

Shaping National Science and Technology Base with Policy: A Case Study of Gambia National Science and Research Policy (2006-2010)

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Abstract

This paper evaluated the contributions of science and research policy to the development of creative and innovative research and the science and technology base of a nation. Using case study strategy of inquiry, it addressed the research question of whether the science and research policies of the Gambia (2006-2010) could significantly shape the science, technology and innovation base of the nation through mediating effects on scientific activities. In contributing to empirical discussions in literature on policy implications for scientific activities, the paper suggests, first, that using public policies, research institutions including universities, could be strengthened to expand and improve national science and technology base. Public policies that foster scientific linkages and collaborations could contribute in building appropriate research competences of scientists, encourage the introduction of new and innovative ideas, and generally expand the national science and technology base. Second, the paper argued that in low income countries such as the Gambia with limited funds for research, the absence of a national science policy framework could lead to donor rather than demand driven research agendas, as research and innovative efforts would produce little research outcomes and necessary technologies to expand the national science and technology base.

Keywords: Science and technology, policy, innovation, scientific performance, higher education.

1. INTRODUCTION

Public research and development programs seek to enhance research competitiveness of research institutions and universities by providing support for academic and industrial/applied research and development. Such support could include improving research governance, funding, infrastructure, skills and capabilities of researchers in public research sector. The long term goals of these programs often focused on bringing about systematic change in science and technology environment that are critical for sustained scientific knowledge development. This is even more so in view of the massive contribution of scientific knowledge development to a state like the Gambia still struggling to build and sustain its science and technology base. Hence in this context, this paper examined the contributions of science and research policy to the development of creative and innovative research and to the development of national economy, and using case study strategy of inquiry, contributes to the ongoing debate in literature on issues of policy to foster scientific activities and evaluation of such activities. It addressed the research question of whether the science and research policies of the Gambia (2006-2010) could significantly shape the science, technology and innovation base of the nation through mediating effects on scientific activities. The inquiry is also theory testing, in the sense that the subject of study is considered a critical case having strategic relevance to the general theoretical position in literature, which links public policies to scientific activities. In this context, the study aimed at generating and testing hypothesis using test of falsification in the fashion: if the observations in the **case** fail to fit with the theoretical preposition in literature, then the theory is considered not valid and must be revised or at worst rejected. Otherwise, the theoretical relevance of public policies to scientific activities is accepted. The preceding section 2 evaluated literature on issues of policy to foster scientific activities. Section 3 detailed the background of research, and in section 4, the paper examined the analysis strategy, which is evaluative and theory testing case study. Section 5 described data collection methods and analysis, which is qualitative involving induction while sub section 5.1 provided details of key findings and discussion of results. The paper ends with concluding remarks and recommendations in section 6.

2. LITERATURE REVIEW

In the context of global competitiveness in the generation of knowledge and the necessity to keep pace with scientific progress, the Gambia faced with the challenges of developing its science and technology base, may

have a compelling need to use policy to foster scientific activities. However, there remains a persisting problem in literature, namely answering the question of whether public policy could be used in shaping, fostering, and evaluating scientific activities. Though issues of policy to foster scientific activities and evaluation of such activities are still under debate in literature (Aksnes and Rip, 2009), state policy may be instrumental in fostering external research collaborations (van Raan 2004) as well as shaping governance of research to serve as powerful driver of scientific activities. Several positions are taken in literature on the issue of policy impact on scientific activities. (Talsma, et al. 2008; Lavis, et al. 2008; WHO Report, June & Aug., 2010) argued that intrinsic and dynamic link exists between public policy and scientific research and clinical practice. In a study of the impact of research, practice, and policy on health, Grady, (2010:268) stated:

the parameters and policies that influence health and health care including environmental, educational, and economic policies, as well as those dealing directly with health and science, are intrinsically and dynamically linked to our scientific research and clinical practice...[Research and policy] are intrinsically linked through dynamic interrelationships, which are characterized by synergies, resonance, and reciprocity...policies [are developed] to better support and facilitate those areas of research that hold promise for advancing the health and well-being of our nation and people around the world, and for advancing basic scientific knowledge and technological capabilities.

