Knowledge Sharing in the Networked Society: Impacts and Policy Implications for Sustainable Development

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Abstract

The paper based on research under the programme on Strengthening Evidence-based Policy Works at Institute of Development Studies (IDS), examines the challenges to global goals for the equality and governance posed by control of Knowledge and ICT. It discusses the issue of knowledge sharing and its potential impact on people's lives and how it is likely to contribute to or damage development agendas over the next 15 years. Examines the positive and negative implications that an increasingly digital world hold for achieving global development goals while making a case for greater attention to be paid to these on the part of the international community especially in relation to democratic governance, institutional accountability, responsiveness and transparency. Authors suggest how development practitioners and policymakers might best respond.

1. Introduction

Digital technologies are changing our relationship with information and how we understand and interpret the world. New tools that are already so common we barely notice them - ranging from social media to big data and online resources - are changing how we create, distribute and consume knowledge. Many of these changes have profound, far-reaching implications not only in terms of scale, access and availability of knowledge, but also for our relationship to that knowledge: our notions of what knowledge matters the most, where it comes from, how we know what to trust, and our own roles in creating and engaging with it.

Access to the Internet continues to reach more and more people, spreading to increasingly remote areas. Growing connectivity is bringing information and new opportunities to many of the world's poorer and marginalised people, and there is much cause for optimism that this trend will continue into the future. This study in the context of sustainable development, discusses how digital technologies stand to change knowledge production and use in developing countries.

Africa, and in particular sub-Saharan Africa, is taken as the sample region to contextualise this study. The study also concentrates on a set of technologies and tools that are most likely to affect poor people, or will influence the work of researchers, practitioners and policymakers in an African development setting. Social media and crowdsourcing, for example, hold the potential for more participatory methods of creating knowledge

and for setting research agendas. Likewise, digital repositories or similar platforms for knowledge sharing hold the potential to disrupt the current flow of development knowledge that is overwhelmingly from the 'developed' to the 'developing'. On the user side, digital discovery tools, for example, can enable practitioners; policymakers and citizens to more easily discover the information and evidence that is most relevant to their needs. We are aware that the subject 'digital technologies and development' can be defined much more broadly - big data, internet of things, drones, wearable tech - but we have tried to limit our scope to roles and affordances of technologies that are most relevant to the knowledge economy. Thus our focus is on knowledge sharing and digital infrastructure, and how knowledge is discovered and sourced, which has led us also to think about the roles of social media and crowdsourcing.

How will digital technology affect those roles of curation, intermediation, gatekeeping and guiding, which have until recently been the preserve of librarians, knowledge managers, publishers and universities, and what will this mean for development actors?

Research Question

This research was designed as a horizon-scanning exercise to anticipate the possible directions that digital technologies might take us in the next 15 years. The questions addressed were what are the implications of digital technologies for sustainable development? What kinds of decisions and actions are needed now from policymakers and practitioners to create a positive digital landscape for development?

Methodology

The data for this research comes from secondary literature, interviews and two workshops with academics, practitioners and decision-makers. 'Foresight' methods and facilitation tools were used look at the different ways that digital technologies might affect developing countries and development efforts. Interviews were conducted with 12 actors in the fields of ICTs, library science, digital technologies and development, selected considering their background and expertise in digital technologies and development, whom changes in the digital landscape would affect. Interviews were intended to elicit responses on the social, technological, environmental, economic and political aspects of respondents' visions of the future, focusing on digital repositories, access, search and discovery. Two workshops were held - one in UK and the other in South Africa - to develop scenarios and related policy implications. Participants came from a range of backgrounds, including researchers, ICT and development practitioners, and policymakers, representing different sectors that stand to be affected by a changing digital landscape. In South Africa authors tried to ensure a group of participants that could help contextualise our discussions in an African development setting.

2. Knowledge Sharing and Development

Half a century ago, Kenneth Goldstein wrote about the world of tomorrow, and looking 100 years into the future, he speculated that: 'No one will use real money any more. ... through special electronic walls of their houses, which are huge television sets, the people are 'plugged in' to all the world and other parts of the solar system.... libraries, museums…'(Goldstein 1969). The pace of change is getting ever faster as we come to terms with sensor technology, 3D printing, big data, voice recognition, automatic translation and human augmentation - all of which have huge implications for how knowledge is created and shared.

As we look towards a horizon of 2030, which coincides with the period of the Sustainable Development Goal proposal of United Nations, it is clear that many think we are on the threshold of a new and hugely significant era. This proposal does not make significant

reference to the major social and geopolitical trends or the growing humanitarian and security concerns, but limits its scope primarily to the domains of digital technologies that enhance knowledge creation and sharing. It is, however, important to note the global implications of the Internet and ICT infrastructure. For good and for ill, the wired networked nations of the world all share common borders. We now have two hundred reasons to care about the information revolution in developing countries.

Focusing on the technology, we can anticipate a period of major transformation. 'The digital progress we've seen recently is certainly impressive, but it's just an indication of what's to come. It's the dawn of the second machine age. To understand why it's unfolding now, we need to understand the nature of technological progress in the era of digital hardware, software and networks. At the heart of this exponential growth lies Moore's Law, which is one of the most famous forecasts, and has held true for the past 50 years since 1965. The essence of Moore's Law is that digital computing power doubles every year for the price that is paid. Moore's Law is illuminated by reference to the story of a clever man who invented chess and, in reward for this, requested the emperor for a reward of a quantity of rice. One piece was to be placed on the corner of the first square of the chessboard, two pieces on the second, four on the third and so on, doubling on each square. By the time the second half of the board is reached, the numbers of grains has grown exponentially into millions, and into the billions by the end of the board. Needless to say, the emperor, who too readily agreed, felt tricked! (Brynjolfsson and McAfee). In terms of digital capacity, we are now well onto the second half of the board, and in terms of cost and power, our digital capacity is now enormous, and growing ever faster and extending onto an ever-greater range of digital devices. This illustration makes it clear why ICT infrastructure is becoming so powerful and access to it becomes ever more important, as it provides the platform on which many of our future services will run.

Access and connectivity is also spreading rapidly, with mobile technologies in particular making Internet access more widely available within developing countries. 'By 2025, the majority of the world's population will, in one generation, have gone from having virtually no access to unfiltered information, to accessing all of the world's information through a device that fits in the palm of the hand. If the current pace of technological innovation is maintained, most of the projected eight billion people on Earth will be online' (Schmidt and Cohen, 2013). If we are all online by 2025 will we really have access to all the world's information? Will the so-called 'digital divide' have been addressed, or will the reality be that there are many more 'last' or 'first mile' development problems to be addressed? It is clear that today, some countries and people are already experiencing life on the second half of the chessboard, while many others have barely left square one. Schmidt and Cohen acknowledge the uncertainties that widening access brings, while also seeing the huge potential good.

Advances in ICT are making it easier for people to organise themselves and press for change. However, 'the notion that we are in an information and knowledge economy is absolutely misleading'. Despite the fact that 98 per cent of the information on the planet is now digital, the human mind remains more important than technology per se. Technology gives us new possibilities for effectively processing information: 'That's what the technological revolution means. Not just that there is information, but that information can be recombined, developed, accessed and utilised on a global scale' (Castells, 2015).

Emerging Trends in Technologies

In future, the majority of digital-based communication is likely to be a mix of people-to-people, people-to-device, and device-to-device (e.g. driverless cars talking to each other), perhaps with most communication falling into the latter category. This increasingly complex web of 'interconnectivity' has been termed the 'internet of things'. By 2020 it is thought that 50 billion to 100 billion devices will be connected to the Internet. However, while many people in developing countries will have access to Internet-capable devices, securing access to the information is still a problem due to prohibitive tariffs and technological barriers. Unless this is addressed - i.e. via competition to try and lower tariffs - access will remain low. It is therefore important to note the difference between having a device and making it useful in terms of accessing information. So making a distinction between access and use of the Internet clarifies the goal of policies aimed at closing the digital divide' (Stork, Et al. 2012).

The big drivers for connectivity and quality of access are bandwidth and harmonisation of the radio spectrum. The greater the bandwidth, the faster our connections can potentially become, although this is always offset by increase in user 'traffic' i.e. the growing amount of data passing across the networks. The way mobile phone infrastructure has been developing, through four generations and with a fifth on the horizon (1G-5G) illustrates how the nature and use of connectivity develops significantly as bandwidth increases.

An US Government report identifies three technology developments that are seen as having a particular significance for the way 'we live, do business and protect ourselves - solutions for storage and processing large quantities of data', 'social networking technologies', and 'smart cities' encompassing a host of urban technologies enabled by enhanced and secure IT systems (US, 2012). Social networks, the Internet of things, big data, automation of knowledge work, and cloud computing will have significant implications for knowledge creation and sharing (Hoorens Et al, 2013). The Report of UK Government Office for Science identifies 53 individual technologies divided into 28 clusters as particularly important for the 2020s; ambient intelligence in the built environment, desirable sustainability and user-centric design, display technologies, managing and processing of real-time social data, multisensory input and sensing, new computer technologies, robotics and sensor networks and speckled computing stand out as directly or indirectly relevant to knowledge sharing: (UK, 2012). It is beyond the scope of this study to explore those areas.

