement policies and strategies for open science. Policies and strategies for science should be based on the core values and principles of open science.
2. Foster the transition to open science and provide appropriate guidance and training to ensure the implementation of the policy.
3. Introduce responsible research and researcher evaluation and assessment practices, which incentivise quality science, recognizing the diversity of research outputs, activities and missions.
4. Support the deployment of necessary infrastructure and services such as open access repositories for publications and data, and open access platforms and journals.
5. Require immediate open access under an open content licence, such as Creative Commons Attribution licence (CC BY). It's required that a machine-readable electronic copy of the published version or the final peer-reviewed manuscript accepted for publication of all peer reviewed publications produced in Nigeria is deposited in a repository and the full-text of all such publications be made openly available immediately, except where an embargo period does not permit such. If a journal's permitted embargo period is longer than these, authors should either negotiate with the publisher to retain the rights so as to comply with this policy, or find a journal or publishing platform that enables them to comply without the need for negotiation.
6. Favour and support inclusive publishing and distribution channels that do not exclude authors on economic grounds, taking advantage of and supporting open access journals that do not charge Article Processing Charges and repositories.

7. Ensure, where possible, that scientific outputs related to publications (e.g. research data, software, source code, source materials, workflows and protocols) should also be made openly available in suitable repositories immediately upon publication.
8. Require researchers to retain ownership of copyright and to licence to publishers only those rights necessary for publication.
9. Encourage researchers and PhD students to deposit preprints of their work under a CC BY licence on a preprint platform/open access repository and prominently state whether or not it has undergone peer review.
10. While the dominant type of scientific publication in many disciplines is the journal article, strongly encourage researchers to provide open access to other types of publications such as monographs, book chapters, conference proceedings, grey literature, reports, etc.
11. For purposes of individual or institutional evaluation of the research outputs of the institution and its members, would only be considered as publications whose metadata and full texts are deposited in repositories according to the requirements stated above.
12. Universities will require that an approved final version of the thesis or dissertation is deposited in a repository. Such theses or dissertations will be made openly available to the public after filing, unless the graduate student is under obligation to abide by an embargo. The university may delay the upload of graduate and postgraduate students works beyond the the date the theses or dissertations become available in an open access repository by specifying the embargo period – up to two years. Where compelling circumstances exist, the Universities may grant embargoes of longer than two years or embargoes requested after filing.
13. Government research agencies, public research funders, universities and research institutions will follow the principle "as open as possible as closed as necessary" and will require that research data and other research outputs (such as software or models) are handled according to the CARE and FAIR principles. If data cannot be open due to legal, privacy or other concerns (for example personal or sensitive data, sacred and secret indigenous knowledge, rare, threatened or endangered species) this should be clearly explained. Researchers are required to deposit the research data needed to validate the results presented in scientific and scholarly publications and their metadata, preferably in a research data repository, and provide open access to it under an open content licence, such as Creative Commons (CC BY or CC0[1]); as well as provide information (via the same repository) about any research output or any other tools and instruments needed to re-use or validate the data.). Some data that are not openly available may nonetheless be shared among specific users according to defined data sharing agreements and access criteria made by local, national or regional pertinent governing instances. Tools and protocols for pseudonymisation and anonymising data, as well as systems for mediated access, could facilitate data availability, so that as much data as possible can be shared as appropriate.
14. Researchers are required to prepare a Data Management Plan showing how data and other research outputs will be managed through the research process and handled

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[1] https://creativecommons.org/publicdomain/zero/1.0/

according to the CARE and FAIR data principles and keep it updated throughout the course of the research project.

15. Data needed for policy making and innovation in government and the private sector (e.g. geospatial, earth observation and environment, meteorological, statistics, mobility, productivity data and so on) should be made available in open, machine-readable, accessible, findable and re-usable formats under an open content licence, such as Creative Commons (CC0).

16. Require the use of Persistent identifiers such as ORCID, Handle/DOIs/ARKs, ROR or others which are free or affordable.

17. Mainstream gender equality aspects into open sciences policies, strategies and practices.

18. Enhance the inclusion of community and participatory science as integral parts of open science policies and practices. Design models that allow co-production of knowledge with communities and establish guidelines to ensure the recognition of such collaborations.

