ST CLEMENTS UNIVERSITY

DOCTOR OF PHILOSOPHY

PhD Thesis

‘’AN INVESTIGATION INTO THE EFFECTS OF RESEARCH GOVERNANCE STRUCTURE AND MECHANISMS ON SCIENTIFIC KNOWLEDGE PRODUCTION: EVIDENCE FROM PUBLIC RESEARCH INSTITUTIONS WITHIN THE GAMBIA PUBLIC SCIENCE".

By

FREDERICK UGWU **OZOR**

November 2012

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FREDERICK UGWU **OZOR**

BY

A THESIS SUBMITTED TO ST. CLEMENTS UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY (PhD)

November 2012

DECLARATION

I, Mr. Frederick Ugwu Ozor, do hereby declare that, this dissertation is entirely my own composition. This has acknowledged all reference to works of other persons.

`

Frederick Ugwu Ozor

APPROVAL PAGE

This is to certify that, this research work carried out under strict supervision and has been approved for submission to the St Clements University in partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy (Science and Technology Policy Studies).

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DEDICATION

This Dissertation is dedicated to the Almighty God, and my son Chinedu Ozor

FREDERICK UGWU OZOR

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ABSTRACT

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Scientific knowledge production, technology and innovation contribute massively to a nation's technology based economy. Public research institutions are principal actors in the production and transfer of scientific knowledge, technologies and innovations for application in industry as well for social and economic development. Based on the relevance of scientists and research institutions as instruments of development and social transformation of society, this thesis seeks to identify and explain factors in research governance that influence scientific knowledge production and to generate knowledge, which could inform public science and research policy in the Gambia. Using primary data generated from samples of research units within the Gambia public research sector, the thesis embarked on a two-phased inquiry, employing exploratory sequential mixed methods. The qualitative phase, using semi-structured interviews, three focus groups' discussions and two interview protocols, was essentially explorative aimed at learning as much as possible specific themes and views of respondents, which are important to institutional research governance and practices. The purpose was to generate new knowledge grounded on data. However, empirical discussions on the contributions of different governance models and structures to scientific output appear limited and mixed in literature, though still ongoing. None of the previous studies including Schubet (2009), which is closest focusing on the contributions of governance models and structures to scientific output, have tested for the possible contribution of scientific committee model of research governance to scientific performance at the individual level of the scientist. In this context, the thesis contributes to these discussions suggesting, first, that scientific committee structures with significant research steering autonomy could contribute not only directly to scientific output but also indirectly through moderating effects on research practices. It further argues that autonomous scientific committee structures tend to play better steering role than management centric model and structures of research governance. Second, elaborating and providing a more insightful explanation and perspective on individual research behavior and outcome of research, this thesis argues that communication and collaborative networks can improve research practices/behavior, which is a most important predictor of scientific performance. Third, other research related behaviors including publication behavior, publication orientation, funding behavior, decisions about research priorities and agenda as well as communication behavior of the scientist are critical for scientific knowledge production. Fourth, analysis of results suggests that intrinsically motivated curiosity is crucial in driving creative and innovative research. For this reason, results of analysis showing negative contribution of non-supportive institutional condition and positive contribution of intrinsic motivation suggest far reaching implications for competiveness of a country like the Gambia still working to build and improve its science and technology base. Overall, the implications of these results for governors of research are that research institutions in the Gambia, considering their missions, should wisely choose their governance

system because of the far-reaching implications it might have for research practices and production of scientific knowledge. Research institutions can improve research competences particularly at individual and operative team levels and enhance performance by developing and implementing research and development strategies that foster appropriate research practices. Further, they could reform the present performance evaluation system based on bibliographic indicators to include qualitative measures, which loosens the rush or pressure on scientists to publish, and deploy appropriate governance mechanisms that increase autonomy of researchers to choose their own goals.

CHAPTER ONE

INTRODUCTION

1.0 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, infrastructure, skills and capabilities of researchers in public research sector. The long term goals of these programs would probably be to bring 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. Therefore, it is important to identify factors in research governance, which contribute to knowledge production by scientists with a view to generating knowledge that can inform both state and institutional science policies aimed at maximizing research output at the micro level of individual researcher. However, there remains a persisting problem in literature, namely answering the question of the impact levels or benefits of different governance models and structures in terms of scientific performance/output of scientists.

In light of the above, survey of relevant literature indicates ongoing empirical discussions in recent years concerning the effects of research governance models and structures, which appear limited and mixed. However, none of the previous empirical studies including Schubet (2009), which is closest focusing on the contributions of governance models and structures to scientific output, have tested the impact of professional self-steering model consisting of research steering chair and hierarchies of scientific committees holding decision competencies with greater autonomy. Schubet (2009) suggested that strengthening internal hierarchy, (ie. increasing management grip on research and decision competencies of Deans and Chancellors/Presidents of research institutions), contributes positively to research efficiency. Nevertheless, there appears to be implicit doubts on the benefits of *internal hierarchical self-control* (i.e. management centric model), of *academic self-management (which measures the degree to which research chairs can decide autonomously,* and of professional self-steering/scientific committee model and structures. The benefits or positive impact of management centric governance model and structures are sometimes doubted ‘’because it is argued that research is not a routine task and the most empowering setting is that of academic freedom’’ (Schubert, 2009: 1225). It has not also been any empirical proof showing that either *academic self-control (which measures the degree to which research chairs can decide autonomously)* or professional self-steering/scientific committee model actually has positive influence on research output. Besides, empirical discussions concerning the correlation between governance structures and scientific output on the background of possible interactions with other explanatory factors such as research behaviour/practices meanwhile appear mixed and inconclusive. Apart from (Horta et al, 2007; Horta and Lacy, 2011) that discussed the impact of research unit size on academics' scientific output and communication behaviour, suggesting that larger units increase overall academics' communication with peers, there appears to be no systematic study of research related behaviours and their impact on scientific output. There appears also to be a missing gap in literature on a possible association between professional self-steering/scientific committee model and structures and research related behaviours/research practices. In this context, it is also important to consider, apart from the question of whether a particular predictor or explanatory variable exerts significant influence on scientific output, the relative significant impact of these causal factors on the response variable. In addition, most recent studies focusing on determinants and hampering factors of scientific output employed one measure for research output at a time, without testing the effects of considering different variables simultaneously. Such works include Lissoni et al. (2009) on factors of size and nature of projects, (Horta, 2010) on author's age and gender , and (Breschi et al. 2005; Van Looy et al. 2006; Stephan et al. 2007) on patenting activities.

On this background, the thesis seeks to identify and explain factors in the research governance that influence research output of public sector scientists in the Gambia and to explain the nature of association among the multi causes of scientific performance of scientists. It seeks to take a more critical and elaborative look at individual research behaviour and its implications for knowledge production, to identify and explain individual and organizational determinants that influence research at the individual level. For the purpose of this thesis analysis, public research sector consists of those institutions that deal with civil research and mainly benefit from public funding (Senker, 2001). The principal purpose of these institutions is to divulge the result of their research, not only to increase stock of knowledge but also to create scientific knowledge for application in industry. On the other hand, the study describes the national system of innovation as the complex network of agents, policies and institutions, such as universities and research centers, supporting the process of technical advance in the economy. The organization of public science system in the Gambia, as in most developing countries, appears however to lack credible governance structure for research (Kirigia and Wambebe, 2006). Nevertheless, some discernible governance pattern can be identified, which suggests that while the government and external donors remain the principal fund provider for research, there is greater internal hierarchy that allows management authorities and, to a limited extent, scientific committees greater power to steer research. Generally anchored on the principles and assumptions derivable from the principal-agent theory, governance of research in the Gambia employs accounting system monitoring resource movements and pay-for-performance schemes as mechanisms for driving research.

Using primary data generated from large sample of research units within the Gambia public research sector, the quantitative phase of this project, *Study 2*, attempts to present results to demonstrate the effect of research governance structures on research output. Besides, structured in two phases, the Thesis uses the first phase, *Study 1*, which is a grounded theory approach, to discover from the participants own perspectives those factors/variables that explain research practices/behaviour of scientists and their contribution to scientific knowledge production. The other, a second quantitative phase (*Study 2*) uses positivist approach to test predetermined hypotheses as are outlined in Table 2. However, a search for a singular solution later integrates the findings from the two phases of the study. In the following section, the chapter discusses the aims and objectives of this research. In particular, the thesis focuses on research objectives warranted by lack of critical discussions in literature on research governance especially in a developing science system. Section 3 provides details on the research questions, which guides the Thesis to meet its objectives. The chapter further discusses the background of the research in section 4, rationale for the research in section 5, outline of the Thesis in section 6, and concluding remarks in section 7.

2.0 RESEARCH AIMS AND OBJECTIVES

A major purpose of this study is to identify and explain factors in research governance that influence scientific knowledge generation in public research institutions within the Gambia science system in the period 2006 and 2010. In the Gambia, major obstacles to research appear to include meagre resources, not very clearly defined research competences, overbearing management control over research, non articulation of a legal-based national science and technology policy, and inadequate research funding. The Gambia government appears to be the principal provider of research funds and consequently it rationally expects reasonable returns from its investments in research and development in the form of generation of scientific knowledge to inform policy for national development. In the context of global competiveness 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. Though issues of policy to foster scientific activities and evaluation of such activities are still under debate (Asksnes 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.

On this background, the aims and objectives of the thesis include:

- To identify and explain factors in the research governance that influence research output of public sector scientists in the Gambia.
- To identify and explain the nature of possible association among the multi causes of scientific performance of scientists
- To proffer solutions to problems that inhibit scientific knowledge production within the Gambia public science system
- To examine the extent to which collaborative research exchanges contribute to the generation of scientific knowledge and innovations, and
- To generate new knowledge; this can inform public science policy in the Gambia.

3.0 RESEARCH QUESTIONS

In the context problems and challenges for the Gambia science system, these questions have always remained and call for answers, what governance model and structures best maximizes research output of scientists? What are the benefits of the different governance models and structures? In specific terms, the details of the research questions include:

1. How does research governance affect scientific knowledge production in public research institutions in the Gambia?
2. Are there possible associations between those multiple factors that influence research?
3. How do other causal factors such as institutional condition for conduct of research and research practices/behaviour including communication behaviour affect scientific output of scientists?
4. What are the motivational factors that affect research performance of scientists?

3.1 HYPOTHESES

Hypothesis 1 Stating the Null Hypothesis (claim)

- The effect of research governance/scientific committee structures, research practices/behaviour, and institutional condition on research output/scientific performance is insignificant

Hypothesis 11 Stating the Alternative Hypothesis

- The effect of research governance/scientific committee structures, research practices/behaviour, and institutional condition on research output/scientific performance is significant

4.0 BACKGROUND FOR THE 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 centres such as WARDA, IITA, IRRI, CIMMYT, ICRISAT and evaluates the local adaptation of inbreed 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, though research is mainly publicly financed, public investment in research in terms of percentage of GDP tends to be generally less than 0.1 %. Besides, there appears to be almost a consensus in literature that research and development capabilities in developing countries including the Gambia do not 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 may 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.

In general, specialized units or centres 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. In this context, it would appear that the health sector have developed a more enduring systematic framework for health research than most other sectors. However, 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 therefore 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.

In the Gambia, major setbacks to research arise from flow of research funds. A greater part of research funds come 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 behaviour of scientists and outcome of research. Medical Research Council, The Gambia Unit, which is a non-government research institution, has conducted most health research in the Gambia using external funds. The external stakeholder may exercise significant influence in the research process. 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.

Although research activities have been going on in the country for several decades and research governance structures such as scientific and ethics committees do exist, 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 policy but the process depended on financial and technical support provided by Development Partners. The aim of the policy is to coordinate and promote 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 would be 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 concerns 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 strategies for achieving long-term research and development objectives, and inconsistent public research policy. 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.

5.0 RATIONALE FOR THE RESEARCH

This research expects to offer insights with promising potentials to enhance knowledge production by researchers/scientists in the Gambia. It can produce new perspectives and model for policy makers and research mangers in understanding and improving science and research process in ways that maximize scientific knowledge production. However, the inquiry into the effects of research governance model and structures on scientific knowledge production within the Gambia national science system is specifically important for the following reasons:

1. The thesis will be of considerable value to policy makers in understanding the benefits of different governance model and structures, and the implications that the governance system could have for research practices or behaviours of scientists and their scientific output. Therefore, the research would hopefully warrant the need to reform and improve the Gambia national science system.
2. The findings and conclusions of this research can help research organizations in the Gambia including the University of the Gambia to increase research effectiveness by choosing their governance structures wisely in order to foster suitable research behaviours/practices of

scientists that optimizes performance at the micro/individual level. Besides, individual researchers can find strength in the insights provided by this work to increase interest in this very important research policy area.

3. The conclusions and recommendations of the thesis will encourage collaborative exchanges and external networks, which have promising potentials to improve competences at the individual and team levels and to enhance performance.
4. Finally, the thesis can open a new window for optimal and effective use of tools and strategies in the management of research and development activities, which can increase scientific knowledge production within the Gambia public science system

6.0 OUTLINE OF THE THESIS

This thesis begins with a research interest, which broadly is public science and technology policy impact on scientific knowledge production in public research institutions in the Gambia (between 2006 and 2010). Interest in research policy and public science anchors on the assumption that public research, development, and technology policy can actually shape science, technology and innovation processes. Public research policies and legislation are tools for influencing transformation of the public research base. They prescribe guidelines for steering research. Research and science policies are sometimes instruments that foster scientific activities. Such policies can promote either quality or quantity of research (Hayati and Ebrahimy 2009; Dewett and Denisi 2004) or become useful in attracting research funds (Arvanitis et al. 2003; Beath et al. 2003). However, discussions are still ongoing in literature on the issue of using policies to shape research governance structures in a way that foster scientific knowledge generation.

Empirical discussions are still on going on the impact levels of governance models and structures. There appears to be implicit doubts on the benefits both of *internal hierarchical self-control/*management centric structures *and of academic self management (which measures the degree to which research chairs can decide autonomously).* While the benefits or positive impact of management centric governance model and structures are sometimes doubted ''because it is argued that research is not a routine task and the most empowering setting is that of academic freedom'' (Schubert, 2009: 1225), it has not been shown either that professional self-steering, i.e. scientific committee model actually influences of research output positively. Scubert, (2009) identified and discussed the governance models in italics. Besides, the question has not been raised on the relative effects of causal factors of scientific knowledge generation, which as a social variable has multi determinants, while possible complex association linkages among those multiple factors influencing research performance remain largely unexplored. In this context, this thesis examines the effects of institutional governance model and structures and on research output of scientists and the contributions of other causal factors to knowledge generation. Evidence from literature further shows that, though research activities have been going on in the country for several decades, scientific and ethics committees have not consistently played significant part in research steering. All sectors have developed their own research systems albeit discordantly, there has not been a political and legal framework for the national science system to harmonize and coordinate research activities. Besides, public research policies and legislation in the Gambia lack the necessary mix with a broader science, technology and innovation strategic plan. However, in the Gambia, there has been very little systematic study done in the direction of research policy and scientific knowledge production. Consequently, this research seeks to contribute to ongoing empirical discussions on the issue of impact of different governance models on knowledge generation as well as attempt to fill missing gaps in literature. There is also the evident need to investigate several limitations to public research in the Gambia, which appear to explain, at least in part, why there are no empirical studies on research governance and its implications for the public science system in the Gambia. In this regard, the thesis will yield some insights and proffer solutions and recommendations for improving the science system.

The methodology of the study is essentially eclectic, a postmodern approach, which combined qualitative and quantitative mini-studies. The approach permits the use of multiple data collection, multiple methodologies and multilevel analyses. The study consists of a two-phased qualitative and quantitative inquiry. The qualitative phase, Study 1, using grounded theory focused on contextual issues and pattern of experiences of people observed with a major concern for direct experience and for gaining understanding of human behaviour from the participants' frame of reference. Thus, the purpose of this phase of the study is to discover emergent meanings from the participants' world. The second phase, Study 2, employs quantitative approach using positivist theoretical and paradigmatic framework. However, postmodernism goes beyond validation of results obtained from the multiple methods to include squaring/comparing results in order to find new possibilities and deeper insights. Postmodernism advocates for mixed methods inquiry, and for de Waal, 2001, its logic of inquiry includes the use of induction (or discovery of patterns), deduction (testing of theories and hypotheses) as well as abduction, which means uncovering and relying on the best of a set of explanations for understanding one's results.

The thesis seeks to address the question of how research governance affects scientific knowledge production in public research institutions in the Gambia as well as the causal and motivational factors that affect research performance of scientists. However, in developing the theoretical framework of the quantitative and deductive part of the study, this project views the issues of research support and evaluation of research performance from the perspectives of principal-agent and the stakeholders' theories. From these theories, this thesis developed ideas about the implications formal research governance structures for research behaviours of scientists and outcome of research. At the deductive and quantitative phase of the study, prepositional positions developed from these issues and themes were tested and interpreted through statistical analysis. While variables and theory were emergent in Study 1, Study 2 tested the following variables for their impact of scientific knowledge output: management centric model and structures/scientific committee model and structures, research practices/behaviour, and institutional condition for conduct of research.

The study area is the Gambia public research system. This study collected data from the following study spots: The University of the Gambia, the Educational Research Network for West and Central Africa (ERNWAC), and The National Agricultural Research Institute (NARI). Others are the Medical Research Council (MRC), the Gambia Unit, International Trypanotolerant Centre (ITC), The Ministry of Health Units (Malaria, Reproductive Health units, etc) and the Department of State for Higher Education, Research, Science and Technology (DOSHERST). The need to enhance understanding of a variety of contextual factors that affect research practices/behaviour, the ease of access to research colleagues to respond readily to the study questionnaires, and the heuristic orientation of the work are reasonable justifications for the choice of the study spots. The research design outlined the use of qualitative/inductive approach and grounded theory methodology as well as quantitative/ deductive method employed to test pre-determined hypotheses. Primary data used in this study came mainly from survey questionnaires, semi-structured interviews, three focus groups' discussions, interview protocols, and personal observations. Secondary data came from published works in the study area as well as institutional sources, which include research institutions in the Gambia and the Higher Education Ministry. Table 4.2 specifies variables and their indicators and measures, which informed the development of the study questionnaire. However, other variables emerged from the participants' point of view as Study 1 progressed. The study population consists of relevant staff list of all public research organizations in the Gambia (including the University of the Gambia) and the sample size is 650. The survey adopted both non-probability (*convenience sampling*) and random, systematic sampling methods. Data collection procedure in respect of Study 1 involved joint systematic data collection, coding, and analysis with theoretical sampling to enable generating a grounded theory of scientific knowledge generation. At the end of the data collection in Study 1, data underwent four states of processing resulting in the development of framework for data analysis. These included data coding and summary, reassembling emerging variables and making prepositions about them, and through selective coding process (a process that identifies core variables), establishing the basis for formal theory. The last stage of data processing involved statistical presentation and data interpretation at the deductive and quantitative phase of the work. At this level, involving a pilot confirmatory stage 1 and quantitative stage 2, a pre-test and test of hypotheses used primary data generated from the survey questionnaires. However, complimentary data came from secondary sources. The quantitative stage 2 of Study 2 involved statistically tabulating and interpreting data using simple statistical tools such as frequency distributions, means, standards deviation, percentage tables and a 5-point Likert scale. The statistical presentation designed to test predetermined hypotheses, involved statistical analysis. Moreover, the study also adopted a multilevel mode of interpretation and analysis, the purpose of which is to explain the responses of some institutional actors in relation to their environment and see how environmental forces might account for research practices/behaviour of participants.

Qualitative data analysis involved open coding, axial- and selective coding processes. As categories, emerging and evolving from data, became structured and saturated, the qualitative study used systematic comparison method to examine relationships between categories. Memos created as the research progressed in fact directed the creation of diagrams that captured relational statements between concepts formed during axial coding. Codes collapsed these memos as they began to resemble each other during organization and memo sorting. A theory of scientific knowledge generation emerged as categories saturated and concepts and relational statements connecting them became fully defined and clarified. Qualitative analysis of data produced the following main findings:

1. Collaborative research exchanges including external linkages and networks tend to enhance research competence and to shape research practices/behaviour
2. Scientific committee model and structures appear to play better steering role than management centric model.
3. Scientific committee structures exert moderating influence on research practices
4. In addition to communication behaviour, other research related behaviours are important determinants of research performance
5. Supportive institutional condition for conduct of research is a prerequisite for effective research performance. Other non-material incentives, the intrinsically motivated curiosity is crucial for creative and innovative research. On the other hand, main findings from quantitative analysis of data include:

1. Results show strongly decreasing satisfaction with institutional condition for conduct of research, a sharp decline in publication counts for scientists after 2009.
2. Scientific knowledge output (response/independent variable) is significantly correlated with scientific committee structures, research practices/behaviour and institutional condition

(which are predictors). Professional self-steering/scientific committee structures, institutional conditions and research practices/behaviour are factors that have causal influences on research output/performance of scientists.

3. The variable, research practices/behaviour is one single most significant factor that contributes to scientific knowledge production/ research performance of the scientist.

Comparing results from both phases of this study, a common ground finding shows that scientific committee structures, institutional conditions and research practices/behaviour are factors that have causal influences on research output/performance.

Analysis of results suggests that scientific committee structures with significant research steering autonomy contribute not only directly to scientific output but also indirectly through mediating/moderating influence on research practices/behaviour. Management centric model and structures can positively contribute to scientific performance, provided supported by advisory group of mainstream scientists/academics at key hierarchical levels of governance. With appropriate competences and steering autonomy, scientific committees could take and implement more informed research decisions than institutional management or even research chairs. When acting alone, management and research chairs might possibly ignore or overrule professional advice and inputs. Scientific committee structures with significant research steering autonomy tend to play better steering role than management centric model and structures. In the context of ongoing empirical discussions on the contributions of different governance models and structures to scientific output, the thesis argues that scientific committee structures with significant research steering autonomy contribute not only directly to scientific output but also indirectly through moderating effects on research practices/behaviour. Analysis of results further yields the insight that research institutions, considering their missions, should wisely choose their governance system because of the far-reaching implications it might have for research practices or behaviours of scientists and their knowledge generation. Expanding existing institutional framework for collaborations and external exchanges of information among scientists, recruiting star scientists from outside, training workshops, and the use of mentors or lead investigators are reasonable mechanisms to foster suitable research behaviour among scientists and research teams. Such mechanisms could enhance research competences and performance of scientists, and prop up institutional research ratings. The thesis analysis of results shows that scholarly practices/behaviour, which can make most significant contribution to research outputs are those conditioned by openness, linkages and external exchanges of information. It further suggests that research related behaviours are multi dimensional and, apart from communication behaviour, other important forms of doing research (or practices/behaviours) could have profound impact on research performance. In the context of empirical discussions on the importance and contribution of communication behaviour to generation of knowledge, the thesis analysis in contributing to these discussions, shows that publication behaviour, publication orientation, funding behaviour, decisions about research priorities and agenda as well as communication behaviour of the scientist are critical for knowledge generation. The thesis finally argues that both extrinsic motivation and intrinsic preferences are important for genuine research. Results of analysis showing negative contribution of non-supportive institutional condition and positive contribution of intrinsic motivation suggest far reaching implications for competiveness of a country like the Gambia still working to build and improve its science and technology base. The implications of these results for research institutions in the Gambia could be to reform the present peer-based evaluation, which incorporates qualitative evaluation and loosens the rush or pressure on scientists to publish. It might also mean deploying appropriate governance mechanisms that increase autonomy of researchers to choose their own goals. Reform becomes necessary in order to downplay the impact of rankings and encourage symbolic benefits/awards for research, which give supportive feedback to the researcher. Encouraging intrinsically motivated behaviour is necessary for creative and innovative research. The reform measures especially in academia could include introducing institutional science policy that encourages the development of ‘‘taste for science’’, which is a special incentive system where higher premium on peer recognition and autonomy than the importance of monetary incentives provides the attraction for scientists to do research.

7.0 CONCLUSION

Using divergent theoretical paradigms, the qualitative and quantitative phases of the thesis produced situated findings. The concluding section of Chapter 5 integrated, summarized and discussed these findings. Common findings from both phases indicate significant impact of research practices on scientific output. An ANOVA F test for analyzing the quantitative response and explanatory variables further indicates most significant impact of research practices on scientific output of researchers. The thesis findings also established that scientific committee structures with important steering autonomy contribute not only directly to scientific output but also indirectly through moderating effect on research behaviour of scientists. Going beyond previous studies (Song et al., 2003; Lacetera et al. 2004, Stokols et al. 2005) showing positive contribution of communication behaviour to scientific output, the thesis demonstrates that other research related behaviours such as publication behaviour, funding behaviour, choices about research priorities could make important contributions to scientific performance. In addition, the thesis argues that both extrinsic and intrinsic preferences are important for genuine research, though results further show that intrinsically motivated curiosity is crucial in driving creative and innovative research. In the context of these findings, it is evident that the main question of factors in research governance that affect scientific output lies on the idea that both individual and organizational influences affect research at the individual level of the researcher. Given that research behaviour is the most significant predictor of knowledge generation and that research related behaviours are multi dimensional and important for research, the thesis provides an elaborative and individual perspective for understanding the governance system and institutional research. Following Horta and Lacy, 2011, the thesis combines both individual and organizational determinants that affect research at the individual level. The aim is to avoid the limitations of a one-sided approach and to achieve indebt understanding of the rather complex and multiple factors influencing research behaviour and performance. In addition to individual choices that the researcher makes about his research, institutional as well as external influences (organizational routines, organizational thinking and methods of doing research, internal and external linkages and networks, moderating influences from governance structures) are also important in shaping research practices/behaviour and the outcome of research.

Overall, the crux of this thesis argument is that scientific committee approach to research governance has promising potentials to enhance knowledge production by researchers/scientists. Scientific committees consisting of mainstream scholars/scientists who understand the process and content of research would appear to be more inclined to accept reforms suggested by Osterloh and Frey, 92009) in favour of a combination of qualitative peer reviews and bibliometrics. Qualitative evaluation loosens the pressure on scientists to publish and supports intrinsically motivated behaviour. The basis for this argument is the crucial place of autonomy, individuality and freedom in creative and innovative research. This would mean autonomy for researchers and significant decision-taking autonomy at all key hierarchical levels of governance. Autonomy for the scientist to follow his own scientific goals rather than monetary incentives is the most important precondition for intrinsic motivation (e.g. symbolic rewards/peer recognition externally mediated). Thus, a working condition that permits a wide range of decision competences, responsibility, autonomy and trust for the researcher (Amabile, 1998; Amabile et al., 1996; Mudambi et al., 2007) is necessary for creative and innovative research.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter begins with review of literature in the domains of research policy and public science systems considered relevant for this project. These areas include the higher education and research system examined from a global perspective; the organization of public science in developing countries and public sector research in the Gambia, organization of research, research policy and scientific production. It further includes research governance and scientific production, system wide research and knowledge flows, and measuring research output. Evidence from literature on global higher education and research systems underscores not only the public good nature of results of research in response to global challenges, but also the relevance of research within a wider global ecology in which collaborative links and mutually beneficial interactions among research actors and the wider environment is developed. This approach to research may provide some insights to inform data collection design of the present work. Besides, evidence from literature in public research systems in developing countries further reveals several challenges, and shows that the state of organization and governance of the scientific world in these regions warrants further search for answers to problems that hinder scientific knowledge production. In particular, this chapter evaluates previous studies on public sector research in the Gambia by way of examining the major sectors engaged in research. The review covers research development in each sector over the years. These sectors include higher education, agriculture, health/medical sciences and private sector research. However, nongovernmental research organizations and prominent private actors, which include the Action Aid, The Gambia in the agricultural sector and the Medical Research Council (MRC), The Gambia Unit in the health sector, carry out private sector research in the Gambia.

Though funded and managed by the British government, the research activities of the MRC, the Gambia Unit have considerable implications for public research policy in the Gambia. However, emerging evidence from literature points to the challenge for academic scholarship to investigate limitations found in public sector research in the Gambia, as there appears to be no empirical studies on research governance and its implications for the public science system in the country. Besides, studies further show how science, technology and innovation can be powerfully shaped and directed by Research and Development and Technology policy. In the Gambia, however no systematic studies appear to have been done in this direction and so this research project hopes to fill this important theoretical and practical gap. The chapter further evaluates literature on the state of university governance in West and Central Africa and identifies major stakes and challenges for research governance. Literature is also examined for the potential impact of knowledge flows on the science and innovation system, and it is evident that in the Gambia, knowledge spillovers generated form informal and formal collaborative research and scientific publications and conferences could possibly have some long-term implications for the national system wide research. Research policy literature generally reveals problems of definition and measurement of research output as well as problem of ranking of universities and research units. The literature evidence therefore suggests caution in attempting to identify and use research output indicators, which of course provides useful insights to inform data design of this project. The chapter ends with review of studies of patenting effects on research output and examines the relevance of patents as scientific output measures.