Looking at the more immediate future, experts highlight the increasing development of mobile applications designed to improve social outcomes and related gender dimensions as girls and women begin to use them effectively to benefit their families and communities. We can also expect applications that make governments more accountable: Early ICT successes that relied on service delivery and civic mapping are creating an appetite among developers and civil society organizations who are increasingly networked internationally to confront power through public information, and practitioners are becoming more sophisticated in their approaches to these questions (The Guardian, 2013). Opening of government data, as discussed later is another area that would enhance accountability. In the other direction, we are likely to see governments increasing their use of data collected from mobile phone usage: ... to focus their efforts to provide better services to the most vulnerable citizens. We will see improved food security and increased agricultural yields, rural education transformed, disease outbreaks detected, and all of this done by sophisticated systems that take advantage of

a basic mobile phone. The emergence of the 'Internet of things' also brings with it the rise of Machine to Machine (M2M) technology and more data being generated, which will require new and innovative business models (Wikipedia, 2014). All of these trends are of clear relevance to the developing country and African context, where mobile technologies are rapidly increasing although, as discussed later in the report, this is not necessarily occurring in an equitable manner.

Metrics and appropriate measurement tools are becoming increasingly important, both to the digital marketing experts and to those who wish to measure impact of knowledge services, behaviors of information consumers and the way data is being used: 'Simple web metrics won't do. This is not about looking for 'last click'. This will be about using all the research resources at our disposal including new ways to analyse digital and social data and understand what our customers actually do over time...' (Bell, 2013).

Information Proliferation

Turning to knowledge, much has been written about knowledge societies and their links to globalisation and economic growth. A major factor in this is the huge proliferation of information - including documents, data, government records, multimedia, and more tacit communication pieces such as blogs - that can be codified and made widely available in digital formats. Over 2.5 quintillion bytes of data are created each day; 90% of the world's stored data was created in the last two years alone' (Pepper and Garrity, 2014)

De Saulles refers to a once-in-a-generation 'technological shift' and notes that changing behaviours are also driving change: 'not only is access to information making the notion of an information society real, but the ability of individuals to create and share information is changing the structures of many industries, in particular the publishing sector. The 'born digital' production model is now

having a major influence as information 'suffers little from rivalry' and the concept is that the 'first copy costs' and then there are little costs involved in producing additional copies (De Saulles, 2012). So data and information are increasingly available in vast quantities, potentially at little cost after initial production. Distribution is becoming much easier, and this promotes access to those who can access the Internet. But the major concern is that 'Knowledge is going to be the new inequality - where does it fit in the Sustainable Development Goals(SDG)?' The other issue that arises is discovering and accessing 'suitable information'.

Knowledge and Open Development

The potential implications of more data, information and knowledge for development are huge, and start with issues around who own knowledge and how it is shared. Experts argue for a new paradigm of open development, which is primarily focused on development goals but with openness, providing: 'an opportunity to achieve those goals in a manner that has never been done before. That is, openness contributes its own logic - a value added to solving problems' (Smith and Reilly, 2013). The landscape in which openness takes place is essentially a networked society, where knowledge - including the tools to use it - is openly licensed and therefore freely shareable. For this to be most effective, a strong ICT infrastructure and digitally literate users and experts are needed. A range of projects is starting up that explore the ways in which open development approaches in knowledge creation and sharing can flourish (Boyera ,2014). These include Open Data for Developing Countries (ODDC), Open and Collaborative Science in Development Network (OSCDNet) and Open Knowledge Hub of Institute of Development Studies (IDS).

Lessons starting to emerge from ODDC project, makes an interesting point about the need for collaborative research processes

which themselves develop the capacity of the intended beneficiaries (Tim Davies 2014). 'In the open data space there is a tendency to move very quickly to discussion of best practice instead of good practice, and there is a real lack of innovation. There is a tendency towards seeing the tool and trying to export it, rather than understanding the process and trying to learn from it in the transfer of ideas' (Interviewee). From these it is clear that we are at a stage where connectivity - via internet and, increasingly, using mobile technology - gives rapidly increasing numbers of people the potential to access a wealth of information, and engage in services supporting knowledge sharing and innovation that are often built on new and disruptive business models. Openness is a key factor in terms of breaking down barriers to content, whatever form that takes, and digital literacy is a key skill both for working online and navigating the knowledge landscape, which is increasingly information and data rich.

Darker Side of Knowledge Sharing

Despite the exciting potential of the open development approach and the growing momentum of the related 'Open Access movement', much information, data and knowledge remains controlled and subject to a model of private ownership and commercial exploitation. The power of the network is becoming ever more important, and 'What we have learned in the past 20-30 years of information networks, is that network effects kick in and the rich get richer, first movers have a big advantage, not only in dissemination of knowledge but in the production of knowledge - you've got much more scope for a privatisation or private control of the digital knowledge ecology'(Interviewee).

There are big questions related to who our knowledge networks serve, whose knowledge is shared and valued, and how knowledge can be truly open and inclusive of poor people, who often lack the means

or 'know-how' to engage in the systems created for them. Yet, if significant efforts are not made to address this, it is hard to see how such systems and related research processes will produce knowledge that is relevant to the real needs and interests of people living in poverty. What the poor want and what we say they need is different. We need to design relevant solutions, in terms of language, format and accessibility for what the poor really want. (Interviewee).

A darker side of the Digital Age, is 'the social and cultural exclusion of large segments of the population of the planet from the global networks that accumulate knowledge, wealth and power' (Castells, 2010). In this context, there is the likelihood of what is termed as 'Balkanisation of the Internet': 'Every society in the world has its own laws, cultural norms and accepted behaviours. As billions of people come online in the next decade, many will discover a newfound independence - in ideas, speech and conversation - that will test these boundaries. (Schmidt and Cohen, 2013). Such a scenario would have a highly influential effect on how our knowledge sharing systems and use of ICT tools develop. Our interviews have identified a range of major concerns related to the Digital Age and our lives online. Unless addressed online fraud and cybercrime, identity theft, no respect for privacy, slander and online bullying, stigmatisation, loss of money, goods, etc., monetisation of free services resulting in exclusion or getting locked in to particular systems, terrorism and security concerns, monopolistic practice and commercial exploitation of open data, and combinations of these factors, which can lead to affected persons taking their lives, suffering depression, etc. will inhibit free and open knowledge sharing. A major concern globally, and particularly for developing countries, derives from increasingly divided societies. 'Such a society would trend toward global homogeneity. It would need policies to preserve and promote diversity'

Knowledge for a task will simply be downloaded when needed. Poor people will just be seen as labor or a market and not as sentient human beings. There will be a central repository with universal access, regularly updated, but where you can get what you need to perform your life's tasks. This is being seen already with privatisation of education systems, the power of social media, and the big search engines wanting all the world's knowledge at their fingertips. As everything is accessible, so we don't now need to remember anything - we just need to know how to search. What is this doing to the human brain? Google searches are not delivering innovative things, but what it thinks you need to know. This takes away your freedom of will'(Interviewee).

Responding to the Threats

The massive growth and widespread diffusion anticipated in IT and connectivity will, present significant challenges for governments and societies, which must find ways to capture the benefits of new ICTs while dealing with the new threats that those technologies present (US, 2012). The response needed is for regulation and governance that relates very clearly to ICT and knowledge system infrastructures. Here, regulation becomes important - a simple model to enable the private sector to do what it can do best - shared infrastructure requirements, but the State needs to also be involved and invest in the interests of the poor and marginalised. I think establishing much better norms in the global system - for even if we are thinking about knowledge sharing systems in Africa, we have to deal on a global level with issues of Internet governance and governance of shared knowledge systems and recognising that things like Wikipedia are becoming part of a global knowledge infrastructure. We need to work on the diversity of those spaces and platforms and find ways to increase their inclusiveness in terms of who's running them' (Interviewee).

Governments, civil society, the media and other knowledge intermediaries have a key role to play in ensuring that the knowledge needed for development is freely shared, and knowledge infrastructures shape our societies in ways that are open and transparent. The range of ways in which governments are interacting with their citizens through e-government applications is increasing, though there is more focus on transactions than participation (ITU, 2014).

Civil society will also have a key role to play in guarding people's access to knowledge and their privacy in the Digital Age, and in helping to build consultative and inclusive regulation. The mainstream media, for example, supported by citizen journalists, will be important. Ideally, the business of journalism will become less extractive and more collaborative (Schmidt and Cohen, 2013).

Digital Knowledge: Trends and Impacts

The Internet has no curriculum, no moral values, and no philosophy. It just brings on the data, railroad cars of it, tons of data. (Sterling, 2002). Against the backdrop of the rapid changes taking place in the Digital Age, we now focus specifically on the trends and impacts related to digital knowledge, and explore new ways of; producing knowledge, curation, its communication, searching and discovering.