19. Foster equitable public-private partnerships for open science and engage the private sector in open science, provided that there is appropriate certification and regulation to prevent vendor lock-in, predatory behaviour and unfair and/or inequitable extraction of profit from publicly funded scientific activities.

3.2 Priority Area 2: Open science infrastructures and services

i. Policy Statement
The Policy will set up and strengthen open science infrastructures and services.

ii. Strategies
Government, universities and research institutions will

1. Recognize that open labs, open science platforms and repositories for publications, research data and source codes, software forges and virtual research environments, and digital research services, in particular those that allow to identify unambiguously scientific objects by persistent unique identifiers (e.g. DOI, Handle, ORCID, ROR), are among the critical components of open science infrastructures. They provide essential open and standardised services to manage and provide access, portability, analysis and federation of data, scientific literature, thematic science priorities or community engagement. Open science infrastructures are often the result of community-building efforts, which are crucial for their long-term sustainability and therefore should be not-for-profit and guarantee permanent and unrestricted access to all public to the largest extent possible.

2. Acknowledge that open science both requires and merits systematic and long-term strategic investment in science technology and innovation, with emphasis on investment in technical and digital infrastructures and related services, including their long term maintenance. These investments should include both financial and human resources.

3. Ensure adequate investment in reliable Internet connectivity and bandwidth for use by scientists and science users across the country, with interconnectivity to the region and the world; and in non-commercial open science infrastructures and services, including high-performance computing, cloud computing, research data and publications repositories, open access journals.
4. Participate in North-South, South-South, triangular cooperation and national collaborations to optimise infrastructure use and joint strategies for shared, multinational, regional and national open science platforms.

3.3 Priority Area 3: Human resources and capacity building for open science

i. Policy Statement
The Policy will ensure investments in human resources and capacity building for open science.

ii. Strategies
Government, universities and research institutions will
1. Provide systematic and continuous capacity building on open science practices (at the institutional and national levels), including technical skills and capacities in digital literacy, digital collaboration practices, data science and stewardship, curation, long-term preservation and archiving, information and data literacy, web safety, content ownership and sharing, as well as software engineering and computer science.
2. Agree on a framework of open science competencies aligned with specific disciplines for researchers at different career stages, as well as for actors active in the private and public sectors; and develop skills and training programmes in support of the attainment of these competencies. A core set of data science and data stewardship skills, skills related to intellectual property law, as well as skills needed to ensure open access and engagement with society, as appropriate, should be regarded as part of the foundational expertise of all researchers and incorporated into higher education research skills curricula.
3. Invest in and promote advanced education and the professionalisation of roles in data science and data stewardship. Enabling open science also requires data governors capable, in cooperation with the scientific community, of setting strategic directions for data management and openness at the national or local levels and advanced and professional data stewards who manage and curate data according to CARE and FAIR principles.
4. Allocate resources for training and awareness-raising on open science. Researchers should have access to appropriate training and support activities on open science on their institutional level.
5. Promote the use of Open Educational Resources (OER), as an instrument for open science capacity building in pedagogy and learning.
6. Support science communication accompanying open science practices with a view to the dissemination of scientific knowledge to scholars in other research fields,

decision-makers and the public at large. Dissemination of scientific information through scientific journalism and media, popularisation of science, open lectures and various social media communications builds public trust in science while increasing the engagement of societal actors beyond the scientific community.

3.4 Priority Area 4: Fostering a culture of open science and aligning incentives and rewards for open science

i. Policy Statement

The Policy will reform research assessment and evaluation (at institutional, research projects and individual researchers' levels - research and career evaluation and awards systems) to reward and incentivise quality, impact and openness.

