

The Intersections Between Open Science and Intellectual Property Rights: Implications for Research Dissemination in African Universities

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Abstract

While Africa has increasing interest in the internet and 4th industrial revolution technologies, it has minimal participation in the creation of scientific knowledge when compared to the Global North. Open science (OS) is a pivotal global response to achieving the Sustainable Development Goals (SDGs), as it is primarily focused on hastening the pace of scientific discovery and creating a culture of accountability to escalate public trust in science. In Africa, the implementation of the OS movement has been very slow due to, among others, poorly defined intellectual property right (IPR) frameworks governing research teams. However, very few studies comprehensively address the co-existence of OS and IPRs, even at a global scale. This article explores literature on OS in Africa, the relationship between OS and IPRs, and the implications for research dissemination in universities in Africa. The OS movement has the potential to impact Africa positively, but incompatibilities may arise between IPR and OS if the IPR frameworks are not properly defined as an essential tool to regulate OS. Fundamental premises should guide the value of an OS environment in African universities, such as affordable and easy sharing of, and access to, data, and engagement with all societal stakeholders to increase both effectiveness and sociopolitical validity. Universities in Africa must develop flexible models of science dissemination to transform the way of doing science and challenge old regulations, including the traditional IPR system.

Keywords: open science; open research; intellectual property (IP); intellectual property rights (IPRs); Africa; universities; research dissemination



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Introduction

The United Nations (UN) Sustainable Development Goals (SDGs) address many challenges faced by nations. The solutions to these challenges can be found through the sharing of scientific articles, data, and science educational resources. Open science (OS) is a movement that promotes sharing and communication of all aspects of research design, methods, and outputs, and aims at reducing obstacles to tools, data, and knowledge. OS is primarily focused on hastening the pace of scientific discovery and creating a culture of accountability to escalate public trust in science, increase the value and reliability of scientific outputs and efficacy, and stimulate discovery and innovation (Heuritsch 2020; Nosek et al. 2015; Nuechterlein et al. 2023; Okafor et al. 2022). Through OS, many of the fundamental issues that society continues to face may be addressed at a global scale. The International Science Council ([ISC] 2020) defined OS as “[s]cience that is open to scrutiny and challenge, and to the knowledge needs and interests of wider publics.” Mwelwa et al. (2020) expounded that OS makes accessible and free to all the record of science and its evolving stock of knowledge, ideas, and possibilities. OS overcomes the barriers of geography, gender, ethnicity, or socio-economic condition. Through OS, the data and evidence of science are made accessible and re-usable by all, considering that safety, security, and privacy are put in place. OS is open to engagement with other societal actors in the common pursuit of new knowledge, and supports people in attaining sustainable and equitable life.

OS, termed the new paradigm for science and knowledge dissemination (Ardil 2007; Kunst and Degkwitz 2018; Smart et al. 2019), is founded on two underlying mechanisms of organising science: openness and connectivity (European Commission 2016). The roots of OS practices employed by research teams at universities are traced back to the Mertonian principles of science: communalism, universalism, disinterestedness, originality, and scepticism (CUDOS norms) (Vicente-Saez, Gustafsson, and Van den Brande 2020). The essential attributes of OS are “open access to the record of science and to the data of science; access to the digital infrastructures that enable widespread engagement and communication; and open engagement between scientists and other societal actors” (ISCI 2020). OS practices also centre on the aspiration for transparent and accessible knowledge shared and developed through collaborative networks that operate in digital platforms, tools, and services for researchers. This facilitates free availability of science, knowledge, and scientific outputs, and also makes the process of knowledge creation more efficient and goal orientated (Tacke 2010). Driving the OS practices is the aspiration for “transparent and accessible knowledge that is shared and developed through collaborative networks” (Vicente-Saez and Martinez-Fuentes 2018).

The principles of OS, which include findable, accessible, interoperable, and reusable (FAIR) digital assets, and open sharing of scientific research outputs, including data, are seen as an anchor to solving health, developmental, educational, and social problems in a more coordinated way (Abebe et al. 2021; Chiware and Skelly 2022; Mwelwa et al.