2.1 HIGHER EDUCATION AND PUBLIC RESEARCH SYSTEM – A GLOBAL PERSPECTIVE

Research generally makes invaluable contribution to a society's economic, social and environmental goals. This study cannot view the research system in isolation from the critical linkages with education, innovation and a nation’s policies and aspirations. Formal higher education, particularly universities have over the years increased in importance as centres 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. However, institutions of higher learning and scholarship face daunting global challenges some of which include the challenge of finding solutions to global problems of climate change, HIV/AIDS, and natural disasters such as earthquakes, volcanic eruptions, tsunamis, etc. The public research system is though narrower than the national research system which 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. In other words, national research systems become broader than sect oral and sub-sect oral systems such as the national agricultural research system, the national health research system and so on. The environment in which research systems are situated are highly diverse, 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. An innovation system refers to a system of organizations within an economic system directly involved in the creation, diffusion and use of scientific and technological knowledge, as well as in the coordination and support of these processes (Danas, 2005)

Arnold and Bell (2001:292) argue that innovation systems are built on the following principles:

1. Innovation is essentially the result of an interactive process between many actors,

including companies, universities, research institutes, NGOs and users. Individual organizations rarely possess all the knowledge necessary for the whole process of innovation. As a result, they need to combine scientific, design, engineering and operational knowledge from different sources.

2. Innovation does not follow a linear path that begins with research, moves through the processes of development, design and engineering, and production, and ends with the successful introduction of new products and processes – what development practitioners call the TOT approach (transfer of technology). Rather, it tends to involve continuous feedback loops between the different stages.
3. The innovation systems framework can be applied to different levels of the economy, depending on whether one is trying to analyze (or promote) innovation at a supranational, regional national, local or sect oral level.
4. The innovation system framework brings together the elements of good practice required to foster innovation. In other words, it provides a coherent analytical tool for handling the disparate processes of knowledge creation, distribution and use, as well as the ways that these affect productivity, competitiveness, and economic and social development.

Multi-stakeholder partnership approach to research and innovation seeks to engage and build on partnerships across public, private and civil society organizations that contribute to innovation and its application; and enabling partners to work together to identify, develop, disseminate and use innovations (technologies, processes, products) within a specific institutional, societal, economic, legal and political context. Major aspects of this wider concept of research and innovation include the notion that context is central and there are multiple stakeholders with a variety of perspectives and functions whose interests need to be considered. Besides, the approach permits wider sources of innovation (including and involving a non-linear pattern of interaction and feedback between research, development and up-date of technology). The increasing emphasis and focus on pluralist research systems have meant the realization of the theoretical and practical relevance of the dynamic and evolving nature of the environment in which research takes place. Strategic response to challenges from all sectors and stakeholders connected with basic and/or industrial or applied research can only improve or remedy deficiencies in the public research system.

A public research system generally displays some basic characteristics. Some of these features may indicate a certain research and development funding intensity including mechanisms for funding both basic and applied research. Research funding may come from the government or its agencies, private business, Non-governmental organizations (NGOs), regional or international institutions. Most governments, as in European Union (EU) countries, using its research and innovation policies and regulations work towards shaping and adapting its public research system to deal with new social, economic and environmental challenges that they identified. For instance, according to European Commission, Report of ERA Expert Group, (2008), in France public research was traditionally funded through contract instruments between the state and research institution (universities and public research organizations). However, since 1999 successive French governments, in addition to direct funding, have tended to fund public research based on project (project funding as against institutional funding) no matter the researcher's institutional affiliation; and to modify the organization of public research system to meet new challenges.

A significant feature of a public research system would arise from the fact 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. 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, Sect oral Ministries, NGOs and beneficiaries of research such as Business, Government, and the Society. In other words, research and knowledge production engaged in an ecosystem. While sharing similar starting points with system approaches 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) to reflect this growing tendency to apply the ecology analogy to knowledge production. The traditional linkage between higher education and basic research further characterize a public research system. Though universities conduct most basic research, public research is organized around universities and public scientific /research organizations. Government interest and role in higher education and research vary significantly from one country to another. Modes of public funding for research and development also vary widely and reflect the institutional setting of countries' research system. According to OECD, Research & Development Database, (2009), the principal mode of Research and Development funding in Germany, Israel and New Zealand is institutional funding, which can help to ensure stable long term funding of research, while Belgium and Korea rely mainly on project funding to higher education. Such project funding include national research and development contracts from line ministries, or Governments may often make contributions to national funding agencies such as Research Councils based on specific projects. A project-based funding can promote competition in the research system and may be targeted towards some strategic areas. However, in developing countries the principal mode of public funding to higher education and research have remained largely institutional funding in the form of state contributions/subventions to universities and other research organizations, though in special circumstances there has been limited project based funding from non-profit international organizations particularly in selected fields of science such as agriculture and medical sciences.

It is generally believed that investment in, and high-level attention to, research and innovation needs supported by a clearer public appreciation that research and the skills that research sustains, are critical elements in addressing the economic, social and environmental problems facing a society. It is further generally believed that public objectives of research can be achieved by creating a research-friendly ecology achieved through a series of coordinated actions encompassing research, but also innovation and the development of lead markets and/or regulatory and public service environments (Report of ERA Expert Group, 2008). While there is often a distinction between basic and applied research, research may be conducted for varying reasons at several levels: national, regional or sub-regional, and the global levels. The argument here is that support for research each of these levels come from quite different reasons. At the national level, support for basic research may seek to enhance the gains for society and economy through dissemination of results of research, flow of trained people, informal networking, problem solving and development of equipment (Salter and Martin, 2001). On the other hand, support for industrial/applied research may come from its potential to inform public policy as well as provide support for innovation and competitiveness. Beyond the nation state and perhaps involving a combination of states, support for basic research may be seek to enhance collaboration and virtual common pot approaches that will stimulate competition in research and achieve economies of scale and scope, for example, more chance to find complementary skills (ERA Expert Group Report). On the other hand, applied research at this level can provide more chance of finding expert solutions to problems. Basic research is defined as experimental or theoretical work undertaken to acquire new knowledge of underlying foundation of a phenomenon and observable fact without any particular application or use in view. Conduct of applied research on the other hand may seek to support innovation and competitiveness. Public support for research generally rest on the argument that the outcome of research (knowledge generated) often has the attributes of public good, being non-rival in use as the results can be used simultaneously by many users. It is also non-excludable as beneficiaries may include people who have not paid for it. Besides, most governments generally accept as their responsibility the development of basic capacity for research through training. Other reasons for government intervention in Research and Development investment is the lack of knowledge of the outcome of research and uncertainty associated with research and innovation generally. ERA Expert Group report further identified challenges of coordination of research efforts, insufficient opportunities created by basic research, gaps in the innovation system or its risks of being stock with obsolete, as reasons for government involvement in research. However, Salter and Martin (2001) have argued that governments may support basic research within their borders because of its contribution to the economy and society. Universities and public research institutions carry out most basic research. Public support for research therefore becomes necessary as it makes invaluable contribution in developing new scientific and technological knowledge and human capital that can lead to innovation beneficial to society and economy. Such benefits accrue to society and the economy through spillovers achieved via open publications, flow of trained persons, informal networking, problem solving and developing new equipments and technologies. On the average, more than three-quarters of all basic research in the Organization for Economic Cooperation and Development area is conducted by universities and public research organizations (OECD, Research and Development database, 2009). These data show that university spending on R&D accounts for 0.40% of GDP in OECE area reflecting the growing importance of universities as providers of useful new knowledge and as trainers of researchers and other highly skilled workers on which knowledge-based economies rely. Globally, university basic research in most countries accounts for 40% to 70 % of all basic research in the country (OECD, Research & Development Database, 2009).

At the global level as in other levels, justification for research support often arise from the concept of public good, and in this context global public good for that matter. It is widely recognized, at the public level at least, that a broader approach to research may provide significant economies of scale, spillovers, and synergetic interactions. Many organizations and researchers/scholars now realize that a number of important economic and social problems go beyond national boundaries, and that a broader approach to research on these, which is often not possible within individual state's projects and resources, can achieve greater results. In other words, it would appear that there are greater promise, performance, though greater danger, of international approach in providing global public goods. Global public good results from response to global challenges. Science has the potential for improving the wherewithal of society and increasing the wealth nations (Henry, 2002; Kealey, 1996; Bacon, 2000). However, Nelson (1959) and Arrow (1962) were the first to argue that the social returns to research investment exceeded the private gains realized by the individual firm and that as a result scientific and technical knowledge possesses a public goods dimension (Ruttan, 2001; Mowery and Rosenberg, 1989). Research programs in both public and private sectors may produce public goods that have social benefits. Public goods have properties of being freely available to all; they do not diminish by use. Knowledge (and results of research) has these qualities, though with some limitations (Powell, 1886; Ruttan, 1991; Stenger, 1992; Jefferson, 1984; and Wills, 1991). Though public good is conventionally relevant and open for use in a given state, its relevance is increasingly recognized to transcend national confines to involve sub-regions, regions and even the global community as certain social problems and benefits from solutions to them may extent to neighbouring nations, regions and the international community. Such global problems generally include health and environmental hazards such as the scourge of HIV/AIDS, climate change, tsunami, the challenge of nuclear fusion, global insecurity arising from terrorist activities and limited and large-scale wars. However, in most states, universities have the traditional role for education but they also play critical role as principal performers in basic research providing human resources for research and innovation. Their relevance within the wider/global research and innovation ecology calls for the harmonization of research policy with education policy as well as encouraging the interface and collaborative links with industry particularly in the high tech sector which are already being given impetus by supporting national and regional policies and programs as in the EU area. In addition to research and education missions of universities, Schoen, et al. (2006) identified eight dimensions of universities' third, if not wider/global, mission of knowledge production and transfer which include human resources, intellectual property, spin offs, contract with industry, contract with public agencies, participation in policy making, engagement in social and cultural life and public understanding of science. Besides, in defining the unique mix of these three missions of universities, Larédo, (2007) argues that universities are influenced by historical conditions and their contexts and the functions, which they are able to perform, namely mass tertiary education, professional specialized higher education and research and academic training and research. These unique features of universities as centres of knowledge production, and the milieu in which they operate, have meant that the present work makes use of the theoretical assumptions and framework of the stakeholder approach. It further employed the ecology approach to knowledge production, as it draws from insights from these approaches and preceding considerations from literature to inform and justify the data collection design, which is directed at considering data inputs from all relevant stakeholder sources.

2.3 THE ORGANIZATION OF PUBLIC SCIENCE IN THE DEVELOPING WORLD

The evident pitfalls of data collection appear to handicap the study of structure of research systems in developing countries. The collection of pieces of relevant information about the scientific world are rather scattered across different establishments, departments and sectors. Keepers of information often withheld much of such information, though they may not be aware of it, and some quickly lost as it appears in reports and gray literature, with few copies and little attention. One major setback in this regard is the lack of local offices or institutions responsible for collecting and archiving such data, reports and articles. Besides, the state of research in developing countries need standardized list of relevant information, to describe it accurately. CREST/IRD Project, (2009:61) recommended,

> *"Up to date [2009], reliable and relevant information is perhaps the key prerequisite for the production of studies to characterize the status of science in the developing world and develop appropriate strategies and Reference Centres or Regional Observatories of science. The Observatories should not only confine themselves with the gathering and analysis of quantitative data and statistical indicators, but also with descriptors (that could be standardized) and relevant narratives"*

However, in spite of these limitations existing literature appears to suggest discernible patterns in the structure of scientific world in developing countries. Nevertheless, the history of research and science and technology (S&T) in developing countries is characterized by two major periods, which include research under the colonial influence and the other under independence. Colonial and other powers influenced specific scientific organization and governance, which varied across countries. Modern science in most developing countries appeared in colonial period. For instance, in 1923 in Burkina Faso modern science developed with the creation of the experimental station for agronomic research in Saria (CREST/IRD Country review template Project, 2009) and in Cameron in 1939 with the creation of the Société d'Etudes Camerounaises (SECAM). Another experimental station was the Institute of Scientific Research in Cameroon (IRCAM) created in December 1949 and placed under the control of the Overseas Scientific Research Institute (ORSTOM), a French organization set up earlier on October 11, 1943 (IDRC/CRDI Report, 2009). Colonial research in these regions focused mainly on agriculture, medical and social sciences fields; and, though publicly funded, was administratively supervised from the metropolis. However, the idea that research can play a pivotal role in national development began under colonial research. Independence was accompanied by wide spread desire in developing countries to take over control of public research. In the Cameron, for instance political independence saw the establishment of a national Scientific Research and Applied Studies and Survey Council (CRSAEE) in 1962 and the National Office of Scientific and Technical research (ONAREST) replaced later on May 2, 1965. The General Delegation further replaced this body for Scientific and Technical Research (DGRST) in 1979.

These changes progressively increased the responsibilities of the institutions for research and triggered increases in the number of national researchers, which rose from 152 to 400 within the period 1980 to 1987 while the number of expatriate researchers remained unchanged (CREST/IRD Country review template Project, 2009). These and similar associations in the regions originated many scientific journals that also have ceased publication for lack of funding and a majority of them disappeared after the first two issues. Foreign institutions support those, which are running well. However, in recent years, some regional and transnational scientific associations and journals are beginning to have stronger funding foothold. One such transnational scientific association is the Association for Public Administration and Management (APAM) based in Nairobi Kenya. In Cote d'Ivoire, the three major Research and Development performers are the University, the Centre National de Recherche Agronomique and the National Polytechnic Institute Houphouët Boigny each, having evolved in different ways, each one experimenting with new ways of linking research and teaching and research and development. Cocody University, the oldest and main university of the country, has 13 research and training units, 12 research centres and institutes, 2 autonomous research centres and one school. The University has tried to integrate research centres with training units; and its organization and management of research makes the university unique in that some research institutes employ full time researchers while a scientific commission supervises research activities in each unit. In addition, the Centre Universitaire de Recherche Appliquée en Télédétection is integrated with the geosciences and mining resources unit.

CREST/IRD Project Report (2009:27) stated that;

> *the academic community wants to keep a clear distinction between the different types of structures, especially concerning budget allocation. Indeed, this integration is seen as the first step towards a merging of the structures designed to compensate for lack of human resources. Abobo Adjam University is experimenting with a new type of recruitment. Academic staff n more belongs to civil service but signs a contract with the university.*

The National Centre for Agronomic Research was created in 1998 after the merging of agronomic research institutes: the Institut des Forêts (forestry), the Institute des Savanes (savannah areas) and the Centre Ivoirien de Recherche Technologique. The center introduced a novel policy of privatization of research as its management revised the Centre to assume a private status and a mixed capital base-40% public and 60% privately funded. These narratives on Coted'Ivoire reveal that the objective of policy of privatization of research was to allow the institute to operate according to global market forces and engage researchers on contract with the institute rather than the State. Researchers sign a contract with the Institute, which of the general policy is to run according to the laws of economics. It is designed to adapt to the global market and to reinforce the relationship with private partners and development'' (CREST/IRD Project, 2009:27). Nevertheless, these case studies and narratives disclose a common trend in the structure of scientific world in developing countries.

Lack of research funds and the inevitable support for research from external sources further characterize public research in developing countries. Much of the internal funding for public sector research in developing countries come in the form of institutional funding as research grants, public subventions or budgetary allocations. Most project-based funding on the other hand come from external sources, particularly from Non-governmental organizations, the World Bank, and other donor and funding institutions and these were mainly bilateral programs in agriculture and medical sciences. On this background, Pound and Adolph (2005:1) in their study claim that in some parts of the developing world during the 1960s and 1970s most technical expatriate researchers whose major roles were on-the-job training for national researchers filled cooperation research positions particularly in the agricultural sector. According to the authors, this period produced ''a cadre of national researchers technically equipped but operating largely with a conventional research approach''.

During this research project era, expatriate researchers operated as project managers and specialist researchers with their national counterparts. The era ended with a shift towards capacity building as well as emphasis on higher degree training and bilateral program based funding. The British Council "shifted from granting scholarships competitively or through sectors to linking higher degree training scholarships to projects. A number of these projects (at least in the agricultural and health sectors) were development projects with a research component'' (Pound and Adolph, 2005:1) .Cameroonian research for instance, benefited from important state support until the middle of the 1980s. CREST/IRD Project Report, (2009:31) further states that;

> *in 1974 Cameroon was one of African States that invested most in research and this was not only possible due to oil revenue but also because of state involvement in the establishment of a scientific elite. Agricultural research, which constituted one of the most dynamic sectors, flourished with the aid of public funds. The Institute de Recherche Agricole and the Institute de Recherché Zoologique et Vétérinaire were the two principal institutions for agricultural research in Cameron.*

According to International Foundation for Science (2003), in developing countries the late 1990s and early 2000s witnessed increasing disillusionment with research among international donors and national governments. Levels of donor and government investments declined considerably and fewer scholarships were available to developing country researchers. Pardey and Beintema (2002) reveal that by the late 1990s, after a period of rapid expansion in budgets of National agricultural research systems (NARS), a slowdown in spending on research had become a worldwide phenomenon. Latin America, Sub-Saharan Africa, and the countries of the former Soviet Union felt the most severe effects. The least affected were the Asian National Agricultural Research System.

Many developing nations experienced brain drain within the period as experienced researchers left due to poor in-country conditions and were not replaced, creating doubts about the capacity of national research to play leading role in poverty alleviation. Using quantitative indicators Pardey and Beintema (2002 cited in a note prepared for Interim Science Council of *Consultative Group on International Agricultural Research* (CGIAR) by Byerlee and Alex, pp 1-4 and available at **www.rimisp.cl/isc/thinkpieces/individual/DerekByerlee.pdf**) described recent developments in agricultural research in developing countries as follows:

- The private sector accounts for an estimated six percent of research resources invested in developing countries compared to just over 50 percent in industrialized countries. Much of this research is located in Latin America and Asia where it is concentrated in a few large countries, such as Brazil, Mexico, Argentina, and India. With the addition of private sector investments, the gap in research intensities (total public and private investment) between industrialized countries (about 5% of Agricultural Gross Domestic Product), and developing countries (0.7%) is even wider.
- Well over 100,000 agricultural scientists (full-time equivalents) are working in the public sector National Agricultural Research Systems (NARSs) of the developing world compared with about 60,000 in industrialized countries. In general, the number of scientists has expanded faster than budgets, resulting in a squeeze in operating budgets and reduced real salaries.
- There is wide diversity across countries in the size and maturity of NARSs. China and India have the largest research systems in the world, with tens of thousands of scientists, and account for over one-half of developing country research capacity, but perhaps three quarters of NARSs in developing countries employ fewer than 20 researchers.
- The quality of scientific work force as measured by the proportion of scientists with

postgraduate degrees has increased sharply in all regions, and especially in Sub-Saharan Africa.

- Studies consistently show high returns to investments in agricultural research in developing countries, averaging over 40%. (See Alston et al. 2000).

In addition, results of recent analysis by the International Food Research Policy Institute (IFPRI) in four countries in Asia suggest that agricultural research and development consistently provides higher returns than other public investments, both in terms of economic payoffs and poverty reduction. However, much of the public investment allocations in research and development in the developing world go to the national agricultural research system and the assumption is that this investment has produced unprecedented results in agricultural productivity over the past two decades. A further belief is that agricultural research and the national innovation systems have potential to stimulate further agricultural growth and poverty reduction in the developing world. These systems could do this by means of providing information, technology and the application of science. In recent years, investment in agricultural research appears to be expanding in Africa as evidenced by current increases in research and development budgets of the governments of Nigeria, Ghana and Kenya in 2011.

Research capacity is an important issue, which is related to the development of science and public science systems in the developing world. Research capacity and the state of science vary across the developing world, and even within countries. Capacity of research systems is often quite variable, depending on funding, incentive systems, and political support. Harris (2004) noted the existence of a wide range of scientific progress in developing countries. Some developing countries such as India, China, Thailand, Brazil, Mexico, Argentina and Chile, to name a few, are actually quite advanced with respect to scientific development, a national budget for research and numerous PhD programs. Low-income countries on the other hand, such as Nicaragua, El Salvador, Ecuador, Bolivia, Haiti and most sub-Saharan African countries, often have none of these. A wide gap exists between the developed and developing countries in the areas of research as well as development of research capacity. Commission for Research Partnerships with Developing Countries (KPFE, 2001) disclosed that about 85% of resources on research worldwide are invested in high-income countries, 10% in India, China and East Asia, leaving only 4-5% for the rest of the world. Most of this research resources in less developed countries are used by northern agencies (eg the UK Medical Research Council) undertaking research in the south. The emigration of experienced national researchers to the North, the often-called brain drain seems to account for the limited research capacity in developing countries. Other setbacks to the development of research capacity in the region include loss of staff through HIV/AIDS, low government research funding allocations, and a limited number of researchers. The effectiveness of researchers is further compromised by ‘’unreliable finance, poorly paid and managed staff, weak and unreliable infrastructure, and sometimes a lack of security'' (DFID, 2004; cited in Pound and Adolph, 2005:1). Describing the state of brain drain in developing countries, a study by the World Bank reported that some 70,000 highly qualified African scholars and experts leave their home countries every year to work abroad, often in more developed countries (available at http://www.commissionforafrica.org/english/report It would appear that the problem of recruiting, retaining and motivating qualified staff in developing countries is especially acute in the public sector. Besides, external support for research in developing countries is often program tied.

In the context of research for development, research capacity is about the ability of individuals and institutions to conduct and use research in effective, efficient and sustainable manner in addressing local, national and regional priorities needs. The usual concept and practice in capacity development have tended to concentrate on development of individual knowledge and skills. However, recent literature on the subject appears to indicate a shift towards a broader multiple stakeholder partnership approach that targets all actors in the system, and the linkages between them, in order to enhance the performance of the system (Lusthaus, Anderson and Murphy, 1995; Horton et al. 2003). These linkages may be in fact more important than the individual elements of the system. For instance, Velho (2002: 26) argued that "a national system of innovation made up of actors which are not particularly strong, but where the links between them are well developed, may operate more effectively (in terms of learning and in generating innovations) than another system in which one or other actor is strong, but the links between them are weak''. This argument in literature underscores the significant contribution of communication and collaborations to research and generation of new knowledge. Linkages especially external networks have potential to enhance research competences at both individual and organizational levels. Research capacity is the sum total of human, financial and institutional conditions for conducting research.

The Central Research Department of UK Department for International Development sees sustainable capacity development of developing country research systems as key to the adoption of evidence-based, innovative approaches, and the production and uptake of technologies and policies that will contribute to economic growth (DFID, 2004). Evidence from literature nevertheless shows that in developing countries, the research tradition of the former colonizers tend to influence public research systems. With few exceptions such as India, public science systems in most of these regions have seen very limited development. The agricultural and health research sectors appear to be more developed in terms of research capacity and funding, though few of the developing countries seem actually quite advanced with respect to scientific development. The quality of scientific work force remains very low in almost all regions. Lack of funds for research and support for research seem hinder the development of most of the public science systems. Structures for steering research remain largely dependent on state funding and supervision, while 'brain drain' tends to limit research capacity. In some cases, poorly paid and managed staff, weak and unreliable infrastructure, and sometimes a lack of job security appear to compromise the entire research process. This state of organization and governance of the scientific world in developing countries however warrants further search for answers to problems that hinder scientific knowledge production.

2.4 PUBLIC SECTOR RESEARCH IN THE GAMBIA

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 labour 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, 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 of 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.

As centres 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. For instance, the higher education policy states that;

> *[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).*

On the issue of the extent to which research evidence informed policy development in the Gambia, 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 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.

In addition, the country has no formally articulated national science and technology policy. The Gambia Education Policy, (2004:33), in recognition of the rewarding but missing partnerships with private sector, states that ‘’strategic and rewarding partnerships will be built with all stakeholders, including the private sector and donor organizations’’. The constraints arising from non-involvement of all stakeholders have tended to delay the development of a national science and technology system. However, in recent years, the government has taken some concrete steps to deal with the challenges of developing policies and creating institutions that facilitate the generation of scientific knowledge and its diffusion, expressed in the form of technological capabilities. Evidence of the government commitment to science and technology development includes the creation of the Directorate of Science, Communication, Information and Technology Education in 2001. Others are the creation of the Ministry for Communication, Infrastructure and Technology in 2001 as well as inauguration of the National Information and Communication Infrastructure (NICI) Policy and Plan developed for The Gambia. Most recently, another concrete step in support of science and technology is the creation of a new Ministry for Higher Education, Research Science and Technology in 2007. The new ministry consists of three directorates (higher education, research and planning, and science and technology). These directorates are responsible for policy development including the management and coordination of programs and activities to enhance socioeconomic development (MoHERST 2010). However, the fact remains that a national science and technology policy has not materialized. This has tended to drawback national development plans, and resulting in lack of a coordinated sense of direction. It has also meant that there are no formal platforms/guidelines to foster research and innovation in the country.

In the Gambia, building capacity is a national policy priority, and the major institutions responsible for this are the University of the Gambia, the Educational Research Network for West and Central Africa (ERNWACA) and the Gambia Economic and Social Development Research Institute (GESDRI). While university research dominates most of the basic research in the Gambia, the prominent sectors of research have generally remained in agriculture and health fields. In evaluating literature on public sector research in the Gambia, the thesis examines the major sectors engaged in research including developments in each over the years. The following sections examine these sectors, which include agriculture, higher education, health/medical sciences and private sector research.

2.4.1 GOVERNMENT-BASED AGRICULTURAL RESEARCH IN THE GAMBIA

Gambia is one of Africa's smallest countries. The country's economy relies heavily on agriculture. A study by Food and Agricultural Organization (FAO) of the United Nations (2004) reveals that in 2002, agriculture sector employed 80% of the Gambia's active population, mainly resource poor smallholders, and the sector accounted for 40% of the country's exports. The primary cash crop is groundnuts while rice and millet are the primary food crops. The logical consequence of this trend is that agricultural research and development remains the principal vehicle in the country's pursuit of food security and economic development. However, public

agricultural research and development investment levels seem to have fluctuated over the last two decades. In 2008, the Gambia invested over 20 billion GM dalasis in this sector. Agricultural Research and Development capacity levels in the Gambia also declined since the turn of the millennium. For instance, in the same year (2008), the country ''employed 38 full-time equivalent (FTE) research staff compared with 42 in 2000'' (Stads and Manneh, 2010:1). In 2001, nine agencies were engaged in agricultural research. These include six government agencies/units: the National Agricultural Research Institute (NARI), the Department of Livestock Services, the Department of Fisheries, the Department of Forestry, the Department of Water Resources, and the Food and Nutrition Unit of the Department of Agricultural Services. Among these are two higher education agencies: the Faculty of Science and Agriculture of the University of The Gambia, and the Gambia College School of Agriculture. The ninth agency is a private enterprise, the Gambia Horticultural Enterprise (Stads et al. 2004).

Established in 1993, the National Agricultural Research Institute (NARI) is the Gambia's principal agricultural research agency ''accounting for two-thirds of public agricultural research and development staff and close to three-quarters of agricultural R&D expenditures in 2008'' (Stads and Manneh, 2010:1). The Department of State for Agriculture administers NARI. The institute conducts adaptive research on crops, livestock, forestry, fisheries, and other natural resources to provide technological solutions to problems of famers. Policy makers rely on its research to provide solutions that can sustainably increase agricultural productivity. Its research findings can further suggest measures to protect the environment and natural resource base (Stads, Fatajo, and Kunjo 2004:2). At its inception, NARI took over the research activities of the former Department of Agricultural Research. However, according to World Bank Report, (1992) and FAO, (1993), the history of agricultural research began during colonial rule with research on groundnuts, the country's most important export crop. However, agricultural research activities expanded in 1965 when the country achieved independence. Research activities were diversified ‘’but were generally conducted within the framework of development projects and did not incorporate appropriate coordination or oversight by the relevant ministries’’ (Stads et al, 2004:2). In 1977, the Department of Agriculture established the Agricultural Research Service, the country's first agricultural agency responsible for coordination and implementation of crop research. Three years later, the Department of Agricultural Research (DAR) established the National Agricultural Research Board. DAR was responsible for crop research, and the Department of Livestock Service (DLS) undertook livestock research, while the Department of Planning hosted social science research at this time. Supported by USAID, the government launched the Agricultural Research and Diversification Project in 1985. In 1993, the Project set up a national agricultural research board, which unified crop, livestock, forestry, and natural resources management research. In the same year, the new and independent National Agricultural Research Institute (NARI) regrouped DAR and many of DLS research staff. NARI became an autonomous public agency supervised by the National Agricultural Board. The Board is responsible for overall policy guidance, research priority setting, and global as well as sectoral program resource allocation in line with the country's national development goals (World Bank Report, 2000).

In addition to research activities of the Gambia Agricultural Research Institute, five other agencies also engaged in agricultural research in 2001. For instance, the Department of Fisheries investigates improvements in fish processing methods and stock assessment, and employed four full time researchers in 2001 (FAO, 1999). The Department of Water Resources, under the Ministry of Natural Resources and Environment, conducts limited water and soil research, and employed three full time researchers the same year. The Department of Forestry, under the Department of State for Fisheries and Natural Resources, conducts limited socioeconomic research. It employed an estimated three full time researchers in 2001. The Department of Livestock Services (DLS), under the Department of State for Agriculture (DOSA), carries out livestock research. The Food and Nutrition Unit of Department of Agricultural Services of the Agriculture Ministry, conducts post harvest research. Non-governmental agencies engaged in agricultural research include Action Aid, The Gambia, involved in poverty eradication programs and conducts limited agricultural research.

