INFORMATION NEEDS FOR BASIC RESEARCH: AN AFRICAN PERSPECTIVE

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Abstract
Effective research and development and or science and innovation system in any country and the world-over depend on a strong base of basic research. One of the challenges that Africa faces is human resource development to deal with a magnitude of problems and challenges of the continent and contribute to the world economy. Basic research and the management of research endeavours contribute to both the development of the much needed human resources and the generation of knowledge for solving problems and dealing with challenges that face the continent and the world. Both researchers and managers of research and innovations, in the course conducting, participating and developing human resources through basic research, experience a variety of information needs. Information needs by their very nature, are affected by various factors including economic, social, psychological and geographical location or context within which a category of information users like researchers and research managers work. To facilitate basic research and thus enhance research and development or maintain a consolidated system of science and innovation various inputs are required. Key among these is the identification and satisfaction of the information needs of stakeholders involved in basic research. This paper explores key information needs of researchers in Africa. In setting the scene for this discussion, definitions of key concepts like basic research, research and development and information needs are provided. The paper high lights the context within which African researchers and research managers operate and how these in turn influence and determine research information needs. It provides some practical solutions in dealing with research information needs.

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Introduction

Systematic and planned investigation of human phenomena and problems or basic research is one of the key modes of knowledge production. There are other modes of knowledge production, principal among which is Mode 2 (of knowledge production) popularized by scholars like Michael Gibbons. This paper however, only focuses on basic research conducted through the traditional scientific enquiry[1] - a form of knowledge production governed by a complex of ideas, methods, values and norms.

An effective science and innovation system in any country and globally depends on a strong basic research base. In addition to knowledge production, basic research facilitates the development of human resources that is required for knowledge production, application and renewal. Bawa and Mouton (2002; pp 296-97) argue that

> *The ability of a nation to claim as its own a sustainable body of natural, human and social scientists [and indeed knowledge] helps enormously to build the confidence of [a] nation. The creation and development and maintenance of this intellectual culture [in a country and continent] depend fundamentally on the research culture of its higher education institutions.*

In the process of conducting and managing research both researchers and managers of research and innovations experience information needs. These information needs must be satisfied in order for the science and innovation system to function effectively.

This paper discusses information needs of researchers and managers of research from an Africa perspective. A word of caution with respect to the generalization of an "African perspective" is however necessary. Africa and its research setting are complex and not a homogeneous environment. African countries themselves do not necessarily have homogenous research environments. For example many of us are aware of the imbalances that had been created in all sectors of the South African society, including the

[1] "Science and scientific inquiry" in this paper are taken to mean and encompass the whole spectrum of knowledge generation across all fields including the naturals and applied sciences; human and social sciences.

science sector, due to the apartheid system of government. Bawa and Mouton (2002, p. 299) [again] point out that during the apartheid period [1948 to 1994] a fragmentation of the higher education system, which is a key intellectual base for scientific knowledge production, occurred, differentiating between historically white Afrikaans – and English medium universities and introducing 'ethnic-based' universities. Although the country has made great strides in the last ten years through various policies and strategies which are aimed at developing a coordinated and effective national science system, there are still some gaps between the various constituencies of the research environment. Therefore, although this paper ventures into addressing the "African perspective" it does so with caution and the audience has to be aware that there are some exceptions. The paper is divided into the following sections: Why information needs?; Basic research in knowledge production and human resource development; Research information needs in Africa; and the Conclusion which looks at meeting research information needs within the context of open access and the public domain in digital data and information for science

Why Information Needs?

To get a better understanding of information needs it is necessary to first understand the related concepts of data; information and knowledge, and their relationships in what is often referred to as the DIK pyramid or chain. Data is the foundation of knowledge. It is a set of symbols to which rules of syntax are applied. Data are observable facts of a situation or the ingredients that make up an event. It is unstructured, isolated and context-independent, but capable of interpretation within a particular context. When data is contextualised it is converted into information.