2020; UNESCO 2021). OS, as an inclusive science, potentially closes the science, technology, and innovation divide between and within nations (Okafor et al. 2022). A report by UNESCO (2021) outlined twelve elements of OS: open data, open infrastructure, open access (OA), open hardware, open laboratories, open-source, open innovation, open notebook, open evaluation, open educational resources (OERs), crowd funding, and citizen science. According to the United Nations Educational, Scientific and Cultural Organisation ([UNESCO] 2021) and Chiware and Skelly (2022), OS policy and practice are a pivotal global response to achieving the SDGs, especially among poorer countries in Africa, Latin America, and Asia. UNESCO (2021) provided a set of recommendations for:

an international framework for OS policy and practice that recognizes disciplinary and regional differences in OS perspectives, takes into account academic freedom, gender-transformative approaches and the specific challenges of scientists and other OS actors in different countries and in particular in developing countries, and contributes to reducing the digital, technological and knowledge divides existing between and within countries.

UNESCO (2021) further suggested that these elements should work in synergy to realise a more effective and scalable OS system.

According to Okafor et al. (2022), there are many other benefits of OS, for example: promoting networking and collaboration among researchers, between researchers and funders, or with other stakeholders; permitting the sharing and transferring of knowledge and scientific data into meaningful information to the general public by giving access to the software and the datasets; contributing to the visibility of research and in turn leading to greater impact of the research on the scientific community or society at large; and innovating and commercialising research protocols and outputs. In addition, McKiernan et al. (2016) noted that data gathered through OA are useful for reproducibility and reusability of research.

This article sought to establish the availability of literature on OS in Africa, determine the relationship between OS and IPRs, and establish the implications of OS for research dissemination in universities in Africa. We reviewed literature to provide an overview of OS in Africa and its co-existence with IPR, and evaluated the state of knowledge on the topic, to create a research agenda for universities in Africa.

Open Science Landscape in Africa

Although Africa has increasing interest in the internet and 4th industrial revolution (4IR) technologies, it has minimal participation in the creation of scientific knowledge when compared to the global north (Kende 2017; Mwelwa et al. 2020). Studies indicate that Africa contributes very little (0.74%) to global scientific knowledge and global knowledge production (ASSAf 2019; Fonn et al. 2018; Mwelwa et al. 2020). While there are 18 OA policies from Africa registered in the Registry of Open Access

Repository Policies and Mandates, Africa still harbours a lack of functional policies and policy-making bodies on OS in areas of funding, research data management, IP, and copyright (Mwelwa et al. 2020; Okafor et al. 2022). There is very little visibility of African scientific research outputs on the internet due to poor representation in indexing systems such as Scopus and the Web of Science. This has resulted in African-published research papers being under-utilised, under-valued, and under-cited in the African and international research arenas.

The low visibility of African scientific research could also be attributed to limited intra-African scientific collaborations and data sharing, as well as intra-regional trade (18%) (Mwelwa et al. 2020), with more collaborations taking place with countries on other continents. The lack of synergies among African science systems, largely operating independently, is a barrier to achieving openness in scientific research and results in the creation of silos of incompatible policies, practices, and inconsistent data sets that are not interoperable (Mwelwa et al. 2020). In a digital driven environment, African countries need to exploit digital technology and forge more meaningful economic partnerships among themselves. “Africa should move on from a world in which maintaining exclusive access to data that individuals and groups have created has been a key to scientific discovery and its application, to one where data access is the priority. One can either hoard little or access a lot. The former is an island—the latter is an ocean” (Boulton et al. 2020). Boulton et al. (2020) recommended that science systems in Africa strive towards the provision of IT infrastructure, policies, incentives, methods, and standards for data sharing, policing of ethical standards, and systems and software needed by high-level analytic and artificial intelligence procedures. This would ensure success in adapting their working practices to the OS movement.

Although many peer-reviewed scholarly journals from Africa are accessible online, publishing resource limitations and the digital divide lead to a failure to host their content online and to create scalable collaborations that could impact African communities. Access challenges to African scientific research outputs are also accentuated by the wide divergence of capability and digital infrastructures and generally weak scientific systems that operate in isolation in African countries. Boulton et al. (2020) expounded that the OS movement gives Africa the capacity to exploit opportunities that could drive innovation and development on the continent. The OS movement creates an opportunity for deep African engagement that could provide evidence-based solutions for the sustainable development goals advocated in the United Nations SDGs and the African Union’s Agenda 2063. Studies of Africa’s open science landscape expose scarce and inadequate data management capacities that hamper attempts made to offer evidence-based policy solutions and implementations for the development of African countries (Mwelwa et al. 2020).