ii. Strategies

Government, universities and research institutions will

1) Develop a framework for research assessment and evaluation that incentivizes research quality and open science behaviours and practices that:
   a) build on the existing global efforts to improve the ways in which the scientific outputs are evaluated with an increased focus on the quality of research outputs rather than quantity, and by fit-for-purpose use of diversified indicators and processes that forego the use of journal-based metrics such as the journal impact factor, consider the intrinsic merit of the work, not the title of the journal or publisher, when research outputs are assessed;
   b) provide value to all relevant research activities and scientific outputs including high-quality FAIR data and metadata, well-documented and reusable software, protocols and workflows, machine-readable summaries of findings, and teaching, outreach and engagement of societal actors;
   c) take into account evidence of research impact and knowledge exchange, such as widening participation in the research process, influence on policy and practice and engaging in open innovation with partners beyond academia;
   d) take into account the fact that assessment of researchers against open science criteria should be fit for different stages of careers, with particular attention to researchers at the beginning of their careers;
   e) ensure that the practice of open science is well known, and is taken into account as a scientific and academic recruitment and promotion criterion.
2) Combine efforts of research funders, universities, research institutions, publishers and editors, and scientific societies across disciplines and countries, to change the current research culture and to recognize researchers for sharing, collaborating and engaging with other researchers and society, and to support, in particular, early-career researchers to drive this cultural change.
3) Ensure diversity in scholarly communications with adherence to the principles of open, transparent and equitable access and supporting non-commercial publishing models and collaborative publishing models with no article processing charges or book processing charges.

4) Prevent predatory publishing behaviours and promote high-quality and responsible research, explore the potential of open science practices to reduce scientific misconduct, including the fabrication and falsification of results, violation of scientific ethical norms, and plagiarism.

CHAPTER FOUR: IMPLEMENTATION ARRANGEMENTS

4.1 Institutional Arrangements – Developing a national guideline

The development of a national guideline for OS is paramount for the implementation of the OS policy. The purpose of these guidelines is to provide direction for the transition towards open science, specifying the key actors' responsibilities and proposing how the guidelines can be implemented and monitored over time. It will also provide the roadmap for open science, along with its associated implementation guidance. The highlights of the guideline are;

i. The national guidelines will serve as a link between international efforts and recommendations, such as those from UNESCO and the work of research-performing and research funding organisations.

ii. The government through its appropriate arm will assign from a holistic perspective on open science, identifying common goals and priorities, mapping the distribution of roles and areas of responsibility, and defining the need for support and guidance.

iii. The assigned will gather knowledge, data and experiences from all actors/stakeholders; which include; researchers, research-performing organisations, research funders (national and international), expert government agencies as well as other agencies and actors (including relevant actors in the private sector).

v. Therefore, each actor is responsible for formulating how these guidelines can and should be implemented within their respective organisations.

4.2 Implementation Plan

The implementation plan for the policy execution will capture current as well as planned efforts by relevant partners and stakeholders towards advancing the various elements of the Open Science Policy. This plan will incorporate components and achieve the following;

i. Ensure both stable and scalable governance, as well as a community framework to engage relevant stakeholders.

ii. Constitute an Open Science Strategy Working Group (OSWG) to serve as the principal body to oversee Open Science at the national level.

iii. Develop a scalable governance framework as a core part of the implementation plan.

iv.Develops consensus on concrete implementation aspects, provides strategic guidance and support to stakeholder groups/subgroups.

v. Develop mechanism for regular review to reflect changes in policy requirements and community practices and relevance.

i. FAIR Principles

FAIR in the context of Open Science refers to the principles of Findability, Accessibility, Interoperability, and Reusability. By adhering to the FAIR principles as foundational values, the Open Science policy seeks to promote a more efficient, collaborative, and impactful scientific ecosystem where data is not only shared but also maximally useful for diverse purposes among researchers and institutions alike. FAIR principles complement the broader goals of Open Science by fostering transparency, collaboration, and accessibility in research practices. These principles provide a framework for making research data more valuable and impactful.

1. **Findability**: Data and metadata should be easy to find for both humans and computers. This involves assigning a unique identifier to the data, providing detailed metadata, and ensuring that the data is indexed and searchable.
2. **Accessibility**: Once data is found, it should be easily accessible. This means that the data should be retrievable by its identifier and should be stored in a stable, long-term repository. Access should be maintained over time, and any restrictions on access should be clearly communicated.
3. **Interoperability**: Data and metadata should be structured in a way that allows for seamless integration with other datasets and tools. This involves using common standards and formats, making it easier for different systems to work together.
4. **Reusability**: Perhaps the most crucial aspect, data should be designed for reuse. This involves providing clear and comprehensive metadata, using standardised vocabularies, and ensuring that the data is well-documented. The goal is to make it easy for others to understand, reproduce, and build upon the results derived from the data.

ii. CARE Principles

The 'CARE Principles for Indigenous Data Governance' address concerns related to the people and purpose of data. The Indigenous Data Sovereignty draws on the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which reaffirms the rights of Indigenous Peoples to control data about their peoples, lands, and resources. Indigenous data governance enacts those rights through mechanisms grounded in Indigenous rights and interests that promote Indigenous values and equity, while providing a framework for addressing deeper historical issues associated with barriers for underrepresented communities and knowledge systems.