In addition, a National Report of Croatia (2007) underscored the use of policy-directed instruments to stimulate research in biotechnology. Generic programs embodied in State policies were directed at promoting human resources for scientific research, and supporting research infrastructure as well as technology transfer through collaborative projects and company creation. In brief, the issues of policy to foster scientific activities center on the ability of policy to attract public and private funds for research as well as the relationship between publication quantity and quality considering the impact of policies and evaluations (Aksnes and Rip, 2009). Where national policies and systems of evaluation of scientific performance emphasize bibliographic measures, scientists/researchers could be pressurized to embark on short-term research rather than long-term quality publications in reputable scientific journals. On the contrary, policies that focus on quality and qualitative indicators of performance could at once loosen the pressure on scientists to publish. In addition, such policies support intrinsically motivated behavior, which is critical for creative and innovative research (Osterloh and Frey, 2009). It follows that policy emphasis could trigger a shift in the scientist's publication behavior. A similar shift in funding behavior of the scientist (i.e. whether to go for research grants or external funding for that matter) could follow. In most cases research institutions and universities pursue policy objectives of attracting research grants and external research funding/orders while governments through appropriate policies foster collaboration with industry in support of applied research or consultancy. Institutional as well as individual researcher's capacity to attract research funding is often considered as proxy of quality and relevance of research. Strong evidence from literature suggests a link between source of research fund and scientific output. Research and Development policies and investments as well as contracts could have profound influence on scientific activity and outcome of research. In the context of policy impact on scientific activities, Moed (2008) in his study of evaluation criteria applied in UK Research Assessment Exercise, further demonstrated a shift in scientists' behavior from 'quality' to 'quantity'. Some studies (e.g. Hayati and Ebrahimi, 2009) found significant association between quantitative and qualitative indicators of performance and scientific publications. While Osterloh and Frey, (2009) argued in support of policies that focus on a combination of quantitative and qualitative measures of scientific performance, (Dewett and Denisi, 2004) argued that quality, creativity in particular is more important than quantity oriented publication behavior for the purpose of garnering reputation. In the context of this ongoing debate in literature, our work contributes to these discussions on the linkage between public policy and scientific activities.

Nevertheless, empirical evidence tends to show that science has the potential for improving the wherewithal of society and increasing the wealth nations (Henry, 2002; Kealey, 1996; Bacon, 2000). Research generally makes invaluable contribution to a society's economic, social and environmental goals. This study cannot view the science and research system in the Gambia in isolation from the critical linkages with education, innovation and the nation's policies and aspirations. Formal higher education, particularly universities have over the years increased in importance as centers for creating and transmitting knowledge and the mainstay of efforts all over the world to strengthen national economies, generate innovations, and support and improve quality of lives of peoples. The public research system, though narrower than the national research system that includes business actors, research and technology organizations as well as a wide range of stakeholders who contribute, fund, support, work in, or make use of research, are situated within specific and highly diverse environment. This environment consists of systems, ranging from large federal-state systems with considerable capacity in strategic research, to small systems with a handful of research stations carrying out mostly adaptive research such as those found in some parts of low-income African countries. These systems are found within the broader national innovation system, implying the existence of pluralist research systems as each is located in specific sector and performing different types of research. A significant feature of a public research system is that research and

knowledge production are activities developed within an organizational context. Consequently, this requires not only an inflow of human resource (researchers and other highly skilled workers). It also requires that public research policies recognize the dynamic and evolving nature of public research system and develop open and mutually beneficial interactions and learning among the principal stakeholders or research performers such as individual researchers, universities and research institutions. In most European states, such policies are adaptive, though to a much lesser extent in developing countries. Other research performers may include research funders such as Research Councils, Business, Sectoral Ministries, NGOs and beneficiaries of research such as businesses, governments, and the society. In other words, research and knowledge production engaged in an ecosystem. While sharing similar starting points with system approach to research and innovation, the ecology approach regards the research and innovation system as an ecosystem. This means bringing in the benefit of focusing on the "distribution and abundance of research performers and knowledge and their interactions with each other and the broader environment" (European Commission, Report of ERA Expert Group, 2008:23). Policy approaches that think of research and innovation system in this way can raise the quality of research by improving connectivity and communication between actors who perform, support and use research. The works of (Bowdon and Miyake 2000; Coombs and Georgehiou 2002; Dvir and Pasher 2004; and Wulf 2007) reflect this growing tendency to apply the ecology analogy to knowledge production and innovation. It is therefore in the context of the framework of this ecology theory that public research system and science and research policies of the Gambia are closely examined and analyzed with a view to generating and testing hypothesis and establishing generalizable conclusions.