The implementation of the OS movement in Africa has been very slow and very few countries have fully institutionalised OS, while many seem to be hesitant in adopting this movement (Mwelwa et al. 2020; Okafor et al. 2022). OS adoption also varies

between English and French-speaking African countries, with English-speaking countries becoming involved in OS comparatively quicker (Ahinon and Havemann 2018). Many OS systems have been established in Africa or for African researchers, through initiatives such as the Open Science in Haiti and Francophone Africa (SOHA) project, African Open Science Platform (AOSP), Africa Open Science and Hardware (AfricaOSH), ratification of the Africa Continental Free Trade Area Agreement, Africa Open Science Platform (AOSP), DataFirst, OA for Africa, and Library Support for Embedded NREN (national research and education networks) Services and E-infrastructure (LIBSENSE). According to Chiware and Skelly (2022), international library and information service organisations have been at the forefront of assisting African institutions to engage in OS policy development. The Electronic Information for Libraries (EIFL) partnered with library consortia in many African countries, and launched projects to boost OA and OS policy development and to improve repositories and training. Embracing these OS initiatives, the UNESCO recommendations, and emerging research on the critical role of OS principles unveil many opportunities for African institutions and governments to develop research infrastructures and supporting, responsive, and coordinated policy frameworks at institutional and national levels (Chiware and Skelly 2022; Mwelwa et al. 2020). According to Boulton et al. (2020), the impact of the OS revolution on research and innovation has the potential to leave Africa with no alternatives but to respond to its challenges. OS in Africa could lead to stronger national science systems that would improve support for the public and private sectors as well as the general public.

Although the OS movement has the potential to impact Africa in a positive way, there are some in the African scientific community who are reluctant to embrace it because of philosophical arguments for the development of local knowledge and priorities. Levin and Leonelli (2016) stressed that “[o]penness is not only a technical problem to be solved but is also a social, cultural, and moral issue.” Echoing similar sentiments, Mwelwa et al. (2020) noted that it is relatively easy to articulate OS, but much more difficult to realise in practice. The fear is that, if OS continues to be dictated from the North, Africa may fail to identify research problems and deploy methodological and epistemological choices adequate to serve the needs of the African societies. Hindrance to OS in Africa is also caused by a lack of awareness among African researchers, unfamiliarity with the movement and/or its ramifications, lack of the requisite skills that enable the practice of OS, reluctance to practice it due to the lack of incentives for OS practices, low motivation, and less recognition given to OS practitioners in Africa (Allen and Mehler 2019; McKiernan et al. 2016; Mwelwa et al. 2020; Okafor et al. 2022; Teferra and Altbach 2004).

Other challenges of OS in Africa include inadequate funding, internet access, science infrastructure, leadership, policy development, and monitoring and evaluation. Barriers to OS in Africa, include levels of restriction in research flexibility, time cost, poor or non-existent incentive structure, and language barriers (Abebe et al. 2021; Allen and Mehler 2019; Chiware and Skelly 2022; Mwelwa et al. 2020). The uniqueness of the

African landscape and its existing challenges indicate that addressing these issues will continue to be a big part of African participation in OS and open data global projects. OS systems should not be limited to solving technical problems and infrastructure development; instead, they should be used to solve broader societal problems (Chiware and Skelly 2022). To solve these problems, two fundamental premises should guide the value of an OS environment in Africa (Mwelwa et al. 2020). First, access to scientific data should be affordable and easy, and second, the engagement of OS with society, business, policymakers, governments, communities, and citizens as knowledge partners should increase both effectiveness and sociopolitical legitimacy.