Information is defined as ideas, imaginative works of the mind and data of value that is potentially useful in decision making, question answering and problem solving (Kaniki 1989; p.19). It can be viewed as a commodity which reduces uncertainty. Information brings a state of awareness of available data. The acquisition of information and its appropriate application can lead a person to a state of knowing. The state of being informed is functionally central to the generation of new knowledge or understanding - the use of such understanding to deal with problems and for a person to provide the value of experience or knowledge to others, which is often referred to as knowledge transfer.

The highest level of the DIK pyramid or chain is knowledge. Probst, Raub and Romhardt (2000, p. 24) define knowledge as:

> *...the whole body of cognitions and skills which individuals use to solve problems. It includes both theories and practical, everyday rules and instructions for action. Knowledge is based on data and information, but unlike these, it is always bound in persons. It is constructed by individuals, and represents their beliefs and causal relationships*

Knowledge is information combined with personal know-how. This means

> *...more often than not, knowledge is dynamic, fluid, and ever-changing. It is expressed through use – in a moment of making or deciding or teaching or learning or changing... while [it] can often be captured and structured [there is a lot of it] that is intuitive and mutable*...(Curley and Kivowitz 2001, p. 29)

Because information is central to the discussion of information needs and pertinent to this paper, it is useful to look at an additional key characteristic in the light f the definitions of data and knowledge. Unlike knowledge which is always bound in individuals, information is peculiar in that,

> *...when [it] is transferred from source to recipient or seller to buyer, it remains available to both. Unlike the sale of a material product, information transfer does not give the recipient the right of exclusive use, nor is there usually any effective bar to his/her deliberately sharing the information with others [in spite of the various intellectual property rights laws and regulations such as copy rights; patents; trademarks and trade secrets etc]. ...it is rarely required for itself alone - it is usually only wanted because of its potential contribution to some human activity [or state of knowing]*. (Vickery and Vickery 1987, p. 27)

In research or knowledge production or the DIK chain/ pyramid therefore each of the elements [data; information; and knowledge] are dependent and complimentary to one another. The availability of relevant data that can be appropriately contextualized is crucial to the process of knowledge production and utilization. Information brings awareness to the receiver of the relevant data in a particular context and reduces uncertainty. It provides the receiver with the prospect of making decisions about specific situations; solving problems and answering specific question about phenomena. Knowledge on the other hand provides the person who has it or the knower with the ability, know-how and skill to make judgments and act upon a given problem. The

knower can transfer this knowledge to others and can in the process of acting upon a specific problem, produce new data and information! Thus making the DIK chain a spiral

In other words, for data to be meaningful it has been organised, contextualised and related to particular situation(s) or phenomena. It must be transformed into information. For example, although an individual may recognise a series or set of numbers, if such numbers are not organised, given meaning and or context they would remain meaningless. However, if the set of numbers are organised in a spreadsheet and labelled as food production statistics over a number of years, for the different countries of the (Southern African Development Community) SADC region they would be useful to someone who has the capacity to use them – for example, someone who may want to reflect on the impact of drought on food production over the years within the region. If the person has the know-how and/or necessary techniques, that is, knowledge to manipulate the data and thus be able to forecast or create models about future food production and food needs in the region, he/she can do so by using the relevant information. To transfer knowledge from one person or group of persons to another on the other hand, the knowledge has to be converted and conveyed in form of information. The extent to which a person or group of persons assimilate and utilise the transferred knowledge depends upon a number of factors some of which relate to cognitive and environmental capacities of the persons involved.

Chen and Hernon (1982) have argued that individuals or groups of individuals and indeed organisations and or governments often find themselves in situations where they must make decisions, answer questions, locate facts, solve problems and or understand something. Such situations cause imbalances in homeostasis and create uncertainty or uncertainties that manifest into need(s). To minimise and or eliminate the uncertainty and or satisfy the need, individuals, personally or as members of or on behalf of an organisation seek and must be provided with information. Information must be given and transferred by somebody or by some source to another person or body through some channel and received by the person requiring or seeking it (information).