3. BACKGROUND OF RESEARCH

The Gambia has a network of public research institutions with external linkages operating alongside the sole university of the Gambia. These institutions specialize in agriculture, natural, social and human sciences. The major research institutions and laboratory units in the Gambia include the following:

1. The National Agricultural Research Institute (NARI). Established in 1994, the NARI is a public research institute and the sole institution in the Gambia active in plant breeding and crop improvement. It is a member of the System-wide Information Network for Genetic Resources (SINGER) of the International Agricultural Research Centre System. Since inception, NARI conducted most plant breeding activities in crop research. The majority of the varieties used in plant breeding in the country are however old improved varieties or traditional varieties. In plant breeding, the institute maintains external collaborative links with international agricultural research centers such as WARDA, IITA, IRRI, CIMMYT, ICRISAT and evaluates the local adaptation of inbred plants to farmers' conditions in the country. The Institute used Hybridization on a limited scale to generate segregating materials for rice and maize, but so far have released no varieties from these activities. Plant breeding activities mainly focused on the major arable crops in the country. In its research programs, a major problem for NARI in the last two decades has been the lack of breeders as well as lack of funding, which hindered training, research activities and the retaining of plant breeders.
2. The Open University, a British university with interest in delivering learning and supporting research inside Africa, maintains collaborative relationships with research institutes in the Gambia. The University engages in collaborative research exchanges with the Medical Research Council (MRC) Laboratories in the country. The Open University has a large research and clinical unit located in Banjul, and the major theme of its collaborative work is translational research in infectious diseases in the Gambia.
3. Established in The Gambia in 1947, MRC, the Gambia Unit is the UK's single largest investment in medical research in a developing country. The Unit's research focuses on infectious diseases of immediate concern to The Gambia and the continent of Africa, with the aim of reducing the burden of illness and death in the country and the developing world as a whole. Currently, the MRC unit in The Gambia has new plans for the next five years, which includes focusing its science on three new themed areas: Child Survival, Disease Control/Elimination, and Vaccines. The Council has particularly shown interest in studying some of the leading causes of illnesses and death in the developing world for almost forty year. MRC, the Gambia has the unique capacity to carry out internationally competitive laboratory, field and clinical research in a single institution.
4. The University of the Gambia established in 1999 has over the years built and sustained interest in basic research in major fields of science that include agriculture, medicine, public health, engineering sciences, bio-chemistry, physics, economics and management, social sciences (particularly, geography, sociology, political science, and psychology). The Research and Strategy committee, a specialized research and development unit provided support and coordinated faculty research up to 2009.

Research and Development (R&D) is about creative work to increase the stock of knowledge, and to use this knowledge to devise new applications (Organization for Economic Cooperation and Development, OECD Fact

book, 2008). Investment in research and development generally reflects a government's (or organization's) willingness to forgo current operations or profit in order to improve future performance or returns. It further reflects the organization's commitment to conduct research and development, and as such has a strategic relevance. In most developing countries including the Gambia, research is mainly publicly financed and public investment in research in terms of percentage of GDP tends to be generally less than 0.1 %. Besides, there appears to be a close consensus in literature that research and development capabilities in developing countries including the Gambia do not generally meet international standards (Nath and Kumar, 1993; Mbagwain, 1995). Measured in terms of organizations devoted to R&D such as budgets, numbers of patents, or rates of peer reviewed publications, this might express the state of an industry, the degree of competition or the impetus for progress. In this context, it is obvious that the state of research institutions in the Gambia, their competitiveness, and impetus for scientific progress rate a long distance beyond international standards because State and institutional investments in research are in fact very small.

At the apex of the Gambia public science and research system is the Department of State for Higher Education, Research and Technology, which coordinates research funding and all science and research activities. In general, specialized units or centers belonging to organizations, universities, and State agencies in the Gambia conduct research and development activities. These activities are often future-oriented, longer-term activities in science and technology that are rooted in methods of scientific research, though with unpredictable results. In the Gambia the National Agricultural Research Institute (NARI), specialized units in the department of state for Higher Education, Research and Technology, the specialist state hospital, the Royal Victoria Hospital (RVH), the Medical Research Council (MRC) The Gambia Unit, and the University of the Gambia are the core players in the R&D processes within the public science system. However, these bodies remain largely underfunded, except the MRC, which the British government externally funds. Investment programs on research generally tend to reflect less of the long-term system wide research needs and objectives. Such long-term needs and objectives may include commercializing research findings, strengthening patents, encouraging knowledge flows, expanding industrial/applied research, and improving the national system of innovation. Meanwhile, with few exceptions as in the health and agriculture sectors, much of the research and development program designs in the Gambia dwell more on pure/basic research rather than on applied and industrial research and development.