Open Science and Intellectual Property Rights

IPRs, which comprise industrial property rights, such as inventions, industrial designs, and trademarks, as well as copyright and related rights, play a major role in the development and advancement of nations in the knowledge economy (World Intellectual Property Organisation [WIPO] 2020, 2). IPRs are rights to a wide range of intangible assets that include patents, copyrights, trademarks, and trade secrets collectively referred to as intellectual property (IP). WIPO (2012, 14) defined IP as “the commercial application of imaginative thought to solving technical or artistic challenges.” Further emphasis was put on IP’s nature of not being the product itself but the special idea behind it, the way the idea is expressed, and the distinctive way it is named and described. IP refers to creations of the mind: inventions, literary and artistic works, and symbols, names, and images used in commerce (WIPO 2020, 2). WIPO (2004, 3) explained that IP is traditionally divided into two branches, “industrial property” and “copyright.” Industrial property comprises inventions and industrial designs, while copyright covers literary, artistic, and scientific works. WIPO (2013, 7) elaborated that IP refers to the intangible assets or the “hidden value” of an enterprise. The promotion and protection of IP through IPRs assign value to knowledge, spur economic growth, create new jobs and industries, and enhance the quality and enjoyment of life.

Very few studies, documents, reports, and specific scientific works directly and comprehensively address the co-existence of OS and IPRs (European Commission 2022). Although the IP system aims at balancing between the interests of innovators and the public, many scholars seem to believe that there is conflict between IP and OS. Some authors, stakeholders, and reports identify IPRs as one of the obstacles to OS. There are two opposing views on how IP protection interacts with innovation and creativity. One view is that IP protection is an incentive for innovation and creativity, while the other view is that IP protection is an impediment to the free and open exchanges of technology, culture, and knowledge (De Beer et al. 2014). The argument on one hand is that OS fosters co-operative work and new ways of knowledge distribution by promoting effective, early, and broad data sharing, and a dynamic exchange of research outcomes not limited to publications. Conversely, IPRs seek to give value and protect knowledge from exploitation. The European Commission (2022) noted that OS is

supported by the fundamental right to science, while IPRs protect the rights of the creators. The All European Academies (ALLEA 2022) statement on aligning IPRs with OS referred to these opposing positions as ideologies that presently dominate global discussions on research policy. The statement expounded that while the OS movement views knowledge generated through research as a global common good of humanity to be shared as openly and as rapidly as possible, the desire to use research as a driver of innovation and economic growth views knowledge as IP to be given value and protection.

Authors such as Hess and Ostrom (2007) and Unger (2019) concluded that the concept of IP ownership is not relevant in the digital age, but that the different possibilities attached to the possession of, or access to, digital information are crucial. In the OS paradigm, an old tradition, i.e., the willingness of scientists and scholars to publish the fruits of their research in scholarly journals without payment, and a new technology, the internet, have converged to make possible an unprecedented public good. A European Commission (2022) study revealed that IPR issues were not addressed as a key element in reviewing the establishment of a new OS paradigm. It also appeared that the research and innovation community did not view better IPR management as promoting innovation. However, the European Commission (2022), in its new IP policy, clarified the crucial role of IP for the Union's growth and the need for more studies on the cross-section of IP and OS. The report explicated that since approximately 2015, studies on IPR in scientific outcomes have attracted interest, and open data issues have raised different IP issues, such as copyright, ownership, and data protection and privacy.

The first position, that of viewing knowledge generated through research as a global common good of humanity to be shared as openly and as rapidly as possible, is supported by statements such as “promote science as a global and borderless public good” (ALLEA 2022), and “advance science as a global public good” (ISC 2020). The second position, that of viewing knowledge as IP to be given value and protected, is not openly expressed as a value system, but is visible in much of the political discourse about research (ALLEA 2022). A normative approach to copyright, a branch of IP, could assist in understanding that IPRs support the view that science has to communicate its results to the public. Copyright law grants authors two different sets of rights: moral and economic. The economic rights come with a list of exceptions or limitations (to copy, alter, distribute, or communicate to the public). As such it is within the confines of IP to reproduce, adapt, distribute, or communicate scientific works to the public. Another reason for making science public is to enable its falsifiability. However, IPRs reserve these rights (to copy, alter, distribute, or communicate to the public) exclusively to the IP owner; as a result, public dissemination to allow public scrutiny of science is impeded (European Commission 2022). The presumption is that there is some tension between OS and IP.