The higher education sector plays a limited role in agricultural research in the Gambia ‘’accounting for an estimated share of 5% of total agricultural research and development staff in 2008’’ (Stads and Manneh, 2010:2). Most of the research activities in this sector are ad hoc in nature relating either to student activities (at the University of the Gambia and the Gambia College of Agriculture), or carried out jointly with the National Agricultural Research Institute or Université Cheikh Anta Diop in neighbouring Senegal. Identifying key trends in the agricultural sector since the year 2000, Fatajo, and Kunjo, (2004:1) noted that agricultural research staff in the Gambia are less qualified compared with many African countries, and ‘’ involvement of the private sector in the Gambia agricultural R&D is minimal, representing 2% of agricultural research staff and spending in 2001’’.

2.4.2 HIGHER EDUCATION AND RESEARH IN THE GAMBIA

The Ministry of Higher Education, Research, Science and Technology is the government agency responsible for education policy in the Gambia. The Gambia Tertiary and Higher education policy, 2004-2015 defines tertiary education to include all post-secondary education programs in technical, teacher and university education as well as research. Currently, three institutions in the Gambia provide a variety of programs at post secondary level. These are the Gambia College providing programs in education, the Gambia Technical Training Institute in technical and vocational education, and the Management Development Institute in management studies. These institutions produce trained and skilled work force at middle level of services and industry. A major goal of the higher education policy is to evolve a tertiary and higher education system with the development of University of the Gambia at the apex. International donors/partners, the World Bank, the IDB, BADEA, the Saudi and Kuwaiti funds, OPEC, UNDP, and the Spanish and Taiwanese governments, support the development of tertiary and higher education sector in the Gambia. According to the permanent secretary, Higher Education Ministry, Sey, policy intervention in higher education sector includes support to the e-learning project at the University, the University Village Project, the Kanilai Institute, the Teachers Professional/Academic Development, the West

African Examination Council and the Ministry of Higher Education, Research, Science and Technology's institutional capacity building (Today online, December 29, 2010).

The University of the Gambia established in 1999 is the sole provider of university education in the Gambia. The Higher Education policy describes the University as a ‘’fledgling institution’’ faced with the important challenge of putting together the necessary physical infrastructure and marshaling competent faculty strength (DoSE, 204:43). The policy priority areas concerning university education include:

1.) encouraging The University of the Gambia (UTG) to offer graduate programs in faculties already established in co-operation with universities outside the country
2.) to encourage UTG to enter into collaborative arrangements with universities outside the country with a view to securing programs and materials in fields that are relevant to the country’s immediate development needs
3.) to encourage the University to occupy a strategic position within the national development strategy, and
4.) Finalize the Higher Education Observatory Act, which involves the establishment of a system of accreditation and validation of qualifications awarded in the country that the University can only provide (DoSE, 2004:43-44).

The university’s research related objective is to ‘’provide relevant, sustainable and high quality tertiary education and research to support socio-economic, scientific and technological advances and development, and promote excellence in the creation and dissemination of knowledge‘’ (DoSE, 2004:41) Available at http://planipolis.iiep.unesco.org/upload/Gambia_Ed_Pol_2004-2015.pdf).

The Higher Education policy (DoSE, 2004:44) on research aims at prioritizing the ‘’establishment of research capacity and promotion of research in critical fields of development in the Gambia, mainly health, agriculture, basic sciences and human resource development’’. The policy proposed a higher education observatory and quality assurance council, would serve as a tool for ensuring that investment in the tertiary education sector would translate into institutional strategies that give explicit priority to improving the quality of teaching and research. For this purpose, the policy expects that the University of the Gambia and other tertiary institutions would develop and articulate the following strategies:

1. Institutional central policy for research via such structures that define the role of research as a component of activities in the institution and the type of research activities that the individual institution engages in
2. Resources for research requiring explicit plans for development of research capacity and provision of resources for promoting the development of existing research units;
3. Research quality, which will involve review of policies and procedures for ensuring research quality, and
4. strategic policy, which outlines strategic research goals and defines research committee, structures, membership and responsibilities. It must also define research plans, procedures for monitoring research performance and project quality.

However, a research steering council with strategic responsibilities for research is yet to materialize. Research activities in the University of the Gambia (UTG) as well as its research capacity are however beginning to take shape, though these and opportunities for doctorate training are still very limited. In working towards achieving the objectives of Gambia education policy, the University has opened up linkages with several external institutions aimed at promoting mutual academic and research benefits and consulting collaborations. These bilateral partnerships were achieved though Memoranda of Understanding. For instance, at faculty level, there are existing exchange programs between the University and St Mary's University, Canada and a number of other universities outside the country. A Research and Strategy Committee existed at UTG up to 2009 as a major research steering body responsible for promoting research culture, environment and infrastructure of the university. The Committee supported the development of research staff involved in research projects. It supervised the competitive research funding through assessment of research proposals submitted to it by the academic staff requesting for grants. These assessments were based on explicit criteria. In spite of these policy provisions, this Committee became moribund after 2009.

Funding for research has remained a major setback to university research in the Gambia. The World Bank, in support of the government education policy (appraisal document, May 2006) gave a grant of approximately USD 8 million. The policy states;

> *that the Government will conduct strategic studies including those related to the creation of a competitive research fund...[sic] the Competitive Research Fund will be managed by the UTG based on guidelines to be developed by the Department of State for Education. While the selection of research grantees is done by the UTG's Research and Strategy Committee, research proposals are to be approved by the University Council, and once approved funds are expected to be released by the Department of State for Education*. (DoSE, 2004:46).

The Competitive Research Fund has already received grants totaling three million dalasis, which is approximate US $ 113,207 from the government. However, the Gambia government expenditure on Research and Development (R&D) is not lumped into one component but spread out using several nomenclatures such as field investigations, research fees, studies and surveys, environmental surveys, or simply research (Gambia National Budget, 2009). Based on these figures, it is evident that international donors, particularly, the World Bank remains the principal funders of university research in the Gambia. Nonetheless, the Higher Education and Research Directorate of the Education Ministry is responsible for,

> *co-ordination of all aspects of tertiary and higher education programs, facilities and resources, and promoting the culture of research the directorate will coordinate the review of strategic policy of all research activities to ensure that they are in accordance with the quality assurance system that are to be set up by tertiary and higher education institutions* (DoSE, 2004:46).

In addition to basic research, several consultancy projects have taken place at the University. These include projects sponsored or funded by IFAD, IDS, ECA, Action Aid, The Gambia, CEF, The Gambia, and Rural Finance and Community Initiatives Project by Department of State for Agriculture. The University of Gambia, School of Medicine also conducts research in health field and has established research cooperation in health related issues with the Ministry of Health units, the Internal Trypanotolerance Centre, and the Medical Research Council, the Gambia Unit. However, university research encounters several challenges. Research skills and capacity of faculty members remain largely under developed as most of them have qualifications below terminal degree (PhD). A greater number of the faculty serve as part-time lectures and for this reason cannot take part fully in academic and research activities in the University. Besides, research culture among serving full time academics is yet to take firm roots as very few actually engage themselves in research. Finally, technical incentives for conduct of research at UTG appear constraining because of inadequate research funding, limited research facilities, and time for research. Faculty members are often overloaded with teaching responsibilities and may engage in other income generating activities in order to supplement their rather merger incomes thereby leaving them with very limited time for active engagement in research. In addition, public and private sector support for research is 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. Statutory allocations for research are fragmented appearing not as a lump sum but provided as research funds to various government departments where the funds remain largely underutilized. The evident non-collaborations between these departments (housing unused research funds) and the University faculty forestall the development of appropriate applied research and consultancy projects by faculty. In brief, it would appear that technical facilities for conduct of research at the University of The Gambia are inadequate. In this context, the thesis would seek to investigate how institutional condition for conduct of research and other motivational factors affect scientific knowledge production.

2.4.3 HEALTH RESEARCH SECTOR IN THE GAMBIA

Building an effective health research system in the Gambia has remained a critical concern and focus of health research policy of the Gambia government. Palmer et al, (2000) observed that ministries of health in developing countries employ and implement deliberate and logical approaches toward building and strengthening national health research (See on line article abstract, available at http://ukpmc.ac.uk/articles/PMC2693112). These approaches include steps to develop a national health research policy and strategic plan, conduct a situational analysis of research in the country, set up a national health research agenda, establish research ethics and scientific committees, and build human and institutional capacity for health research management and conduct. These steps call for the development of a framework for health research policy, which is essential for the development of demand driven research or innovation systems in health and in science and technology more generally (Efron 2002; Rath 2005; Watson 2003; OECD 2003). Such policy framework is also necessary for an effective health priority setting as it provides the basic background and sets the necessary research agenda for choosing health research concerns. Without a defined national health research agenda, researchers and research funders are unable to align their work with the health and development needs of the country. According to (Ali, 2004; COHRED, 2007), in low income countries with limited funds for research, the absence of such policy framework can lead to donor rather than demand driven research agendas, as research efforts would produce little research to inform decision making in the health sector. Gambia has developed a national policy framework for health research with overriding goal of building research capacity. Assisted by Council on health research for development (COHRED), the country has also developed a national health research system (Cited in Arudo et al, 2008, Available at http://portal.unesco.org/education/en/files/58049 . Though the system is yet to be firmly rooted, it has discernible governance structures. For instance, the Gambia has a research program unit at the Directorate of Planning and Information at the Ministry of Health and Social Welfare, dealing with matters of research as part of Information Management and planning within the Ministry.

The Gambia, as most developing countries, however faces a number of challenges in responding to the need for knowledge to improve decision-making and developing a functional national health research system. Some of these challenges include lack of legal and strategic frameworks for research and credible governance structures for research. Others include lack of coordination of research activities; inadequate participation of stakeholders in research, policy and implementation processes; lack of demand for research; low accessibility and use of research findings; and inadequate financial and human capacity (Kirigia and Wambebe, 2006; D'Souza and Sadana, 2006)

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2.4.4 CONTEXT OF DEVELOPING HEALTH RESEARCH SYSTEM IN THE GAMBIA

The Gambia public health programs grapple with how best to achieve wider coverage in dealing with daunting, health problems, which confront the country. There is a compelling need for research to inform policy in order to respond to the increasingly complex situation in the health sector. This is because of the high burden of communicable diseases, a rising number of cases of injuries from car accidents, limited health budgets and scarce human resource (Palmer et al., 2009). However, some health sector institutions in the Gambia such as the Royal Victoria Teaching Hospital, Banjul conduct health research, though these are usually small or limited studies to identify and address operational issues. Overall, using external resources, the Medical Research Council, The Gambia that is a nongovernmental research institution, has conducted a major part of health research in the sector.

Ministry of Health began the process of developing a national health research system in the Gambia in 2002. The African Development Bank and the World Health Organization (WHO) supported the Health Ministry in the initial step of developing a health research policy, which seeks to promote and coordinate health research relevant to the health needs of the population. Several other stakeholders including the academia, civil society organizations, and another development partner, UNICEF were involved. As the process of developing a national health research policy unfolded, a number of initiatives were undertaken in the period from 2002 to 2008. These initiatives included:

1. The implementation of a national review of ethics in health research,
2. The establishment of an Ethics Committee at the Royal Victoria Teaching Hospital, and
3. The establishment of a research and publications committee at the University of The Gambia.

However, despite advocacy efforts, the draft of the national health research policy failed to secure Cabinet approval principally for political reason bordering on " concerns originating from perceived imbalances in research capacity between the public sector and the more highly capacitated non-government research institutions" (Palmer et al ., 2009; available at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2693112/#__ref-listid3723234). 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. 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 develop a national system of science governance and to formulate strategies for science, technology and innovation that are integrated into the national development plans and programs. Overall, evidence from literature suggests the need for scholars to investigate the determinants and hampering factors of scientific output. Meanwhile, there appears to be no empirical study on research governance in the Gambia and its implications for development of the national science system.

2.5 RESEARCH ORGANIZATION

Literature on the effects of research organization and governance is wide and diverse. However, recent empirical discussions on research governance and knowledge generation focused mainly on structures of research teams, their responsibilities, and communication structures including intra- and inter-group collaborations. Another concern in literature is on how collaborations affect the research output of research organizations. While research laboratories are the most complex and dynamic institutions (Crow and Bozeman, 1998), studies of research institutions in France, Germany, Italy, United States and United Kingdom show increasing interest in analyzing research productivity determinants (David, et al, 1999). Some studies have tended to analyze the link between size and research output (Marts, et al, 1993; Johnes and Johnes, 1993; Von Tuzelmann, et al, 2003) and most of them focused on returns to scale of production. On the other hand, Hicks and Skea, (1989) argued that while significant relationship may be found between size and output, characteristics that are not linked to size can explain scientific output. Johnson (1993; 1995) revealed that the theory of increasing scientific production returns informed the UK's policies towards the end of 1970s, which aimed at concentrating financial and human resources in large laboratories. However, recent studies have focused on identifying determinants and hampering factors of the scientific output of researchers. In their study of French and Italian cases, Lissoni et) al. (2009) proved that factors like the size and the nature of projects (national or international, collaborative or not collaborative), authors' age and gender (Horta, 2010) tend to influence scientific output. (Breschi et al. 2005; Van Looy et al. 2006; Stephan et al. 2007) identified patenting activities as one of the determinants and factors hampering scientific output. Moreover, Carayol and Matt (2004:1100) analyzed the influence of research organization and academic production at Luis Pasteur University in France and found a significant but negative coefficient for size variable, suggesting that smaller laboratories are more productive and insisting that ‘'labs have different organizations, which influence their scientific performance''. Bonaccorsi and Daraio (2005) argued that ‘'size of laboratories is never positively related to productivity'' while Turner and Mairesse (2005) pointed out that the influence of size of laboratory on individual production (in number and quality) is significant but small. (Horta and Lacy, 2011) discussed the impact of research unit size on academics' scientific output and communication behaviour, suggesting that larger units increase overall academics' communication with peers. However, some studies looked for determinants of scientific productivity at the individual level (Gonzalez-Brambilla and Veloso, 2007; Von Tunzelmann *et al*., 2003; Long and McGinnis, 1981), others at the organizational/university level (Valadkhani and Ville, 2009) and laboratory levels (Carayol and Matt, 2004). However, recognizing the limitations of either approaches, Horta and Lacy, (2011) combined both individual and organizational determinants that affect research at the individual level.

A budding literature on research governance and knowledge generation suggests that hiring external researchers into existing environments is important for the ability of organizations to generate and access new knowledge. For example, Song et al. (2003) demonstrated that researcher mobility is more likely to result in inter firm knowledge transfer; Lacetera et al (2004) suggested that hiring star scientists could reshape the direction of research organizations. Looking at academic inbreeding helps reflect on what may happen to practices and outcomes of scientists that never change their research environment, as compared to those that are mobile (Horter et al., 2007). The authors argue that collaboration and scholarly exchanges in the form exchange programs can increase rather than slow the growth of externally leaned knowledge or new approaches to the generation of knowledge. Openness and collaboration are of critical importance in the present day research environment (Adams et al. 2005). Research requires collaboration with colleagues outside the institution to maximize resources, achieve critical mass or find complementary skills (Thornsteinsdottir, 2000), aspects that have become ever more relevant in the last decades (Adams et al., 2005).

Some studies have described research collaboration as a research behaviour, or communication behaviour, which is important in knowledge generation process. ‘’Communication between researchers is considered an integral part of research organization… and for this reason, one may expect the amount of communication to be related to research output: by improving the overall organization of work and by facilitating coordination of tasks'' (Vasileiadou and Vliegenthart, 2009:1261; Chompalov et al.2002; Shinn, 1982). However, contemporary research environment appears to be changing increasingly towards collaborative research in all formats, especially bottom-up collaborative efforts (Sonnemwald, 2007; Shrum, et al., 2007) as well as institutionally instigated collaborations (Beaver, 2001). Investigating collaborations in the field of physics, Shrum et al. (2007:119) defined technology as ''the set of instruments and practices that researchers employ in the acquisition and manipulation of information", and suggested that technology conditions the degree of interdependence in collaboration. But Hackett, (2005) observed that the social organization of collaboration has changed, as the traditional research groups are being complemented by episodic working groups, with contractual agreements between organizations, international collaborations, and interactions between scientists and non-scientists (engineers, companies, and such like collaborators). Research collaboration may be useful for exchange of information and for substantive discussions including coordination of tasks among group/team members. Hara et al., (2003) drew a distinction between integrative and complementary collaborations. The authors argued that this distinction is based on the degree of interdependence between collaborators, which conditions the dynamics of research collaboration. In complementary collaboration, there is less need for intra-team communication and less need to work closely together as each partner is responsible for one stage of work. Integrative collaboration would involve allocation of non-specialized tasks to group members, with all partners involved in all stages of the research project and a high degree of interdependence among them. The link between the amount of communication and productivity in research collaboration would depend on the degree of interdependence between partners involved in a research project. Consequently, in integrative collaboration, where partners are all involved in all stages of work and so more interdependent, the link between communication and research productivity tend to be stronger than in complementary collaboration where collaboration appears to be less interdependent (Vasileiadou and Vliegenthart, 2009). However, in their study of the effects of co-authorship networks on scientific output, (Abbasi et al, 2012) added to literature showing that scholars with more co-authors and those who exhibit higher levels of 'betweenness' centrality (i.e., the extent to which a co-author is between another pair of co-authors) perform better in terms of research (i.e., higher g-index). Furthermore, the authors argued that scholars with efficient collaboration networks who maintain a strong co-authorship relationship with one primary co-author within a group of linked co-authors (i.e., co-authors that have joint publications) perform better. Social networks play a critical role in determining the way individuals and organizations resolve their problems and succeed in achieving their goals (Abbasi and Altmann 2011). Social networks in research can help in understanding how professionals share information, and generate and share knowledge.

Research organization defines the environment and character of institutional research conditions, and the provision and use of research infrastructures/facilities, which includes appropriate libraries, laboratories, effective information and communication systems. Managers of research have tended to shape such institutional conditions. Conducive institutional conditions are supportive of research. The use of internet for instance has some impact on research productivity. Using two distributed research teams, with different coordination and management need, Vasileiadou and Vliegenthart (2009) examined the impact of internet use on research productivity and found a limited impact, which may be relevant only when collaborative endeavors suffer coordination problems. At the same time, meetings between researchers, or collaborative research for that matter, proved the most important predictor of research productivity. This means that internet use can positively contribute to scientific output. Earlier research had tended to focus on the use of internet in research ‘’not only as a means of communication and collaboration, but also increasingly, as data, methodologies, and types of output of research fields’’ (Heimeriks and Vasileiadou, 2008; also cited in Vasileiadou and Vliegenthart, 2009:1260). The use of internet would generally improve research work by providing access to resources and facilitating the sharing of files, data and ideas (Walsh et al., 2000; Garvey, 1979; David and Steinmueller, 2003; Nentwich, 2003; Hiemeriks and Vasileiadou, 2008). However, at the same time its use may also be detrimental (Wilson, 1995; Bishop, 1994 cited in Walsh and Roselle, 1999; Nentwich, 2003).

Overall, empirical discussions in literature on the effects and on impact levels of different governance models and structures are scanty though still ongoing. However, none of the previous empirical studies including Schubet (2009), which is closest focusing on governance structures, have tested the effects of scientific committee model and structures consisting of research chairs and scientific committees holding autonomous decision competencies. Schubet (2009) argued that strengthening internal hierarchy, that is, increasing management grip on research and decision competencies of Deans and chancellors/Presidents of research institutions, contributes positively to research efficiency. Nonetheless, there appears to be implicit doubts on the benefits both of internal hierarchical self-control (management centric structures) and of academic self-management (professional self-steering structures). While the benefits or positive impact of management centric governance model and structures are sometimes doubted ‘’because it is argued that research is not a routine task and the most empowering setting is that of academic freedom’’ (Schubert, 2009: 1225), the effects of scientific committee model and structures on research output has not been empirically investigated.

2.5.1 RESEARCH POLICY

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 other words, 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). The policy mix approach can contribute in improving the overall innovation system performance through raising research and development intensity.

Issues of policy to foster scientific activities and evaluation of such activities are still under debate in research policy literature. National policies can be used to promote either qualitative or quantitative research (Asksnes and Rip, 2009) or to bring about reforms in the public research and science system. Public research reforms have often resulted from significant public legislation. These reforms, widespread in the post 2000 period among EU member states resulted in the creation of autonomous research institutions, development of national research policy and competitive funding models (European Commission, JRC-IPTS Report, 2009). This trend implies that public research policies and legislation can serve as instruments to influence the public research base by providing methods of steering research. For instance, a number of European Research Area (ERA) member states have followed the New Public Management approach of writing performance contract with universities. According to ERA Expert Group Report (2009), ERA states took policy measures to press for varying levels of institutional autonomy within the university sector often resulting in reduction of level of prescription and direct management of the sector by the state.

In developing countries, national science and research policies have witnessed various forms of reforms in recent years. These reforms have tended to cover a wide range of concerns such as research organization and governance, academic freedom and institutional autonomy, funding structures, scientific and technological information network, research collaborations, patenting/legal protection for research results, and the integration of research with national science, technology and innovation objectives. In Cameron for instance ‘’a new central research steering body, the Ministry of Scientific Research and Innovation was created in 2004 to replace the old Ministry of Technical and Scientific Research, a change which according to the then Minister, was motivated by the wish to lay emphasis on innovation’’ (IDRC Report, 2009:10). The policy reform thrust was innovation. Consequently, the government created two new departments, namely the Department of Technical and Scientific Cooperation, and the Department for the promotion and support to innovation. The 2005 public legislation mandated the new Ministry to carry out the responsibilities for,

5. *Animating, coordinating and controlling research activities within the national territory with the aim of promoting social, economic and cultural development.*
6. *Valorizing and exploiting research results in permanent liaison with all sectors of the national economy, ministerial departments, and the organizations concerned (IDRC Report, 2009:10).*

A policy reform the same year placed the Division of Planning, Research and Cooperation of the Higher Education Ministry in charge of coordinating the implementation of government policy relating to higher education research. Overall, the reform process in state universities in Cameron tended to increase university autonomy particularly over research control and governance. The IDRC Report, (2009:13) states;

> *The university reform which started in 1993, besides leading to the creation of 7 States Universities in Cameroon, has above all, permitted the redistribution of responsibilities at the summit of these units notably the creation of the position of Vice- Chancellor to whom specific responsibilities have been entrusted. In 1999, the position of Deputy Vice-Chancellor for Research and Cooperation (DVC/RC), and in 2007, the position of Deputy Vice-Chancellor in charge of Research, Cooperation and Relations with the Business World (DVC/RCB), were created.*

A similar trend is found in Ecuador, where the State established a new Science and Technology Plan in 2005 to achieve the objective of,

> *strengthening of science and technology capacity through the stimulation of basic and applied research, aid innovation and technology transfer to increase the country's productivity and competitiveness, and the promotion of articulation between the productive, governmental and academic sectors (The Country Review Template, CREST- IDR Project, 2009:19).*

In the Gambia on the other hand, evidence of national science policy reforms include the creation of the Ministry for Communication, Infrastructure and Technology in 2001 as well as the National Information and Communication Infrastructure (NICI) policy and plan developed for the Gambia the same year. Another includes the most recent creation of a new Ministry for Higher Education, Research Science and Technology in early 2007 (Higher Education Strategy Paper, 2007:5).

National research policies can foster, encourage and facilitate internal and international research cooperation. Vital means of maximizing the benefits of research increasingly appear to include universities, research institutes and laboratories cooperating and collaborating 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). However, public research and development policy is another important means of maximizing the` benefits of research. Research and development expenditure can be a strategy for achieving research policy objectives of the state. In their study of research productivity determinants, (Adams and Griliches, 1997) found significant relationship between research and development expenditures and research output. At the level of fields, the authors found approximate parity between growth rates of papers and citations and the growth rate of R&D. Moreover, Choi et al (2009) analyzed the relationship between output and outcome factors (that represent performance at the individual company level) and long-term impact factors (ie, influence factors that represent performance at industrial and national level) of development projects in Korea. Literature on research and development policy in developing countries shows greater concern for research aspect rather than the development of technology. In their study of newly industrializing countries (NIC described as technology-followers), Forbes and Wield (2000) argued that technology–followers (newly industrializing countries) spent much on the research aspect and need a different type of research and development. The authors suggested, first, that industrial research and development in NICs must be done in firms, not autonomous laboratories. Second, these countries need development, nor research. Third, it is fundamentally necessary to rethink the role of research and development activity in follower firms in order to foster learning across the firm because such organized activity is often the formal innovating unit of the firm. In a technology-follower, this kind of activity might instead function as the firm's formal learning unit. Therefore, evidence from literature suggests that applied research and its related development efforts directed towards innovation and technology development are minimal in the developing world. However, a greater part of the industrial research policies has tended to focus on issues of technology transfer. For instance, in his study of the effects of deregulation policy introduced in India in mid-1980s, Aggarwal (2000) argued that deregulation promoted complementarities between technology imports and these in-house efforts. The author suggested that, in the context of industrial research producing innovations, deregulated policy regimes allowed technology imports to play the major role of technology up-gradation as competition introduced thereby might encourage firms to modernize their technologies through deregulation. However, there is a near consensus view in the literature that research and development capabilities of developing economies do not match international standard. The dominant view is that regulated policy regimes are important for filling gaps in domestic technological capabilities.

In technology-leaders (advanced industrialized countries), research ‘‘expands the base of knowledge on which existing industries depend and generates new knowledge that leads to new technologies and the birth of new industries” (Rosenbloom and Spencer, 1996:1). Sufficient evidence in literature tends to suggest that strong innovation regimes often lead to greater creation of innovations. Godoe (2000:1033) defines an innovation regime “as principles, norms and ideology, rules and decision-making procedures forming actors' expectations and actions in terms of the future development of a technology”. In their contribution on the subject, Chesbrough and Teece (1996) demonstrated that distinguishing autonomous innovations from systemic or radical innovations is critical for the success of organizing innovation processes. While the creation of autonomous innovation may result in benefits for market type organizations, systemic innovations require a type of coordination, scale and obligation beyond the capabilities of the former. Understanding the role of strong innovation regimes therefore may serve as a useful model to make the formulation of research and development policy more rational and meaningful (Manfield, 1991;

Pavitt, 1991). However, in most developing countries including the Gambia, research and development policies of government appear to lack the necessary mix with the broader science, technology and innovation strategic plan. In the Gambia, though officially articulated, national innovation plan lacks the necessary policy mix with other aspects of development agenda. Using Thailand as a case study with the aim of understanding national innovation systems in developing countries, **Intarakumnerd, et al. (2002:1445) argued that''** the development level of Thailand's NIS [National Innovation System] does not link to its economic structural development level...Its national innovation system remains weak and fragmented". The authors suggest that governments of developing countries like Thailand should plan and implement policies that help to address the weakness and fragmentation of the national innovation system. In brief, research, development, and technology policy can powerfully shape and direct science, technology and innovation.

2.6 RESEARCH GOVERNANCE AND SCIENTIFIC KNOWLEDGE

Recent literature on public sector reforms, higher education and research appears to be characterized by new approaches and re-thinking in governance of research institutions. There appears to be a growing emphasis on a shift from the traditional centralized authority and power structures to their redistribution across various policy levels. New approaches to governance warranted new institutional arrangements for coordinating public sector activities (Kooiman, 2000). Leišytė (2007:17) observed that in many countries coordination of organizational operations has changed ‘’from a classical form of state dominated regulation in parallel with professional self governance to forms in which various actors at various policy levels govern the system’’. In the new governance model, described as "multi level, multi actor governance" (Van Kersbergen and van Waarden, 2001), coordination occurs through interactions at various policy levels as many of the actors tend to influence policy agenda setting, policy development and determination, policy implementation and evaluation (De Boer, Enders, and Leisyte, 2007). In most parts of continental Europe, public sector policies have tended to shape governance of higher education and research. Shifts in policy reforms in these countries have produced changes in governance forms, in patterns of interaction among authority structures and roles at various policy levels. In most parts of Europe, and to a lesser extent in developing countries, various forms of multi-level governance are replacing state centric/state bureaucracy in the governance of higher education and research. The post-2000 period in Europe witnessed reforms in the governance of research institutions including universities, which introduced more competitive and performance oriented modes of coordination and greater autonomy to universities. The reforms included managerial-executive leadership structures at the institutional level.

Policy makers in most parts of Europe expect that executive leadership governance structures would promote higher quality education and more relevant research output. While monitoring of output is increasing, achievement of academic objectives by faculty appears to be increasing. In addition to incentive structures, performance based contracts with individual faculty members and department have lead to increased pressure to achieve in terms of output of doctorates, and publications, attracting third-party funding for research projects, etc. In developing countries on the other hand there appears to be increasing demand for policy reforms allowing shifts in research governance from government to governance, from centralized to decentralized control and coordination of research efforts. There has been increasing demand for university autonomy and academic freedom and a shift from state centric to decentralized steering of research in most of West and Central African universities. Highlighting this trend, IDRC Report (2009:6) states,

> *As in most African countries south of the Sahara, the early 90s was marked by claims for more liberty resulting to what many observers qualified [as] the wind of freedom. It is in this context that the university centers of Buea and Ngaoundéré were transformed to full flesh universities in 1992. Same as the universities of Yaoundé I, Yaoundé II, Douala, and Dschang were created on January 19, 1993.*

There are various hierarchical levels in university research governance in Cameron, Nigeria, the Gambia and a host of other public sector research institutions in West African. These hierarchies include faculty and departmental research committees, referees and special scientific committees, though without significant research steering autonomy. The state in most cases maintained a supervisory role and remained a dominant player in research policy arena.