Other problems and challenges confront the Gambia science system. However in spite of these problems, it would appear that the health sector has developed a more enduring systematic framework for developing health research than most other sectors. In all sectors, major setbacks to research and innovation in the Gambia tend to arise from lack of legal and strategic framework for research, inconsistent public research policy and effective research governance structures. In the health sector though, there has been an urgent need to address an increasingly complex situation, still characterized by high burden of communicable diseases, poverty and hunger, inadequate housing, insecurity, limited education and health budgets and a human resource crisis. These and similar needs have so far justified the increasing awareness and appreciation of the value of research in all sectors in the Gambia, which can objectively address problems of society. Public policies and programs in key sectors of the Gambia economy are still grappling with how best to deal with the most pressing problems faced by the population. However, these problems are essentially African in nature and Gambian for that matter, and so demand solutions by African or Gambian scientists. This means that knowledge generated elsewhere and innovative technology developed there from, the often-called imported technology, in most cases have proved ineffective solutions to problems of African peoples. It follows further that state research policies in Africa must necessarily pursue the important goal of setting up supportive research structures and institutional condition for conduct of research in order to support the generation of indigenous research breakthroughs and technological innovations atoned to African conditions and problems.

In the Gambia, other setbacks to research arise from flow of research funds. A greater part of research funds usually came from external sources while research governance has tended to be ineffective in producing results. It is possible that source of funding as well as funding options may have some implications for research behavior of scientists and outcome of research (Ozor, 2012). Medical Research Council, The Gambia Unit, which is a non-government research institution, has conducted most health research in the Gambia using external funds. Besides, some public sector institutions in the Gambia also conduct research but these are usually small studies intended to identify and address operational issues and yet funds were both inadequate and poorly managed. In most cases, these studies resulted in very few published research results while the Medical Research Council produced a greater part of studies published in international and local peer-reviewed scientific journals. For these reasons, it is reasonable to argue that external stakeholder/funding influence could significantly affect research processes in the Gambia.

Although research activities have been going on in the country for several decades, there has been no legal or political framework for a national science system (Palmer et al, 2009). In 2002, the Gambia Ministry of Health, with support from the African Development Bank and the World Health Organization (WHO), embarked on the process of developing a national health research system. The process resulted in the development of a National Health Research Policy as a first step. The Ministry recognized the need for a national health policy but the

process depended on financial and technical support provided by Development Partners. The policy design aimed at coordinating and promoting research on health problems of relevance to the health needs of the population. The Health Ministry appointed a team to spearhead the process in partnership with a wide range of partners from public, private and nongovernmental sectors. The development of a national health research policy was envisaged as a first step towards strengthening the national health research system in The Gambia. The measures for achieving this objective included setting the stage for developing research priorities based on real needs of the health sector, improving accessibility of data/information for decision-making and the use of data for resource mobilization. These policy concerns of course highlight the problems in almost all sectors of the Gambia public science system. Other common problems include ill-equipped laboratories, obsolete physical structures and technical infrastructures, lack of requisite skills, dominant management grip over research, lack of strategic focus for achieving long-term research and development objectives, and inconsistent public research policies. Consequently, the situation presents persisting challenges, which include policy tasks of installing suitable legal and strategic frameworks for research and setting up wise research governance model and structures. In brief, a core research question is whether public policy can foster scientific activities, knowledge production and innovation for national development.