In the process of conducting and managing research both researchers and managers of research and innovations experience information needs. These information needs must be satisfied in order for the science and innovation system to function effectively. However, in order to satisfy information needs a number of activities or conditions are necessary. Principal among these are that:

1. Information needs must be identified and assessed,
2. Information systems that contain appropriate information resources and actual information must be identified and or developed,
3. Appropriate information delivery systems or channels must be used to communicate and or share the information and
4. An assessment and measurement of the impact of the information communicated must be done.

Some of the information used for decision making is based upon internalized information, namely, acquired knowledge or localized information, within an organization or country. Often however, human problems, organizational decisions and government alternatives like the use genetically engineered and chemically treated maize [corn] in the drought-hit Southern African countries are too complex to be dealt with simply by localized or internalized information or knowledge. They require different types of information and data from a variety of sources. This is even more critical in the global economy where individual countries' decisions and activities affect others. Therefore, availability, access to or sharing of relevant data and information about activities in other countries are critical in order for any country and particularly those of Africa to deal with complex situations. However, as I (Kaniki 1985: 19) and many others have argued, in order to provide relevant information there is need to understand the various needs of the different stakeholders in research and the context within which they operate. Information needs even among people, organizations and countries of the "same" group or class will vary due to different factors such as education, economic status, geographical location, availability of information systems and services, awareness of the available information systems and services, access to these services and several other variables.

One of the major reasons for the interest in the study of information needs and information flow is the desire among scholars like information professionals, knowledge producers and managers to gain a better understanding of the conceptual framework of information needs. A better understanding of the situations, circumstances, processes and behaviour involved and circumstances in which people seek and utilize information is important. This author has gone on to argue elsewhere (Kaniki 1989, p. 65) that this desire is driven by the conviction that by understanding the need for information and the use to which information is put, information professionals can effectively design and evaluate information systems and services.

Bishop (1994, p. 695) has candidly summarized this argument within the today's electronic information environment by stating that:

> *The success of institutional networking endevour – and national efforts such as those associated with the National Research and Educational Network or, more broadly, the National Information Infrastructure (NII) – depend on the development of network features, policies, and support programs that are based on a solid knowledge of users' needs and habits and substantiated links between network use and engineering outcomes.*

In spite of the fact that the study of information needs has be bedeviled by a lack of theory, the many studies done over the years and models advanced developed over the years have provided us with some understanding of their peculiarities of needs. Information needs are affected by different factor including demographic, cognition and environmental factors.

Basic research in knowledge production and human resource development

Let us temporarily move away from the discussion of information needs per se and briefly look at basic research in knowledge production and development of human resources. Basic research is defined by the Frascati Manual (OECD 1994, par 57) defines as:

> *Experimental or theoretical work undertaken primarily to acquire knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.*

However, research and development which the same manual defines as "…creative work undertaken …in order to increase the stock of knowledge… and the use of this knowledge to devise new applications" is dependent on existing knowledge that is gained from basic research and or practical experience. It draws upon human resources or expertise that is able to think, plan investigations and operate systematically to generate both basic and applied research – a cadre of human resources that is developed through the basic research process. A strong base of basic research within a country or continent like Africa is critical because it provides the "laboratory" if you will, for learning the know-how, know-why, and basic techniques or skills necessary for identifying phenomena and or problems, investigating them, analyzing and interpreting the outcomes. Some of these outcomes of basic research are applied for innovation purposes, in the R&D environment. It is highly unlikely if not impossible that a cadre of research and experimental development (R&D) experts that are required for the applications of basic research can be produced through R&D alone or Mode 2 of knowledge production. Higher Educations Institutions (HEIs) particularly in Africa are the key contributors and or are expected to be the key contributors to basic research. Because of this Bawa and Mouton (2002; p297) argue that "…the creation and development and maintenance of intellectual culture [in a country] depends fundamentally on the research culture of its higher education institutions. It therefore follows that a poor research culture and system of higher education institutions will negatively impact on the basic research output and development of research experts.