Scholars have identified and distinguished between a number of governance forms and typologies of governance and coordination mechanisms for organization activities. These control and coordination mechanisms include markets, hierarchies, and relational contracting (Binsbergen, De Boer, and van Vught, 1994; Bradach and Eccles, 1991). Clark (1983) described what he called 'triangle of coordination' in the governance of higher education systems, which consists of three axes: the state, the market, and the academic oligarchy. The three corners of the triangle represent, "the extreme of one form and a minimum of the other two, and locations within the triangle represent combinations of the three elements in different degrees" (Clark, 1983:142). According to the author, the US has a more market-like coordination of higher education, and Sweden and the Soviet Union are examples of a more state oriented coordination while the UK and Italy are examples of an academic oligarchy being the dominating form of coordination. In the academic oligarchy model, university research depends less on government and more on the market forces. (Maassen and van Vught, 1994) developed two models concerning the role of the state in higher education and research governance. These are state control and state supervision models. A government closely regulates and finances higher educational institutions in state-control model, and top-down decision-making and strict application of rules and control mechanisms characterize education and research governance. The State attempts to legitimatize intervention and control through its claim of steering the economy, while ‘’areas of control include access issues, degree requirements, curriculum, the examination system, and the appointment and remuneration of academics’’ (Neave and van Vught, 1994:8). On the other hand ‘’the state supervised model draws on cybernetic perspective of decision-making and is based on the principles of monitoring and feedback’’ (Maassen and van Vught, 1994:38). Under this model, higher educational institutions oversee their own daily functions and management, while the state supervises the higher education system in terms of assuring academic quality and of maintaining a certain level of accountability.

The ‘market-driven system' is another governance model often associated with business-like approach to management of universities and research. The model appears to be in vogue in countries where the State plays a minor role in public and private education and research and where universities have to find several sources of financing through bidding and competition. Under this model, coordination mechanisms include the interplay of market forces and self-regulation and steering, particularly performance-based steering. The in-built market-type mechanisms stimulate competition among researchers through competitive-based research grants and contracts. Existing literature in this field appears to suggest that ‘’management and governance structures prove incapable of enabling organizations to self-steer their operations in an increasing changing environment’’ (Leišytė, 2007:30).

In addition, a greater part of comparative literature identifies the rise of managerialism in internal governance of universities (Amaral et al., 2002; Braun and Merrien, 1999). Currie et al., 2003:98) described new managerialism as the advent of "executive leadership at the expense of the professional role in decision making and instrumental rationality stressing 'the three Es' and top down structures, such as centralization and hierarchy". Stakeholder model of university governance is yet another approach, which is about the involvement of external factors other than the state. Under this model, external actors seem to exert considerable influence on the goals and direction of higher education and research. External involvement appears to be justified by the imperatives of external ties, which universities inevitably must have with their environment. Research institutions and universities are under obligation to meet the explanations and demands of research grant providers, businesses, local industry, and local communities and such like stakeholders (Leišytė, 2007:32). Strong evidence from review of literature on governance models shows that the market oriented governance model seeks to make research and development relevant to the needs of users and the market (Fransman 1992). This model, to a large extent, may rest on the assumption that are empirically and theoretically unjustified in the real world of innovations, thus ultimately creating policies and strategies that are contradictory to their intended benefits. This may explain why recent innovation policy and strategy research has attempted to counterbalance the inherent biases and unintended consequences inevitable in a market-oriented R&D governance model (Godoe, 2009).

In summary, it would appear that there is not much in literature on the effects of research governance models and structures in the context of developing countries. However, evaluation of studies on the state of university governance in West and Central Africa shows that the major stakes and challenges for research governance generally include,

> *few established regional laboratories/research groups; limited number of well trained resident scientists committed to solving local health problem through well designed research projects; absence of heavy equipment even in some established laboratories (multiplex analyzer etc.); limited funding sources especially for poverty related disease research; poor*

awareness of ethical issues and arbitrary costing of projects. Others include poor completion rates for projects, compliance to contractual requirements for funded research, especially for institutional and higher education grants, and difficulties in tracking projects because of non-compliance to guidelines on submission and reporting. It further includes low level of reporting on research activities, heavy teaching loads, uncertainties in the rhythm of disbursement of funds for research (this is receiving the very close attention of the administration in the Gambia),inadequate laboratory space and lack of equipment; inadequate access to training for the conduct and management of research (IDRC , 2009:37).

These constraints and concerns present enormous challenges that confront governance of research institutions in developing countries.

2.7 SYSTEM WIDE RESEARCH AND KNOWLEDGE SPILLOVERS

Evidence from literature shows that one of the benefits often claimed for investment in research and development is that there is a spill over effect, often described as technological externalities. Industries benefit from both their own research and development efforts as well as the efforts of other national and overseas industries. In a study of the long-term impact of research and development investment upon UK industry's productivity performance and the nature of ‘’spillovers” from such investment, Higón, (2007) suggested that efforts to invest on research coming from the industry itself and from other national industries have a positive impact on the industry's productivity. Mamuneas (1999), in a study of the effects of publicly financed research and development on cost structure of six high-tech US industries, argued that public investment capital reduces the variable production cost in all industries. An increase in such publicly financed capital investment causes output to increase. This implies that producers as well as consumers are better off in terms of costs, despite the presence of strong monopoly power in some industries. (Kafouros and Buckley, 2008) further noted that although research and development spillovers play a key role in the battle for technological leadership, it is unclear under what conditions firms build on and benefit from the discoveries of others. However, the authors suggested that, depending on technological opportunities, firm size and competitive pressure, the net impact of research and development spillovers on productivity could be either positive or negative. Though spillover effects are positively associated with technological opportunities a firm faces, the situation is reversed when the size of the firm is in question. This means that whilst external research and development affects large self-reliant firms negatively, its impact on the productivity of smaller firms is positive and even higher than that of their own (internal) investment in this regard. Smaller firms usually introduce incremental innovations characterized by a strong reliance on external technologies.

The conception of knowledge spillover thus far is that of external technical benefits arising from a firm's own or others' research and development efforts. Malerba et al. (2007:4) observed that;

> *‘’research efforts include own R&D resources, but also external sources of knowledge in terms of knowledge flow. Knowledge can be transferred from one firm or country to another. It can be codified or employees move from one firm or country to another as they change jobs. In a study of the effects of inter-industry spillovers from publicly financed business research and development on similar private efforts and productivity, Bönte, (2004:1635) provided ‘’evidence of productivity-enhancing effects of spillovers from privately financed R&D while results are less clear-cut for publicly financed R&D’’.*

Moreover, the research and development sector of a nation’s economy and knowledge spillovers have implications for long-term economic growth (Aghion and Howitt, 1992; Grossman and Helpman, 1991; and Romer, 1986, 1990). For this reason, it would appear that quantifying the extent and impact of knowledge spillovers might be a key factor in designing an appropriate national science and technology policy. Knowledge spillovers describe increases (or additions) to 'knowledge poll' of a firm, which arise essentially from the theoretical assumption that knowledge has a public good character by virtue of its non-rivalry in consumption and non-appropriability of research returns. It further describes the transfer (or diffusion) of knowledge, which may occur through a variety of channels ranging from direct formal or informal exchanges, collaborative research, and network of inventors to scientific journal publications. In this context, Malerba et al. (2007:4) stated that;

> *spillovers are typically measured with reference to a pool of available external knowledge, obtained from R&D capital of potential sources, eg other firms, regions or countries. Because of its (partial) public good nature, knowledge produced one economic agent may spill over to other agents, who can subsequently employ it or produce new knowledge.*

Consequently, knowledge spillovers may lead to external benefits of private investments in knowledge creation and to a market failure, which may justify options in government science and technology policy to intervene in order to deal with knowledge spillovers (Jaffee 1986, 1988). Such interventions include public support or subsidization of business and the strategy of direct public sector research and development investment (eg. establishing public laboratories).

Generally, the government may provide subsidies for firms, which generate research and development spillovers in open economies. However, (Leahy and Neary, 1999) provided evidence to show that in the presence of strategic behavior by firms, local research and development spillovers to other domestic firms may justify a tax on such investment rather than a subsidy. A good reason for this kind of tax is that research and development cooperation over-internalizes the external technological benefits of knowledge spillovers. The authors further suggested that international spillovers that benefit foreign firms might justify a subsidy, even though the government cares only about the profits of home firms. In addition, Jaffee, et al. (1986, 1988) in their discussion of measurement of knowledge spillovers recommended the use of patent citations to overcome the constraints of observability and precise measurement between firms (or even separately identifying the sources of increase of a firm's knowledge poll). Though the appropriateness of patent citations for measuring knowledge flow is questioned (Griliches, 1990), Jaffe et. al. (2000) using a detailed survey of inventors, in a more recent work identified spillovers by looking at the particular mechanisms of communication that actually permit knowledge to flow. Identifying what network of investors emerges from research done to create new patentable knowledge provides an approach that enables assessment of the existence of knowledge flow, at least at the research unit level. Based on a survey of the inventors of 9017 European patented inventions, Giuri et al, (2007) provided new information about the characteristics of European inventors, the sources of their knowledge, the importance of formal and informal collaborations, the motivations to invent, and the actual use and economic value of the patents (protected knowledge). Survey of inventors is not only an important source of identifying knowledge spillovers but also a tool for assessing their actual use and economic value. Another significant source of knowledge flow is journal literature (Oermann et al, 2008), which is relevant for the transfer, assimilation and use of information within the scientific community. (Sorenson and Fleming, (2004) identified the norm of publication as an important mechanism that permits rapid diffusion of knowledge gained through research. This mechanism permits more rapid diffusion than interpersonal and social networks. The authors argued that scientific publication constitute a significant mechanism for accelerating the rate of technological innovation.

(De Toqueville, 1848; Marx, 1844; Sveikaiskas, 1981; Mansfield, 1972; Adams, 1990; Henderson and Cockburn, 1994; Gambardella, 1995; Jaffe and Trajtenberg, 1996; and Mowery and Ziedonis, 2000) contributed to the growing literature on the linkage of basic science with technological innovation and economic growth. Some scholars have pointed out the importance of diffusion of knowledge as a basis for technological innovation. (Sorenson and Fleming, 2004), demonstrated that patents that reference published material, whether peer-reviewed or not, receive more citations, primarily because their influence diffuses faster in time and space. The work of the authors provided ‘’strong evidence for the notion that science accelerates innovation because its norm of openness and publication speed the diffusion of knowledge’’ **(**Sorenson and Fleming, 2004:1626). A related issue in literature is the impact of collaborations on rate of knowledge diffusion. Using detailed data on California biotechnology, Zucker, et al. (2010) proved that the positive impact of research universities on nearby firms relates to identifiable market exchange between particular university star scientists and firms and not to generalized knowledge spillovers. The authors concluded that the number of star-firm collaborations powerfully predicts success: for an average firm, five articles coauthored by academic stars and the firm's scientists imply about five more products in development, 3.5 more products on the market, and 860 more employees. Stars collaborating with or employed by firms, or who patent, have significantly higher citation rates than pure academic stars. In the context of literature on the potential impact of knowledge flows on the science and innovation system, it is possible that in the Gambia, knowledge spillovers generated form informal and formal collaborative research and scientific publications and conferences could have some long-term implications for the national innovation system. To the best of the knowledge of this thesis author, no systematic study has thus far been done to examine the implications of knowledge flows for the Gambia national science and innovation system.

2.8 MEASURING RESEARCH OUTPUT

Research output is usually defined in science literature for specific purposes of a study. The definition may compare the performance of research units or the ranking of universities or even of fields of sciences. Research output measurements are sometimes based on bibliometric indicators or proxies and in some cases on impact factors. Nevertheless, there is a persisting problem. Since reducing the complexity to a single number provides the basis for ranking, the weighting of different dimensions remains a problem in comparison. Leydesdorff, (2008) observed that clearly defined impact factors, though often for other purposes can vary in the order of magnitude between for instance mathematics and the life sciences. Rankings based on quantitative measures presents a problem. It is not always easy to compare universities accurately because the rate of publications and citations among fields of sciences differ significantly (Collins, 1985). In this context, Leydesdorff, (2008) observed that it is also not easy to decompose fields of science because journal sets often overlap. Consequently, technical problem that might heavily influence rankings surround field-normalization. The problem of developing balanced research output measures would arise from the fact that research institutions and universities often develop unique agendas and profiles (Enders, 2001). Jansen et al. (2007) identified four types of research units with distinct research output-profiles. These are research units specializing in certain activities and which focus on specific output bundles. Examples are units that publish many papers, those that write not as many but highly cited papers, units that engage in graduate teaching, and those that are concerned with transfer activities such as cooperation with companies or memberships in scientific advisory boards. It follows that some universities may emphasize graduate teaching while de-emphasizing publications. Others may pay greater attention to knowledge or technology transfer to companies. Schubert, (2009:1229) suggested that these unique output bundles might ‘’provide some indication [about] which output indicators should be included in order to measure output….However, the balanced scheme may not provide the only reasonable output definition’’. Found in literature is a wide range of research output indicators, which includes bibliographic measures such as publications, citations, conference articles, intentional job offers, and international co-authored publications. Other output measures often used in literature deal with knowledge transfer. These are such measures as intellectual/technical advisory services for firms, research cooperation with companies, and professional membership in advisory boards. The number of doctoral titles, editorships and scholarships/fellowships are yet other research output measures that relate to the task of education and qualification. In the matter of measurement of research output and ranking of universities, it is evident that there are several dimensions of, and complexity to, output indicators.

However, ranking is based on reducing this complexity to a single number considered a balanced scheme, which seemingly represents straightforward indicators. Nevertheless, the fact remains that one-dimensional ranking based on a specific output cluster-bundle (e.g. knowledge transfer, publications and citations, for instance) is inadequate. For the same reason, funding decisions based on similar measures are riddled with institutional bias, programmatic preferences, etc. (Wenneras and Wold, 1997; Bornmann and Daniel, 2006). Besides, consideration of efficiency in terms of research productivity could raise questions about publications and citation per dollar. In this context, Dosi *et al*. (2006) suggested that European universities might be more efficient than American ones because of the huge differences in their budgets. Narin, (1995) further observed that patent indicators are used in evaluation of industrial research at many different levels of aggregation. Such levels may include the level of applications to look at industrial research capability from a national or regional viewpoint comparing (for example, EU regional technology with that of Japan and North America). Another is the strategic level of applications. In this context, patent indicators may become standards for looking at industrial research from a company viewpoint. For example, CHI Research, Inc. used them to compare auto- company research output, company-by-company and technology-by-technology.

What then is the solution to these definitional and measurement problems of research output and ranking of research units and universities? For a solution, Schubert (2009) suggested the development of a balanced scheme or balanced output set defined as a set of output indicators consisting of the dimensions in the three sets of output bundles categorized as bibliographic indicators, knowledge transfer and tasks of education and qualification. The definition gives no special weight to any of the bundles. On the other hand, Leydesdorff, (2008) argued that since systems of scientific communication and technological innovation provide us with rich domains for studying the dynamics of science, technology, and innovation (Moed *et al*., 2004), one could measure, model and simulate the communication of knowledge. However, one needs models from non-linear dynamics because knowledge transfer is not linear. Considered as a meaning, knowledge makes a difference and potentially reduces uncertainty (Leydesdorff, 2006). Leydesdorff, (2008) further identified measurements tools for variables, which are used outside the context of analytical perspectives when legitimating research allocation decisions. This is to say that researchers can develop research output measures in a context consisting of peoples and institutions (sociology of science), content and theories (philosophy of science and artificial intelligence), and texts and journals (scientometrics).

Apparently, the above issues and concerns raised in literature have significant implications for the research methods and data design of this thesis. The works of Schubert, (2009) and Leišytė, (2007) provided the thesis with some clues on which research output measures to adopt. The works of these authors underscored the methodological issue of achieving a broad and balanced output measure. Moreover, Leydesdorff, (2006, 2008) and Moed et al., (2004) provided further vital information for the data design as the authors highlighted the definitional and measurement problems surrounding research output indicators. The authors further pointed to the intellectual caution needed in attempting to identify and use indicators to 'flag problems of organizations'. Such caution is necessary in attempting to categorize organization processes and, in research assessment exercises, to make deliberate distinction between the purposes of categorization of output measures. There is need for caution in making a distinction between improving the quality of people and their research and development and the citation impact of published output (Lawrence, 2007). Associated with these concerns is the suggestion to place the definition and measurement of research output in the context of sociology of science, philosophy of science, and scientometrics outside of analytical perspectives (Leydesdorff, 2008). These considerations justified the choice of constructivist approach in qualitative phase of this thesis.

2.9 EFFECTS OF PATENTING ON ACADEMIC RESEARCH

There appears to a consensus in literature that industry and production activities rely on scientific knowledge and technology generated and delivered by public research organizations. Geuna and Nesta, (2003:3) observed that ‘’in the open science model, access to scientific and technological knowledge produced in PROs [Public Research Organizations] is free of additional costs; these institutions are financed by government because they produce outputs that are characterized by positive externalities beneficial to society as a whole’’. Nevertheless, firms may have to engage in upstream research because, according to Cohen and Levinthal (1989), they may not have the capacity to benefit from available information and knowledge produced by public research organizations. This has meant that public research institutions and upstream research by firms are the principal sources of technology transfer (TT) activities. TT activities may assume several forms including the development of technical artifacts (such as databases, legal protection of intellectual property rights/patents, and software) and research collaborations between universities and firms by means of research contracts. A persisting problem has ever revolved around the narrow transfer of research results to industrial users. This has given rise to the question of how to protect the intellectual property rights (IPR) of researchers in order to ensure that they reap the benefits of their efforts in devoting part of their time to TT activities. However, in recent years particularly in Europe, TT activities included efforts to not only access and protect intellectual property, but also make it available for industry.

A greater part of literature on patenting deals with university patenting and the impact of intellectual property rights protection systems on academic research. In a study of the effects of increased patenting on research output in European universities, Geuna and Nesta (2003:4) argued that IPR is only one of the factors that can influence the behaviour of academic researchers and underpinned the importance of balancing the advantages of patenting activities ''against costs or the risks involved in the activities''. The US Patent and Trademark Office defined a patent as an intellectual property right granted by a government for the purpose of,

> *excluding others from making, using, offering for sale, or selling the invention throughout the United States or importing the invention into the United States for a limited time in exchange for public disclosure of the invention when the patent is granted* (Available at http://www.uspto.gov/patents/index.jsp).

Patent laws may assign the title of invention either to public research organizations (PROs), the university, or the researcher. Poti and Reale (2005:5) observed that, in Germany in 1998, "a new legislation assigned the title of inventions produced within research funded by the State to public research organizations, but the privilege granted to professors was abolished only in 2001". Currently, in most parts of the world, State legislation defined the academic researcher's invention as a service belonging to the university. In France as in most parts of Africa, universities enjoy the title of inventions realized by their professors. The Italian law 383/2001 (art. 7) "established the recognition of IPR to University's and Public Research Organization's employees for their own inventions" (Poti and Reale, 2005:5). Besides, a subsequent Italian law D. L. 30/2005 (art 65) in 2005 reserved to public researchers the IPR entitlements only in case of research funded with core intra-institutional fund, while in all other contract funding, the law reserved ownership to the public researcher.

How then do these patenting mechanisms provide incentives to realize patentable invention? The patenting of inventions of public scientists within their institutions affects the behaviour of individual scientists ((Poti and Reale, 2005). The authors confirmed the persistence of academic incentives in the patenting activities of Italian public research institutions. However, several key issues surround the scientific and economic impacts of strategic intellectual property (IP) behaviour. On the issue of patenting and licensing in public research organizations, governments, researchers and other stakeholders need more information on the quantity and quality of IP actually under management at PROs in order to understand whether concerns about the scientific and economic impacts of strategic IP behaviour are valid (OECD, 2002:198; Chapter 6 of the OECD ST&I Outlook, 2002).

Agres, (2002) made a case for not taking patents and fewer innovations by firms. The view that universities are ivory towers that produce academic output disconnected from technology has come under increasing attack in literature. Academics did and do produce research relevant to technological development as evidenced by the fact that their contribution feature in the list of industrial patents. University patenting is not a new phenomenon in US (Mowery et al. 2001, Mowery and Sampat, 2001) and its development does not have to depend on specific policy incentives. Debates on the potential impacts and benefits of intellectual property activities of public research organizations have continued. (Darby, 1996; Louis et al. 2001) argued that increased university Intellectual Property Rights has not tilted the balance between basic and applied research. The authors provided evidence to show that entrepreneurial scientists (researchers with a record of accomplishment in technology transfer activity) have high scientific productivity. On the other hand, (Poyago-Theotoky et al. 2002) maintained that Technology Transfer activity does not divert from basic research. In addition, Henderson et al. (1998) argued that quantitative growth in public patenting has not always been characterized by good quality. A recent study by Cesroni and Piccaluga, (2002) demonstrated that public patenting increase could be attributed to entry of new universities in patenting activities, resulting in lower quality of patents. Since it is not easy to make a clear distinction between basic and applied research, some doubts surround the claim that applied research is more relevant in the transfer of technologies and knowledge. Besides, the use of patents as indicator of knowledge flow has come under increasing criticism in literature. However, from the survey of literature carried out for this thesis, there appears to be no conclusive evidence that patenting is an effective instrument for technology transfer. Hence, patents seem disputable and undependable as research output measure. For this reason, the thesis excluded patents as scientific output measure.

2.10 CONCLUSION

In conclusion, this chapter evaluated studies on public research systems and higher education from a global perspective. In this context, contemporary emphasis in literature is on multiple stakeholder partnership approach to research and innovation in a wider concept. Context is central. The underlying notion is that it is important to consider the interests of multiple stakeholders with a variety of perspectives and functions. It is widely recognized, at the public level at least, that a broader approach to research may provide significant economies of scale, spillovers, and synergetic interactions. Many organizations and researchers/scholars now realize that a number of important economic and social problems go beyond national boundaries, and that a broader approach to research, than is possible within individual state's projects and resources, can achieve greater results.

In addition, this chapter surveyed literature on the structure of scientific world in developing countries. Support for research in developing countries come mainly from external sources. A greater part of the research and development investments in the developing world is located within the National Agricultural Research systems (NARS), and the assumption is that this investment has produced unprecedented results in agricultural productivity over the past two decades. Research capacity and the state of science vary across the region, and even within countries, capacity of research systems is often quite variable, depending on funding, incentive systems, and political support. Existing research suggests that some developing countries especially the middle income countries such as India, China, Thailand, Brazil, Mexico, Argentina and Chile, to name a few, that are actually quite advanced with respect to scientific development, with a national budget for research and numerous PhD programs (Harris (2004). However, brain drain, low government research funding allocations, and a low number of researchers, unreliable finance, poorly paid and managed staff, weak and unreliable infrastructure, and sometimes a lack of security appear to weaken research capacity in developing countries.

The prominent sectors of research in the Gambia are agriculture and health. Apart from university research, which focuses mainly on basic research, there is virtually no evidence of industrial research in literature. Research evidence identifies major developments in agricultural research in the Gambia since year 2000. Compared with many African countries, agricultural research staffs in the Gambia are significantly less qualified. Further, the involvement of the private sector in the Gambia agricultural research and development is minimal, representing 2% of agricultural research staff and spending in 2001 (Stads, Fatajo and Kunjo, 2004). On the other hand, university research activities are beginning to take shape in a context where there are extensive linkages with external institutions as well as collaborative networks involving academics engaged in basic research. On the health sector, literature further reveals that, though the Gambia has developed a national health research system, the system is yet to be firmly rooted. The research program unit at the Directorate of Planning and Information manages and steers research done within the Health Ministry. However, the Medical Research Council, the Gambia unit dominates research activities in this sector.

The chapter further evaluated literature on knowledge spillovers/flows. Evidence from existing literature reveals that knowledge flows emanate from several sources ranging from direct formal or informal exchanges, collaborative research (among academics, between university and firm, and between or among firms), and network of inventors to scientific journal publications. (Sorenson and Fleming, 2004) identifies the norm of publication as an important mechanism that permit rapid diffusion of knowledge gained through research (more rapidly than through interpersonal and social networks). Their work argue that scientific publication constitute a significant mechanism for accelerating the rate of technological innovation. Having examined literature for the potential impact of knowledge flows on the science and innovation system, it is evident that in the Gambia, knowledge spillovers generated form informal and formal collaborative research and scientific publications and conferences, could possibly have some long-term implications for research behavior, scientific output, and the national system wide research. It is also evident that yet very limited empirical studies have thus far examined the relevance of knowledge flows for the Gambia national science system. In this context, the thesis will seek to examine the extent to which collaborative research exchanges and other research related behaviours contribute to production of knowledge and innovations in the Gambia.

Evaluation of literature further reveals evidence of definitional and measurement problems associated with the concept of research output and the ranking of research units and universities. Some authors pointed to the need for exercising intellectual caution in attempting to identify and use indicators in order to categorize organization processes (Leydesdorff, 2008, 2006; Moed *et al*. (2004; Lawrence, 2007). For reasons of the problematic of conceptualizing scientific output, the qualitative phase of this thesis adopts a constructivist approach, which allows for the construction of research output from the participants own perspective and the contextualization of research findings in the qualitative phase of this project.

Recent literature on research governance tends to emphasize multi-level governance structures reflecting a shift from the more state centric (or government-centered) governance of research. A similar trend is found in developing countries as evidenced by increasing demand for university autonomy and academic freedom. There is evidence of a shift from state centric to decentralized steering of research in most of West and Central African universities. University research steering in Cameron, Nigeria, the Gambia and a host of other public sector research institutions in West African reflect hierarchies of competences, though autonomous decision competence remained with institutional management. However, research policy literature in developing countries reveals very limited empirical studies on the effects of research governance on scientific knowledge production, and none using qualitative approaches.

Moreover, a greater part of literature on research policy has shown interest in the ongoing debates on the effects of different governance models and structures on scientific output/performance of researchers. These empirical discussions appear mixed and inconclusive. Besides, there appears to be implicit doubts on the benefits both of *internal hierarchical self-control/*management centric structures *and of academic self-management (which measures the degree to which research chairs can decide autonomously)* or scientific committee model and structures, which this thesis identifies and describes as professional self-steering model. Scubert, (2009) identified and discussed the governance models in italics. The benefits or positive impact of management centric governance model and structures are sometimes doubted ‘’because it is argued that research is not a routine task and the most empowering setting is that of academic freedom’’ (Schubert, 2009: 1225), it has not been shown either that scientific committee model actually has positive influence of research output. Besides, there appears to be a gap in literature in the ongoing empirical discussions concerning the influence levels of different governance models and structures and scientific output in a context of possible association between explanatory factors of scientific output. Thus, it remains an open question as to whether research governance model and research practices/ behaviour are correlated. Apart from (Horta et al, 2007; Horta and Lacy, 2011) that discussed the importance and contribution of communication behaviour to knowledge generation, there appears to be no systematic study of other research related behaviours and their impact on scientific output. In this context, it is also important to consider other aspects of research practices/behaviour, which permits a more elaborative and individual perspective to performance of the scientists.

Apart from the question of whether a particular predictor or explanatory variable exerts significant influence on scientific output, it is equally evident from existing literature that no empirical study has focused on the relative significant impact of these causal factors on the response variable. In addition, most recent studies focusing on determinants and hampering factors of scientific output employed one measure for research output at a time, without testing the effects of considering different variables simultaneously. Such works include Lissoni et al. (2009) on factors of size and nature of projects, authors 'age and gender and (Breschi et al. 2005; Van Looy et al. 2006; Stephan et al. 2007) on patenting activities. Thus, similar to Horta and Lacy, (2011), this thesis combines both individual and organizational factors that affect research performance at the individual level.

CHAPTER THREE

RESEARCH METHODOLOGY: *A POSTMODERN APPROACH*

3.0 INTRODUCTION

The purpose of this chapter is to discuss research methodology for this thesis, which is essentially eclectic in thrust. The thesis used a combination of Grounded Theory approach in the first qualitative phase and positivist research strategy in the second quantitative phase. Overall, the methodology is postmodernism, which is multi-methods in orientation. The chapter describes the framework for data collection, data storing, and interpretation. In applying a multi-methods approach, each method has positive strengths, and combining different methods in a single inquiry can indeed result in gaining the best of both research worlds. However, in the following section, the chapter discussed research paradigms and the basis of distinction among them. Section 2 discussed phenomenological paradigm. In particular the section examined the concept, origin, purposes and types of phenomenology. Section 3 discussed positivist paradigm, its origin and related paradigms. The chapter further discussed the concept, benefits, and application of postmodernism in section 4. Section 5 discussed choice of paradigm for the thesis, providing reasons for opting for postmodern paradigm. The chapter discussed qualitative research in section 6 while section 7 described the focus and methods of quantitative research. In section 8, this chapter identified and discussed the theoretical framework of the thesis analysis. The chapter further examined Grounded theory in section 9, and in the subsequent subsections, the chapter discussed in particular the process of developing a grounded theory, constraints on grounded theory approach including the thesis's justifications for applying grounded theory. The chapter ends with a conclusion in section 10.