4. ANALYSIS STRATEGY: CASE STUDY

In this evaluative and theory testing case study, the Gambia science and research policy (2006-2010) is the subject of inquiry by means of which the theoretical focus or analytical framework (i.e. the defining effects of public policy on scientific activities, innovation and national economy), were viewed and explained. The research objective is thus to evaluate policy impacts on research and innovation in a single study with a view to establishing generalizable claims based on critical reflexivity theory testing framework (Flyvbjerg, 2006, 2011). This is because the study objective is also theory testing, which aims at confirming or otherwise rejecting the general theoretical stance in literature that links public policies to scientific activities. The study therefore addressed the research question of whether the science and research policies of the Gambia (2006-2010) could significantly shape the science, technology and innovation base of the nation through mediating effects on scientific activities. The Gambia science and research system and policy process are defined as rudimentary possessing none of the attributes and complexities of advanced science systems and public policy making and implementation processes, which often involved a multiplicity of actors engaged in complex competitive interactions, alliances and negotiations. Research policy process in more advanced countries appears to reflect a growing tendency to recognize and account for the evolving nature of science and research systems and the need to engage the beneficial interactions among key policy players and the environment (Wulf 2007). Thus, this study defines the subject of study, which is the **case** as having critical relevance in relation to the unsettled debate in literature that public policy could serve as important instrument for fostering scientific activities and the evaluation of such activities. It follows that evidence from the study of the **case** would be used to falsify or otherwise confirm the theory about the correlation between policy and scientific activities, and in the context of this theoretical focus, contributing thereby to the ongoing empirical discussions in literature on the subject matter. The study employed phenomenology, which involved using inductive and qualitative methods to gather close and deep information and perceptions and representing these from participants' perspectives, the epistemological assumption being that the reality of policy impacts must be presented as interpreted by informants, not possibly determined objectively. The methodology or strategy of inquiry, which is case study, determined the use of multiple data collection tools, procedures and method. Hence in this paper, employing phenomenological interviews, primary qualitative data were generated and inductively and qualitatively analyzed, though further secondary and complementary data and information were generated from institutional sources in the Gambia and West Africa including already published works in research policy literature. Besides, prior knowledge of theoretical propositions in the context of policy impacts on scientific activities was useful in the analysis of data and information. Key findings were presented in narratives of respondents, though these were reduced to standardized format and followed by more indebt discussions of results. The paper ends with a conclusion and recommendations, which might usefully inform policy process.

5. DATA COLLECTION AND ANALYSIS

Data collection involved interview of a sample of fifteen participants consisting of academics/scientists, institutional research managers and research policy makers from the Gambia Higher Education Ministry and the University. These were interviewed to observe and test the theoretical proposition that public research policy and programs impact on scientific activities, which is defined in terms of research practices/behavior, research governance processes, and performance of scientists. Overall, the analysis relied on qualitative as well as other sources of evidence.

Result of analysis of data shows that the State's participation in science and research is limited to a 'coordinating role, not supervisory or regulatory'. Participant 15, who is the Director of Planning and Research in the Higher Education Ministry, said,

the government empowers them [research institutions] and provides the platform for them to do their activities very freely...The role of the State is limited to coordinating, promoting research and generally providing the policy framework for public sector research

The Higher Education Ministry is charged with “the responsibility for policy development and the management and coordination of programs that are related to higher and tertiary education; skills training, research, science and technology for the socio-economic development of this country”. The Ministry is concerned with institutional research support in terms of funding, providing infrastructural facilities and support for human capacity development. Participant 15, explaining the coordinating role of the Ministry in terms of human capacity development, further said:

getting the right people, the required people for development of this country, giving them the right education, the right skills, the right attitude, you know, to man those development programs.....here we talking about the UTG, GTTI, MDI, etc, you know, and other tertiary institutions in the country as well as the private sector that will look at apprenticeship and technical and professional skills that are needed for the various sectors

Qualitative evidence further shows that currently, there is no comprehensive “policy on higher education and a policy direction”, though there are discordant, uncoordinated science policies at national and institutional levels, which explains the observed differences in the institutional research governance approaches and structures. Interpreting and comparing data, this inquiry found that, though a national science, research and technology policy is currently being developed, State and institutional research policies defined and shaped institutional research governance. Science and research policy created specific research conditions within the public research institutions at the national science level, and thus intervening and mediating upon research practices of scientists. Participant 14 (a senior Ministry official) said that the national science policy and the up-coming Program on Accelerated Growth and Development (PAGE) are designed to,

create a situation where you bring in people with that competence, that technical competence; people with training at different levels, and also create the funding, for example, national research funding that is completely recognized by the State resources; create that situation where we can go into industrial research as well as academic research.