Social Knowledge

The Internet has profoundly shaped the dynamics of knowledge creation and dissemination. Fast and easy online publication means that a new scholarly paper is now published roughly every 20 seconds. Over 50 % of these papers are made freely available. Gradually, the Internet has begun to affect not just the amount and the availability of research and knowledge, but its very nature. The first trend to examine in this context is the blurring of 'the age-old distinction between information producers and information consumers' (Rowlands,Et

al. 2008). The proliferation of interactive websites and tools known collectively as 'web 2.0' or the 'social web' has allowed individuals to create, manage and publish their own micro-content. We are now firmly in the age of the 'prosumer' - a term first coined by Alvin Toffler (Toffler, 1980). Another new development is that researchers now have a range of social platforms and networks available to them beyond the traditional academic journal. Joint projects can be developed and updated using wiki platforms, and blog comments can provide instant feedback on research in progress. Papers can be shared, annotated and discussed on services such as E-Lis, Research Gate, Mendeley and Academia.edu.

Digital scholarship incorporates new tools and processes such as 'data visualization, network analysis, text-analytic techniques, GIS/mapping, and data mining (Jain, 2014). Our interviewees hope that this evolution of scholarship will include more voices from Africa and the global South, supported by growing access to social web technologies and open platforms. One interviewee points to the potential for more experiential knowledge sharing across communities of practice, and platforms such as Eldis Communities. Participatory research with poor people, using a range of multimedia, can also be seen in action at www.participate2015.org.

Crowdsourced Knowledge

Crowdsourcing as a concept comes from the business sector, where it was developed as an innovative and efficient way to outsource work to 'ordinary people' rather than using employees or contractors (Calhoun, 2014). As such, it is 'a model capable of aggregating talent, leveraging ingenuity while reducing the costs and time formally needed to solve problems' (Brabham, 2008). Many cultural and scientific endeavors have since used the model successfully, especially in projects involving large-scale digitization, where manual correction of text prepared with

Optical Character Recognition (OCR) programmes is required. These include Project Gutenberg's 'Distributed Proofreaders' initiative, and newspaper archive digitization projects in California, Massachusetts and elsewhere where data tasks are fragmented partly as a means of preventing the general population having access to 'big picture' knowledge while still leveraging their labor.

There is potential for Mass Observation methods to be updated for use in the age of social media - for example, in a global call for observations on development policy issues as they affect 'ordinary people'. The Map Kibera citizen mapping project created the first free and open digital map of the Kibera slum area in Nairobi, Kenya, empowering marginalised youth as well as creating brand new knowledge resources.

Globally, the 'epitome of crowdsourcing' is Wikipedia (Calhoun, 2014). As of December 2015, the English version of Wikipedia includes 5,063,907 articles in 38,336,171 pages and more than 1000 new articles are added daily. But the Wikipedia model raises an issue with crowdsourced knowledge: who is the crowd? As pointed out in our interviews and workshops, Wikipedia editors are a relatively homogeneous group - overwhelmingly white, male and middle class. In addition, the editorial criteria may not currently be hospitable to certain types of content, especially from developing countries. However, the global influence of Wikipedia and its associated projects means that it could transform the online knowledge landscape if its community of editors grows and its projects diversify. New knowledge can also be what we might call 'involuntarily crowdsourced' through analysing the vast amounts of data shared on public social media.

Local Knowledge

One consequence of increasing levels of Internet access and the development of open

platforms for sharing knowledge is the greater exposure and credibility of local and indigenous forms of knowledge. The social networking technology has the power to provide community-specific products for sharing local knowledge of specific data such as rainfall patterns. One workshop participant noted that there has been donor, philanthropic and publisher investment in initiatives to increase access to indigenous research, especially from Africa.

At the same time, the open digital landscape has led to an awareness that traditional knowledge needs to be protected from capture by commercial actors, whether by expanding intellectual property regimes or with whole new instruments. The Open African Innovation Research and Training Project is one example of efforts to reconcile open development with intellectual property protection (Open AIR, 2015). A number of communities have also adopted new forms of self-governance and knowledge management in relation to their traditional heritage. The Kukula Healers in Bushbuckridge, South Africa, have created a common pool of members' individually held traditional knowledge through a Bio-cultural Community Protocol (BCP). The BCP has assisted the healers to protect their knowledge of medicinal plants against bio-piracy, and to provide for sustainable use of natural plant resources. An interviewee suggested a 'glocal' future for knowledge sharing, where local village communities can virtually connect to other local communities who have similar interests and information requirements. Relevance becomes an extremely important factor in a world of information abundance.

The example of the Maarifa (Swahili for 'knowledge') centres supported across East Africa by the Arid Lands Information Network illustrates a community-based knowledge sharing approach, which has reach to farmers (ALIN, 2015). The community-managed centres use solar-powered technology and equipment linked to the Internet via the cell phone networks, to make knowledge available as part of wider strategies of face-to-face and digital knowledge sharing with and among the community. The Maarifa centres act as local knowledge intermediary hubs, providing access to books, internet and knowledge and research evidence that is translated and repackaged to make them accessible to local people. Through ICT training and local expert support, users are helped to engage with relevant knowledge, and also share their experience through blogs and citizen journalism.

There are still many barriers to the international acceptance of knowledge produced in Africa and the global South, chiefly around the issue of quality and how this is measured. So greater investment in local research capacity is needed.

Curating and Communicating Knowledge

The Digital Age and the evolving online information ecosystem have had an inevitable impact on the nature of libraries and librarians. Earlier 'library was a building holding tangible items such as books and journals. In the new paradigm libraries provide an invisible infrastructure to enable the provision of information to inform research' (Kennan and Wilson 2006). This invisibility or disintermediation, whereby users perceive their access to information as more direct, has the effect of 'screening out' all the people and tasks involved in providing the information (Brown and Duguid, 2002).

Social Digital Libraries

One challenge for libraries and librarians is how to become visible and valued without disrupting the easy access to resources now expected by their users. What is the role of the library 'in a world where so many information sources are place-independent, dynamic and transitory'? (Brophy, 2007). One key lesson for libraries is to build services

around the user and the user's workflow. Providing digital content is only one aspect of this. There is a big difference between "being where our users are" and "being useful to our users where they are" (Rowlands Et al. 2008). Libraries need to manage the shifts, not just from print to digital, but from pre-designed to personalised collections, from owning to renting, from desktop to mobile, from archiving to publishing, and from the hard drive to the cloud. further shifts towards social digital libraries are from focus on collections to online communities and networks, repositories to social platforms, vertical (top-down) communications to horizontal communications, content consumers to content creators and contributors, read-only sites to active connections for discovery and interaction and authority and authenticity valued to engagement and participation (Calhoun,2014). Digital library is: 'a tool at the centre of intellectual activity having no logical, conceptual, physical, temporal, or personal borders or barriers to information. Generally accepted conceptions have shifted from a content-centric system that merely supports the organisation and provision of access to particular collections of data and information, to a person-centric system' (Calhoun, 2014).

A crucial point explored by the study was the fact that there are still those who are absent from the digital landscape, either by choice or through lack of capacity and resources. Rural populations are particularly ill-served by Internet access globally, and as one of our interviewees noted, are glossed over in the hype surrounding mobile and smartphone penetration rates. Being 'useful to users where they are' in this case may mean developing inclusive non-digital services as well as making sure digital services audience-appropriate and keeping pace with commercial products.

It should be noted that even BiblioTech, the all-digital public library, maintains a physical space. 'The social function of library as the 'third space' for the community needed to be addressed... A digital library is of no use to those without technology access. Our physical location provides technology access where consumer buying power and Internet access are severely limited (Cole, 2014). Digital libraries in Africa, believing that they could ultimately, more than any other means before, aid literacy development and higher education, in Africa and foster more quality academic output and research (Rikowski, 2011) .

Digitization and Preservation

Related to digital libraries is the question of digitization of print materials, and how these are managed and preserved in a dynamic online environment. The following important questions posed by Britz and Lor still remains unanswered (Britz and Lor, 2004):

- Who has access to this information? For example, will African scholars be able to access this information free of charge?

- What control will the originating community have over their information once others have digitised it?

- Will originating communities be identified as the original creators of their cultural heritage and will they have the right to control access and non-disclosure of certain categories of their cultural heritage, for example sacred knowledge artifacts?

- To what extent will the global rules on intellectual property be able to protect this common heritage of Africa and prevent it from becoming exclusive, private property? Will the international intellectual property regimes be able to maintain the balance between private ownership and common heritage of the people of Africa?

- Will the people of Africa be fairly

compensated for the use of their knowledge by others and what incentives will there be for them to make their body of knowledge available to the rest of the world?

If local capacity for African-owned digitization initiatives increases, some of these questions could become less troubling.

Intermediary Roles and Skills

There is wide agreement that navigating the enormous amount of information on the web requires skilled intermediaries, and that managing emerging forms of data and knowledge may even require a whole new kind of information professionals. Studies from USA and UK identified the need for future professionals with skills in data curation, researcher support, project management, deep subject knowledge and networking. An additional major area where librarians' voices are needed in Africa, as identified by our interviewees, is in advocating and lobbying for coordinated open knowledge infrastructure and standards. In the wider context of economic and political development, it has been suggested that libraries, through extracting and delivering reliable, authoritative and up-to-date information, can stimulate growth and contribute to social justice (Tise, 2012).