The tension between OS and IPRs arises in the right to commercial exploitation and protection of IP. Vicente-Saez, Gustafsson, and Van den Brande (2020) lamented that

open innovation policies restrict IPRs in science projects through strict consortia agreements. Citing the example of patents, ALLEA (2022) explained that OS envisages the rapid, early, and full publication of research outputs, yet the requirement to apply for patent rights and protect IP obstruct such activities. The need in patent law to avoid public disclosure of ideas prior to making a patent application runs counter to the OS philosophy of publishing more and earlier in the research process. It encourages waiting until the research is complete and any possibility of commercial exploitation has been identified and protected (ALLEA 2022; Heller and Eisenberg 1998; Rai and Eisenberg 2003; Reichman and Uhler 2003; Rhoten and Powell 2007). The problem is how to publish open access while also protecting the IPRs, that is, protecting IPRs in a way that reflects the values of OS. In the OS paradigm, publication is supposed to be moved upstream in the research process and broadened to include not just final reports but intermediate data products, protocols, software tools, etc. In OS, researchers move from publishing as early as possible to sharing research data. This implies protecting IPRs at early stages of research, which many presume may thwart the circulation of scientific knowledge and increase the social costs of innovation.

Although many scientists support the OS agenda in principle, they are often resistant in practice. They raise many concerns pertaining to OS, which entails the sharing of research resources, including materials or data. According to Mwelwa et al. (2020), there is little trust in the OS approach among researchers and innovators in Zambia. Of concern are issues regarded as important for career progression, such as ownership of results, the IP that might arise from technological developments, and the importance of publications and prime authorship. Fears are that diverse forms of exploitation and inequitable practices may arise, disadvantaging under-resourced scholars and individuals, and under-developed countries and institutions. Cited challenges include loss of control and ownership of shared methods, data or codes, and engendered professional vulnerability or equity (Ewuoso et al. 2022; Munung, Mayosi, and De Vries 2017). Loss of control is the main reason why many scientists are reluctant to share research data, because having control enables them to prevent exploitation and misuse. The fear of engendered professional vulnerability or loss of equity (Bezuidenhout 2019; Bull et al. 2015; Ewuoso et al. 2022; Munung, Mayosi, and De Vries 2017) emanates from the view that researchers will not be adequately acknowledged, rewarded, or credited for the resources they share, and the efforts they put into generating and editing research data and resources. The concern is that researchers in high-income countries may quickly scoop the shared methods and data to publish more articles before primary data collectors have had the time to publish.

The presumption that there is some tension between OS and IP can be falsified by viewing this relationship more thoroughly. There are no incompatibilities between IPR and OS. According to Förstner et al. (2011), the European Commission (2016), and Heck et al. (2020), the OS movement suggests openness in all phases of the research lifecycle and considers the use of new technologies in areas like content access, shared ideas, and collaboration. What is required is to properly define the IPRs framework so

that it becomes an essential tool for regulating OS (Barbarossa, Grande, and Triaille 2017). According to ALLEA (2022), giving value to research output through IPRs is a more utilitarian view of research compared to OS, which is an idealistic view of research output as a public good. In modern market economies, the transfer of knowledge between the public and private spheres is indispensable, but needs to be better implemented amid the OS movement. As such, the two positions can be aligned, as observed in the copyright and the Creative Commons (CC). A similar approach can be applied to the other branches of IP, such as patents, to better reflect the public good aspects of open knowledge.

Implications for African Universities and Research Dissemination

While there may be no tensions between IPR and OS, incompatibilities may arise if the IPR framework is not properly defined as an essential tool to regulate OS. Many research grants have a contractual obligation that treats IP as knowledge to be valorised and protected. However, there is a need to justify the restriction of IPRs, especially where research has been publicly funded and is carried out in public institutions. Valorising knowledge or restricting IPRs in such situations raises questions on how an act of enclosure on the intellectual commons is justified, or whether it is merely a case of socialising the risks and privatising the profits (ALLEA 2022).

The OS movement spreads further to unravel debate on research behaviour, such as open peer review, open grant writing, and open evaluation. Manco (2022) elucidated that OS also has negative facets such as threats, conflicts, and contradictions. A contradiction identified by Levin and Leonelli (2016) is that open science policies are generally formulated in a general way with general principles mostly revolving around economic value and data commodification, without carefully considering particular differences in individuals, contexts, or social processes. In addition, Elliott and Resnik (2019) stated that OS policies can create irregularities when they force academic scientists to share their data, yet allowing industry scientists not to share.