Overall, results from analysis of qualitative data indicated that the defining factors of State and institutional research policies impact on research practices/behavior. By means of intervening influence on research governance, State and institutional research policies impact on research practices and performance. Research practices/behavior is defined in terms of the scientist’s choices/decisions about his work. These choices or research related behaviors include funding, publication, and communication behaviors (Ozor, 2012). In addition, result from analysis of qualitative data further indicated that the defining influences of State and institutional policies tend to shape the development of human and overall institutional capacity for research. Non policy prioritization of human capacity development implies that development of individual skills and expertise for research is inadequate and non-supportive of research. However, State and institutional policy emphasis on external collaborations tended to produce a counterbalance as these policy stance actually “ ‘enhanced human capacity’ and produced ‘quality [research] and added value’. In this context, qualitative evidence showed that, though limited research is taking place and public and private sector linkages and support for research are still expanding, institutional science policy nevertheless encouraged collaboration, particularly external exchanges. Apparently, external networks and contacts with external educational and scientific institutions are growing rapidly. Qualitative evidence further indicated a high degree of preference among academics and scientists to interact with colleagues from other universities and research organizations. There is also evidence of some degree of internal co-authorship networks. Publication data and information obtained from institutional databases showed that all publications by respondents interviewed were ‘offshore’, that is, papers published in international scientific journals. Collaborative research exchanges positively affected the ‘capacity’ of the scientist to conduct research. Respondents believed that collaboration with international research institutions could “give you insight into other research activities that are taking place elsewhere in the world” and could also help to “build relationships between researchers in the international arena”. Besides, Participant 5 stated that collaboration expanded the scope of his research interests. Participant 13, a medical scientist, added,

those kind of collaborations, whether with funders, industry, or even among colleagues, you know...elm brings out the best in research because definitely surgeons have an expertise in certain areas and if we have people who are good statisticians for example, we would have made excellent combination to collaborate with such kind of people

Moreover, respondents thought that “collaborative research reduced costs and time [spent on research]”, expanded funding sources and provided opportunities for dissemination of research results.

5.1 SUMMARY OF KEY FINDINGS AND DISCUSSION OF RESULTS

In recent years, the benefits of developing effective science and technology (S&T) and innovation systems seem to have informed the Gambia higher education and research policies. Report of the Gambia Round Table Conference, (2007:2), which produced A Higher Education Strategy Paper, 2007-2011 states that,

With higher education come new specialized knowledge and skills. In addition, with increased capacity come the ability to improve one's socio economic condition and contribute to the overall development of one's country. At the national level, it is understood that a well-educated and highly skilled labor force is a pre-requisite for economic growth and socio-economic development. In order to achieve the kind of socio-economic and technological progress envisaged in The Gambia Inc. _ Vision 2020, there is need to develop a critical mass of university -educated people who are able to apply the products of research, science and technology to increase the productive capacities of the country. Indeed, the education sector is expected to continue investing in training infrastructure to produce a continuing stream of technicians in order to cater for a diversification of economic and social activities (GOTG, 1996:39).

However, qualitative and existing evidence established that the Gambia has not yet developed an effective science and technology system, and the country "currently lacks a science, technology, and innovation policy to define national S&T objectives and priorities and to provide a policy framework to underpin socioeconomic development" (Stads and Manneh, 2010:3). Besides, innovation is still very rudimentary. Higher education and research nevertheless are becoming strategic instruments for developing core competencies, training in employability skills and for opening-up opportunities for trainee-ships in research groups and in other working environments at doctoral/graduate and undergraduate levels (Blasi, 2005). Research, particularly those directed at producing tangible returns to the economy and society as well as innovation, provides suitable platform for generating development. The implication of non systematization of science and research and of not establishing a clearly articulated national science and technology policy is the apparent weakening of the national science and technology base given the limited institutional pool of trained and competent scientists with capacity for research. Development of appropriate research competences appears further weakened by non supportive state of institutional infrastructural facilities. In addition, a precisely articulated policy framework is also necessary for an effective research priority setting as it provides the basic background and sets the necessary research agenda for choosing appropriate research concerns. Without a defined national research agenda, researchers and research funders are unable to align their work with the health, other setoral, and overall development needs of the country. These suggestions are consistent with the argument in literature that in low income countries such as the Gambia with limited funds for research, the absence of a national science policy framework could lead to donor rather than demand driven research agendas, as research and innovative efforts would produce little research outcomes and necessary technologies to upturn the national science and technology base (Ali, 2004; COHRED, 2007).