Open Platforms and Repositories

One area where libraries have evolved and added to the services they manage is in the development of open access digital repositories. 'A repository may be defined as a set of systems and services which facilitates the collection, storage, management, retrieval, display, and reuse of digital objects. Repositories may be set up by institutions, subject communities, research funders, or other groups. They may provide access to a variety of digital objects, including peer-reviewed journal articles, book chapters, theses, datasets, learning objects, or rich media files' (Pinfield, 2009). The enormous growth in the number of repositories worldwide from less than 500 in 2006 to 3000 in 2014 is due to the rise of the open access movement. Now 50 %t of scholarly papers are freely available online, mostly through repositories.

Even in terms of raw numbers, the take-up of these platforms in Africa has been comparatively low with just 3.8 per cent of the total repositories recorded in the Directory of Open Access Repositories (Pinfield et al. 2014). A lack of ICT infrastructure is the main reason for this, although issues of language and culture also come into play (Jain, 2011). The key issues are being related to: acceptance of electronic information, absence of information management strategies/policies, copyright and IPR concerns, inadequate technical infrastructure, lack of awareness and understanding of the concepts, and lack of funds (Chisenga, 2006).

Africa needs to have ownership of its knowledge stock and the technology to disseminate it, and to move from a consumer of knowledge to a producer (Nwagwu, 2013). Despite new access mechanisms, real knowledge sharing is lagging behind in terms of access and usage in Africa. Access to knowledge created elsewhere, e.g. Europe and USA, is easier than accessing knowledge created by neighbors within the African continent. This results in asymmetry in the global research landscape. Many countries in Africa and Central Asia are lacking essential technological structures for their researchers to make open access contributions and share intellectual results freely. Consequently, scientific publications from these countries have low visibility and little impact on the international scholarly community' (Xia, 2012).

Although 'current OA practice focuses on knowledge transfer from the developed to the developing world' (Nwagwu 2013: 5), there are examples of African innovation and ownership in this area. These include the African Open Access Repository Initiative at

Stellenbosch University African Journals Online and the Scholarly Communication in Africa Programme. The global picture is slowly changing. From 1996 to 2012, the number of research papers published in scientific journals with at least one African author more than quadrupled i.e. from about 12,500 to over 52,000. During the same time, the share of the world's articles with African authors almost doubled from 1.2 per cent to around 2.3 per cent (Schemm, 2013).

Challenges for Use of Repositories

We have found that even where African repositories exist, there are major barriers to their effective usage as knowledge sharing tools, especially at the national, regional or federated level. This is in contrast to Latin America, where such efforts are being taken seriously - for example, the National Research and Education Network of Ecuador and Network of Scientific Journals from Latin America, Caribbean, Spain and Portugal. Our interviewees highlighted areas such as sustainability/continuity, differences in regional and disciplinary priorities, perverse incentives, ownership issues, usability, technical capacity and advocacy. These are discussed in more detail below.

Sustainability/Continuity: Libraries often get funding, and at the end of the project, that is the end of that'. There is no investment in continuity or efforts to avoid duplication or learn from previous projects. No continued staffing, technical maintenance or long-term preservation strategies.

Regional and Disciplinary Priorities: This study found that agricultural research platforms dominate in the African repository context, due to the interest in funding agricultural innovation and supporting knowledge sharing in this area. Recently, platforms, which share knowledge on Ebola, have inevitably attracted funding as well. North African regimes also make open knowledge sharing less likely in that region.

Perverse Incentives: Even where institutions and funders have open access policies, there are forces militating against their implementation. Many African universities, for example, receive government funding that is dependent on the number of peer-reviewed journal articles their faculties publish. Few of these peer-reviewed journals are (currently) Open Access.

Ownership: Although there is some appetite for national and regional-level federated repositories, the need for information to have 'ownership and origins' and the uncertainty around responsibility for archiving and sharing, may lead to the continued primacy of institutional-level systems that compete with each other.

Usability: Questions persist over the usability of repository systems from the point of view both of those contributing content and the end user trying to access that content. Systems for adding new content need to be made more intuitive, and collections should be structured to support access and discovery rather than serve institutional goals.

Technical Capacity: Although 'out-of-the-box' open source platforms promise easy set-up of repositories for institutions, the continued maintenance of these platforms is not trivial and few African institutions have the requisite skills embedded in their permanent staff.

Advocacy: Advocacy is needed at every level, but may be more successful at some levels than others. Repository managers and librarians need to go directly to policymakers and top-level institutional leaders. There is also still a need for awareness raising, myth busting and incentives at the individual researcher level.

Mitigating the Challenges

A recent report from the Confederation of Open Access Repositories acknowledged that despite the great potential of repositories as

an essential infrastructure for scholarship in the Digital Age, there have been challenges in recruiting content in sustainable and scalable ways (COAR, 2013). The report describes the following profiles that can be adopted to mitigate these challenges.

Incentives: promoting the benefits of repositories through advocacy and metrics, as well as the adoption of policies/mandates that require deposit.

Integration: amalgamating repository services with other institutional services like research information systems and research biographies.

Mediation: implementing tools, workflows and agreements that ease and simplify the deposit process.

Aside from the institutional, national and international digital libraries and repository approaches, there are some interesting examples of digital initiatives that have been designed to be responsive to the knowledge and information needs of local communities.

Open Data

Effective hubs and knowledge sharing systems rely just as much on open data as open access. Open data is defined as data which anyone is free to use, reuse, and redistribute - subject only, at most, to the requirement to attribute and/or share-alike. The ability to make connections with other data thereby augmenting your own data to create new information and knowledge is a very powerful proposition. The explosion of data in this Digital Age has provided organisations and individuals alike with a new resource on which to capitalise.

Open Data Barometer report for the Open Data Institute, found that one area of growth is the number of Open Government Data (OGD) portals (Davies, 2013). In the past five years, OGD policies have seen rapid diffusion. But there are regional and country differences for example, leading countries are

investing in the creation of 'National Data Infrastructures' while mid-ranking countries have often failed to make key data sets available. This can be attributed to the absence of strong 'right to information' laws as well as limited training and support for intermediaries. Low-ranking countries have not yet started to engage with open data, and many developing countries lack basic foundations such as well-managed and digitised government data sets. The potentials for OGD listed by Davies include the following.

- More efficient and effective government - both through government using its own data better, and through innovators outside of government identifying improved ways

- to provide public services, meeting the diverse needs of citizens through digital technologies.

- Innovation and economic growth - acting as a twenty-first century infrastructure, and a raw material, for activity in the information economy. Start-ups and established businesses can use open data to generate new products and services, and secure efficiencies, generating a net gain for country economies.

- Transparency and accountability - allowing citizens to see, understand and monitor what their governments are doing.

- Inclusion and empowerment - enabling marginalised groups to get involved in the political process, and removing imbalances of power created through information asymmetry.

Global Standards and Interoperability

The real value of repositories lies in their potential to become an interconnected repository network - a network that can provide unified access to an aggregated set of scholarly and related outputs that machines and researchers can work with in new ways (COAR, 2012). But this is entirely

reliant on interoperability i.e. is the ability of systems to communicate with each other. It can allow to exploit computational power so that we can aggregate repository content, data mine content from repositories, create new tools and services on top of repositories, and generate new knowledge from them. Interoperability is the technical 'glue' that makes it possible to virtually connect repositories to each other and to other systems and transfer information, metadata, and digital objects between each other.

The Open Access Initiative's Protocol for Metadata Harvesting (OAI-PMH) has been one of the cornerstone of interoperability (Open Archives 2014). The issues that are to be addressed in this areaare: metadata harvesting; repository networks; usage statistics; cross-system transfer; author identification; persistent identifiers; and managing compound objects (COAR, 2012).

The development of these international standards for machine-readable information has been vital in enabling global information sharing. Knowledge sharing systems require collaboration across countries, because many major issues such as climate change and epidemics are not framed within a single country.

Open repository software for example, DSpace, Fedora and EPrints comes with interoperability features such as OAI-PMH compliance as standard 'out of the box', but these capabilities are not always enabled in African implementations. There were about 50 OAI-PMH compliant repositories on the African continent by 2011, compared to 995 in Europe (Khan,2013). The lack of take-up could indicate a need to raise awareness when planning repository and open access projects, and there is also a lack of sophisticated use cases. Knowing how others are taking advantage of interoperability capabilities is an important part of joining up the open landscape across borders and building consistent capacity.

Social Media

The internet has altered not only the way knowledge is produced and curated, but also the way it is communicated. There is a 5-10 per cent increase every month in social media activity around scholarly articles (Adie and Ro, 2013). In terms of development information and political participation, 'social networks will play an important role in the development sector, especially in building relationships among development organisations and target populations, and disseminating and sharing information and dialogue on a range of development strategies.

Another area in which social networks will play an important role is in enhancing political participation among Africans. Freely available services for example, LinkedIn, Instagram, Twitter, Flickr, Tumblr and Facebook have increased people's willingness to share personal and professional information. However, there is a 'dark side' to social media usage, which encompasses government surveillance and general invasion of privacy, as well as the prospect of identity theft, fraud, blackmail and other cybercrimes.

Social media may well evolve in ways that are more difficult for governments to monitor (US, 2012). Future social networks may well not be formal organisations 'but rather anarchic collectives built on sophisticated variants of peer-to-peer file-sharing technologies, against which developed - and many developing - world governments might have no meaningful negotiating leverage'.