African universities and research institutions face a lot of challenges in the OS environment. Many researchers, institutions, governments, and international funders are unsettled by OS because they have become comfortable in the habits of conducting science and handling data from the traditional scientific process (Mwelwa et al. 2020). As a result, OS is “either misconstrued, neglected, or not yet institutionalised” (Krishna 2020). There is also the challenge of a lack of data science and software engineering skills, which affects the rest of the world (Mwelwa et al. 2020). Africa has not been able to train and produce enough data analysts, data scientists, and other support staff required to effectively acquire and process large data sets to identify patterns, establish relationships, and solve problems, thus widening the skills gap with much of the rest of the world (Mwelwa et al 2020; Okafor et al. 2022). In addition, there is failure to optimise the use of resources, a lack of collaborative training among institutions, and

African students only learn of data science during tertiary level education (Mwelwa, Smith, and Molutsi 2018).

OS can bring about intra-African collaboration; however, according to Mwelwa et al (2020), certain metrics (research income, numbers of citations, publication in so-called “high-impact” journals, prizes, and the academic league tables) have become barriers to change by concentrating on the performance of the university team rather than the wider scientific group of which the university team or individual may be a member. Some scholars are concerned about the impact of participation in OS on their career paths, because many African scientists have been reduced to data collectors and laboratory technicians, without advancing their career paths in developing as research leaders. There is the assumption that well-resourced researchers doing secondary (replication) research would exploit or side-line researchers from poor backgrounds by taking the methods and data they share in open networks and databases, an approach referred to as helicopter science (Bull et al. 2015; Ewuoso et al. 2022). The belief is that there are power dynamics that make researchers from the Global South suffer while Western collaborators benefit, resulting in asymmetric benefits of N-S collaboration. Munung, Mayosi, and De Vries (2017), Levin and Leonelli (2016), Mwelwa et al. (2020), Abebe et al. (2021), and May (2021) elaborated how researchers from the Global South are often reduced to information gatherers for their Western counterparts or interests, resulting in data migration from Africa and the loss of IP, including from indigenous sources.

The perception is that openness is a way of trying to exploit researchers and research institutions in developing and under-resourced countries by the powerful and better resourced institutions and researchers. As a result, when African universities approve of OS, they will be contributing academic resources to the Global North. The key challenge for universities is the lack of adequate governance structures to protect OS participants from poorly resourced institutions, and underdeveloped and developing countries. Vicente-Saez, Gustafsson, and Van den Brande (2020) carried out a study on emergent principles and practices of OS and innovation of university research teams in a digital world. Their findings indicated that IP laws governing research teams (university regulation and/or national/EU laws), lack of incentives for research career development, lack of standards (regarding data governance, infrastructure, practices, publishing protocols, skills, and technical support), misconceptions of what open science entails, and confusing publishing practices have prevented the adoption of open science practices.

Universities in Africa can benefit a lot by exploiting OS and innovation practices. Learning and creation of new knowledge can be improved, and research and innovation can be hastened. The development of highly innovative and entrepreneurial people can be supported, boosting university collaboration with companies and research organisations leading to groundbreaking open innovation practices in universities (Vicente-Saez, Gustafsson, and Van den Brande 2020). There is a need for Africa to

influence the agenda and ensure that collaborations support the career development of African scientists. Mwelwa et al. (2020) and Chiware and Skelly (2022) suggested that, while OS is being promoted as the best avenue to share and drive scientific discoveries, African governments and universities need to build research infrastructures and develop national OS policy frameworks that are responsive to the OS movement.

The key principles to guide the OS policy development in Africa include open access, open data, citizenship science, collaboration, and stakeholder and community engagements. These fundamental principles would augment the realisation of the end goals of openness, integrity, and FAIR data sharing within the African and global research systems. The European Commission (2022) suggested the need to construct a different paradigm for scientific knowledge production, communication and valorisation, aligned to current technological possibilities and societal needs. The European Commission (2022) further outlined eight components of OS: the future of scholarly communication; findable, accessible, interoperable, and reusable (FAIR) data; the European Open Science Cloud; next-generation metrics; rewards and incentives; skills in open science (open education); citizen science; and research integrity. These components affect issues surrounding IPR and have to be implemented carefully if they are to succeed.