1. **Collective Benefit** Data ecosystems shall be designed and function in ways that enable Indigenous Peoples to derive benefit from the data.

2. **Authority to Control**: Indigenous Peoples' rights and interests in Indigenous data must be recognised and their authority to control such data be empowered. Indigenous data governance enables Indigenous Peoples and governing bodies to determine how Indigenous Peoples, as well as Indigenous lands, territories, resources, knowledge and geographical indicators, are represented and identified within data.

3. **Responsibility**: Those working with Indigenous data have a responsibility to share how those data are used to support Indigenous Peoples' self-determination and collective benefit. Accountability requires meaningful and openly available evidence of these efforts and the benefits accruing to Indigenous Peoples.

4. **Ethics** Indigenous Peoples' rights and wellbeing should be the primary concern at all stages of the data life cycle and across the data ecosystem.

iii. Open Governance

An open governance approach, will be adopted for the implementation, operations, set objectives and performances of the policy as follows.

1. Develop and maintain a comprehensive open science policy and guidelines for implementation in consultation with relevant partners, and stakeholders.
2. The policy will be aligned with the UNESCO Recommendation on Open Science.

iv. Open Incentives and Recognition/Rewards

1. Clearly acknowledge copyright for research outputs.
2. Apply the relevant CC-BY-licence across all research outputs (incl. research data) funded with public money.
3. Allocate unique persistent identifiers to research outputs submitted to digital platforms, e.g. Handles, DOIs, ORCiDs, and RORs (institutional IDs).
4. Incentivise and recognise researchers' contributions to national knowledge products through appropriately developing a metric system for the country.

v. Intellectual Property

Intellectual property rights (IPR) will apply as defined in the work contract between the researcher and institutions, funders, grants or consortia agreements. Where other contracts exist prior to these agreements, such will also be respected. Similarly, the science/research outputs will be published and shared according to the conditions of the agreements. Where no condition exists regarding the publication and sharing of the science/research outputs, the research outputs by default will be made available under an open licence (CC-BY). This will be done in consultation with the researcher, serving the best interest of society. The licence will be

selected according to the type of research output and to label the research output and facilitate its utilisation. For source code, a General Public Licence (GPU) will be considered. For all other data, CC-BY licence will be considered. Data which are not restricted by copyright will be marked with the Creative Commons Public Domain Mark69.

4.3 Monitoring and Evaluation

The implementation of this policy will be monitored and evaluated on an Open Monitoring and Evaluation basis. The monitoring and evaluation mechanism will evaluate the impact of this policy continuously to ascertain its impact on scientific progress, collaboration, and innovation in consultation with its academic and research institutions, supervisory parastatals, partners, and stakeholders, with the following:

I.   Deploy appropriate monitoring and evaluation mechanisms to measure the effectiveness and efficiency of open science policies and incentives against defined objectives, including the identification of unintended consequences and potential negative effects, especially on early-career researchers.
II. Collect and disseminate progress, good practice, innovation and research reports on open science and its implications, with the support of UNESCO and with a multi-stakeholder approach.
III. Develop a monitoring framework with qualitative and quantitative indicators, within national strategic plans under public oversight, including the scientific community, and supported by open non-proprietary and transparent infrastructures and the private sector where necessary.
IV. Develop strategies to monitor the effectiveness and long-term efficiency of open science, with the focus on strengthening the nexus between science, policy and society, increased transparency and accountability for inclusive and equitable quality research, across a multi-stakeholder participatory approach.