Research information needs in Africa

As argued earlier information needs even among people, organizations and countries of the "same" group or class will vary due to different factors such as, levels of education, economic status, geographical location, availability of information systems and services, awareness of the available information systems and services, access to these services and several other variables. The degree or level of need for information will thus vary from person to person or among groups of persons and from time to time. The context within

which a person and or group of persons operate is crucial to determining the level of need and prospects of providing appropriate information.

In a book entitled *Africa in the Millennium* (2001) edited by Maloka and Le Roux various scholars have presented the current African politico-socio- and economic context within which the science sector operates. The authors highlight issues of inter-ethnic conflicts and war; regional and fragmentation of the African leadership; recurrence of military governments; economic stagnation and international marginalization. They also mention the faltering democratization and instability; pressures from the global economy which they argue has historically been hostile to Africa leading it to increasingly occupy an ambivalent position in the world economy and reflected in its marginality. The authors also highlight other constraints and or challenges that Africa faces. These include: shrinking international aid; environmental challenges; the HIV/Aids pandemic; migration or scientific diaspora or brain drain and xenophobia. More directly related to research and knowledge production, transfer and utilization, these scholars have highlighted internet connectivity constraints; commodification of knowledge and the problems of knowledge production and dissemination. Adebowale for example, has specifically highlighted the marginality of African scholars by showing that between 1982 and 1992 African human scientists did not publish in the four key geopolitical African journals as compared to their counterparts from the north!

World development indicators 2001 on aid dependency; science and technology expenditure; the information age including per capita daily newspapers, radios, television, facsimile machine, personal computers and Internet connectivity of African countries does not seem to paint a different picture as that presented by the above scholars. It must be pointed out however that some country like South Africa has more internet connectivity than other African countries. A country like Uganda for example, has recently increased per capital cellular phone distribution in the country.

As argued earlier higher education institutions form the base for basic research in most Africa. Few countries like South Africa and Egypt for example have more that one science councils which actively participate in the basics research arena with HEIs. Most of these HEIs depend on government funding either partially in the form of government subsidies and or fully for their academic and research endevours. Because of the pressures that HEIs face and the fact that they have the various roles like teaching, research and community development, little of the funds and in the majority of cases, no funds are invested or set aside for research, knowledge production and management. While Adebolwa highlights the lack of publishing among African scholars, many HEI's have not renewed their journal subscriptions for many years due to rising costs; have no research equipment and appropriate system for managing research!

Another key peculiarity of the African science sector is the general lack of and or up to date science and innovation polices in most countries, for the coordination and facilitation of science research and management. Furthermore in many of the African countries government branches themselves are involved in research, while at the same time being responsible for policy formulation and monitoring of policies and strategies. This is very common in ministries of agriculture, veterinary water and so on in which research units and or stations carry out basic research.

It is against this background that African researchers and research managers operate. It is against this same background that African researchers are expected to compete with their colleagues in the international research arena and contribute towards the global research output. An effective research process requires an awareness of who is doing what; what kind of research is being conducted within a specific field, the data generated and the knowledge that has already been generated. These data and information form the basis for further research. Therefore, similar to their counterparts elsewhere, researchers need information about and awareness of the current research in their own fields. They need to keep abreast of new knowledge and developments in their fields. They also need to be networked with colleagues in the same fields. However, in the current circumstances as

painted above, the majority of African researchers find it extremely difficulty to achieve this.

Research and innovation managers who also operate in the same environment like researchers, experience similar information needs, but to a different degree. More specifically however, they need information on experts in particular fields. This provides comparative data for analysis of the output of institutions and countries. They also need information on applicable and adaptable indicators for research output and productivity. Most importantly though, research and innovation managers need information on applicable and adaptable indicators for assessing impact of basics research and the transfer of such research into the innovation arena.

It is almost impossible for one research institution or country to fund and resources (in terms of expertise) all the research in every field. Therefore researchers and research managers need information of sources of research funding around the world and collaborative possibilities within a country and internationally. This requires an effective research information management system. In addition, research managers need information on processes and procedures for accessing such funds. For example, it is my understanding that the Nation Health Institute (USA) requires that persons they fund must have completed a comprehensive course and certified in research ethics.