Universities are among the major players in the OS and innovation practices and as such, need to have adequate awareness and understanding of IP as an enabler instead of a hindrance to OS. There is still limited awareness of the role that IPRs play in valorising research results and on how IP is used. Nuechterlein et al. (2023) identified knowledge gaps related to IPRs among researchers who sought clarity regarding the appropriateness of patenting in certain contexts, preferred avenues for pursuing patents, and the patent law system more broadly. There were concerns about OS exposing the potential conflicts between work that is already ongoing and a potentially new mandate associated with OS. Most researchers struggle to balance the perceived tension between OS and IPRs because universities are requested to make scientific knowledge openly available, accessible, and reusable for everyone, yet also be more entrepreneurial and contribute to innovation and economic growth (managing IPRs). Nuechterlein et al. (2023) lamented that collaborations between researchers and government agencies, private funders, and other research groups and departments may be complicated and even jeopardised by an OS policy, if not properly implemented.

According to Rhoten and Powell (2007), OS denotes a fundamental change in the institutional norms and logics of university science as it consequently calls for universities to be more entrepreneurial and contribute to innovation and economic growth. There is a shift away from discovery-orientated research and toward market-driven applications. This has raised debates about the extent of the influence of policy initiatives and technological innovation. As a result, the OS principles emanating from Merton's norms of CUDOS are not embraced as the guiding principles in market-driven contexts. Fini, Lacetera, and Shane (2010) and Van Dongen et al. (2017) expounded

that universities have to rethink issues of patenting and IP ownership as these are no longer a prerequisite to contribute to higher levels of research exploitation, neither are they the optimal mode for research commercialisation. What is going to work in the OS era, where scientists work in collaboration with companies, are university policies that include transparent guidelines on IP ownership and publication freedom.

The OS movement necessitates a reconsideration of the key principles that guide research (Blasimme et al. 2018; Ewuoso et al. 2022). Key issues arising within the OS era include the feasibility of sharing the data without violating the permission granted by the participants before participating in research. For example, in data collection, a researcher must obtain informed consent from the research subjects prior to collecting and using personal data. There is a need to revisit the principles and policies regarding consent and privacy that are suitable for OS to ensure the feasibility of sharing and reusing of data in an OS environment. Stodden (2010), Ali-Khan, Harris, and Gold (2017), and Manco (2022) suggested the adoption of policy countermeasures related to citizen scientists to increase their contributions and changes to data and code reuse so that OS does not impose an additional burden on researchers but makes sharing easy. They also recommended the building of structures that enhance the competitiveness of researchers, research plans, and partnerships with research participants and industry. The OS era requires universities to construct appropriately designed internal policies that correspond with the values, desires, and ethics priorities of their communities of interest, as there is likely no one-size-fits-all approach to OS (Nuechterlein et al. 2023).

Conclusions and Recommendations

The OS movement has the potential to provide a global approach to achieving the Sustainable Development Goals (SDGs), especially among poorer countries, including those in Africa. Through OS, the data and evidence of science are made accessible and re-usable by all, considering that safety, security, and privacy are put in place. OS practices should be promoted to increase the circulation and exploitation of knowledge while adjusting to and respecting the limits of IP and national security rights of countries. OS concerns address mainly potential changes in research practices and the need for more infrastructure beyond existing platforms. Fundamental premises should guide the value of an OS environment in Africa, such as affordable and easy data sharing, and access to scientific data. The engagement of OS with society, business, policymakers, governments, communities, and citizens as knowledge partners should increase both effectiveness and sociopolitical legitimacy. It is imperative to balance openness with culturally respectful and collaborative practices, as well as appropriate infrastructure and guidance for OS to be the route that is most expeditious and beneficial for society.

Although the IP system aims to balance the interests of innovators and the public, many scholars seem to believe that there is conflict between IP and OS. This presumption can be falsified by properly defining the IPRs framework so that it becomes an essential tool

for regulating OS. There is also a need to constantly upgrade IPR standards and regimes to keep up with rapid technological developments, the new requirements of science, and modern scientific communication needs and facilities. Advancing OS in African universities requires partnerships and collaborations between stakeholders, including government, academic and research institutions, research funders, researchers, and end users of the research outputs. Universities need to develop well-managed, integrated, digital services and open, sharing practices through OS platforms that serve a broad community. If universities in Africa open up research processes and science, they would transform the way of conducting science and challenging old regulations, including the traditional IPR system. The co-existence of IPRs and OS reflects the need for flexible models of science dissemination within universities in Africa.

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