3.1 RESEARCH PARADIGMS

Research is a systematic study of a subject aimed at discovering new facts and reaching new conclusions. Smith and Dainty (1991:68) described research as a process of inquiry that adds to knowledge of a phenomenon, ''...a systematic, careful inquiry or examination to discover new information or relationships and to expand/verify existing knowledge for specific purpose''. The Longman dictionary (1995:1205) defined research as "“the studious study/examination of a subject that is intended to discover new facts or test new ideas; the activity of finding information about something that one is interested in or needs to know about''. Since research is a rigorous and deliberate process, the researcher must necessarily make use of paradigms to guide and facilitate his work. Paradigms are models, or more specifically frameworks derived from a worldview or belief system about the nature of knowledge and existence. A framework, according to dictionary meaning, is a set of assumptions, concepts, values and practices, which constitute a general structure, a useful instrument/lens for looking at, or mirroring reality. Dix, (2007) distinguished between a model and framework. According to the author, a framework provides the researcher with a practical tool for thinking of ways of doing his research, and a model on the other hand is a specific hypothetical structure consisting of interrelated concepts, often diagrammatically represented. Models become useful in investigation, in developing and testing a hypothesis. However, a model is sometimes seen as a framework. A paradigm is essentially a framework because it constitutes a general structure for viewing reality. Paradigms are shared by a scientific community and serve as a guide as to how that community acts with regard to inquiry. Paradigms guide the research efforts of scientific communities. Reflecting on the meaning of a paradigm, Johnson and Onwuegbuzie, (2004:24) wrote:

> *In this article, by research paradigm we mean a set of beliefs, values, and assumptions that a community of researchers has in common regarding the nature and conduct of research. The beliefs include, but are not limited to, ontological beliefs, epistemological beliefs, axiological beliefs, aesthetic beliefs, and methodological beliefs. In short, as we use the term, a research paradigm refers to a research culture.*

A paradigm ‘’stands for the entire constellation of beliefs, values and techniques, which are shared by the members of a community” (Kuhn, 1970:175). The author understood paradigm as a “disciplinary matrix”, and describing paradigms in a stronger sense, argued that paradigms provide a framework consisting of shared beliefs, shared symbolic generalizations, shared values and shared examples which provide reference points in an otherwise uncertain universe (Kuhn 1970: 181-187). Thus, paradigms provide guidelines for actors/researchers involved in complex problem-solving and knowledge production situations. These guidelines reduce the complexities to a point that makes the resolution of the problem possible. Patton (1990) described a paradigm as a worldview, a general perspective, a way of breaking down the complexity of the real world. The term, paradigm derives from the Greek word *paradeiknyai,* which means ‘to show side by side’. It may refer to a pattern or example of something. Therefore, a paradigm connotes the notion of a mental picture or pattern of thought. Senge (1990:8) described paradigms in cognitive terms as '‘...deeply ingrained assumptions and generalizations that influence how people see the world and behave’’. However, in a later study, Senge et al. (1994) recognized that people are not always conscious of their mental models. The authors therefore argued that though mental models are necessary for people to wade through the environment of life, all mental models are somehow flawed. On paradigms, Guba and Lincoln, (1994:107) stated that;

> *‘’a paradigm may be viewed as a set of basic beliefs…that deals with ultimates or first principles. It represents a world view that defines for its holder the nature of the ‘’world’’. The individual’s place in it, and the range of possible relationships to that world and its parts…The beliefs are basic in the sense that they must be accepted simply on faith (however well argued); there is no way to establish their ultimate truthfulness. If there were, the philosophical debates…would have been resolved millennia ago’’*

Holding a similar view, Covey (1989) argued that paradigms represent a mental map through which people see the world, perceive, understand, interpret, and explain the world around them. This means that people interpret their experiences through their individual mental maps. Mental maps are not always questioned because ‘’they are accepted simply on faith’’ (Guba and Lincoln, 1994:107). Through these lenses, people assume that what they see is "reality". People see the world as they are conditioned to see it through their cognitive/mental maps, their perceptions or paradigms. Paradigms shape our basic attitudes, behaviours and even the way we interact with others. According to Guba and Lincoln (1994), a paradigm is a worldview that describes the nature of the world, a person's place in it and his relationship to the world. A paradigm provides a conceptual framework for seeing and making sense of the social world. According to Burrell and Morgan (1979; 24)), "To be located in a particular paradigm is to view the world in a particular way”. In addition, (Patton, 1990: 37) described paradigm as a "worldview”. Though Henning *et al.* (2004) defined a paradigm as a theory or hypothesis, a paradigm is rather an approach, a framework within which theories are built. This framework influences the researcher’s thinking about how to deal with questions under investigation. This is because holding a particular worldview influences our personal behaviour, our professional practice, and ultimately the position we take with regard to the subject of research we undertake. Perceived as a model, a paradigm is an interpretative framework, guided by "a set of beliefs and feelings about the world and how it should be understood and studied" (Guba, 1990). Guba and Lincoln, (1994:108) argued that ‘‘[Research] paradigms define for the [researcher] what it is they are about, and what falls within and outside the limits of legitimate [research]”. By acknowledging or even advocating certain values and beliefs and denying the legitimacy of other/concurrent belief systems, paradigms define what problems must be resolved and how to resolve them. In a recent study, Smyth (2004:168) reflected on the purpose of a framework and described paradigm as a,

> *‘’Research tool intended to assist a researcher to develop awareness and understanding of the situation under scrutiny and to communicate this. As with all investigation in the social world, the framework itself forms part of the agenda for negotiation to be scrutinized and tested, reviewed and reformed as a result of investigation’’*

Paradigms differ according to their different philosophical traditions, and according to their epistemological and ontological assumptions. Certain basic beliefs characterize a particular research paradigm, and responses to three fundamental questions determine these beliefs. Denzin and Lincoln (2001) listed three categories of questions that determine such beliefs. These are:

7. On ontology, the question is what is the form and nature of reality? Ontology deals with the question of what is real.
8. On epistemology, the question is what the basic belief about knowledge is (that is, what can be known; what is the relationship between the inquirer and the known)? Epistemology is

the branch of philosophy that studies the nature of knowledge and the process by which knowledge is acquired and validated (Gall, Borg, and Gall, 1996)

9. Methodology: how can the inquirer go about finding out whatever he/she believes can be known; how do we know the world, or gain knowledge of it?

However, other elements that also characterize a paradigm are derivable from the question about value, the axiological question, and the question of language/rhetoric of the research. Lincoln and Cuba (2000) in challenging the assumptions underlying positivism identified two more categories that constitute the basis for distinction between different paradigms. These are beliefs in causality and axiology. While axiology deals with the issue of value, the assumptions of causality assert the position of nature and probability of casual relationships. Specific assumptions about research may include the role of value in research, how to avoid value from influencing research and how best to make use of research products. Hence, in undertaking a particular research, the investigator must understand the assumptions surrounding the research framework (Smith and Dainty, 1991). The assumptions, values, and beliefs underlying a research constitute the research approach. It follows that a research approach consists of a set of assumptions and beliefs upon which it is built and consequently shapes the understanding of how things are connected. Each approach has its strengths and weaknesses, and a researcher's choice will depend on his worldview; his values, assumptions and beliefs about the world.

Research paradigms perform significant functions in research. Dill and Romiszowski (1997) argued that paradigms perform the important function of defining how the world operates, how knowledge is obtained from this world, and how one is to think, speak and write about this knowledge. Paradigms enable the definition of questions to be asked, and warrants the methodologies to be employed in answering research questions. Other function of paradigms includes the determination of the limits of publishable knowledge. A paradigm structures the world of the researcher, and provides the meaning and importance of this world. The significance of paradigms is that they shape how we perceive the world and those around us; the community of practitioners reinforces them. Within the research process, the beliefs a researcher holds will invariably reflect in the planning of his research, how data is both collected and analyzed, and how research results are presented. For the researcher, it is important to recognize his paradigm because it allows him to identify his role in the research process, determine the course of any research project and to distinguish other perspectives.

During the past century, different paradigms have arisen in response to the remarkable growth in social sciences research. There are two dominant paradigms, which are positivism and anti-positivism (or naturalistic inquiry). A relentless focus on the differences between the two orientations have tended to sustain the paradigm wars while the two dominant paradigms have resulted in two research cultures, "one professing the superiority of 'deep, rich observational data', and the other the virtues of 'hard, generalizable'...data" (Sieber, 1973:1335). Kuhn (1970:187) descried science as "a series of peaceful interludes punctuated by intellectually violent revolutions". A fundamental theme of author's argument is that the typical developmental pattern of a mature science is the successive transition from one paradigm to another through a process of revolution. Existing world view/paradigm is tenaciously guided as it provided for its proponents the only realistic lens for perceiving and analyzing problems of society. The adherents tend to ignore research findings that might threaten the existing paradigm and trigger the development of a new and competing paradigm. The inevitable tension in scientific research arises from the fact that every problem that 'normal science' sees as a puzzle can be seen, from another perspective, as a counter-instance and therefore a source of crisis over its acceptance. Covey (1989) argued that when a person sees the world from a different viewpoint and a scientific community shares this, then a paradigm shift is experienced. However, nearly every breakthrough in research derived from a paradigm shift. The 1990s experienced formal movements in the philosophy of science and debates over the use of the term ‘positivism’, when advocates of qualitative research began to use the label ‘’positivism’’ to describe quantitative research as outmoded thinking across a wide range of disciplines. These debates became a key feature of what were to be known as ‘science wars’ within this period (Labinger and Collins, 2001).

Research paradigms define for the researcher the legitimate limits of inquiry (Guba and Lincoln, (1994). The researcher's basic assumptions and beliefs determine his paradigm, but in order to add rigor to the research, the inquirer must investigate these assumptions and beliefs to produce a research perspective. Smith and Dainty, (1991) argued that not understanding the research perspective and limitations have the potential to deliver unsuccessful result from a research. In brief, research paradigms enable the organization of empirical observations as they shape and direct research efforts, narrow the areas of search, point to the direction of likely discoveries, and help to make sense out of observed patterns in social life (Babbie, 1995). Paradigms provide a framework for organizing research; they provide perspectives for making sense out of things. The researcher's beliefs and feelings about the world and how it should be understood and studied, (that is, his worldview), tend to shape his personal behaviour and the position he takes with regard to the subject of research undertaken. However, current thinking seem to emphasize a shift from the notion of broad ‘world view’ to specific thinking or perspective of the researcher about the nature of research (Morgan, 2007). This is what Creswell, (2009) described as 'knowledge claim'. Thus, a research methodology, which must necessarily be in tune with the researcher's basic beliefs and assumptions about the nature of knowledge and subject of inquiry, must also be derivable from the research questions of ontology and epistemology. As Bell, (1996; 2003) aptly observed, paradigms consist of an accepted set of theories, methods and ways of defining data.

3.2 PHENOMENOLICAL PARADIGM

Phenomenology is about the study of experience through the perspectives of actors in a situation. As an approach to inquiry, it seeks to identify phenomena through how the phenomena are perceived by research participants. This being the case, phenomenological research involves using inductive and qualitative methods to gather close and deep information and perceptions and representing these from participants' perspectives. The epistemological assumption of phenomenology is that knowledge is personal and subjective. Hence, this paradigm emphasizes the important place of personal experience and interpretation in social inquiry (Lester, 1999). Phenomenological paradigm can be a useful framework for understanding subjective experience and for gaining insights into people's feeling, beliefs, motivations and actions and thus overcoming the limitations of positivist approaches in social research.

Though the origin of phenomenology can be traced to Kant and Hegel, Vandenberg (1997:1) regards Husserl as ''the fountainhead of phenomenology in the twentieth century''. According to Eagleton (1983:55), Husserl reasoned that reality, seen as 'pure phenomenon' is subjective providing absolute data where inquiry must begin. Reality is the outcome of interaction between elements of the physical world and the consciousness of the observer. Consciousness involves an interpretative process from which the sense of reality is experienced and shaped (Spinelli, 1996). According to the author, reality is thus open to multiple interpretations; there is no ‘objective’ reality, but interpreted reality, one that is entirely ours. This is the epistemological basis of phenomenological paradigm.

Phenomenology deals with structures of consciousness, the knowledge of something. It is concerned with some phenomenon, as experienced from the first-person point of view, given relevant conditions of experience (Stanford Encyclopedia of Philosophy, 2004). Classical Husserlian phenomenology argues that our experience represents things or is directed towards things only through particular concepts, thoughts, ideas, or images. These concepts, ideas, and thoughts make up the meaning or content of a given experience, and remain essentially subjective. However, evidence from recent literature on the subject indicates that phenomenological research overlaps with other qualitative approaches, which include ethnography, hermeneutics, symbolic interactionism, and other variants that feature in the Encyclopedia of Phenomenology (Stanford Encyclopedia of Philosophy, 2008). These are

1) Transcendental constitutive phenomenology, which studies how objects are constituted in pure or transcendental consciousness without consideration of the issue of how these objects relate to the natural world.
2) Naturalistic constitutive phenomenology, which studies how we know things in the natural world in consonance with the natural attitude and belies that consciousness is an integral part of nature
3) Existential phenomenology, which studies concrete human existence including experience and action we freely choose to have or take in concrete situations.
4) Generative historicist phenomenology, which studies how meanings, made out from human

experience, is generated in historical processes of collective experience over time.

5) Genetic phenomenology that studies the origin of things, and which occur within one's own stream of experience.
6) Hermeneutical phenomenology that studies interpretative structures of experience, how we understand and engage things around us in our human world, including ourselves and others
7) Realistic phenomenology, which studies the structure of consciousness and intentionality based on the assumption that knowledge has ontological features.

A multicultural approach to phenomenology recognizes and respects the participants' experiences and responses. It gives room for research objects to help define the direction of the research, and further permits the research object to benefit from the individuality and worth of the diverse life experiences of participants. This type of phenomenological paradigm insists that 'research must take place with the entity-in question for fullest understanding', and sees that researcher as a veritable instrument in the research process because it considers the experience and perspectives of the researcher as valuable and meaningful to the research (Lincoln and Guba, 1985).

Another variant of phenomenology is heuristics, which makes the researcher visible in the frame of the research and recognizes the inquirer as an interested and subjective actor. Heuristic inquiry requires that the researcher must ''have personal experience with and intense interest in the phenomenon under study'' while the participants must '' share an intensity of interest in the phenomenon'' (Patton, 1990:71). On the other hand, symbolic interactionism represents a school of thought pioneered by Dewey, Charles Cooley (1864-1929), and Herbert Mead (1862-1931). Blumer (1967) actually introduced the term, social interactionism, and suggested that the culture of a specific group consists of 'social symbols' and 'common understandings', and as group members are socialized into the group's culture, this ''produces co-operative behaviour and symbolic understanding'' (cited in Manning and Smith, 2010:37). Blumer (1986:2) suggested that symbolic interactionism is based on three ideas. The first is that ''human beings act toward things on the basis of the meanings that the things have for them', the second that these meanings are derived from social interaction and group life'', and thirdly, that 'these meanings are handled in, and modified through, an interpretative process used by the person in dealing with the things he [or she] encounters' (cited in Annells, 1996). Symbolic interactionism is unique in that it recognizes that people interpret and define each other's actions rather than merely reacting to other's actions. Social life is expressed through symbols and language symbols are important instrument in reaching socially constructed or negotiated meanings (Lewis, 1992). Language and symbols are used in reaching common understanding in social interactions, allowing individuals to give meaning to things, objects and ideas. This perspective is anchored to actions occurring in specific social groups and focuses on the meanings which group members give to each other's behaviour. Symbolic interactionists argue that social interactions and the resulting patterns of social organization can be understood simply by paying attention to capacity of group member to create symbolically meaningful objects. This means that, not only can humans change themselves, but also can bring about change in society. These ideas are similar to social constructivism. Recent writers on this include (Lincoln and Guba, 2000; Schwandt, 2000; Neuman, 2000; and Crotty, 1998). These authors argued that people seek understanding of the world in which they live and develop subjective meanings of their experiences. These meanings are varied and many and constructed and voiced through interactions with other persons. Overall, symbolic interactionism hypothesizes that meaning is socially constructed, is negotiated and changes over time through the reflexive interaction of individuals (Loosemore, 1999; Goulding, 2005, Mansourian, 2006). It focuses on explorative or descriptive as well as interpretative aspects of research and presents a difficult form of empirical research because the social interactionist must spend enough time in the field (Manning and Smith, 2010). However, pure phenomenology seeks primarily to describe, not necessarily to explain. Phenomenological methods begin from a point free from preconceived perceptions or hypothesis, and are useful in highlighting the experiences and perceptions of people from their own perspectives. Though particularly an effective approach in single case studies, phenomenology might be useful in drawing attention to different situations, and when an interpretative dimension is added, it can provide a basis for building an empirical theory (Manning and Smith, 2010).

3.3 POSITIVIST PARADIGM`

The positivist paradigm has its origin in the philosophical ideas of the French philosopher, August Comte (1798-1857), who emphasized observation, logic and reason as basis for understanding and explaining human behaviour. Positivist thinkers use the method of observation and experiment in the process of generating knowledge, a method that has come to be understood within the framework of the principles and assumptions of science (Nirod and Dash, 2005). Conen, et al. (2000) argued that science is based on the assumptions of determinism, empiricism, parsimony, and generality. Determinism refers to the assumption that other circumstances cause events, and understanding such casual links between events becomes necessary for prediction and control. Empiricism describes the assumption about the collection of verifiable empirical; data to support theories and hypotheses. Parsimony is about the explanation of phenomena in an economic manner, and generality is the process of generalizing the observation of a particular phenomenon leading to prediction about the world at large. Based on these assumptions, the ultimate purpose of science is to integrate and systematize research findings and produce theory that describes and explains reality.

Positivist paradigm can be viewed as nomothetic as it emphasizes quantitative analysis of a few aspects/sample from a large population in order to test hypotheses and make statistical generalizations. The positivist methods involve moving from general explanations to specific data, from theory to particular instances, which is essentially deductive. The ontological viewpoint is that the researcher and research object are considered independent of each other, and for this reason, the logical choice of method is one of experimentation, manipulation, and hypothesis testing (Guba and Lincoln, 1994: 109). For the positivist, objective reality exists outside the individual and, his epistemology is that this reality can be discovered with predictable degree of certainty using objectively appropriate scientific methods (Carson et al., 2001; Jean Lee, 1992; Long et al., 2000; Neuman, 2003). Kidd, (2002) observed that this is the traditional approach of the physical sciences, which is also the dominant approach in established social sciences such as psychology and economics. The assumption of certainty underlines the positivist thinking, and such concepts as reliability, validity, and statistical significance are used in positivist research for the purpose of describing reality with certainty (Hanson and Grimmer, 2007). Guba and Lincoln, (2000) argued that objective reality exists, but suggested that methods to discover reality produce probabilistic and ultimately uncertain understandings. However, quantitative thinking came from a tradition of established by such authorities as Comte, Mill, Durkheim, and Locke (Smith, 1983). Early positivist believed that society could be studied scientifically in much the same way as in physical sciences, and advocated for objectivity in the study of social phenomena. Positivist research aims to produce objective and generalizable results using unbiased surveys. In social sciences, the positivist model provides a framework for scientific study of society and of specific and identifiable patterns in social relations. The basic paradigmatic assumption of the positivist is the rationality of social behaviour.

Positivism represents conventional approach to quantitative research. However, there are a number of related paradigms that lend themselves to quantitative analysis. These include the deterministic, idiographic, and nomothetic approaches. The deterministic model, often described as cause-and-effect model, is evident in natural sciences, though the approach may be used in social scientific inquiry. This perspective examines the nature of causation of human and social behaviour. In social inquiry, determinism addresses the question of whether personal behaviour is the product of personal willpower, forces in the world that are outside one's control. The model can be used in the study of prejudice and juvenile delinquency. However, lying at the base of explanatory social science, the deterministic perspective does not assume that all human behaviour are determined , or that causal patterns are simple ones, or even suggest all answers about what causes what. For this reason, the approach embodies probabilistic element and thus may be describes as probabilistic casual framework of inquiry. Idiographic paradigm on the other hand provide a framework for explaining phenomena by means of ''enumeration of the very many, perhaps unique, considerations that lie behind a given action (Babbie, 1995:67). Clinical psychologists using this approach would search for answers for deviant behaviour in their patients. A third related positivist paradigm, the nomothetic approach provides a framework for discovering only those factors considered most important in explaining the general categories of actions or events, without listing all considerations that result in a particular action. This approach may be used in the study of voting behaviour and political orientation, and ''involves isolating those relatively few considerations, which will provide partial explanation for the voting behaviour of most people or of all persons'' (Babbie, 1995:67). Its purpose is to provide adequate explanation with least number of casual variables to account for general patterns of cause and effect

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3.4 POSTMODERNISM

Postmodernism, which developed as a philosophical and intellectual movement within the domain of knowledge production, claims that there is no ultimate epistemology upon which to base the search for knowledge (Lyon, 1994). Postmodernism is not concerned with the 'truth' of research product but rather the pragmatic applicability of results (Annells, 1996). The ontological position of postmodern paradigm is that there is no single or even absolute representation of reality, and this being the case research cannot work towards the production of absolute truth (Rogers et al. 1995; cited in Bowker, 2001). This is because all forms of knowledge are socially, historically and culturally mediated (Charmax, 1995; Kvale, 1996). Implied in the postmodern philosophy is the notion of dissolving hierarchies of knowledge, which refers to the claim by positivists to be able to produce superior knowledge than anti-positivist or qualitative research can possibly do.

The historical connection between postmodernism and modernism has meant that positivist research methods cannot be excluded from postmodern agenda (Graham, 1992). Postmodernism is a reaction to modernity, which is characterized by science based essentially on the positivist paradigm. Though the methods of positivism actually produced remarkable scientific breakthroughs, postmodern paradigm questions whether science alone can lead to scientific progress (Wilson, 1997). Whereas modernity trusted science to lead us down the road of progress, postmodernism questioned whether science alone could really get us there. Thus, according to the postmodern thinker, greater knowledge can be gained through multiple approaches to the research. Fiat and Venkatesh, (1995) argued that though postmodern research adopts a constructionist view, it does not deny the epistemology of the positivism. Postmodern paradigm calls for wider pool of epistemological process. From these, the researcher can conceptualize the social world and the search for knowledge. Charmax, (1995) further observed that affirmative postmodernism is concerned with widening the pool of approaches to knowledge beyond mere empiricism to include subjective approaches.

Hlynka and Yeaman (1992) outlined some key features of postmodern thinking. These are

1) Commitment to multiple approaches, methods, and values
2) Accommodation of dual meanings and alternative explanations/interpretations
3) No single truth or theory that explains everything; rather there are multiple truths.

According to the postmodernist, truth or reality, what can be known is dynamic, changing and bounded by time, space, and perspective. Thus, recognizing the contextual situation of research, the postmodernist research aims to achieve greater breadth and depth of findings. This approach assumes that paying attention to contextual aspects of research facilitates conceptualization of co-existing realities. In fact, the basic notion of postmodern methodology is that alternative approaches can produce wider perspectives from which to understand the social world. In this context, Fielding and Fielding, (1986) observed that multiple approaches to knowledge produce greater depth and breadth of understanding on a subject instead of focusing on objectivity and accuracy alone as positivism does. The rigid procedures of positivist enterprise do not limit the methodology of postmodernism; rather the postmodern paradigm combines multiple methods in the search for knowledge (Firat and Venkatesh, 1995). Multiple methods approach to research is not only useful for validating research results but also enables a more comprehensive interpretation because it addresses the complexities that may be found in a research setting. Qualitative methods can be useful in providing alternative answers otherwise not possible through quantitative methods alone, and may also raise new questions and answers that may lead to reformulation of old theories. Mertens, (2007) argued that, in combining qualitative and quantitative methods, the qualitative dimension provides a platform to gather community views, socially constructed values and meanings at each stage of the research while the quantitative aspect offers the opportunity to establish valid findings acceptable to the community and scholars.

Foster, (1997) introduced the notion of conceptual triangulation in the postmodern mixed methodology, a notion that has relevance for validation of research results. Triangulation generally tests consistency of results obtained through different methods. Triangulation in social research involves the use of multiple methods and measures in order to ‘’overcome the problems of bias and validity’’ (Blakie, 1991:115, 2000; Scadura and Williams, 2000). However, the notion of validation that has to do with objectivity is in question. For the qualitative researcher, objectivity is fluid and ‘’can only be known through its representations’’ (Denzin and Lincoln, 2009:5). In this direction, (Flick, 2002:227) argued that ‘’triangulation is not a tool or strategy for validation, but an alternative to validation’’. It follows that triangulation of methods, rather than simply serve as means of validating results, can in fact enrich research results. In this context, Flick, (2002:229) observed that ‘’the combination of multiple methodological practices, empirical materials, perspectives, and observers in a single study, is best understood, then, as a strategy that adds rigor, breadth, complexity, richness and depth to any inquiry’’. The use of multiple methods provides an effective framework for observing phenomena in order to achieve a more accurate interpretation and analysis (Cox and Hassard, 2005). Triangulation of methods can serve as an effective means of observing and describing the comprehensive details of phenomenon and of confirming constructs and hypothesis (Eisenhardt, 1995). In addition, triangulation involves the use of the language of ‘‘capture, positioning, and confining’’ (Denzin, 1989:48; Blaikie, 1991, 2000; Ghauri and Grnberg, 2002). To capture data means to represent observations or complexities of reality during the research process. Positioning or confining is about situating or limiting the phenomenon under study to a particular context. Therefore, the underlying assumption of triangulation is that the inquirer can get closer to a more comprehensive understanding of phenomenon by taking multiple measurements, using multiple methods and applying multi level analysis.

Post modern thinking is that there are multiple truths because there are multiple perspectives and ways/methods of knowing. Reality is objective as well as subjective and contextualized. Reality is mediated, and for this reason, the postmodernist rejects ‘’the taken-for-granted truths and social categories, which nevertheless must be investigated and explained’’ (Chia, 1995:594). Hence, postmodernism acknowledges the co-existence of realities. The methodological procedures of postmodernism produce multiple research results discovered through mixed methods. These results may converge or diverge. Convergence of results may mean that consensus exists on how reality is viewed from the multiple paradigmatic frameworks, or that a common reality is shared as each method produced the same result. On the other hand, lack of convergence may reflect legitimate differences in the views about reality, or the habitation of different social worlds. However, postmodernism acknowledges that research conclusions produced from multiple approaches are tentative interpretations reached by squaring/comparing findings from different perspectives. Multi methods research produces insights or new possibilities by combining and re-combining findings from different sources, though always within the particular traditions and limitations of the referent study population (Hardy et al., 2001).

Postmodernism emphasizes pragmatic orientation to research, and a pragmatic methodology provides specific justification for combing qualitative and quantitative research (Johnson and Onwuegbuzie, 2006). Lincoln and Guba, (2000) discussed pragmatic notions in mixed methods approach to research. In this context, Morgan, (2007) discussed ways that pragmatism can provide new opportunities in social science methodology. The author argued that in combining qualitative and quantitative research, a pragmatic approach allows the researcher to use abduction, instead of the exclusive use of either inductive or deductive reasoning. Where qualitative and quantitative researches are combined in a sequential manner, the adductive process permits ‘’ the inductive results from a qualitative approach [to] serve as inputs to the deductive goals of a quantitative approach, and vice versa’’ (Morgan, 2007:72). A pragmatic approach permits the search for answers that work, the search for what connects the different approaches to research.

3.5-CHOICE OF PARADIGM AND STRATEGY OF INQUIRY

Three interrelated questions shape decisions about research design and the choice of research paradigm. These include knowledge claim, which is the broad claim or theory about knowledge that is brought into the research by the researcher including the element of perspective, i.e. the element of objectivity/subjectivity. Another is the question of methodology/strategy e.g. case study, ethnography, survey research, etc, which sets the stage, or determines the method of data collection. The third question is that of method, the tools and procedures for collection and analysis of data. With these considerations in mind, and based on a postmodern epistemological stance, this thesis adopted a two phased, mixed methods strategy, which sequentially combined qualitative method in the first phase (Study 1) and a quantitative method in a second phase (Study 2). Specifically, the ontological position of study 1 is essentially constructionist. For this reason, the reality of research experiences and practices of participants is treated as constructed and revealed by them. The qualitative study assumed that participants in their interaction with phenomena within their environment interpret events, their ideas and actions and attach subjective meanings to these as they construct new experiences. People develop subjective meanings of their experiences, and these meanings are varied and multiple. Thus, the focus of study 1 is exploratory, descriptive and interpretative of the varied and complex research experiences of participants (as constructed and voiced by scholars/scientists in their interaction with others). The informants are academics and scientists. Consequently, the design of this qualitative phase of the thesis is emergent in order to discover meanings as revealed by informants. Study 1 further takes the epistemological position of the constructionist paradigm assuming that data are contained within the perspectives of participants involved in scientific activities as individual researchers, research teams, research governors/managers or research related activities by research policy makers. For this reason, the inquirer has to interact with informants in order to achieve fuller understanding of the perspectives, behaviours and circumstances of informants. In brief, the choice of constructionist paradigm determined the data collection design for the qualitative phase of this thesis. However, because qualitative paradigms often do overlap, the epistemology of inquiry is subjectivist, and the inquiry interactive, the thesis's strategy for qualitative data collection and analysis is grounded theory methodology, which is appropriate for describing and interpreting research processes and situation under study. Grounded Theory is discussed in greater detail in section 3.9.