Mobile Knowledge Sharing

The future of knowledge sharing is mobile, especially in the African context. While most African countries cannot generate enough power for their needs, mobile penetration is high. 'Mobile devices will offer facilities and functionalities to instantly capture knowledge generated by individuals whether at home, at work, on holiday, on the bus, on

the plane, etc. and transmit it to distributed servers for processing/categorization and immediate access by all those who want it'. The huge uptake of the Kenyan M-PESA mobile banking system suggests a strong model for future services facilitating all forms of social and commercial activity - and possibly education and information services too. A few positive ways in which mobile phones will be used for knowledge sharing, include knowledge on market prices, availability of products, advisory services, access to weather data, sharing of ideas and knowledge through online communities of practice especially through relevant social media, questions and answer services, access to relevant literature, weather/climate information, online learning and skills development and not forgetting entertainment and leisure. However, there are privacy implications, for mobile devices are easily monitored and hacked, and the power that service owners whether government or commercial have over data gathered by those devices leads to concerns over how people's personal data will be used.

New Ways of Searching and Discovering

Despite a young population especially in Africa, which is often termed 'digital natives' 'the pervasive presence of technology in their lives has not resulted in improved information retrieval, information seeking or evaluation skills' (Rowlands Et al, 2008). As previously discussed, digital platforms would be advised to respond to user behavior and expectations, largely formed by Google. Library users demand 24/7 access, instant gratification at a click, and are increasingly looking for 'the answer' rather than for a particular format: a research monograph or a journal article for instance. So they scan, flick and 'power browse' their way through digital content (Ibid).

Discovery Tools

Google and other internet search engines can be termed the biggest discovery tools, but a search engine's results are only as good as the content it indexes - i.e. it is important that designers, digital libraries and other information sources provide good metadata so that their content can be found and correctly indexed. Alongside Google, academic libraries are increasingly adopting resource discovery tools or 'next generation catalogues' that aim to go beyond the traditional database of library holdings and offer the user a more 'Google-like' search experience across multiple online resources (Stone, 2009). These resources might include institutional repositories and other open access collections as well as proprietary databases (Shapiro 2013).

In terms of what users want from their library search, delivery is more important than discovery. This applies more to print materials, but it is also important for discovery systems and catalogues to provide clear guidance on how to access the digital resources they supposedly connect to.

Digital Knowledge, Africa and Development Goals

A Foresight report on Africa 2060 concluded that: 'Innovation, entrepreneurship, technology, knowledge, and globalization are among the areas that have generated significant "good news" to record from Africa' This study looked more specifically at development and the global agendas around development goals, and explored the roles of digital knowledge and related ICTs, as we move from the period of the Millennium Development Goals (MDGs) to the post-2015 development agenda and the SDGs. We focus our discussion on data and insights relevant to the African context, and it is interesting to note that Africa is currently working on a 2060 agenda vision, to coincide with the centenary of the African Union. In the context of the post-2015 development agenda, the following major areas needs attention in relation to digital knowledge and Africa:
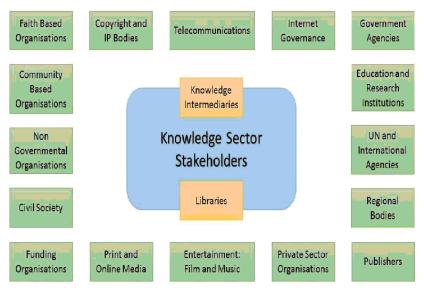
Figure: Key Stakeholders

- an inclusive and accessible ICT infrastructure

- development of skills for the Digital Age

- approaches to address growing digital divides

- deeper understanding of the relationship between ICTs, digital knowledge sharing and achievement of development goals

- metrics and measurement that support the wider integration of knowledge in the SDGs

- innovation in use of ICTs for knowledge sharing across and within African countries.

Our discussions found that there are 'many policies but poor implementation' and this is a challenge for many actors to pick up on. It is important to recognise that in any context, there is a wide range of potential national and international actors and stakeholders when it comes to knowledge creation, sharing and discovery in the Digital Age. The following figure illustrates this by mapping out some of the main actors.

Inclusive and Accessible ICT infrastructure

The MDGs made specific reference to ICTs as an enabler and provided access indicators in relation to fixed telephone, mobile cellular and Internet subscriptions. An analysis of the International Telecommunication Union (ITU) 2013 data shows that northern Africa is generally ahead of the average for developing regions, while sub-Saharan Africa is generally ahead of the average for less developed countries. There are now 650 million phone users in Africa, but with only one in three people on average in Africa and Southern Asia having their own unique subscription to a mobile service, there is still significant growth to come (Schmidt and Cohen,2013). Even though impressive, the statistics do not illustrate who has access in terms of gender and diversity, nor do they provide insights in relation to urban/rural divides. Simple access measures also typically fail to make effective use of the connectivity to support knowledge-based economic and livelihood-relevant activities. Data collected by ITU reveals that Internet access is clearly lagging behind mobile, and in the coming

years there is likely to be a closer correspondence as users with 3G- and 4G-based data services increasingly access the Internet via their mobile phones (ITU, 2013).

Developing the ICT infrastructure to enable effective digital knowledge sharing is a critical issue, The undersea cables are increasingly connecting Africa internationally, but internally, connectivity remains a problem (Song, 2014). This limits the development of repositories and streaming applications. The rest of the world is getting more cloud based, but lack of data centres for cloud-based services in Africa means it will lag behind in comparison if it had 'close proximity' infrastructures.

Development of Skills

The benefits of digital knowledge content becoming available and an open development paradigm are clearly going to be constrained in the African context while the ICT infrastructure lags behind that of developed countries, limiting access and stifling the development of relevant skills for the Digital Age. Data from the World Economic Forum (WEF) Global Information Technology Report (2013), shows that sub-Saharan Africa lags behind the rest of the world on a range of relevant indicators including skills, infrastructure and digital content. .

Evidence from the ICT Development Index (IDI) also highlights the need not only for improved infrastructure and investment in broadband, but also for skill (ITU, 2013). Commenting on this report, Essoungou notes a growing divide: 30 of the continent's 55 countries surveyed are part of the 39 least connected countries, home to 2.4 billion people with particularly low levels of ICT development' (Essoungou, 2013). This skill divide is across the continent and also between urban and rural locations. 'ICT performance is better in countries with higher shares of the population living in urban areas, where access to ICT infrastructure, usage and skills is more favourable. Yet it is precisely in poor and rural areas where ICTs can make a particularly significant impact. It is not technology alone, however, that makes this possible, but the knowledge-related applications that are made available and the skills of the people who use them.

Growing Digital Divide

Divides we have noted in the African context relate to access and the type of digital content being made available as well as its relevance to Africa's development challenges and skills. Unless development policies including those related to ICT infrastructure are inclusive, big problems can arise. (Mayaki, 2014). Inclusion and relevance to people's needs are of great importance when it comes to development, and a big part of the challenge is also to respond to demand. 'One of the main reasons why many ICT initiatives have failed is that they have been excessively top-down, externally driven and supply led, with insufficient attention being paid to real development needs, however these are defined Approaches that are purely demand driven are also often doomed to fail, because local advocates have incomplete knowledge about the optimal ICT-based solutions that could support their needs (Unwin, 2009). Helpfully, ICTs themselves can now enable better communications between different actors to support this process of discovering needs and giving voice to users of knowledge sharing systems.

The rural landscape could change dramatically in Africa, narrowing the digital and knowledge divides, if plans by Google and Facebook to make Internet accessible via drones (BBC, 2014) and balloons prove to be effective. Likewise, as more rural users gain access to mobile payment systems such as M-PESA in Kenya, EcoCash in Zimbabwe and Tigo Pesa in Tanzania, the range of mobile services they can access will also increase. These are likely to include extension information services, m-government, rural insurance, agriculture support services, money transfer and other financial services.

New mobile developments will also provide governments with tools to approach security and surveillance in new ways. Once access to services and knowledge improves, it becomes ever more important for users to have digital literacy skills from an early age, and for educational curricula to be designed to respond to this need.

Digital Knowledge and Development Goals

By contrast with the MDGs, which focused targets on developing countries, the SDGs are inclusive of all countries, and allow for a more complete global vision to be shaped around sustainable development. An online and face-to-face participatory process, using a globally accessible voting system based on the 'My World' website (http://vote.myworld2015.org/), has engaged civil society in identifying priorities for future development goals. The data indicate a strong demand for good education, with African countries and those with a low Human Development Index (HDI) score ranking it highest. Many respondents also highlight the importance of phone and Internet access. One may assume that knowledge and communication are at the heart of these two expressed priorities for a good education and phone and Internet access.

The Open Working Group of the UN General Assembly, in its proposal for the SDGs, identifies 169 measurable. There is, however, no explicit focus on creating an enabling ICT-based knowledge infrastructure for the Digital Age, and in a manner that would promote equitable access and be beneficial to developing countries. There is a strong focus in the report on resource access (including phone and Internet access) but little attention given to knowledge per se - the word appears just seven times in the draft statements. But the proposal does, however, give some prominence to data monitoring and accountability, perhaps reflecting the new emphasis on a 'data revolution' Neither this report nor the MDG report on Africa, makes mention of digital; it is also telling that there is no reference either to 'information science' or libraries, but there is one reference to information systems in relation to education management.