As centers for generating new knowledge and innovation and for developing capacities, universities have globally tended to be the major recipients of new public and private funds devoted to development. In recent years, this consideration seems to focus the Gambia government's higher education policy as well a research and development investments towards research and capacity development. In this context, the higher education policy states,

[the government] recognizes the pervasive impact which science and technology can possibly have on national development, as well as the need to build capacity to increase competitiveness, participate in and partake of today's global knowledge economy, and—importantly—redress the effects of capacity losses over the past decade (Stads and Manneh, 2010:3).

However, contrarily to State policy pronouncements, this study established that State and institutional investments in research within the period under study remained minimal reflecting very limited commitment to research and development that has strategic relevance. The implication of this finding is that State limited investment in research and development has tended to delay the development of appropriate scientific competences and the national science and technology system. This is because funding decisions/behavior of scientists remained largely constrained, and choices/decisions about research interests and priorities depended on this limited funding options in a stifling research context defined by State and institutional policies. In addition, the defining influences of State and institutional polices tended to limit the development of human and overall institutional capacity for research. A complementary explanation for this result is that the very limited State statutory allocation for research are fragmented appearing not as a lump sum but provided as research funds to various government departments where the funds remained largely underutilized and much of research funding of course came from external sources, especially the World Bank. In the context of university research, research skills and capacity of faculty members became largely under developed for the same reasons as most of them possessed qualifications below terminal degree (PhD). Besides, the State's very limited investment in university education could attract high profile scholars. A greater number of the faculty serve as part-time lectures and for this reason could take part fully in academic and research activities in the University. Moreover, research culture among serving full time academics is yet to take firm roots as less than 40% of faculty actually engaged themselves in research. Finally, technical incentives for conduct of research at University of The Gambia appear constraining because of inadequate research funding, limited research facilities, and time for research. Faculty

members were often overloaded with teaching responsibilities and might engage in other income generating activities in order to supplement their rather meager incomes thereby leaving them with very limited time for active engagement in research. In addition, public and private sector support for research within the period under study was minimal considering the very limited university share of the overall public research and development expenditure and nonexistent funding support from a fledgling private sector in the Gambia. Another constraint was the evident non-collaborations between government departments housing unused research funds and the University faculty as well as the minimal private sector collaboration, which appeared to forestall the development of appropriate applied research and consultancy projects by faculty.

Moreover, result from analysis of qualitative data further established that State and institutional research policies impact on research practices and scientific performance. Defining influence of State and institutional policies tend to affect the development of human and overall institutional capacity for research and the production of scientific knowledge and technologies. The result of this analysis provide a strong confirmation of the argument in literature that national research policies can foster, encourage and facilitate internal and international research cooperation, and for this reason has the potential to develop scientific competences of researchers and their knowledge production (Gruenfeld et al., 2000; Fleming and Sorenson, 2004; Horta et al, 2007; **Vasileiadou and Vliegthart, 2009**; Ozor, 2013). A plausible explanation for policy impacts on research related behaviors is that openness to external influences, new methods, new approaches, new knowledge, ‘‘access to information and networks’’ (Horta et al, 2007:20), can condition and drive research practices and the outcome of research. Individuals including scientists develop perspectives and initiate behaviors/activities through learning, organizational socialization or social networks that they enter. Collaborative research exchanges defined how the scientist organized his work or his communication behavior being one of several other research related behaviors. Thus, according to Ozor, (2013: 262),

Social networks, collaborative exchanges and linkages therefore appear to be a conditioning/mediating or moderating factor that offers possible explanation why research/scholarly practices tend to be strengthened thus contributing significantly to scientific performance.

In this context, (Horta et al, 2007, Gruenfeld et al., 2000) underscored the contribution of social communication behavior of the scientist to knowledge production. Corroborating this view, **Vasileiadou and Vliegthart, 2009:1261** argued that ‘‘**communication between researchers is considered an integral part of research organization... and for this reason, one may expect that the amount of communication is related to research output: by improving the overall organization of work and by facilitating coordination of tasks**’’. Collaborative exchanges including external scientific linkages and networks could foster learning, organizational socialization, and permit efficient use of knowledge from ‘‘a pool of existing and emergent knowledge’’ (Kogut and Zander, 1992; Fleming and Sorenson, 2004). Hence, in contributing to empirical discussions in literature on policy implications for scientific activities, this paper argues that using public policies, research institutions including universities, as vital means of maximizing the benefits of research, could be strengthened to expand and improve national science and technology base. Such policies must necessarily encourage and support cooperation and collaboration with industry as well as with international research institutions. In recent years, there has been an increase in the number of collaborations between scholars (Abbasi et al., 2012) as well as a rapid growth of international scientific collaboration (Wanger and Leydesdorff, 2005). Public research and development policy could become an important means of maximizing the benefits of research. The argument here is that public policies that foster scientific linkages and collaborations could contribute in building appropriate research competences of scientists, encourage the introduction of new and innovative ideas, and generally expand the national science and technology base.