However, the overall knowledge claim of the thesis is pragmatic, which means that this study is result or problem-oriented. The pragmatic, result oriented emphasis of the postmodern approach is underscored in the observation that ''the proof of research conducted by whatever means resides in the pudding of its outcome'' (Howe and Eisenhart, 1990:6). On this background, the study design is both qualitative and quantitative in thrust, and the strategy of inquiry involved sequential collection of data in order to best describe, interpret and explain the research problem. By approaching the phenomena under investigation in different ways, from different perspectives, the thesis was able to triangulate data (which is to say, the conjunction of two independent measures), thereby generating data that otherwise could not easily be sighted from one source alone. The idea of mixing methods and approaches is not new. Jack, (1979) triangulated data as a means of seeking convergence across qualitative and quantitative methods. Some scholars believe that mixed methods and data triangulation have potential benefits for research. In combining methods, biases found in a single method could cancel biases inherent in another. Results obtained from one method could inform the method for the other (Green, Caracelli, and Graham, 1989). Employing both qualitative and quantitative methods within the same study to observe the same phenomenon produces a rich composite, which otherwise a single approach cannot obtain (Lincoln and Guba, 18985; Neimeyer and Resnikoff, 1983). These benefits have led some scholars to develop procedures for mixed methods approaches. Some of these outlined by Creswell, (2009:18-19) include sequential, concurrent, and transformative procedures. According to the author, the researcher doing a sequential, mixed methods research, may seek to ‘’ elaborate on or expand the findings of one method with another method’’. This thesis used a two-phased, sequential mixed methods approach, beginning with a qualitative research, followed by a pilot phase and ended with a quantitative method.

Based on the potential gains of mixed methods study, the thesis began with qualitative method for the purpose of exploring and describing research experiences of scientists in the public research institutions in the Gambia and generating themes about their research practices/behaviour and scientific performance. Then, subsequently, in a second phase using quantitative method, these themes provided the basis for survey of the degree and relative influence of factors in the research situation including governance structures on research behaviour and scientific performance at the individual level. The rationale for using both qualitative and quantitative methods is that the effects of factors in research governance on scientific performance can best be studied by allowing core themes and constructs to emerge from participants in the first exploratory qualitative study. Another reason for the mixed methods approach is to obtain a deeper understanding of the research problem by converging both quantitative, numeric data and the contextual details from qualitative research. Besides, the themes and conclusions of the exploratory phase would inform the development of appropriate survey instrument in order to generate data to quantitatively test predetermined hypotheses with a sample and then generalize results to a population.

3.6 QUALITATIVE RESEARCH

Several perspectives/theoretical paradigms are found in qualitative research. Qualitative inquiry cuts across several disciplines and fields of study and uses different research methodologies as well as methods of data collection and analysis, though the methodology or strategy employed would determine data collection procedures. Methodologies employed in qualitative research are many and varied, though the most commonly used include narrative, phenomenology, ethnography, case study, and grounded theory (Tewksbury, 2009). Qualitative inquiry is about exploring issues and, as all scientific inquiries, it seeks to understand phenomena or problems but from the perspectives of the local population involved in the inquiry. Tewksbury, (2009:38-9) argued that qualitative research ‘’focuses on the meanings, traits and defining characteristics of events, people, interactions, settings/cultures and experience’’. Berg, (2007: 3) stated that “Quality refers to the what, how, when, and where of a thing – its essence and ambience. Qualitative research thus refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things.” These definitions apparently exclude quantity, numbers or numerical considerations from the concern of qualitative approach to the conduct of social science research. Rather, it is concerned with using specific meanings, definitions, and contexts, not broad, general meanings. It is in this context that Denzin and Lincoln, (2005:3) observed that qualitative research ‘’is a situated activity that locates the observer in the world’’. Qualitative research is particularly suitable for obtaining culturally specific data and information concerning the values, beliefs, behaviours, actions, and social contexts of a study population. It makes use of text data, and sometimes image data, to provide descriptions of how people experience specific research situation or issue. Qualitative research makes use of varied empirical material obtained from case study, personal experience, and life story interview, as well as introspective, observational, historical, interactive, and visual texts to describe social processes (Denzin and Lincoln, 2005). Thus, qualitative research, which places greater emphasis on interpretation, produces comprehensive views on the object of study, looks at contexts and searches for a depth of understanding of concepts. It is characterized by an exploratory, descriptive, and humanistic focus as it provides information on the ‘human’ side of an issue, thus, reflecting the natural contradictions in human behaviours, emotions, beliefs, opinions and relationships. For this reason, qualitative research is essentially interpretative, meaning that the qualitative inquirer makes an interpretation of data.

Since qualitative research involves interpretative and humanistic approach to the study of social phenomena, its methods emphasize a first place value on total understandings and interpretation of peoples’ experiences, actions and beliefs in specific contexts, which are dynamic. It follows that the qualitative researcher constantly attempts to understand, interpret meanings, or make sense out of social phenomena in terms of how the participants view, understand or experience the issue, object or processes/interactions under study. For this reason, the qualitative researcher studies things in their natural settings. Closeness to the site/home/business premise of the respondent enables the researcher to obtain indebt information about the person, object or situation under study and immersion in the actual experiences of participants. The qualitative researcher further acknowledges his personal involvement, bias, values and interest in the research process. This immersion and introspection represent the researcher's attempt to be open and honest, thus recognizing that all research is value laden (Mertens, 2003). The qualitative researcher filters through data and examines patterns of meanings emerging from close observations. The findings of qualitative research are placed in a particular context.

Qualitative research cuts across disciplines, fields and subject matter, and is multi methods in focus (Flick, 2002:226-227). Multiple methods enable the qualitative researcher to secure in-depth understanding of the phenomenon in question. Traditionally, data collection methods in qualitative research include interviews with individuals, observations of people, places and actions/interactions including immersions in settings. However, in addition to these traditional data collection methods, new methods are emerging such as sounds, e-mails and scrapbooks (Creswell, 2009). Researcher immersion in the research setting is necessary in order to fully understand the issue, object, situation, and social interactions under study (Tewksbury, 2009). The qualitative researcher further attempts to involve participants in data collection process and to respond to their sensibilities. As far as possible the research site is not disturbed as the researcher attempts to build rapport and credibility with respondents.

Qualitative research is emergent as constructs, categories, theory and other aspects emerge during the study. Research questions may change as the inquirer is informed by the evolving research process and data collection may be expanded as the process of constant comparison of data and categories continues until data saturation is attained. This unfolding nature of qualitative research makes it impossible to predetermine or tightly set the initial research proposal. In addition, qualitative research makes use of multiple models of logic, though it is largely inductive. This means that the qualitative researcher uses both inductive and deductive reasoning, but his use of logical systems is also repetitive and simultaneous. This is because the thinking process involving both induction and deduction slides back and forward during data collection and analysis; from data analysis to problem formulation and reformulation and back. Besides, since qualitative research process involves simultaneous data collection and analysis ending with writing up results, the reasoning process simultaneously involves both inductive and deductive logics. In brief, Creswell, (2009:29) described qualitative approach as,

> *one in which the inquirer often makes knowledge claims based primarily on constructivist perspectives (i.e., the multiple meanings of individual experiences meanings socially and historically constructed, with an intent of developing a theory or pattern) or advocacy/participatory perspectives (i.e., political, issue-oriented, collaborative, or change oriented) or both. It also uses strategies of inquiry such as narratives, phenomenologies, ethnographies, grounded theory studies, or case studies. The researcher collects open-ended, emerging data with the primary intent of developing themes from the data.*

Qualitative research is multidisciplinary cutting across the humanities, social sciences as well as physical sciences, and it is multi-paradigmatic in focus. Qualitative researchers recognize the value of multi-methods approach to research and take a humanistic perspective to the study of phenomena. They are committed to the interpretative analysis of individual experiences from the perspectives of the objects of study. Qualitative research is characterized by exploratory and descriptive focus, emergent design, data collection in the natural setting, immersion in the study site, acknowledgment of researcher involvement, emphasis on ‘human as instrument, multiple data collection methods, iterative and simultaneous reasoning, though largely inductive analysis.

3.7 QUANTITATIVE RESEARCH

Quantitative studies focus on phenomena, which are quantifiable and typically represented as statistics. The focal concern of quantitative research is objectivity. The quantitative approach assumes that the objective study of phenomena is just what is necessary to understand the nature and structure of reality (Neuman, 2003). This approach is characterized by deductive-statistical orientation, and uses such concepts as validity, reliability and objectivity to defend and empirically test generalizations or predetermined hypothesis. Quantitative methods define procedures for the selection of study elements, which involve random selection of a study sample drawn from, and representative of, a given population. It makes use of standardized survey instruments aimed at collecting ‘’closed-ended’’ data (Creswell, 2007:6). The approach specifies not only methods but also appropriate framework for statistical analysis right from the beginning. The parameter or estimation of numbers required to achieve statistically significant findings at acceptable level of statistical power determines the sample size. Quantitative inquiry further specifies rigorous criteria for determining reliability of the measuring instruments employed, and its research findings must be replicable by other researchers. Quantitative approach to inquiry is theory driven. Weinreich, (2006) observed that quantitative research begins with identification of a research interest or topic and a theory.

Comparing and contrasting quantitative and qualitative research have generated some debates among scholars amidst competing claims of superiority of one approach over the other as a more ‘scientific’ approach to doing social research. Tewksbury, (2009) argued for the superiority of qualitative research over quantitative inquiry. Mahoney and Goertz, (2006:227-

228), describing the tension and debates arising from the distinction between quantitative and qualitative research, stated,

> *We prefer to think of the two traditions as alternative cultures. Each has its own values, beliefs, and norms. Each is sometimes privately suspicious or skeptical of the other though usually more publicly polite. Communication across traditions tends to be difficult and marked by misunderstanding. When members of one tradition offer their insights to members of the other community, the advice is likely to be viewed (rightly or wrongly) as unhelpful and even belittling*

However, Grimmer and Hanson, (2007:58-59) argued that the distinction between the two is only ''approximate'', merely imprecise and also blurred since a good number of research clearly focusing on one approach, ''nevertheless uses several techniques, often mixing the quantitative and the qualitative''. The authors suggested that rather than see each research approach as exclusive entities, the organizing notion of a continuum, with core positivism at one end and constructivism at the other, can be used to resolve the argument. Both research traditions are descriptive categories that cover many different actual methods (Gummesson, 2005; Long et al., 2000; Wilson and Natale, 2001). Though qualitative and quantitative researchers pursue different specific purposes that produce different set of values and norms shaping research practices, both research traditions share the common objective of producing valid descriptions and causal inferences (Grimmer and Hanson, 2006; Brady and Collier, 2004).

Nevertheless, some discernible differences can be found between quantitative and qualitative inquiries based on their distinctive research purposes and practices/methods. Adopting a criteria approach (Brady and Collier, 2004), Mahoney and Goertz, (2006) identified ten areas across which quantitative and qualitative research can be contrasted. These areas include approaches to explanation, conceptions of causation, multivariate explanations, equifinality, scope and causal generalization, case selection practices, weighting observations, substantively important cases, lack of fit, and concepts and measurement. Besides, some scholars described each position with reference to ontology, epistemology, and research purpose (Carson et al., 2001; Jean Lee, 1992; Healy and Perry, 2000; Kidd, 2002; Guba and Lincoln, 2000). However, this thesis makes a distinction between the two research traditions based on their modes of inquiry. The criteria for this purpose include purpose of research, assumptions, approaches, and researcher's role in research. First, quantitative research seeks to generalize results of research, prediction, and causal explanations for relationships established. Worrall (2000) underscored the predictive advantage that quantitative method of inquiry possesses, that is, its ability to make correct predictions about what will be. Quantitative inquiry seeks to achieve numeric description of things and prediction of relationships whereas qualitative research focuses on interpretation of ''the meanings, traits and defining characteristics of events, people, interactions, settings/cultures and experience'' (Tewksbury, 2009:38-39) from the perspectives of informants. Results of qualitative research are in contrast essentially contextualized.

Second, the ontological and epistemological assumptions of both research traditions differ. Quantitative research assumes that objective reality exists outside the individual and this reality can be discovered with predictable degree of certainty using objectively appropriate scientific methods. Quantitative research is concerned primarily with methods, standardized methods of inquiry and focuses on specific definitions and deliberately operationalized meanings of particular concepts and variables. On the other hand, the ontological assumption of qualitative research is that reality is socially constructed, and epistemologically, the focus is on the subject of inquiry as it places primary value on full understandings and on how people interact, experience and understand in given social situations that are dynamic. Quantitative research assumes that variables can be identified and relationships accurately measured, whereas qualitative researcher assumes that variables are complex and interwoven, and as such difficult to measure. Contrasting quantitative and qualitative inquiry, Denzin and Lincoln (2007:10) stated:

> *Qualitative researchers stress the socially constructed nature of reality, the intimate relationship between researcher and what is studied, and the situational constraints that shape inquiry. Such researchers emphasize the value-laden nature of inquiry. They stress answers to questions about how social experience is created and given meaning. In contrast, quantitative studies emphasize measurement and analysis of causal relationships between variables, not processes. Proponents of such studies claim that their work is done from a value free framework*

Third, the methodological orientation and procedures of the two research traditions also differ. Traditionally, a quantitative research begins with hypotheses and theories. Its methods involve manipulation and control of data, use of formal instruments and experimentation, deductive logical system or mathematical logic, and analysis of abstract data. The approach seeks to conform to acceptable norms of doing research within the positivist research community. It is committed to quantification of data, and axiologically, uses abstract language in writing up results of research. On the other hand, qualitative research process ends with hypothesis and theory grounded on data. Qualitative research method is characterized by exploratory and descriptive focus, emergent design, data collection in the natural setting, immersion in the study site, acknowledgment of researcher involvement, emphasis on researcher as instrument, and multiple data collection methods. In the search for patterns in the observed phenomena, it uses iterative and simultaneous reasoning, though largely inductive reasoning and analysis. Quantitative research is value free, and the researcher and object of research are considered independent of each other as the researcher remains detached from the research process. The quantitative researcher is committed to objective pursuit and portrayal of what can be known. In contrast, qualitative research acknowledges the researcher's personal involvement, bias, values and interest in the research process.

Overall, the strength of qualitative research seems to derive from the ability of its methods to produce quantifiable and reliable data that are generalizable to some larger population. However, its weakness appears to lie on the assumption that variables can be identified and relationships measured with some degree of precision. Besides, since a major purpose of quantitative inquiry is generalizability of results, it tends to de-contextualize social behaviour in ways that rob it of its real world setting. Since quantitative research design is static, not emergent, it tends to ignore the consideration of factors not accounted for at the beginning of the research. Weinreich, (2006) observed that quantitative approach to inquiry breaks down when the phenomenon under study is difficult to measure, when data cannot be reduced to numerical indices.

3.8 THEORETICAL FRAMEWORK OF RESEARCH

Generally in developing countries public research institutes are characterized by ill-equipped, sometimes obsolete facilities and infrastructures, lack of requisite skills, ill-defined competences and limited abilities to conduct research, absence of research and development strategy, and often inconsistent public research policy. In spite of policy pronouncements in support of science, innovation and technology, most governments in these countries seem to have demonstrated insincere, and in some cases inadequate commitment to research and development. Their efforts in this sector appear to be devoted more to laboratory research than to industrial research. University research in most parts of West Africa suffers from a lack of vision, appropriate policy frameworks and strategic planning, and a service culture within the structures responsible for administering, coordinating, and promoting research (IDRC/WARO Conference in Dakar, 2008). (Camara and Touray, 2010:2) stated that other constraints on institutional research include ‘’heavy teaching loads/responsibilities; professors have little time for research or prefer consultation work to improve their salaries. The state appears reluctant to finance research, and lecturers are often reluctant to use for research the part of their salary allotted for research’’. The authors further observed that research steering role of scientific councils are relegated to routine or secondary tasks because of limited financial resources. In the Gambia, major obstacles to public sector research include meagre resources, limited professional autonomy over research, as well as tight management control over research funds. Research governance structures are in most cases management centered while research coordination mechanisms remain largely ineffective. In the context of the state of public science and research in the Gambia described above, this section discussed the theoretical framework for analysis of quantitative data in the second phase of the sequential two-phased thesis. In doing so, the section views the issues of research support, creation of institutional conditions for conduct of research, research practices/behaviour, research governance and scientific performance from the perspectives of investment, principal agent and the stakeholders’ theories.

Generally, in the science world, a number of patterns in the organization of public science system are discernible. In western countries, for instance, the pattern tends to converge towards New Public Management (NPM), a catch phrase for reforms of public sector research that has taken place over the last decades (Schubert, 2009). However, a common pattern in most continental countries of Europe such as Germany, France and Australia tends to display two dominant features. According to (Braun and Merrien 1999; Schimank, 2007a and b), these features include, first, reduced control over research by state authorities, particularly at the purely operational level, thereby leaving greater autonomy to researchers. Second, stronger more strengthened internal hierarchy, which leaves management authorities (deans and the Vice chancellor) with greater control over research. Among the mechanisms often employed in these governance dimensions are resource controlling, global budgeting, goal agreement, and performance-oriented budgeting by indicators (e.g. performance oriented payment schemes). In the Gambia, as in most developing countries, the State is the principal provider of research funds and a major investor in public research and consequently has tended to have dominant influence on public sector science and research, though other stakeholders such as foreign donors and research grant providers as well as research teams and researchers are significant players in the public research arena. On this background therefore, this thesis, applying investment theory to institutional research, begins by stating the obvious, which is that the state rationally expects reasonable returns from its investment in the form of generation of scientific knowledge to inform policy for national development. Based on this expectation, the State makes careful assessment of benefits to society as well as risks involved in every policy decision situation to invest public resources on research. The investment theory argues that the principal (in this case, the State) has rights over reasonable returns to its investments (e.g. in the form of economic and social benefits for society). The principal (or other stakeholders providing research grants) expects some returns to it in the form of knowledge generated through research. However, even though researchers may exclusively publish their findings, they are not the owners or only recipients of benefits resulting from scientific knowledge. In this context, Schubert, (2009) argued that people may not patent a formula developed and published by a mathematician in ways that excludes its use by others. Besides, since most scientists and inventor are institutionally affiliated, the public research institution, or the State in some cases, generally owns a patent resulting from a researcher's invention. In fact, you cannot hoard knowledge because you can only patent the physical expression knowledge.

Another theoretical framework for understanding the research governance-output nexus is the principal agent theory. How does this theory apply to sciences? The theory recognizes the separation of ownership (in our context societal resources devoted to research) and control of resources (in this context resource control by researchers). It argues that where the principal (the state authorities, institutional management, or society) cannot oversee the agents' efforts (the researcher's efforts in this context), then the agent tends to work less often attributing failures to hard luck, but not to laziness (Jensen and Meckling, 1976; Holmstrom, 1979; Bolton and Dewatripont, 2005). According to agency theory, scholars and scientists have to be monitored and sanctioned in much the same way as in private companies. The theory assumes that management control and effective administration of sanctions using pay-for-performance schemes can foster appropriate behaviour, improve performance, and achieve efficient allocation of resources (Lavy, 2007; Swiss, 2005). The principal agent view dominates the New Public Management and corporate governance, and in recent years the approach is applied to academia either implicitly (e.g. Worell, 2009) or explicitly (e.g. Deem, 2004; Schimank, 2005). The principal mechanisms for governing behaviour of academics and scientists thus include reward for performance according to output indicators such as rankings, ratings, and competitive fundraising. In academia, a consequence of these features in governance of science and research is the establishment of peer review as a main success criterion (Stephan, 1996; Gittelman and Kogut, 2003). Incentives from peer review system include awards, memberships in scientific societies (Frey and Neckermann, 2008), and for most scholars, scientific publication and citations in renowned scientific journals. Indicators for performance that rank scholars are based on peer reviewed publications and citations.

Thus, it would appear that research ‘’governance system based on peer reviews and academic rankings seems to combine perfectly an output-oriented evaluation of researchers’’ (Osterloh and Frey, 2009:6). However, the principal agent view has come under sustained criticisms in the literature on corporate governance due mainly to corporate failures (Benz and Frey, 2007; Daily, Dalton, and Canella, 2003). Osterloh and Frey, (2009) introduced the notion of psychological economics to explain scholarly behaviour and research, which is largely curiosity driven. The authors suggested that scientific performance of scholars could be improved by qualitative peer-based review system, careful selection and socialization of scholars, supportive feedback, and symbolic rewards (e.g. externally mediated peer recognition). Overall, this new approach modified the agency view by emphasizing the importance of combining qualitative peer review and bibliographic measures as basis for evaluation of scholarly behaviour. The approach is particularly apt for understanding research governance in academia. However, this thesis adopts the modified version of agency view even though the area of study includes non university scientists whose work including publications and inventions are nevertheless ultimately subjected to some kind of qualitative peer review.

Meanwhile, in reaction to the argument in literature that the agent tends to work less in situations where the principal cannot oversee his efforts, (Schubert, 2009:1226; Beer, 2004; Nwanji and Howell, 2005) argued that the stakeholder theory takes care of this kind of 'moral hazards' when applied and grounded in general ethical theories. This is because, according to the stakeholder theory, management and stakeholders have the moral right and obligation to act within the terms of their relationships. Nevertheless, the argument that subjecting the work of the researcher/scientist/scholar to observation reduces incentive to work may appear to be a natural assumption at first sight. On the contrary, the scientist/scholar is also intrinsically prompted to conduct original research, though this may not necessarily be the case in other research related activities such as educating doctoral students, editing journals and reviewing articles. Since creative research and innovation are curiosity driven and scientists are prompted mainly by intrinsically motivated curiosity, Schubert, (2009) argued that 'moral hazards would, at least partly, no longer count. This would mean that intrinsic factors to a large extent determine the behaviour of researchers/scientists. In this context, Gagne and Deci, (2005) argued that, according to the determination theory, intrinsic behaviour depends on two preconditions, namely autonomy and supportive feedback (recognition by peers), which helps to build and sustain the researcher's competence.

University research governance in the Gambia appears to display characteristics of some degree of control by external stakeholders, strong internal hierarchy, some degree of market control and limited State control over research. Though this governance pattern may apply to other research institutions and units, there appears to be varying levels of direct State involvement in research activities. The State tends to have stronger control in research units with limited autonomy such as the National Agricultural Research Institute. It would appear however that the principal-agent as well as the investment theories both apply and provide suitable platforms for describing and explaining public sector research processes in the Gambia, including the university research. In the Gambia public science system, the principal-agent situation is apt as the State (i.e. the principal) has right of ownership over resources and the researchers (i.e. the agents) have control over resources, and in addition, the State provides society's resources (obtained through taxation) to researchers in the form of research funds and grants. On the other hand, the stakeholders theory recognizes the non involvement, though limited control by the principal and urges for attention beyond the investors (in this case the State, corporate bodies, and external donors/ research financiers) to include all groups who may have interest in long-term success of research units (Freeman, 1984; Blair, 1985). The stakeholder theory attempts to describe, prescribe, and derive alternatives for corporate governance that include and balance a multitude of interests (Nwanji and Howell, 2005). The contribution of this theory, particularly the instrumental stakeholder variant of the theory, is that if managers must maximize the objective function of their firms they must take into account the interests of their stakeholders (Donaldson and Preston, 1995). This would mean that the organization can achieve improved performance when management understands its stakeholders' environment and manages more effectively within the terms of relationships that exist in that organization. Relating the stakeholder view to science, these relationships would refer to existing structure of research hierarchies, communication channels and structures of responsibilities and obligations. Considering the interests of all stakeholders can further contribute to redefining the corporate entity through a focus on performance measurement (Logsdon and Wood, 1997). In brief, it is evident that these theories do in fact apply to the organization and governance of public research including university research. Potential sources of increase in scientific knowledge production can thus be identified in the context of specific governance model, which will guide the data design for this thesis. These include:

- In the context of academic self-governance, sources of increase in knowledge production include increasing autonomy of researchers and research units, strategic role by Senate and Faculty scientific boards/committees, collegial decision making on issues of funding and approval of research proposals. In addition, increasing the coordination and evaluation role of academics/scientists would, at least in theory, possibly result in more efficient, faster and problem oriented resource allocation.
- In the context of managerial self-governance model, efficiency gains may be achieved by stronger internal hierarch (e.g. increasing the influence of Deans and Vice Chancellor over

research in respect of performance evaluation. The assumption under this model is that increasing the autonomy of researchers would probably create 'moral hazards' and reduce accountability since resources could be used for other purposes.

- In the context of stakeholder guidance model of governance, enhanced management understanding of stakeholder environment and greater management concern for stakeholder interests can improve overall performance of public research system. In this context, it is possible to manage more effectively within the terms of relationships that exist in the organization.
- Another potential source of increase in knowledge production is developing an accounting system that monitors resources/funds movement of respective research units. This can foster effective feedback information for decision making units.
- Finally, an important likely source of increase is enhancing strategic research roles of coordination structures, especially a research council, which would advise, guide and decide on matters concerning determination of institutional research agenda.

However, discussion of these governance structures and coordination mechanisms serve as a prologue to a fuller discussion in Chapter Four. This section so far discussed the theoretical framework of analysis of quantitative data. On the other hand, the theoretical framework for the qualitative phase of the thesis is symbolic interactionism, which the section on Phenomenology discussed in some detail.

3.9 GROUNDED THEORY APPROACH

The first qualitative phase of this thesis (*Study 1*) employed the use of grounded theory approach, a qualitative research methodology (strategy of inquiry), for developing a substantive theory of scientific knowledge production in a developing country. A research methodology defines the approach for interpreting data. It is a strategy of inquiry consisting of a set of assumptions, skills and practices, which the researcher uses as he ''moves from paradigm to the empirical world'' (Denzin and Lincoln, 2007:25). According to these authors, strategies of inquiry lead the researcher to specific methods of data collection and analysis, and confine him/her to specific methodological practices. Phenomenology, case study, ethnography, grounded theory; historical autographic, clinical, and biographical methods are good examples of strategies of inquiry. This thesis drew qualitative evidence from the Gambia and used Glaser's version of grounded theory strategy based on its focus on the emergent nature of theory. In literature, this version is labeled 'traditional' or 'Classic' grounded theory.

However, most qualitative studies in organization and management used grounded theory approach, first developed by Glaser and Strauss (1967). The use of this strategy of inquiry has extended to a number of domains including sociology, nursing, education, political science, psychology, and economics. The study of European Integration and recently of European financial services (Howell, 2000; 2002) used this approach. Grounded theory approach emerged in the 1960s when hypothetico-deductive theory dominated social science research. In contrasting grounded theory with logico-deductive theory, Glaser and Strauss, (1967) argued that in the 1960s, the prevailing emphasis on theory testing neglected the process of theory generation. Another impetus for the emergence of grounded theory was the argument in literature that the dominant positivist theories progressively became more removed from social phenomena that they were supposed to explain. Grounded Theory was developed in reaction against this dominant positivist trend, and was seen as part of the humanist attempt to tie social science data more closely to the beliefs and concerns of participants so that social-science practitioners would find in theory a more congenial guide to the problems of practice (Layder, 1982).