If, as Sanou states in the foreword of the report- Measuring the Information Society (ITU 2014), ICT is an enabler to achieving development goals, it is very important to understand in the African context what the evidence shows, and how ICTs and the knowledge infrastructure are helping. This would then need to be translated into meaningful strategies and measures for future development goals, ensuring that they play a role in delivering on Africa's ambitions and vision for the future. The danger of ICTs and knowledge systems being seen simply as a crosscutting issue is that in achieving the SDGs, we may inadvertently be creating unnecessarily negative outcomes and impacts through the knowledge systems we create. Knowledge itself also has to be seen as a resource. It is therefore very important to recognise that knowledge systems and technology can never be seen as simply neutral, and there is a need to target investment in ICT infrastructure and related aspects of regulation and governance to negate potential negative impacts.

The post-2015 development agenda needs to be looked at holistically, and the role of digital knowledge needs to be fully integrated into this agenda and the SDGs. This means ensuring that each SDG target is supported by a strategy to provide a suitably diverse pool of knowledge that is carefully curated, and that knowledge sharing systems are designed to be inclusive and strategically managed. This process needs to involve digitally literate knowledge intermediaries who understand the key issues around ICTs and knowledge management, and design processes that engage with and protect the rights of the poorest and most vulnerable people.

Supporting Innovation

The Common African Position expressed by the UN Economic Commission for Africa (UNECA) in The MDGReport 2014 stresses the needs for funding Africa-grown technological innovation, and its development, transfer and diffusion, and for enhancing technological capacities for Africa's transformative agenda (UN, 2014). It also puts strong emphasis on people-centred development and the need for entrepreneurship and life skills, as well as vocational and technical training to respond to labor market demands, which includes reference to the need for information and technology skills.

Despite the gloomy overall picture for innovation in sub-Saharan Africa presented by many studies the picture on the ground can appear more positive for development: 'With technology innovation hubs springing up across the continent, technology communities within many African countries are gaining access to state of the art facilities, events, mentorship and training; making it more likely that they'll devise impactful solutions (Hoorens Et al. 2013).

The challenge is to innovate in ways that benefit the poorest citizens and engage them in the digitally based knowledge societies. The frugal approaches described by Bound and Thornton, albeit in the Indian context, as well as social innovation examples provided by Banks, would appear to offer good ways forward to support innovation in the knowledge sector that would benefit those working in rural areas and in the informal sector, where primary access to digital knowledge is likely to be via mobile phone (Bound and Thornton 2012, Banks 2013).

Relationship of SDGs and Digital Age

Conceptually we still don't have adequate definitions of critical terms like information revolution or digital divide that capture all the richness and variability of developing countries (Wilson, 2004). It will be crucial to build the right framework for measuring and bridging divides that continue to evolve in nature as the Digital Age unfolds, with a greater focus on the infrastructure that supports knowledge creation and sharing, and who is benefiting from the ways in which knowledge is distributed. It is good to see that the latest ITU report, Measuring the Information Society, incorporates 'rural society covered by at least a 3G network', though many African countries rank very low on this measure or do not appear at all. The ITU data illustrate significant time lags and 'divide' in terms of take-up of new infrastructure (ITU, 2014).

The ITU's IDI index and UNDP's HDI index are (when combined) actively monitoring access by different actors, including skills and access to infrastructure and digital content. But what is really needed is a measure that focuses on the role of knowledge and knowledge intermediaries and their contributions; positive and negative to development in the Digital Age.

In the past few years, the role of data in particular has been given a lot more prominence, and use of data for development is the major focus of the World Economic Forum Report (Bilbao-Osorio Et al. 2014). While big and open data are not the focus of this study, it is important to note this trend; the UN MDG report 2014 is particularly relevant to metrics, highlighting the need for 'sustainable data for sustainable development' and noting that: Reliable and robust data are critical for devising appropriate policies and interventions for the achievement of the MDGs and for holding Governments and the international community accountable.

Reliable statistics for monitoring development are regarded as currently inadequate and patchy, and continue to present major challenges for measuring indicators relevant to the post-2015 development agenda. Looking to the future,

the UN report states that: The Report of the High Level Panel of Eminent Persons on the Post-2015 Development Agenda called for a 'Data Revolution', which reflects the growing demand for better, faster, more accessible, and more disaggregated data for bringing poverty down and achieving sustainable development (UN, 2014).

Value Creation in a Development Context

The context and trends outlined above carry with them opportunities for greater inclusiveness, wider access to information, and better knowledge sharing in development efforts. They also hold a darker potential to create new disparities, exacerbate existing ones, and lead to a homogenisation of knowledge that stifles discussions that stray from the norm and mainstream. The present study has attempted to look more holistically at what different futures may look like. It has explored some of the positive and negative implications for development in relation to where value may be added or lost, and who wins or loses as a result of distributional outcomes of different knowledge infrastructures and policy approaches. Inevitably, this analysis involves making value judgments, and the authors view that the development outcomes we aspire to are ones that:

- promote equitable access to relevant knowledge for all

- widen availability of knowledge to support the livelihood development of all, with a particular focus on poor people living and working in rural areas and in the informal sector

- support the creation of a diverse knowledge pool

- provide uncensored and free access to knowledge made openly available wherever possible by governments, civil society and the private sector

- support an appropriate level of regulation to enable the private sector and

innovation to flourish while avoiding the creation of unduly powerful elites or hugely influential monopolies.

Positive Implications and Opportunities

The positive opportunities presented by the Digital Age to achieve the stated outcomes in relation to development are as follows.

Access and Availability: If the accelerating range of digital materials is made widely open and available through good policies and incentives, a wealth of opportunities will present themselves, including for groups who are marginalised. These include: improved transactional information drawing on better connections that overcome distance and support innovative practice and a range of improved and context-relevant financial and business services; and transformative changes that eliminate barriers to market entry and enable a much wider cross-section of the population to acquire knowledge skills and credentials through online learning.

Digital repositories or other knowledge sharing systems will enable research to be more available and accessible, and local research will be more visible.

Governance and Service Delivery: Digital changes can lead to positive changes in how government works, how it interacts with its citizenry, and how it delivers services. Digital tools and crowdsourcing approaches can increase and improve citizen voice and government transparency, allowing citizens to be more informed about budgets, issues and upcoming decisions. Digital technologies will also offer technocratic improvements to service delivery. Data on health, education, infrastructure, social protection and other government sectors will be more abundant and more tools will be available to analyse it.

Quality and Relevance of Knowledge: Digital technologies have the potential for a transformative impact, disrupting current regimes of knowledge production and

publication, and enabling poor regions to become producers rather than net recipients of relevant development knowledge about themselves. This can happen if networks and incentive systems and structures are established that support local knowledge production, validation and distribution. New technologies will not, overnight, unhinge existing systems held in place by strong historical, political and cultural forces; but technologies do hold the potential to create new structures of knowledge production and sharing that can grow and start to compete with publishing regimes. Given the right circumstances for cooperation, federated groups of digital repositories could introduce systems for aggregating their resources, developing user-friendly discovery tools, and implementing structures for peer review.

Wisdom of the Crowd: Crowdsourcing methods are becoming a powerful tool to help development initiatives become better targeted, informed and researched. They can aid research into identifying needs and problems, ranging from wide-scale regional issues down to those at the community level. In the process, it can help to gather relevant information and identify problems.

Negative Implications and Threats

The Digital Age also presents some major threats to achieving the stated outcomes in relation to development, which include the following.

Infrastructure and Governance: Many governments, even though they recognise the importance of ICTs and knowledge sharing as enablers, find it difficult to prioritise the well-coordinated and long-term investment needed when other major issues (health, education and poverty) demand more immediate attention. Furthermore, many governments may lack the political will for free and open knowledge flows even if they had the capacity to deliver it.

Privacy, Censorship and Control: In the wrong hands, digital technologies can bolster authoritarianism by providing ever more effective methods of surveillance, censorship and control.

Homogenisation of Knowledge: There is a danger that digital trends will result in a global homogenisation of knowledge toward the mainstream. Rather than giving local knowledge a greater chance to flourish, a free flow of knowledge could just as easily edge out voices that do not fit within dominant discourses and epistemes that are largely products of Western cultures. Some voices will always dominate, and there could potentially be far less room for separate discussions to follow different courses, emphasising different priorities and perspectives.

Fracturing: The converse threat is that knowledge and worldviews fracture into smaller and smaller groups.

Meritocracy of the Motivated: In a world where opportunities to learn, gain credentials and do business abound, rewards will go to the highly motivated self-starters. Despite ongoing disparities, the Digital Age will be trumpeted as a meritocracy, making inequalities appear more justifiable.

Unsustainable Models: Open knowledge is not free. The systems, infrastructure and human resources needed for it require considerable, ongoing investment. There is currently no business model that will allow knowledge to be open and free at the point of use that does not need support from governments and funding organisations. Without some form of reliable, ongoing support and investment from African governments and the international community, open knowledge will remain a patchy, unfulfilled promise, often benefiting only those with the access and skills to use it.