A closely related question, which needs further investigation, is the extent to which research evidence informed policy development in the Gambia. In this context, a study conducted by the Gambia Economic and Social Research, Institute and Educational Research Network for West and Central Africa observed that policy process does not sufficiently link research to policy development. This is because it is possible that global trends, structural adjustments, and international aid agencies (these agencies make policy reforms a condition for aid) determined established policies. Economic and social development planners need valid, reliable and relevant information, as do international agencies in confirming and re-enforcing their investment strategies. However, in the Gambia, the demand for such information far surpasses the existing capacity for accessing, retrieval, the organization, interpretation and overall use of complex research data (GESDRI/ ERNWACA, 2006/2007). The Gambia evidently lacks capacity for scientific research. The country lacks a critical mass of highly trained and competent Science and Technology (S&T) personnel and possesses limited S&T infrastructure and resources. There are no proper incentives and partnerships with the private sector (which in itself is underdeveloped) to engage in a more strategic and long-term development of the human resource base. The Gambia further makes very little investment in research and development (GOTG, 2006), and primary data are unavailable for concrete policy decisions. Nevertheless, in spite of these conditions, other factors in the policy process such as political will, preferences and priorities of policy makers, the growing (though very limited) research competences, and

existing pool of knowledge could be of critical relevance in the determination of the extent to which policy makers could make use of research evidence. For these reasons, the issue calls for further scientific investigation.

6. CONCLUDING REMARKS AND RECOMMENDATIONS

This paper established that Gambia has no formally articulated national science and technology policy. Though, the Gambia Education Policy, (2004:33), in recognition of the rewarding but missing partnerships with private sector, stated that ‘‘strategic and rewarding partnerships will be built with all stakeholders, including the private sector and donor organizations’’. It is evidently clear that there has not been any comprehensive national policy in the area of higher education research, science and technology nor articulated national science and technology policy in the Gambia, except isolated references to science and research in national development documents such as the current Program on Accelerated Growth and Employment (PAGE), 2012. However, the Higher Education Ministry is currently developing a science and technology policy, which will drive science and research. Nevertheless, the fact remains that there is an urgent need to address the issue of developing a national research, science and technology policy in order to provide a national platform for harmonizing and coordinating the several hitherto discordant research and science policies and research activities of the various research organizations in the country including the University of the Gambia. A legally based national research, science and technology policy could provide guidelines for developing institutional research strategic goals and a national research council, which could oversee and regulate national science and research in line with national development goals. Though research activities have been going on in the country for several decades and sectoral research systems (agriculture, education and health) have been developed, the fact remains that there has been no legal or political framework for a national system in any of these sectors. Since constraints arising from non-involvement of all stakeholders appeared to have delayed the development of a national science and technology system, it is important to develop a legally based national science and technology policy integrated into an overall development policy agenda of government. It is also necessary to formulate strategies for science, technology and innovation that are integrated into the national development plans and programs. This would require developing policies and creating institutions that facilitate the generation of scientific knowledge and its diffusion, expressed in the form of technological capabilities.

Besides, research and development policy has always remained an important research policy field. It is theoretically and practically inevitable that bolstering the economic performance of a nation and responding to its societal needs ‘‘will require research and development policy to be placed in a broader context and in coherence with other policy fields’’ (European Commission, JRC-IPTS Report, 2009:15). It is theoretically and practically necessary to link research and development policy to innovation. In this context, national research and development policies must seek to achieve appropriate policy mix. The UK's 1993 Science White Paper is an example of policy mix approach. It is a policy document, which clearly indicated that ‘‘science and technology policy could not be separated from the concept and process of innovation. Consequently, all subsequent policy statements must deal with science and technology as integral part of UK's innovation policy’’ (European Commission, JRC-IPTS Report, 2009:16). In the Gambia however there is evident absence of legally based national science and technology policy and consequently the nation's science system cannot benefit from the strengths of mixed policy approach. The policy mix approach is recommended for developing countries like the Gambia because of its potential for improving the overall innovation system performance through raising research and development intensity.

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