Since its inception scholars have made efforts to systematize Grounded theory canons and procedures. The process began with the parting of ways between the co-authors on the basis of ontological differences. While Glaser garnered post positivist paradigm, Strauss retained the original qualitative paradigm. Beginning from 1990, the two began to develop their identities for the originality of Grounded Theory, each modifying and improving their work and developing different perspectives. Glaserian and Straussian versions of Grounded Theory differ over the aims, principles and procedures associated with the implementation of the method. According to Annells (1996), Glaserian perspective in Grounded Theory relates to critical realism ontologically, modified objectivist epistemology, and methodologically, focuses on the interpretive, contextual and emergent nature of theory development. On the other hand, the work of Strauss with other disciples such as Corbin and Charmaz, has taken a perspective that reflect relativist ontology, subjectivist epistemology, and in its methodology, ‘’recognizes the interactive nature of the inquirer and the participants, placing their grounded theory approach under constructivist paradigm of inquiry’’ (Devadas et al., 2011:322). The contrast between Glaser's 1978 *Theoretical Sensitivity* and Strauss and Corbin's 1990 *The Basics of Qualitative Research* in light of the original work of the two authors in 1967 demonstrates the obvious differences in their perceptions of the method of grounded theory approach. According to (Jones and Noble, 2007; Mansourian, 2006), the differences between the two schools of Grounded theory lie in their methodological procedures for coding data and developing categories, memoing and sampling, emergence, researcher distance and theory development. Strauss’s version incorporates rigid and complex process of systematic coding whereas Glaser's insists that theory must be true to data and has to emerge from phenomenon under study. The Glassian approach inductively focuses on data, and aims at 'discovering the reality' by allowing data to emerge without forcing it. The Struass's version on the other hand is considered to be more generic and verificational approach than emergent (Babchuk, 2011). Creswell (2005) identified and described three versions of Grounded Theory as emergent (Glaser), systematic (Strauss & Corbin), and constructivist (Charmaz). Denzin (2007) described seven versions including positivist, post positivist, constructivist, and objectivist. Others are postmodern, situational, and computer-assisted. (Babchuk, 2009) settled for two, namely "traditional" versions of Glaser and Strauss (emergent and systematic) and the theoretically repositioned approaches of Charmaz and Clarke (constructivist and postmodern/situational). However, (Goulding, 2002:163; Jones and Noble, 2007) suggested that researchers using Grounded Theory should select one approach, remain consistent in its application to avoid "methodological muddling". Babchuk, (2011) further suggested that grounded theory researchers must be able to justify their choice among the competing versions, articulate the steps or procedural chain employed in their research, and use the key components of the methodology as outlined by scholars of grounded theory method. Since there are several versions of methodological procedures for implementing Grounded Theory, Chiovitti and Piran (2003) called for rigor in its use and the need to properly explain the process by which theory was generated. Criticizing the unrestrained manner in which grounded theory approach is currently used, Jones and Noble (2007) highlighted the need for more discipline in the methodology.

Grounded theory is about the inductive discovery of theory grounded in systematically analyzed data. This approach to research progressively developed since its adoption in the 1960s in ways consistent with its original formulation so that currently it is the most comprehensive qualitative research methodology in use today. It is an approach to solving social problems. It is pragmatic in orientation and concerned with understanding phenomena from the perspective of human agent. Its procedures are not statistical or quantitative. According to (Schwandt, 2001; McCallin, 2003), the major aim of grounded theory is to produce formal, substantive theory about the behavioural patterns that shape social processes as people interact together in groups. Defining grounded theory, Strauss and Corbin (1990:23) stated:

> *A grounded theory is one that is inductively derived from the study of the phenomenon it represents. That is, it is discovered, developed and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon. Therefore, data collection, analysis and theory stand in reciprocal relationship to one another.*

According to Glaser, (2004:7) classic Grounded Theory is,

> *simply a set of integrated conceptual hypotheses systematically generated to produce an inductive theory about a substantive area. Classic GT is a highly structured but eminently flexible methodology. Its data collection and analysis procedures are explicit and the pacing of these procedures is, at once, simultaneous, sequential, subsequent, scheduled and serendipitous, forming an integrated methodological "whole" that enables the emergence of conceptual theory as distinct from the thematic analysis characteristic of QDA [qualitative data analysis] research.*

Grounded theory approach to research uses inductive logical system to empirically discover theory, which is grounded on data (Glaser and Strauss, 1967; Goulding, 2000), and which fits into the immediate situation under study. The emergent nature of Grounded Theory means that data collection and analysis occur simultaneously, permitting the inquirer to discover trends as they emerge, and to further explore and observe variations and relationships in these trends (Villani et al. 2010). The responsiveness of Grounded Theory is meant to focus inquiry towards local understandings or contextual values of respondents so that theories developed would minimally fit into the situation under study. Though grounded theories that are developed remain largely contextualized being subject to contextual influences, the introduction of grounded theory approach presents possibilities for generalizable findings (Egan, 2002). Classic Grounded Theory emphasized that theories developed under grounded theory approach must be applicable in real world settings and capable of predicting and explaining human conduct and group behaviour by means of establishing empirical generalizations. However, some scholars (Charmaz, 2000, 2006; 2009; Bryant and Charmaz, 2007a, 2007b; Clarke, 2005; Bryant 2002, 2003; Bowers and Schatzman, 2009) have theoretically repositioned grounded theory approach in order to accommodate the epistemological, theoretical and methodological developments over the last two decades. Charmaz (2009:10) developed a contructivist grounded theory based on relativist epistemology, the recognition of dual relevance of the researcher and object of research in a field setting, and acknowledgement of flexible methodological practices that permit an “interpretive portrayal of the studied world, not an exact picture of it”. Going beyond the traditional description and analysis of social processes, Clarke, (2005) focused on throwing more light on a social situation by taking an ecological view of the research situation and employing methods, which permit construction of meanings by both participants and the researcher through interaction with them (Babchuk, 2008). These developments in the context of competing models of grounded theory methodology, have tended to underscore the inherent diversity in the grounded theory approaches, which must be seen as a basis for discussion and exchange of ideas rather than battle ground for a true grounded theory approach (Bryant and Charmaz, 2007b; Babchuk, 2011).

According to Charmaz, (2006), the unique features of grounded theory research include recurrent use of multiple logical systems in simultaneous data collection and analysis, constructing codes and categories from data, constant comparative method of comparing data and categories and expansion of data sources as analysis continues, ongoing theory development, use of theoretical sampling that precede and inform theory development, use of memos to aid and refine coding process, on-going review of literature, and theoretical saturation of categories, which indicates the end of data collection. Grounded theory strategy of inquiry deals not only with the process of research but also the results of research process (Bryant and Charmaz, 2007a). It is a qualitative approach for inductively developing theory from the ground up through a systematic process (Eich, 2008). Theory is generated through three simultaneous processes of data collection, coding and analysis (Howell, 2000:7). According to the co-founders, joint collection, coding and analysis of data is the key operating factor in theory building process, and these three simultaneous operations ''should blur and intertwine continually from the beginning of a study to its end'(Glaser and Strauss (1967:43). Based on the assumption that theory is discovered from data, a grounded theory researcher sets aside any preconceived notions of the phenomenon about which he wants to theorize. Initial decisions about the research are not based on preconceived theoretical framework. In this context, Egan, (2002:278) stated:

> *A general understanding of the phenomenon under investigation is considered sufficient for the initiation of this type of research. Having established a problem or topic in general terms and chosen a site where the research question could be examined more closely, evidence is allowed to accumulate by the researcher, resulting in an "emerging" theory.*

Careful and meticulous application of the grounded theory ensures that theory developed satisfies acceptable scientific standards of universality, precision, verification, repeatability and vigor (Corbin and Strauss, 1990). However, the theory implies an over-emphasis on verification and consequently under-emphasis on a priori approach to research. In other words, grounded theory research rejects off hand the argument that the probable effects of something can be determined based on facts or principles known to be generally true and so insists on provisional verification (Howell, 2000:4). What this means is that the grounded theory researcher must pay special attention to 'theoretical sensibility'. Ignoring, at least initially, relevant literature and existing theory in order to minimize the possibility of contaminating data with existing and thus biased concepts and relationships (Vidich and Lyman, 2000), the grounded theory researcher must be alert to the importance of categories as they emerge from constant comparisons. 'Theoretical sensibility' means that the researcher looks at data for emerging impressions, develops concepts and establishes relationships between concepts. In doing this, the researcher is assisted, to some extent, by knowledge of existing theories, which can be applied at a later stage of the research, if they are considered useful (Egan, 2002). In discovering grounded theory, the researcher generates conceptual categories from observed data, and supporting or illustrating this category or its properties from empirical evidence. The conceptual category is an abstraction from the real world under study. Theory makes possible the formulation of hypothesis and permits conceptual categories to emerge from data so that analysis may identify concepts relevant in understanding and interpreting data. Grounded theory methodology consists of bedrock aspects of theoretical sampling, constant comparative technique (e.g. comparing incidents applicable to each category, integrating categories and their properties, or simply comparing data to theoretical categories), and developing theory through theoretical saturation of conceptual categories (Hood, 2007). In brief, citing Denscombe, (2003), Graham and Thomas, (2008:116) stated that the main features of grounded theory include:

> *using empirical research as its starting point; an iterative process of data collection and analysis; producing explanations that are recognizable to the subjects of the research; being geared to modest localized explanations based on the immediate evidence; an emergent design and being linked with qualitative research, exploratory investigations, small-scale studies and research focusing on human interaction in specific settings*

Overall, using the grounded theory strategy, this thesis seeks to build a substantive theory of scientific knowledge production, which explains research practices/behaviour at the individual level of research process and the nexus between institutional research governance and scientific knowledge production within the public science system of the Gambia.

3.9.1 THE PROCESS OF DEVELOPING A GROUNDED THEORY

The work of Glaser and Strauss (1967) on interactions between health care professionals and their dying patients resulted in the development of grounded theory methodology. These authors were influenced by the work of early anthropologists and 'Chicago Scholl' sociologists who popularized new approaches to the study and understanding of human cultures and people in these cultures ((Vidich and Lyman, 2000; Bogdan and Biklen, 2007). There appears to be a consensus in literature that grounded theory research is holistic, naturalistic and inductive, and its procedures are not linear (Egan, 2002). A major thrust of classic grounded theory approach is the discovery of new theory, through systematic qualitative procedures. Grounded theory research is particularly useful when the research objective is theory building (Villani et al. 2010).

According to Goulding (2009:283), a set of fundamental processes must be followed if a study is to be recognized as a product of grounded theory methodology, and these include theoretical sampling, constant comparison, open coding, memos, axial coding, and selective coding. Ideally, a grounded theory research begins with identifying an area of research interest. However, Goulding, 2000; 2005) argued that under grounded theory assumptions, this interest will come naturally because previous knowledge in the area of research is not expected and as such gives the researcher opportunity to build his own theories. The author nevertheless added that knowledge of previous literature and existing theories is encouraged, but must not be relied on, in order to give focus to the research. Grounded theory approach entails simultaneous collection, coding, and interpretation of data. Interviews, focus group discussions, and field observations are some of the various data collection techniques used in pursuing a grounded theory research. The approach further requires constant comparison of data, which is necessary to discover any merging themes and patterns (Goulding, 2001). Constant comparative process provides a useful platform for identifying and coding concepts within the data (Villani et al. 2010) The process allows the transcribing and examination of data for content soon after collection (i.e. coding). Coding of concepts begins after consulting the initial data source, which provides data on the basis of which subsequent data collection and analysis are pursued (Corbin and Strauss, 2008). In other words, the researcher examines and includes ideas emerging from initial data analysis in a subsequent data collection as he/she enters the field again. It further implies that the grounded theory researcher, using semi-structured interviews for instance, may develop an interview schedule in the later stages of the research project that appears different from the original schedule used in the first interview (Connel et al. 1997). The method employed in coding concepts is memoing, and memos may include field notes and more elaborated line by line notes of interview transcripts. Theoretical sampling is a significant grounded theory procedure, which involves sampling of data aimed at developing emergent theory (Glaser and Strauss 1967; Goulding 2000). Theoretical sampling implies that decisions about identifying data sources or data selection and collection are determined by emerging categories and grounded theory. Sampling plan is informed theoretically. The flexibility of the sampling strategy of Grounded Theory permits data collection process to account for insights gained during the research process (Egan, 2002). The process of conducting a grounded theory research further involves data analysis, which is an ongoing process. Coding, which follows after the initial thorough review of data, is the first analysis activity to identify categories. Defining the three subcomponents of coding activities, which are naming, comparing and memoing, Locke (2001:47) stated:

> *Naming involves attempts by researchers to conceptualize and develop abstract meaning for the incidents or observations recorded in their data documentation by articulating what they perceive are occurring or being expressed in those incidents. After careful consideration, the*

incident is named and described from as many angles or perspectives as can be generated by the researcher, with support from associated documentation.
Comparing entails the development of a common name or category for multiple incidents or observations in the data that lead to the development of more general categories. Comparing is critical for creating conceptual categories and supports the sharpening of the naming of categories; this is why it occurs in a manner corresponding to the naming activity described above. Memoing is the act of taking notes for elaboration. It takes on two forms: 1) notes that capture insights and ideas sparked by a particular incident while in the field—providing related insight or illustration, 2) recording of ideas generated later in the research process as the properties of categories are generated and theoretical ideas emerge.

The coding process produces categories, which are grouped and compared for emerging meanings and patterns. As data collection process is ongoing informed by analysis, new categories may be compared to emerging ones. Concepts are clarified as data collection and analysis become more focused. In this process, logics and analysis are likely to be iterative. In the process of constant comparison and axial coding, the researcher may make associated theoretical judgments as categories and their properties merge or collapse. Supported from data, a hypothesis about relationships between categories may be established. According to Egan, (2002:286), ‘’ Grounded theory research is concluded when the researcher has observed a point of data saturation and a sufficient theory has emerged from the data’’. Data saturation involves staying in the field until no new evidence is found to elaborate the phenomenon under study. According to Corbin and Strauss (2008), theoretical saturation indicates a point in analysis in which further data collection would add nothing to the developing theory. Validation of findings has become an important feature of grounded theory process. In this context, (Malshe and Sohi, 2009) suggested that the grounded theory researcher has to meticulously interrogate conclusions from data before leaving the field. However, a more detailed description of the process of conducting a grounded theory research is given in Chapter Four.

Meanwhile, this section further discussed the appropriateness and potential gains of applying a Grounded Theory in an institutional science and research context. First, grounded theory methodology permits understanding of given social situations by examining processes operating in them. The focus on processes allows the researcher to discover the participants’ major concerns, what is going on. Thus, grounded theory strategy of inquiry is appropriate for seeking answers to questions of what are the participants' main problems and how are they trying to resolve them. The approach permits the conceptualization of what is going in a natural setting, and the development of concepts that explain people's actions, which relate to a given phenomenon (Glaser and Strauss, 1967; Egan, 2002). It permits the discovery of local understandings, which without grounded theory inquiry may remain implicit and unexplained. Thus, in the context of this thesis, grounded theory methodology allows the inquirer to step out of the overused conventional methodologies to deal with the research questions of how governance of research, behaviour of scientists or research practices and other causal and motivational factors affect scientific knowledge production. The approach has potential to produce deeper and richer insights into research behaviours/practices that have significant implications for scientific performance. It can further uncover previously unexamined knowledge about the complex interrelatedness of causal factors of performance at the individual level of the scientist.

Second, grounded theory methodology makes use of incidents as units of analysis, rather than the individual's characteristics as in behavioural sciences. This feature of Grounded Theory permits the researcher to observe and analyze contextual influences and issues. This is because grounded theory procedures require honestly taking all data as it comes, figuring it out and then conceptualizing it (Glaser, 1998, 2014). Concepts and their relationships emerge as these incidents are compared in a given area so that broader contextual issues are accounted for in the developing theory. Grounded theory methodology can enable researchers gain contextualized, rich descriptions of phenomena under study (Seidel et al. 2009). Further, as a theory of action, Grounded Theory makes its greatest mark in exploratory research particularly in unexplored research areas. There is no evidence of work in the area of institutional research governance in the Gambia using grounded theory to generate and develop concepts and theory. A grounded theory approach would explore and uncover local understandings about research experiences of scientist and provide support for developing previously undiscovered theory of scientific knowledge production as no significant empirical work exists in the area of research governance in the Gambia. Grounded theory inquiry is particularly useful when the research objective is theory building. In this case, since a principal research objective is to generate new knowledge that can inform public research policy in the Gambia, Grounded theory methodology is an appropriate and effective strategy for theory building, which is a crucial basic step in an unexplored area (Villani et al. 2010).

In summary, since grounded theory makes use of all conceivable data resources the theory that emerges 'will be abstract enough and include sufficient variation to make it applicable to a variety of contexts related to that phenomenon' (Strauss and Corbin, 1990:23). It means also that the substantive theory developed from data would provide insights, which other researchers doing work on research policy and scientific production in a developing country could find useful. Besides, grounded theory methodology would enable this thesis to generate a new theory in an area where very little is known and provide a fresh slant on existing knowledge about public science policy implications for production of scientific knowledge in the Gambia.

3.9.2 CONSTRIANTS ON THE GROUNDED THEORY APPROACH

Some of the problems associated with grounded theory method include constraints of access to primary data sources, and the need to maintain continuity with the research setting as well as the core practice of overlapping data collection and analysis. Nevertheless, grounded theory is the most appropriate methodology for this thesis in spite of these limitations. Empirical evidence on public science and research in the Gambia appears to support the application of grounded theory strategy. Policy decisions to commit funds to research and generally support research efforts as well as research governance and practice appear to have far-reaching implications for research governance, research practices and institutional condition for conduct of research. For this reason, the thesis, using grounded theory methodology, can empirically investigate the contextual and cultural factors that influence scientific performance in the Gambia. .

In addition, grounded theory approach is criticized on grounds of its claim of being able to generate generalizable theories, which are nevertheless based on a relatively limited exposure to the phenomenon under study. Some scholars have argued that a theory developed under grounded theory methodology fails to meet the requirements for theory building outlined by Lynham (2002). This limitation of grounded theory is based on validity of theory generated. In this context, Hultgren and Coomer, (1989) argued that Grounded Theory claim of confirmation, reconfirmations, and continuous refinement and development of the emerging theory are limited. This limitation of grounded theory approach arises ‘’due largely to the dependence of grounded theory on saturation from a narrowly defined group of study participants and setting’’ (Egan, 2002:287). Critics of Grounded Theory argue that validation of theory must go beyond theoretical saturation within the narrow contexts found in most grounded theory inquiries. In their study of consumer behaviour in Australia using grounded theory approach, (Villani et al. 2010) acknowledging this limitation stated that ‘’ the limitation of the current research relates to its scope - Australian context and six product categories. To produce more generalizable results, multiple countries should be examined, both in population and available brands''. However, in defense of grounded theory approach, Glaser (1998) argued that the results of a grounded theory research do not amount to a reporting of facts but constitute a set of probability statements about the relationship between concepts, or an integrated set of conceptual hypotheses developed from empirical data. Therefore, validity of results might be a problem, but generally not considered an issue in grounded theory inquiry, judged by its fit, relevance, workability and modifiability. In this context, Egan, (2002) argued that grounded theory research has predictive value and can produce or enable identification of hypothesis for potential testing. The theoretical outcome of a research can claim a basis from the context in which the phenomenon under investigation actually originated.

Moreover, grounded theory research has been criticized for being suited mainly for explorative studies, and like all qualitative studies, its major focus is description. Achieving data accuracy in terms of its subjectivity, interpretation, plausibility, data voice, and constructivism is always worrisome in grounded theory research as in all qualitative studies (Glaser, 2004). In addition Grounded Theory emphasis on theory discovery implies that theory development results from continuous interplay between data collection and analysis of that data. Unlike most traditional research methods, the inquirer does not begin his data analysis after data collection is completed. On the contrary, under Grounded Theory, the search for meaning through the interrogation of data begins in the early stages of data collection (Glaser and Strauss, 1967; Glaser, 1978, 1992; Charmaz, 1983; Strauss, 1991; Strauss and Corbin, 1990, 1994; Stern, 1994). This distinct feature, critics argue, rubs grounded theory of any extant theory, which is either ignored or avoided, until the end of the analytical period. ''This is not necessarily the case, and has been misconstrued as meaning that the researcher must enter the field with a very blank agenda'' Goulding, (1999:6).

Indeed, the researcher using grounded theory does not begin without a theory because, as Glaser (1978) has noted, existing theory plays an important role in sensitizing the researcher to the conceptual significance of emerging concepts and categories. Knowledge and theory inform and feed into each other. Glaser (1978) argues that without this inextricable bound between knowledge and theory, and without grounding inquiry in extant knowledge, the ability of the researcher to recognize patterns would be limited to the obvious and the superficial, depriving the analyst of the conceptual advantage from which to develop theory. Therefore, Goulding, (1999:7) writes ‘’contrary to popular belief, grounded theory research is not 'a theoretical' but requires an understanding of related theory and empirical work in order to enhance theoretical sensitivity’’. Theory and theorizing creates, expands and modifies knowledge. In his interpretation of the meaning and relevance of theory, Morse, (1994:25-6) stated:

> *A theory provides the best comprehensive, coherent and simplest model for linking diverse and unrelated facts in a useful and pragmatic way. It is a way of revealing the obvious, the implicit, the unrecognized and the unknown. Theorizing is the process of constructing alternative explanations until a ‘best fit’ is obtained that explains the data most simply. This involves asking questions of the data that will create links to established theory.*

In addition, some qualitative researchers have criticized the assumptions and analytical methods of grounded theory based on a number of reasons. Some of the critics have suggested that grounded theorist fail to give adequate attention to data collection techniques as well as the quality of data collected. However, Goulding (2009) argued that such criticism misconstrue and misinterpret the aims of grounded theory research and arise from some features of the methodology such as language in which meanings are coded and interpreted. Language has been an issue on which perceptions of grounded theory differ sharply. Another criticism of grounded theory approach is the unrestrained generic use of the term to describe all sorts of qualitative studies even when they fail to display the essential features of a grounded theory research. Benoliel (1996) in a review of grounded theory articles published over a 4-year period, suggested that only a few of those articles claiming to have used grounded theory approach actually displayed the necessary features of this methodology. Goulding (2005) criticized the unrestrained manner in which grounded theory methodology is currently used reporting that many research papers which purport to sue grounded theory are merely purposive sampling and interviews, lacking any level of theoretical sensitivity. In a review of empirical studies claiming to have used grounded theory, Jones and Noble (2007) reported that a number had omitted theoretical sampling, which resulted in generating a theory lacking in density and variability. According to Goulding (2009:390), Roy Suddaby (2006), in response to this criticism, published what a grounded theory research is not, which includes,

1) *Grounded theory is not an excuse to ignore literature*
2) *Grounded theory is not presentation of raw data*
3) *Grounded theory is not theory testing, content analysis or word counts*
4) *Grounded theory is not simply routine application of formulaic technique to data*
5) *Grounded theory is not perfect*
6) *Grounded theory is not easy*

4.0 CONCLUSION

This chapter examined the theoretical framework for the thesis, which consists of a combination of investment theory, the principal-agent and stakeholders' theories. These theories are used to examine issues relating to the role and relevance of formal research governance structures, research practices, and scientific knowledge production. The relevance of the stakeholder theory lies on its assumption that an organization can achieve improved performance when management understands its stakeholders' environment and manages more effectively within the terms of relationships that exist in that organization. In the context of the present study, the assumption is that improved performance can be achieved, provided managers of research institutions understand the concerns of all stakeholders and manages within the terms of existing structures of research hierarchies and communication channels including structures of responsibilities and obligations. The chapter further noted that a number of empirical work including theory development has been carried out in the domain of creative and innovation processes (Indulska et al. 2009; case studies (Bandara et al. 2005; focus groups Raduescu et al. 2006; experiments Mendling et al. 2009; surveys Recker, 2008; or quantitative research (Hicks and Skea, 1989; Adams and Grilicks, 1998). However, the fact remains that no empirical work using grounded theory methodology has been done in the area of institutional science and research in a developing country such as the Gambia. Thus, this situation presents a challenge to Third World scholars as it opens up a window of opportunity for them to contribute to theory development using grounded theory strategy of inquiry.

Overall, a multi methods approach is appropriate for this thesis. Based on a postmodern epistemological stance, the thesis adopted a two phased, mixed methods strategy, which sequentially combined qualitative method in the first phase (Study 1) and a quantitative method in a second phase (Study 2). Specifically, the ontological position of study 1 is essentially constructionist because it treats the reality of research experiences and practices of participants as constructed and revealed by them. The focus is basically exploratory, descriptive and interpretative of the varied and complex research experiences of participants. Consequently, the design of the qualitative phase of the thesis is emergent in order to discover meanings as revealed by informants. Further, Study 1 takes the epistemological position of the constructionist paradigm assuming that data are contained within the perspectives of participants involved in scientific activities as individual researchers, research teams, research governors/managers and research policy makers. Granted that qualitative paradigms often do overlap, and since the epistemology of inquiry is subjectivist and the inquiry interactive, the thesis's strategy for qualitative data collection and analysis is grounded theory methodology, which is appropriate for describing and interpreting research processes and situation under study. However, the overall knowledge claim of the thesis is pragmatic, which means that the thesis is result or problem-oriented. For this reason, the study design is both qualitative and quantitative in thrust, and the strategy of inquiry involved sequential collection of data in order to best describe, interpret and explain the research problem. By approaching the phenomena under investigation in different ways, from different perspectives, the thesis was able to triangulate data. Data triangulation therefore produced data, which otherwise could not easily be sighted from one source alone.

This thesis's strategy of the first phase inquiry is Grounded Theory. However, since its inception scholars have made efforts to systematize Grounded Theory canons and procedures, which began with the parting of ways between the co-authors on the basis of ontological differences. Consequently, several versions of Grounded Theory are found and for this reason, the thesis selected Glaser's classic version based on its focus on the emergent nature of grounded theory. However, Chapter Four discussed in greater detail the procedural chain employed in doing a grounded theory research in the first phase of the thesis, which contained key components of the methodology. Grounded Theory is considered appropriate based on its potential gains when applied in an institutional science and research context. In the context of this thesis, grounded theory methodology allowed the inquirer to step out of the overused conventional methodologies to deal with the research questions of how governance of research, behaviour of scientists or research practices and other causal and motivational factors affect scientific knowledge production. Further, it could be useful in uncovering previously unexamined knowledge about the complex interrelatedness of causal factors of performance at the individual level of the scientist. Since there is no evidence of empirical work in the area of institutional research governance in the Gambia, grounded theory approach could generate and develop concepts and provide support for developing previously undiscovered theory of scientific knowledge production. Besides, since this thesis's major objective is to generate new knowledge that can inform public research policy in the Gambia, grounded theory methodology is an appropriate and effective strategy for theory building, which is a crucial basic step in an unexplored area (Villani et al. 2010). The approach would enable this thesis to provide a fresh slant on existing knowledge about public science policy implications for production of scientific knowledge in the Gambia. However, grounded theory approach is criticized on the ground of unrestrained generic use of the term to describe all sorts of qualitative studies, even when they fail to display the essential features of a grounded theory research. For this reason, (Goulding, 2002:163; Jones and Noble, 2007) suggested that researchers using Grounded Theory should select one approach, remain consistent in its application to avoid "methodological muddling". Further, grounded theory researchers must be able to justify their choice among the competing versions, articulate the steps or procedural chains employed in their research, and use the key components of the methodology as outlined by scholars of grounded theory method (Babchuk, 2011). Other scholars (Chiovitti and Piran, 2003; Jones and Noble, 2007) have called for rigor in implementing the methodological procedures of grounded theory, discipline in the methodology, and the need to properly explain the process by which theory was generated.

CHAPTER FOUR

RESEARH METHODS AND DATA DSIGN

4.0 INTRODUCTION

This chapter discussed the data collection plan and described the mode of observation as well as the various steps involved in carrying out the project. It is organized in sections, which explain specific sub areas of research methods and data design used. Section 1 provided a detailed account of the study area, which is the Gambia public research system. The section further introduced the study spots where data were collected as well as the location of the research participants. Section 2 discussed why the selection of the study area. The study area is the Gambia public research system because some degree of complexity and richness generally characterizes the research organization and governance that makes it attractive for research. In the Gambia, the systemic nature of the Gambia public education and science places the study area in a specific context that makes possible a close examination of institutional research situation. It further permits closer examination of significant knowledge flows and the evaluation of the system wide implications of university research. However, sections three, four and five discussed the research design, procedures of qualitative data collection and analysis, and validation stage respectively. Section six discussed the procedures of quantitative data collection and analysis and section seven provided detailed definition of variables used in the quantitative analysis. Section eight described the study population and sample size and section nine described the procedures of sampling qualitative and quantitative data. Section ten provided the details of quantitative data analysis and interpretation and section eleven outlined the process and rationale of integrating results obtained separately from qualitative and quantitative analyses of data. The chapter ended with a conclusion.

4.1 STUDY AREA

This section identified the Gambia public science system as the study area and introduced the study spots where data were collected and subsequently analyzed. The organization of public science system in the Gambia as in most developing countries appears however to lack definitive and well established governance structure for research and so thesis focused on public research policies between 2006 and 2010 which have created some discernible research governance pattern in the country. This governance pattern suggests a greater internal hierarchy in research governance, which allows management authorities greater power over research. A plausible explanation for the management centered research governance structure is that the government and external donors have remained the principal funders and stakeholders in public research over the years. The Gambia public education and research system is defined by the dominant roles of the government and external sponsors such as the World Bank. While the government's research policy objectives have remained largely espoused, there are however identifiable concrete steps taken over the years to support and shape public research. For instance, research support remains the principal public strategy for achieving the education and development goals of the Gambia

government. The government maintains the policy position that the state of the art research facilities and supportive research environment are necessary conditions for attracting and retaining a vibrant core of research experts to promote both basic and industrial research relevant for national development. The Department of State for Higher Education, Research, Science and Technology, (DOSHERST) deals with issues of public research and higher education policy and strategy. The Department oversees the implementation of the Tertiary and Higher Education component of the Education Policy 2004-2015 that embodies the following main government priority areas in education:

- Encourage the University of the Gambia (UTG) to progressively offer graduate programs within existing facilities and in collaboration with foreign universities
- Assist the UTG to take up strategic position within the national development agenda.
- Encourage external linkages of the UTG with other universities in pursuit of Research and Development objectives and other programs relevant to the Gambia.