Information Overload: Efficiencies in making knowledge available and accessible

have, in the minds of the public, reduced the need for information intermediaries and professionals. When most information needs can be fulfilled online, the skills that go into curating materials, making them visible, and helping to guide people to what they need become largely invisible. In a world where knowledge is free, open and abundant, there is a danger of a lack of knowledge professionals and institutions just when they are most needed to help guide those who lack digital literacy through it all.

Growing Disparities: Perhaps the biggest threat posed by the Digital Age is that rather than leading to greater equality of opportunities and outcomes, it instead creates new disparities or exacerbates existing ones. There are many types of disparities that the Digital Age could exacerbate like digital skills and literacy, digital capital, and rural/urban differences.

We have presented insights from relevant literature and drawn on the perspectives of those we have interviewed and met during the course of this project, incorporating a diverse range of expert knowledge and experience around digital knowledge and the African context. We have concluded by assessing some of the considerations that we believe to be most important when thinking about the future and formulating policy. We believe these are also important aspects to describe and measure when setting development goals.

We used this material to inform wider discussion about future scenarios. The analysis lead us to a preferred scenario, and we present specific recommendations for strategic approaches and policies that could render this preferred scenario more likely and deliver more positive and equitable impacts of the Digital Age for developing countries.

3. Scenarios and Policy Implications

In the above section we looked at trends in digital knowledge, examining their impact on development and the potential for these changes to bring about new opportunities and threats in the future. In this section we present four scenarios of different futures to help think about the specific ways in which knowledge creation, sharing and use might change. We then present a fifth, preferred scenario that visualises a future of positive outcomes, and discuss policy strategies that would lead us towards that scenario.

We held two workshops to develop the scenarios and discuss related policy implications. Participants in both workshops included a range of stakeholders representing different groups that will be affected by technological changes: researchers and ICT and development practitioners, and policymakers. The first workshop in UK was held in conjunction with another complementary horizon-scanning research project focusing on 'Big Data and Development'. Participants first discussed numerous drivers of change identified in the social, technological, environmental, economic and political framework, finally narrowing them down to two that were most important for defining how the world would look in future. These were:

Access to Knowledge and Data: Capturing whether knowledge of all kinds is openly accessible or closed and controlled.

Asset scarcity and Distribution: Capturing whether resources are abundant and widely distributed, or scarce and concentrated in terms of ownership. 'Assets' are defined broadly, including wealth, energy and environmental resources, as well as human assets such as health and education.

The two drivers were then used as axes to form the basis of four distinct scenarios.

Scenario 1 is a world of abundant assets and relatively dispersed ownership, where knowledge is openly available but regulation and surveillance are pervasive.

Scenario 2 is also a world of freely available knowledge but in a context where many

important assets are scarce and ownership of these assets is relatively concentrated.

Scenario 3 is also a world of resource scarcity and concentrated ownership but where access to knowledge is tightly managed and controlled.

Scenario 4 combines tight management and control of knowledge with abundant assets, with ownership distributed relatively widely.

Preferred Scenario

The above four scenarios became the basis for discussion and analysis at the research study's second workshop, held in South Africa. This workshop included representatives from academia, civil society, the private sector, and government, all with an understanding of ICT issues in the African context. This exercise sought to identify positive and negative potential impacts that each scenario would hold for developing countries in Africa. Participants analysed the effectiveness of potential policies across the different scenarios, leading to a preferred scenario that encompassed desirable outcomes from across all four scenarios.

Key characteristics of preferred scenario are Internet access is universal, and considered a right, information is abundant and available, better tools and cooperation have resulted in more African research, crowdsourcing helps with service delivery and government accountability and there is a balance between openness and privacy.

Who would have thought it possible, back in 2015 when they were drafting the SDG, how much could have changed for the better in 15 years? So many things that seemed naïve and unrealistic back then have now been achieved, helping to realise a more prosperous and just society. This was accomplished largely through the pursuit of prudent policies based on a few principles that were agreed on globally and implemented by national governments, with crowdsourced feedback mechanisms enabling citizens to hold the international community to account for delivering an open and fair digital society.

One of the key principles of today is that Internet access is a basic right. In a world where so much information is available online, being denied internet access is almost like being denied a livelihood. So even those of us in lower-income brackets have a minimum allocation of Internet access like electricity and water. For this to happen, agreements to build a global ICT infrastructure were drafted and set into motion through the mechanics of the SDGs. This included direct funding from governments, but also good policies to incentivise private investment in the infrastructure.

For researchers, government policy and implementing bodies, and development practitioners, openness also includes access to research documentation, data sets and government records. Processes of research and innovation are supported by strong information science and data management, together with widespread curation and preservation capacity. The way we used to research and develop new ideas has changed dramatically.

Global knowledge has become more truly global. By that, we mean that knowledge about developing countries and research on development is produced and shared much more within developing countries themselves. An Africa-wide repository of locally produced research automatically harvests documents from universities and research institutes throughout Africa, making them easily available and searchable. A pan-African research body administers the system, and has set up a peer-review system that ensures the quality of materials in the repository. In addition, under this research scheme, African governments have implemented policies to incentivise publishing in the repository. The result has

been a marked rise in local contributions to literature on local development, which has improved the quantity and relevance of development-to-development efforts, and helped to set new agendas for both research and development.

Information and data scientists, librarians and knowledge intermediaries play a vital role in this pan-African research council and its repository system. New digital documents and data sets are being produced in heaps, and information professionals are needed at all levels to make sure that it is all easily searchable and discoverable. They are also a much-used resource at libraries, whether university or public ones, to help guide people to the information they need.

Technology has also made education more widely available. Online course didn't totally disrupt the education business model, but they have become one of a number of important tools in helping to increase access to quality education. The availability of information and knowledge has also made it easier for students to find what they need, even in remote areas. Most importantly, new models of knowledge sharing have enabled more African researchers to contribute to global online education systems, joining the ranks of globally famous online lecturers that previously came exclusively from Western universities.

With so much information available to all, privacy is an ongoing public debate. There are variations from country to country , for example, how much of your health information can be made available to government and to the public for medical research purposes. Even though most people believe that government policies toward privacy, transparency and data use are working well for now, it is good that these worries can be freely aired and discussed.

Government services have also improved from e-government and m-government systems that support regional, national and local services. Through crowdsourcing and large amounts of data, the government is able to get a much more granular view of citizens' needs and thus target policies and programmes more accurately. We're also able to hold the government to account much better. Civil society has grown stronger and more effective through the abundance of information it can access to guide its strategies and advocacy work, and the networked approaches linking different groups together. The Digital Age has ushered in new opportunities, reaching all the way into remote villages, and this has resulted in a stronger global economy with a lot less inequality and poverty. Social entrepreneurship, corporate social responsibility and profit sharing with workers have become widespread and, nationally and internationally, incentives serve to increase competition and break monopolies.

4. Policy Implications and Recommendations

The study has developed a preferred future scenario for knowledge sharing, drawing on insights from the African context. Throughout the process, the study focused on identifying the potential positive impacts for developing countries and the policies and strategic approaches that would make these more likely to happen. Due to the approach we have taken, they are likely to be most relevant to the African context, while also significant for consideration in the wider contexts of developing countries globally. They all contribute in different ways to the 'preferred 2030 scenario', which was designed and informed by interaction with a diverse range of stakeholders with interests in international development and the role of knowledge in the Digital Age.

The strategic areas and approaches relevant to policy, recommendations are discussed here in relation to four key aspects: cross-cutting principles, an enabling environment, human capacity and infrastructure and tools.

Crosscutting Principles

Ownership, Privacy and Security: Digital technologies can threaten the privacy and security of poor and marginalised groups, whether that threat is from global powers, corporations or oppressive national regimes. Regulation is needed to ensure that knowledge-based digital initiatives are open, transparent and secure. Global pressure should be exerted on states that violate basic principles of privacy and security. Safeguards must be in place to ensure that knowledge is not hijacked by corporations and used at the expense of the public good or the knowledge creators.

Universal Access: Without universal access, Open Access through digital media only reaches those with digital technologies, so investment in ICT infrastructure and inclusive services remains critical. There is a need for indicators and metrics that are relevant to universal access and what users can do with their access, which reflect these dimensions. The concept of universal access will need to be regularly reviewed and redefined to promote equity and inclusiveness in an ever-changing Digital Age.

Open Knowledge: Open knowledge helps to close the digital divide and spur innovation. Current incentive structures discourage researchers from publishing in open access platforms, and the costs of accessing research through mainstream publishers is often prohibitive for people in developing countries. Knowledge, data sets and records from public bodies, government and the private sector need to be made openly available wherever possible. This will support inclusive work and innovation at regional, national and local levels. Open access should address all development goals and not just be considered relevant to academia. This requires Open Access (OA) and Freedom of Information (FOI) legislation and should be balanced with an individual's freedom and privacy, and increased understanding of copyright and intellectual property, including patents. Furthermore, this requires a revolution in publishing and distribution, investing in digitization and distribution, which has been one of the major costs and bottlenecks for developing country knowledge sharing. Many argue for investment in regional interoperable knowledge systems, where open linked data sets can be built to support a wide range of services in key thematic areas. Others advocate for a continental agreement for open reusable transparent platform-agnostic and device-agnostic ICT infrastructures. Both of these should be given serious consideration, with a strategy for knowledge sharing central to this cross-border strategy.