The need for intellectual protection is crucial for both researchers and managers of research. For managers of research, they need to know whether or not a particular idea or innovation is protected. They also need information on the processes and procedures for protecting intellectual rights of researchers within their institutions, country and internationally. Research and innovation managers in turn provide advice and guidance to researchers on intellectual property rights (IPR) and transfer of research output into innovation. Related to IPR is of course the need among researcher managers for information on the costing of research outputs and or innovations.

The need to identify key areas of research and research capacity development within a country is critical for researchers and research managers. This is necessary in order to achieve a balanced and coordinated national development. However, it requires a clear national agenda supported by national science policy and strategy. Unfortunately, as we have noted above, few African countries have clear and up-to-date policies and strategies for science innovation systems and human resources development. In some countries like South Africa there have been attempts to set national priorities or agenda. The White paper on the national system of science and innovation for example, aims at coordinating the science sector and putting in place the strategies and systems for effecting the policy. The National Research Foundation (NRF) in South Africa is tasked with among other research capacity development, funding and national human resource development. In meeting this main mission the NRF has among other activities, identified research focus areas that it funds and put in place specific programmes for funding students and research capacity development in general.

These information needs are not unique to African scholars and research managers. However, the peculiarity of the African context is that researchers and research managers spend a lot of time to access information on basic research problems and research management because of the context within which they operate. For their counterparts of the north these are almost taken for granted because information on these matters is generally easily available and accessible. African researchers are expected to deal with these basis information needs and in addition expected to deal with other research areas as those by others of the north.

Conclusion

What are the prospects of meeting research information needs within the context of open access and the public domain in digital data and information for science? This paper has shown above that in research or knowledge production or the DIK chain/ pyramid each of the elements [data; information; and knowledge] are dependent and complimentary to one another. The availability of relevant data that can be appropriately contextualized is crucial to the process of knowledge production and utilization. Data are the basic building blocks of research findings and the availability of relevant data is indispensable for the

validation of research results. With digitization and the availability of the whole gamut of information and communication technologies, including the internet and its resources and services, research data has developed from a supporting role into a strategic one. However, the research data though available out there "somewhere" [in cyberspace] needs to be accessed, contextualized and used. The best known technique today is that of data mining. This process implies "mining" the databases for patterns or connected bits of data or information that can be assembled into a large picture. By pulling together various data from different sources, African researchers can generate new knowledge from the data assembled in the databases. It also means that the databases have relevant data populated by research from Africa itself. This of course means that we have to take into consideration the legal and economic views that are presented by others at this symposium.

In view of this the role of the African Union and particularly the New Partnership for African Development (NEPAD) initiatives becomes relevant. As an integrated strategy NEPAD aims at eradicating poverty and enhance sustainable development. There are four pillars to the NEPAD strategy these include:

1. The promotion of cross-border co-operation and connectivity, utilization of knowledge currently available in centres of excellence on the continent. This of course assumes that these centres of excellence are identified and they will continue to be sustained.
2. The development and adaptation of information collection and analytical capacity [see also Chrisanthi Avgerou's paper] to support production activities as well as exports. This of course assumes that the technology and expertise for efficient information collection and management are available and accessible
3. The generation of a critical mass of technological expertise in targeted areas that offer high growth potential, especially in biotechnology and natural science; and
4. The assimilation and adaptation of exiting technologies in to diversity manufacturing

As the Minister of Arts, Cultural Science and Technology, South Africa Dr. B Ngubane in his Key note address to the NEPAD workshop on *A Framework for Science and technology* held at Sandton in Johannesburg South Africa, 17 February 2003 however, stressed that "…strategic significance of the platforms lie in their focus on strengthening of regional and sub regional cooperation through the use of geographical information systems (GIS), through the convergence of products standards, quality and control and the integration of excellence in spheres of biotechnology and natural science".

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