4.4. Implementation Cost

A framework for the Open Science Policy will be established, to ensure the long-term viability and effectiveness, operational and financial sustainability of its practices, services, infrastructures, and funding models in support of the broader scientific community, following the key strategies below:

I.   **Long-Term Planning and Vision**: Develop a comprehensive long-term plan and vision for open science that outlines the objectives, goals, and desired outcomes of the policy, as part of its strategic planning. This plan will consider evolving trends and technological advancements in the field of open science to ensure the policy remains relevant and effective over time.

II.   **Capacity Building and Training**: Encourage institutions to invest in the training and capacity building of its staff to ensure they have the necessary skills and knowledge to effectively implement and adhere to open science practices. This can include attending workshops, seminars, and online resources to promote a culture of open science within the organisation.

III.   **Collaboration and Partnerships**: Encourage collaboration across the research ecosystem (institutions, funding agencies, and governmental organisations) to share resources, best practices, and infrastructure for sustaining open science initiatives.

IV.   **Diversification of Funding Sources**: Explore various funding sources, which include institutional, national and international; to diversify its funding streams for sustaining open science practices.

V.   **Continuous Evaluation and Improvement**: promote regular evaluation of the effectiveness and impact of its Open Science Policy through performance metrics, feedback from stakeholders, and comprehensive assessments and make necessary adjustments and improvements to its policy to ensure its long-term sustainability and relevance based on the evaluation outcomes.

VI.   **Infrastructure Development and Maintenance**: Encourage continued investment in the development and maintenance of robust infrastructures (Research Repositories) to support the storage, sharing, and dissemination of research data and outputs. Similarly, regular maintenance and updates of these infrastructures will be essential to ensure their long-term sustainability and efficiency.

Dispute Resolution

Any disputes arising out of this policy will be resolved by mediation or arbitration, as agreed by the parties involved.

Policy Review

An evidenced-based review of the policy implementation will take place five years following its adoption and subsequent reviews will take place on a biennial basis.

ANNEXES

Annex 1: Implementation Plan for the National Open Science Policy

Priority Area 1: Enabling policy environment for open science			
Policy Statement: The Policy will put in place an enabling policy environment for open science, including legislative initiatives where appropriate			
OBJECTIVE	**STRATEGY**	**RESPONSIBILITY**	**TIMEFRAME**
Priority Area 2: Open science infrastructures and services			
Policy Statement: The Policy will set up and strengthen open science infrastructures and services			
OBJECTIVE	**STRATEGY**	**RESPONSIBILITY**	**TIMEFRAME**
Priority Area 3: Human resources and capacity building for open science			
Policy Statement: The Policy will ensure investments in human resources and capacity building for open science			
OBJECTIVE	**STRATEGY**	**RESPONSIBILITY**	**TIMEFRAME**
Priority Area 4: Fostering a culture of open science and aligning incentives and rewards for open science			
Policy Statement: The Policy will reform research assessment and evaluation (at institutional, research projects and individual researchers levels - research and career evaluation and awards systems) to reward and incentivise quality, impact and openness			
OBJECTIVE	**STRATEGY**	**RESPONSIBILITY**	**TIMEFRAME**

Annex 2: Monitoring and Evaluation Framework

Priority Area 1: Enabling policy environment for open science						
Outcome: Enabling legal, policy and regulatory environments at national and institutional levels, and embedded open science practices across research activities						
Objectives	**Output (s)**	**Performance Indicator(s)**	**Baseline**	**Target**	**Source (s) of Verification**	**Assumptions/Risks**
Priority Area 2: Open science infrastructures and services						
Outcome: Open science infrastructures and services are set up and strengthened						
Objectives	**Output (s)**	**Performance Indicator(s)**	**Baseline**	**Target**	**Source (s) of Verification**	**Assumptions/Risks**
Priority Area 3: Human resources and capacity building for open science						
Outcome: The availability of human resources for open science is ensured through capacity building, including researcher training						
Objectives	**Output (s)**	**Performance Indicator(s)**	**Baseline**	**Target**	**Source (s) of Verification**	**Assumptions/Risks**
Priority Area 4: Fostering a culture of open science and aligning incentives and rewards for open science						
Outcome: Research assessment is reformed to reward and incentivise quality, impact and openness						
Objectives	**Output (s)**	**Performance Indicator(s)**	**Baseline**	**Target**	**Source (s) of Verification**	**Assumptions/Risks**

Annex 3: Costing Summary