Inclusive Knowledge: Subjects of development knowledge need to be more central to how that knowledge is produced, distributed and used. Digital technologies are increasingly making it possible to disrupt current research and publishing regimes that privilege knowledge produced and packaged in developed countries. National and regional repositories with quality assurance mechanisms can also help increase participation and create demand for research from developing countries. These approaches should align with greater investment and incentives for African research within curricula of national universities.

Another important aspect of inclusive knowledge is including poor people in developing knowledge infrastructures and knowledge intermediary systems so that knowledge efforts better respond to their needs.

Enabling Environment

The SDGs currently mention access to ICTs and the assumption is that knowledge creation, sharing, research capacity and ICT infrastructure are seen as crosscutting themes. It is also acknowledged that there are many relevant indicators monitored - for example, the ITU's ICT Development Index (IDI),

UNDP's Human Development Index (HDI) and the Web Foundations Index. However, we recommend a more explicit focus on 'Digital Society Development' goals that provide the basis for a coordinated agenda on the different ways in which knowledge is created, used and shared.

Meaningful Metrics and Indicators

These goals should relate not only to universal ICT access, but also cover metrics for digital literacy, infrastructure, standards, public service access, costs, openness and capacity to inclusively create and share knowledge, and to monitor how the benefits of digital development are distributed. They should include:

- metrics to measure behavior change and the impact of policies designed to support development in the Digital Age

- metrics that inform our understanding of the opportunities presented by the 'Internet of Things', and the ways in which 'machine-to-machine' communication and links between humans and computers can provide positive outcomes for development

- regularly review and update concepts such as 'digital divide' and 'universal access', and their related measures, to ensure targeted investment in more equitable and universally beneficial Digital Age outcomes in terms of access to and usage of high-quality knowledge services supported by digital technologies.

Knowledge-Mobilising Institutions

The library and information science sector as a whole needs stronger institutions and regional knowledge intermediary groups that can clearly advocate for and explain the benefits of investment in development of national and regional open knowledge infrastructures and related skills. Without this, the investment needed by governments and institutions in the research and

knowledge systems and processes to support effective delivery of the SDGs and the post-2015 development agenda will, in all likelihood, be segmented. That would represent a missed opportunity to deliver truly transformative results for Africa and other developing countries.

Developing a Sustainable Business Model

Strategies are needed to define how open knowledge systems can operate sustainably, and this will require knowledge-mobilising institutions to develop business models that are less dependent on government or donor subsidies. This probably means developing closer links with private sector actors, and following similar models. But it will also need committed, long-term strategies from governments for investing in infrastructure, and from international development agencies for establishing priorities within the SDG framework and making financial resources available accordingly.

Incentives and Policies

Repositories will never become appealing as a place to publish or find information without better policies and incentives. Policies must change from the university level up through the national and regional levels to encourage the use of repositories and to develop and implement coordinated systems to combine resources and ensure quality standards. Government policies can encourage university repositories to cooperate, rather than compete as they now often do, in federated repository systems that make all the repositories searchable through one platform. Such a system would allow for mechanisms to carry out peer review, and materials that have successfully passed review would be tagged for users' benefit. This would, in turn, make it easier for university promotion, rewards and tenure systems to reward documents peer-reviewed through this system, and distinguish them from low-quality works that are currently perhaps over-represented in many repositories.

Human Capacity

The Digital Age needs people with new skills and competencies in a range of areas, in order to develop relevant knowledge systems that can respond well to the challenge of delivering development goals like the following.

Library and Information Skillsets

Physical library spaces that support interaction and learning related to information literacy and research skills remain relevant and valuable, but information systems are becoming more distributed and content is becoming increasingly digital. To build an effective open knowledge society in the Digital Age requires a strong cadre of information and data scientists, who can support the development from traditional to digital libraries and online information and knowledge sharing systems. Such experts are critical not just in libraries but in government, civil society and the private sector, and play a key role in supporting the research process. In knowledge intermediary roles they also help shape policy debates and can play a key role in bringing together issues related to information, development and governance, and knowledge sets that are increasingly complex and driven by different power interests.

There is a particular need for significant investment in developing skills to manage digital repositories and knowledge sharing systems. A lack of technical expertise and awareness of good practices currently holds many OA repositories back from becoming more than merely confidential secondary libraries for institutions, and from sharing in ways that aggregate resources, impact and benefits.

Knowledge Intermediaries

Knowledge intermediaries - media, civil society organisations, knowledge managers - will continue to play an important role in connecting and translating knowledge among different groups in society, and in helping set the agenda for public discourses around relevant issues. It is important to continue to develop skills that make use of local capacity and contextual knowledge to support the needs of researchers, policymakers, practitioners, private sector entrepreneurs and the public. This means investing in the capacity of knowledge intermediaries, information and data scientists, and skilled experts who can work at the intersection of development, information science and governance.

Research and Digital Scholarship

More investment is needed in African research. Many African countries have poor incentives for research, focusing instead on teaching, and consequently lose many of their best researchers due to a brain drain. Investment needs to be targeted - e.g. National Research and Education Networks need more investment so researchers have more access, and an enabling environment. It will also be important to develop strong regional data sets on digital library content and use, providing valuable information on supply and demand side trends. This should inform development of research and strategic development of online content and digitization programmes.

Education Curricula

Education systems need to produce students who, from an early age, are digitally literate and fully aware of the tools for knowledge navigation and the opportunities that can be found online. This includes ICT training, but goes beyond this, to equip students with awareness of the pitfalls and challenges of the virtual world. Curricula need to be relevant to the national and local context and labour market, but also imbue students with lifelong skills for seeking and critically assessing knowledge.

Infrastructure and Tools

Regional, National and Local systems: Investment and coordination are needed in regional, national and localised repositories

or knowledge sharing systems. The latter require collaboration across countries as climate change and epidemics for example are not framed within a single country. In particular, support needs to be given to digitization programmes that are demand driven and targeted at making local and global thematic research relevant to the SDGs and post-2015 development agenda in Africa available on relevant and accessible repositories and knowledge sharing systems. There is a need for user-friendly platforms to communicate scientific discoveries to nurses, farmers and the public more widely.

Search and Discovery Tools

The ability for people to find the information they need depends on how open and available relevant content is, the design and functionality of the search and discovery tools, and the skills of the information seeker. Academic researchers often need specialised search engines to help discover relevant materials that Google searches alone fail to render, in many cases also providing quality assurance. Social media have also started playing an important role in the way information and knowledge is discovered, be it via direct marketing, discussions or debates that can take advantage of the social graph that some social media sites have built to help spread the message within a group. Having material in different places can also enable information to be more easily discovered. Aggregators which can be thematic, regional or country-specific can also help. Better approaches are also needed to customise the way information and knowledge is discovered. By combining users' data on behaviour, interests, location, and demographic, discovery tools can become more powerful and specific to individuals' information needs.

Knowledge Sharing Systems

Participants in our workshop were divided on whether digital repositories were the best way forward to support open knowledge sharing. This was due to the mixed performance of existing repositories in Africa, the current disincentives to use them, and some of the technical and funding challenges in supporting them. However, it is also evident that there has been significant growth, particularly in DSpace repositories in Africa, in recent years. There is also a nascent but growing enthusiasm for the possibilities that repositories hold for aggregating online resources, making them available, and implementing review mechanisms for quality assurance.

Crowdsourcing Tools

Crowdsourcing methods will increasingly become a tool for gathering data, ideas and perspectives in useful ways. They can help to identify development priorities down to the community level, set relevant agendas, and resource talent and funding to innovative solutions that are feasible and appropriate to the context. Similarly, crowdsourcing tools should be developed to help governments determine needs, research appropriate solutions, and monitor the impact of their projects. Civil society can also hold government to account through crowdsourced information.

Crowdsourcing methods should also be used to more effectively monitor goals around issues such as digital competencies, free and open access to information, privacy rights, right to be forgotten, and level of service, with indicators to rank country commitment to achieving these goals which could themselves be refined and updated via crowdsourcing.

5. Conclusions

The study enabled interaction with a diverse range of stakeholders and hear their views on the critical issues for knowledge sharing in the future. It also scanned relevant literature and used Foresight methodologies to structure the analysis of drivers of change and potential future scenarios, and put forward a range of important

recommendations relating to policy and strategic approaches.

The study revealed that we are at an important and formative moment in relation to how we shape development in the Digital Age. Some see rapid changes ahead as technology propels us to find new solutions, while others are more sceptical and see little likelihood of the poorest benefiting in ways that address their needs. It is, however, clear that the kind of knowledge infrastructure, knowledge intermediary skills and capacities, and related governance systems that we create in Africa and developing countries will be hugely significant in shaping the lives of citizens and addressing development challenges in an inclusive and equitable manner.

The implementation of the SDGs and post-2015 development agenda needs to be supported by significant and well-coordinated investment in the knowledge sector. It should have its own clear targets and engage citizens in monitoring activities to ensure that knowledge is openly shared wherever possible, and that goals for the type of digital development we are seeking are also identified and achieved at local, national and global levels. In this way, we stand the best chance of delivering the outcomes that mirror the preferred scenario discussed in the study.

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