However, the fact remains that the Gambia government has shown very limited commitment to research and development efforts, and there appears to have been no lump sum statutory allocations for research rather the state's Research and Development expenditures between 2007 and 2009 are dispersed under various subheads as sown in Table 1 below. The highest single annual allocation per state department was D700, 000.00 for DOSHERST in 2008 and 2009 respectively.

Table 4.1 Government investment in public research-the Gambia

Ministry	Actual 2007	Approved 2008	Estimated 2009
Ministry of Works, Construction and Infrastructure	D238,970:00	D3,090,000:00	D2,080,000:00
Ministry of Health and Social Welfare	Nil	Nil	D365,000:00
Ministry of Fisheries and Water Resources	D59,988:00	D80,000:00	D400,000:00
Ministry of Higher Education, Research, Sciences and Technology	Nil	D700,000:00	D700,000:00
Ministry of Energy	Nil	Nil	D150,000:00
GRAND TOTAL	D298,958:00 US$11,072.52	D4,370,000:00 US$161,851.85	D4,195,000:00 US$155,370.37

Source: National office of statistics, The Gambia

Major institutional research actors within the Gambia national system of innovation include The University of the Gambia and the Educational Research Network for West and Central Africa (ERNWACA), which undertake basic research. Others are The National Agricultural Research Institute (NARI), Medical Research Council (MRC) and International Trypanotolerant Centre

(ITC), which are concerned with science and technology activities. External actors/stakeholders within the public research system include the British Council, which provides major financial and logistic support for the MRC and the World Bank, which has been the principal fund provider for university research in the Gambia. For instance, the World Bank released approximately eight million US dollars (USD 8 million) to support the Gambia government public education program, the Third Education Sector Project Phase 11(2006-2011) in pursuit of the government's education improvement initiatives. Some of these funds were slated for significant high quality tertiary education and research. Moreover, in contributing its support for public research, the Gambia government through its education sector project (Appraisal policy document, 2006) provided for the creation of a competitive research fund to be managed by the University of the Gambia in accordance with guidelines provided by the policy instrument, which specified criteria for the selection of research grantees. Under this initiative, funds are to be released by the education ministry as soon as the University Council approves a list of selected research grantees. Following collaborative initiatives with the Education Ministry the University received approximately USD 113, 207 for competitive research from the government in 2009. The major objectives of the competitive research fund are to promote the development of institutional and individual research capacity at the University of the Gambia (UTG), the conduct of scholarly research, and the facilitation of dissemination of results of research findings in peer reviewed journals and scientific conferences. The competitive research fund is also expected to provide retention incentive for the university faculty members. While the DOSHERST maintains custody and disburses the funds in line with the guidelines, the Research and Strategy Committee of UTG receives and approves proposals for research, administers the funds in accordance with the guidelines, and determines the maximum funding level for research proposals. It also monitors research projects supported by the fund, organizes seminars for researchers to disseminate the results of their findings, and generally shapes research agenda at the University of the Gambia.

University research in the Gambia is taking shape, though funded with limited research resources. Linked with a number of local and international institutions, the University of the Gambia has in recent years entered into mutually beneficial academic, research and consulting collaborations. In pursuit of research and development objectives of its mandate, the University set up a Research and Strategy Committee made up of faculty academics to promote the development of research culture, environment and institutional infrastructure, support the strengthening of research expertise among faculty members, and support university staff in carrying out scientific and ethically sound research. In addition, the School of Medicine of the University has its own Research and Publication Committee set up to formulate research policy and strategies, including student research agenda, to promote active participation in research among academic staff through seminars, scientific conferences, and research retreats, and to review research proposal and papers/articles before submission to relevant medical/professional journals. There exists some collaboration and cooperation in the area of research among the Royal Victoria Teaching Hospital (a specialist hospital, which is the University's School of Medicine), Ministry of Health Units (such as the Malaria, and the Reproductive Health units), the internal Trypanotolenrance Centre and the Medical Research Council, The Gambia Unit. However, as in other fields of university research, research in medical and allied fields is confronted with several constraints which include limited research funds, underdeveloped research skills among faculty members, non-supportive research environment, inadequate support from both private and public sources, lack of supportive institutional conditions and data, and overloaded teaching and research staff. While the academic qualifications of faculty members are very limited with few having terminal degrees (such as

PhDs), there remains the challenge of improving research capacity by means of raising the quality of the research environment through the provision of adequate funding, infrastructure, research incentives and time for research. Besides, there is glaring absence of long-term support from both private and public sectors. The institutional conditions for research at the University of the Gambia are defined in terms of laboratories, libraries, equipment, and effective information storage and retrieval systems are very limited. Finally, faculty members are over loaded with teaching responsibilities, which permits very limited time and research efforts.

Non-university research in the Gambia includes research activities carried out at the National Agricultural Research Institute (NARI), The Medical Research Council (the Gambia), the Internal Trypanotolenrance, and the Educational Research Network for West and Central Africa. NARI accounts for about two-thirds of The Gambia's researchers and research and development expenditures. The Department of State for Agriculture administers the Institute and operates ten research programs. NARI directed its research activities towards adaptive and applied research on crops, livestock, fisheries, forestry, and other natural resource. These activities are expected to provide innovative and technological answers to problems of agricultural production and to inform policy on agricultural, environmental and natural resource issues. However, research and development expenditures on agricultural research and qualifications of agricultural researchers are very limited while agricultural research scope and intensity ratio in the Gambia remain lowest in Africa.

4.2 STUDY AREA SELECTION

This section discussed why the study area is selected, and adduced a number of reasons to warrant the choice. Seen from the point of view of organization process management, a degree of complexity and richness characterized research organization and management that makes it attractive for research. The study chose to enable understanding of a variety of contextual factors that affect the research organization process. This complexity of organizational process led the research interest to examine the strategies and tactics that research role occupants and the organizations as a whole apply in order to handle these complex phenomena. Moreover, the systemic nature of the Gambia public science system places the study area in context and boundary for closer study of institutional research and the examination of significance of knowledge flows. It further permits the evaluation of the system wide implication of university research. Another major reason for the selection of the study area is the apparent constraints of public science in the Gambia and the fact that topical research policy issues remain largely unexplored by empirical studies. Institutional research in the Gambia encounter varying degrees of constraints in a context where national science and technology policy, though still evolving, is not yet firmly rooted in public law. Basic university research is still very limited while adaptive and applied research is far from being advanced. The only exception is the research activities of the Medical Research Council, funded exclusively by the British Government. However, university research in the Gambia is taking shape, though funded with limited research resources and confronted with several challenges, which include the need to improve research capacity of faculty, secure long-term support from both private and public sectors, and provide supportive institutional conditions for research. In addition, research and development expenditures in non-university research remain generally limited while research scope and intensity ratio remain lowest compared to other systems of innovation in Africa. These conditions warrant an empirical work to find answers expected to inform research policy in the Gambia.

The accessibility to research colleagues who would readily respond to the study questionnaires and interview sessions justified the selection of the study area. The author is a faculty member of the University of the Gambia, and the study population is located in the Gambia. This means the access to respondents/informants is a lot easier while costs remain minimal. Finally, at the quantitative level of data collection and analysis especially, the use of randomization techniques is expected to obliterate the possibility of biases that might arise from the researchers' choice and selection of sampling elements.

4.3.0 RESEARCH DSIGHN

This investigation seeks to determine/explain the effects of research governance structure and mechanisms on scientific knowledge production within the Gambia public science system. The study further seeks to explore/examine specific institutional research situations and to direct observations to informants on their experiences, feelings, beliefs and convictions about research phenomenon under study. This thesis therefore seeks to understand what is happening in specific research situations and how research players manage their roles. This will mean an attempt to understand how informants perceive their institutional research governance policy and structures, their beliefs and convictions about research processes and practices, and meanings they attribute to research outcomes. It therefore means an attempt to achieve a deeper understanding of core issues about public sector research in the Gambia and ultimately to develop a grounded theory of knowledge production that goes beyond a universal law. Since the research questions and objectives imply the need both to explore and explain, the thesis adopted a mixed methods approach involving both qualitative and quantitative methods (Tashakkori and Teddlie, 2003) in order to better understand the research problem. Some writers consider mixed methods as a methodology with underlying philosophical assumptions (Tashakkori and Teddlie, 1998). Others (Onwuegbuzie and Teddlie, 2003; Creswell, Plano Clark, et al., 2003) focus on methods of collecting and analyzing data and thus consider it basically as a 'method'. Creswell, (2007:21) defined a mixed methods approach to inquiry as,

> *one in which the researcher tends to base knowledge claims on pragmatic grounds (e.g., consequence-oriented, problem-centered, and pluralistic). It employs strategies of inquiry that involve collecting data either simultaneously or sequentially to best understand research problem. The data collection also involves gathering both numeric information (e.g., on instruments) as well as text information (e.g., on interviews) so that the final database represents both quantitative and qualitative information.*

Mixed methods may be considered a research design embedded in some philosophical assumptions or world views, which provide the framework or direct the methods of collecting and analyzing data and involving mixture of qualitative and quantitative approaches in a single study or multiple studies. It involves collecting and analyzing qualitative and quantitative data.

Using the criteria established by Creswell et al., (2003) for choosing a mixed methods strategy, the study design is sequential exploratory, which means that first qualitative data were collected and analyzed, followed thereafter by collection and analysis of quantitative data, and both phases are given equal priority or weight in the processes. Qualitative and quantitative data and findings are integrated at the point of data interpretation in the thesis, which means that data and findings from the qualitative phase were compared and supported with data, findings and conclusions from the quantitative phase. This exploratory sequential strategy is useful not only for exploration, but also for expanding the qualitative findings (Creswell, 2009). The purpose of this model is primarily to explore the phenomenon under investigation, test some elements of the emerging theory of scientific knowledge production from the qualitative phase, and ultimately generalize results to the study population. The overall theoretical perspective is explicitly investment, principal agent, and stakeholder theories, which guided the entire design.

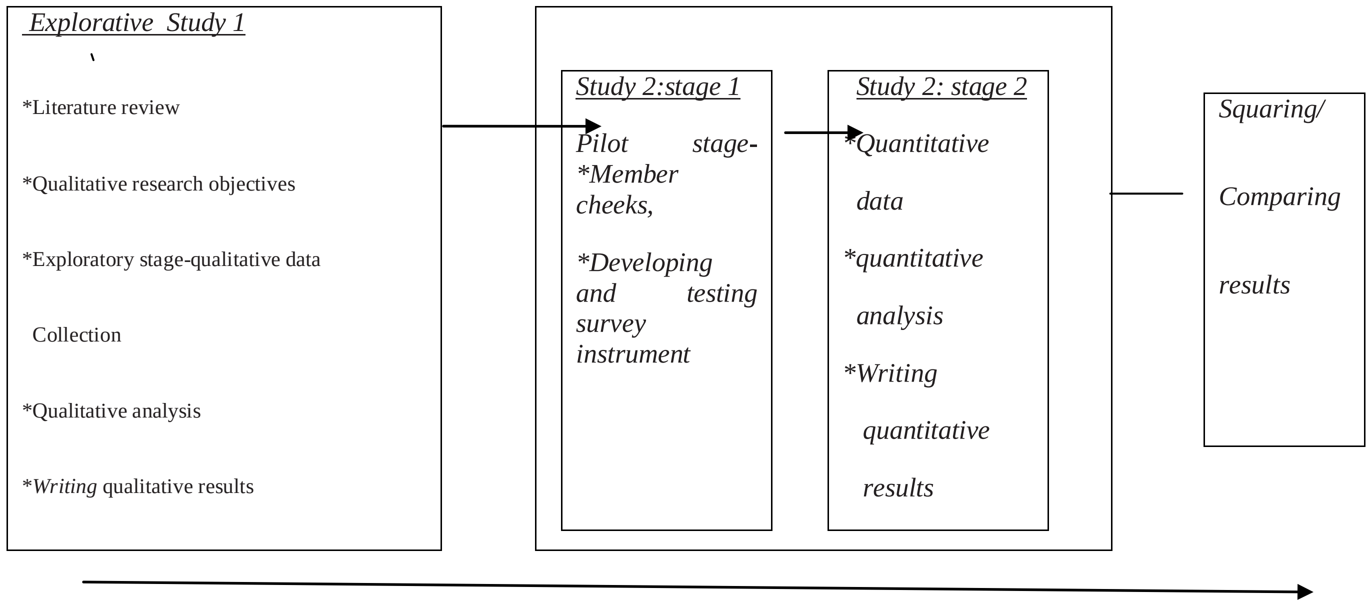
The first qualitative phase of the study (Study 1) used grounded theory method and aimed at exploring/discovering ‘reality’ through the informants’ perspectives because, according to Oslon, (1999:3), ‘’the subjective researcher seeks to know reality through the eyes of the respondent’’. Study 1 was inductive, which began ‘’from observations and examination of particular instances; from facts/data to general principles’’ (Beverridge, 1950:113). This phase of the thesis aimed at developing a theory of scientific knowledge production in the Gambia, which is grounded on data. The data collection plan for Study 1 is essentially inductive, and observation instruments included semi-structured interviews and focus groups’ discussions designed to collect initial data and information that might shed some light on concerns and issues of conducting original research by participants. The open-ended questionnaires were expected also to generate initial data on research practices/behaviours and governance factors that affect scientific performance at the individual level of the scientist. However, this survey instruments and other subsequent modes of observations used at this phase of the study were not designed with or guided by any precise deductive theory in mind. Data emerging from these sources were subjected only to qualitative analysis at this stage. However, themes and specific statements/views from participants in the first qualitative phase provided the groundwork for development of subsequent survey questionnaires grounded in participants’ views, which were administered in the second quantitative phase. In discussing the procedures of data analysis and validation, and in particular, the development of survey instruments for a mixed methods approach to inquiry, Creswell, 2007:252-3 stated:

> *In a sequential approach, obtain themes and specific statements from participants in an initial qualitative data collection. In the next phase, use these statements as specific items and the themes for scales to create a survey instrument that is grounded in the views of the participants. A third, final phase might be to validate the instrument with a large sample representative of a population.*

Nevertheless, testing or determining the validity of the qualitative data and findings is a subject of much debate in literature (Lincoln and Guba, 2000). The notion of validity is used in qualitative inquiry to suggest determining whether the findings are accurate, authentic, trustworthy, or credible (Creswell and Miller, 2000). Though reliability and generalization play a minor role in qualitative research, validity is seen to be its strength (Creswell, 2007, 2009). In this context, the validity test strategy consists of member-checks by which, specific description, themes, or the final report are taken back to participants for their responses as to whether the participants' positions are accurately represented. In addition, the inquirer developed a survey questionnaire with inputs from the first qualitative phase. This instrument was field tested at the pilot stage using five randomly selected participants in order to establish the content validity of an instrument and to improve questions, format, and the scales, and comments from these participants were incorporated into final questionnaire revision before administration. Above all, these tests provide a framework for accessing the trustworthiness of both qualitative and quantitative data and findings. Figure 4.1 presents a visual model and procedures of the design.

Figure 4.1 Research Design-Stages of development

Qualitative Phase Quantitative Phase



This mixed methods research involved a quantitative phase and a qualitative phase in an overall research study. The rationale for combining qualitative and quantitative research is to better understand the phenomenon under investigation by triangulating both broad numeric trends from quantitative research and the detail of qualitative research and to explore participant views for the purpose of using these views to develop and test survey instrument with a sample from the study population. Johnson and Onwuegbuzie, (2004:17) define mixed methods research as:

> *the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study…it is inclusive, pluralistic, and complementary, and it suggests that researchers take an eclectic approach to method selection and the thinking about and conduct of research*

The authors argued that the logic of mixed methods inquiry is to use induction in the discovery of patterns, deduction in testing of theories and hypotheses, and abduction in uncovering and relying on the best of a set of explanations for understanding one's results (e.g. de Waal, 2001). Abductive reasoning, which is evident in recent literature about grounded theory (Charmaz, 2006; Reichertz, 2007; Richardson and Adams St Pierre, 2005), occurs at all stages of analysis, though more evident during the constant comparative analysis of categories to categories that end up with theoretical integration. According to Reichertz (2007: 220), the researcher using the logic of abduction ‘‘has decided … no longer to adhere to the conventional view of things … Abduction is therefore a cerebral process, an intellectual act, a mental leap, that brings together things which one had never associated with one another: A cognitive logic of discovery’’. By combining the two major research paradigms, mixed methods research is often seen, in philosophical terms, as a third research movement (‘a third wave’), which goes beyond the paradigm wars to offer a logical and more pragmatic alternative (Johnson and Onwuegbuzie, 2004). Consistent with the principles of mixed research, the researcher, using different strategies, approaches, and methods, collect multiple data ‘’in such a way that the resulting mixture or combination is likely to result in complementary strengths and non-overlapping weaknesses’’(Johnson and Onwuegbuzie, 2004:18). Mixed methods produce superior results because it provides a more comprehensive evidence for studying a research problem than either qualitative or quantitative study can do alone. A major purpose for its use in this study is to optimize the strengths of both quantitative and qualitative approaches. However, the mixture or combination of methods would produce complementary strengths and non-overlapping weaknesses considering the strengths and weaknesses of traditional quantitative and qualitative studies. This is because mixed methods can answer research questions which qualitative or quantitative study cannot answer alone as qualitative data may explain quantitative results or results from both studies may be converged. In this thesis, qualitative observations (themes and views of participants) are added to a quantitative survey instrument and analysis. This measure served first as a manipulation cheek or legitimating test (as in the pilot stage), clarification, elaboration or complementary strategy to overcome some potential problems of interpretations of results found in positivist studies. Secondly, qualitative interviews enabled the investigator to tap onto participants' views and meanings again to overcome some of the potential weaknesses of the quantitative phase In this context, mixed methods is designed to achieve convergence and corroboration of results from different methods and designs studying the same phenomenon as well as elaboration, enhancement, illustration, clarification, and expansion of the qualitative results from one method with results from the quantitative method (Greene, et al. 1989; Johnson and Onwuegbuzie, 2004; Creswell, 2007, 2009). It provided a 'practical' means of addressing the research problem by allowing the use of words and numbers, inductive and deductive logics, multiple worldviews, and multiple modes and skills of observations. Besides, mixed methods approach is apt for exploring the phenomenon under investigation, for theory development, testing some elements of the emerging theory of scientific knowledge production from the qualitative phase, and generalizing results to the study population. In terms of paradigm emphasis, the thesis gave equal status to each approach. The time order is sequential from qualitative to quantitative study. The validation steps at the pilot stage concerned the assessment of the trustworthiness of both the qualitative and quantitative data and findings. In brief, mixture of methods occurred at the levels of research objectives, data collection, and of data analysis and interpretation. In addition, phase 1 involved qualitative analysis and phase 2 quantitative analysis and interpretation, while the integration of results from both phases involved comparing results, expanding qualitative results, 'exploring patterns that span conflicting understandings' in search of common ground (Lewis and Grimes, 1999: 675), and generalizing results to the study population (Creswell, 2009).

4.3.1 PROCEDURES OF QUALITATIVE DATA COLLECTION AND ANALYSIS.

Since the grounded theory process has been discussed already in Chapter 3, this section begins with more detailed discussion of procedures of qualitative data collection and analysis. Qualitative data were collected and analyzed using grounded theory method, which involved an iterative process. Grounded theory is explicitly emergent, a feature that sets it apart from other research approaches. Unlike most other research, grounded theory does not test hypothesis, rather theory is emergent, discovered in data. Since this thesis seeks to explore and explain research processes in the Gambia as it is, understand what is happening in the situation under investigation, and, according to Glaser, (1967), to discover theory implicit in data, data collection technique is anchored on participants' perspectives. Qualitative data were collected using semi-structured questionnaires (open-ended), focus groups' discussions, a number of interview protocols and already published works. Semi-structured interview consisting of twelve questions were administered to ten respondents within the educational institution and public research and educational institutions including the University of the Gambia in order to generate primary data for qualitative analysis in Study 1. Focus Group Discussions centered on ten questions/issues and involved twelve participants. There were three groups' discussions with four participants in each group.

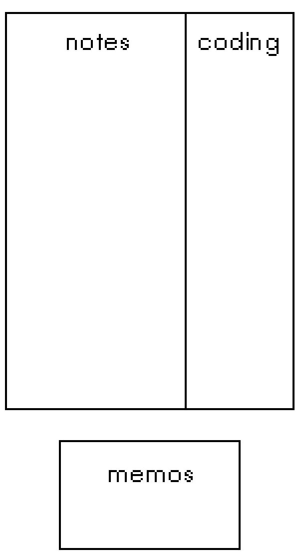
The semi-structured interview instrument (see Appendix II) was designed to enable the author gain insights into actual participants' individual and group life and research experiences from their point of reference. The study conducted a majority of the interviews in a semi-structured manner in order to permit room for the unexpected. The open-ended questions aimed at eliciting a variety of views and opinions from the informants. Data generated from this sources including focus groups' discussions and a number of interview protocols in Study 1 were analyzed in order to explain public research process and practices by identifying core and subsidiary processes operating in it and obtaining ideas from the participants own perspectives.

Three focus groups' discussions consisted of four participants in each group, who included university and non-university scientists. These groups were randomly selected across the fields of science. Ten questions/issues as shown in Appendix IV a, b and c (Examples of Interview Protocols) were presented to each group for discussion. These groups' discussions provided qualitative data and information about the study population revealing data about research language, issues and challenges, which participants identified. The discussions further revealed data about the informants' perceptions and meanings, which they attach to their institutional research policy, research governance structures and mechanisms, as well as research processes and outcomes. In brief, the three groups' discussions thus provided an important primary data source for Study 1.

In addition, other interview protocols included interviews of two University research managers and two senior management staff of the Department of State for Higher Education, Research, Science and Technology (DOSHERST). Secondary data sources were also useful. Most studies including qualitative research are hypothesis testing. Study 1 using grounded theory method gave no special treatment to evaluation of literature; rather literature was accessed as it became relevant and necessary to provide secondary data, which might strengthen analysis. Data obtained from already published works including quantitative studies in research policy domain and ''whatever comes the researchers' way while studying a substantive area'' (Glaser, 1978; 1998) were used to support analysis. Besides, public research organizations in the Gambia and Africa provided institutional data.

Data collection and analysis took place simultaneously while searching for all possible interpretations. Transcripts were written from the focus groups' discussions while key word notes were made, which were later converted to themes. Data analysis was systematic and began as soon as data become available, and proceeded through identifying categories and connecting them. Data were interpreted using a coding procedure that began with open coding, which is a process of breaking down data into clear units of meaning. The process started with analyzing the text line by line for the purpose of identifying key words or themes, which connect the informant's account to the experience under investigation. The coding process began with a close line-by-line examination of the first interview. In order to identify and code categories, the author began by asking himself: what is going on here? What is the situation? How is the informant managing that situation? Therefore what categories are suggested by that sentence? Coding that followed was done adjacent to both interview notes and key word notes made on transcripts from focus groups' discussions as shown in Figure 2 below.

Figure 4.2 Examples of Interview Notes/Memos



In brief, data analysis proceeded from open coding (identifying categories and their properties) through axial coding (examining conditions, strategies, and consequences) to selective coding along an emerging thematic line. Further, constant comparison method was applied at this point as the next interview was examined and coded with the first interview in mind. Subsequent interview data as well as data from other sources (focus groups' discussions and interview protocols) were coded with the emerging theory in mind. This method of initially comparing dataset-to-dataset and later comparing dataset to theory is constant comparison. Comparison was done in search of emerging patterns and themes. According to Spiggle, (1994:493-4),

> *Comparison explores differences and similarities across incidents within the data currently collected and provide guidelines for collecting additional data...Analysis explicitly compare each incident in the data with other incidents appearing to belong to the same category, exploring their similarities and differences*

In effect, comparison facilitates concept identification. Concept identification represents ''a progression from open coding (which is about merely describing what is happening in the data) to explaining the relationship between and across incidents'' (Goulding, 1999:9). Identifying concepts is about abstraction of meaning achieved by means of a coding technique often referred to as 'axial coding', and for Glaser and Strauss, (1967), it involves the process of abstraction onto a theoretical level. Constantly comparing data in order to discover emerging themes/patterns is the basis for identifying concepts (Goulding, 2001; Villani et al. 2010). Axial coding deals with developing abstract concepts in terms of their interrelationships and such concepts embody a number of more concrete instances found in the data. In this context, emerging concepts warranted the expansion of data sources (further sampling) and further data collection (Egan, 2004), and through constant comparison with additional data, these concepts were sharpened or further developed. Hence, data collection and analysis was ongoing (Schultz et al. 1996) and iterative. However, this coding process lays the foundation for theory development. According to Spiggle, (1994:494), ‘’the theoretical significance of a concept springs from its relationship to other concepts or its connection to a broader gestalt of an individual's experience". To illustrate the coding process and constant comparison method, suppose the first two informants mentioned having to ‘organize time or organize work’ in response to the interview question: How is your research work affected by what you feel about your field of research? Tentatively, these two sentences could be coded ‘’*organizing*’’, perhaps among other codes. This done, the author would mindful of any theoretical ideas that might come to mind, which could be written in a memo. The investigator could note in a memo that the respondent’s *career perception,* affects how he *organized* his work (i.e. research practice or work structure). Meanwhile, the inquirer used a separate piece of paper for memoing. Memos are notes used soon after data collection, to document the impressions of the author and the description of the situation. These notes provide a bank of ideas, which would be revisited when mapping out the emerging theory.

What then are categories and their properties? A category is a theme (a variable or concept), which makes sense of what the informant/participant has said. It is interpreted in light of the situation under study, other interviews and the merging theory. The tentative category ‘’*organizing*’’ in the illustration above has two components- ‘*organizing time’* in terms of time spent on research and on teaching, and ‘*organizing work* in terms of choice of research themes and priorities, sharing resources with colleagues/ collaborative research, funding decision, strategies for publications/other research output, and research output orientation (i.e. quality vs. quantity). Each of these elements could be considered a property, a sub-category of *organizing (*or a cluster of properties). A category (or even more) is adopted as core if it is found to emerge with high frequency of mention and well connected to other categories that are emerging. When a core variable is identified, sentences that do not relate to it are no longer coded. Rather, sentences are coded which relate to the core, other categories, and properties. Any identified connections between categories are recorded in memos. Informed by emerging concepts and relationships, the initial sample could be expanded through theoretical sampling. In order to strengthen the emerging theory by defining the properties of the categories, and how these mediate the relationship of category-to-category, the initial sample is added to or expanded by such means that increase diversity in useful ways. In other words, sampling is directed by the emerging theory. This is because as concepts are identified and theory begins to develop, further individuals, places and situations need to be added in the search in order to identify and include other properties that illuminate the connections between categories and thus strengthen the findings. Glaser and Strauss refer to this process as theoretical sampling, which involves sampling of data as dictated by the developing theory (Glaser and Strauss 1967; Goulding 2000). Sample is emergent, just as theory and method generally are. Theoretical sampling of new data is essentially a deductive process involving sampling new individuals, situations and places not altogether obvious to the researcher. This was done by going through old-field notes and memos already coded or newly generated data. Theoretical sampling strengthens theory by producing new data that define the properties of the categories, and how these mediate the relationship of category-to-category. What were known about the core and other categories through theoretical sampling soon reached a point of saturation and at this point when nothing more could be gained to illuminate relationships between category and category that the emergent theory became valid. Corbin and Strauss, (2008) described this process as theoretical saturation, which recognizes the point in the analysis in which further data collection adds nothing to the developing theory. When this point is reached, further coding (or search for mediating properties) for that particular category ceases. In time the core category and categories related to it become saturated, and at this point a large number of memos would have been accumulated. Between them, these memos would capture different aspects of theory emerging from the data.

The process of theory development was followed by sorting out memos, which put fractured data back together, though however the sorting process was marked by memo-to-memos phenomenon as new ideas emerged and were recorded in new memos. Grounded theory method assumes that theory is concealed in data for the investigator to discover. While coding makes visible some of the components of this theory, memoing brings together the relationships that link categories to each other (being the inquirer's conjunctions/guesses about relationships between categories). Sorting memos generated theory that explained the research governance phenomenon under study. Sorting of memos is the means of putting fractured data back together. The sorting process generates theory that explains the main concern under study. Cards were used in this study for memoing, which made sorting a lot easier. Memos were grouped together based on similar categories or properties they addressed. The groups of memos were arranged in two-dimensional space in order to capture the structure of the eventual report of the thesis. The cards were then gathered and arranged in the sequence that allowed the structure to be described. This sorting process prepared the ground for the final write up of the report. The sorted memo piles were written up allowing the various categories to be related to each other and to the core variables producing thereby a substantive grounded theory. It is through this process and procedures of data collection, data analysis and interpretation that work in the qualitative phase of the thesis was conducted and finally integrated into a grounded theory of scientific knowledge production.

4.3.2 VALIDATION STAGE

The following validation measures were taken prior to the quantitative phase of this thesis in order to ensure that relevant survey questions were asked and directed towards the quantitative research objectives and, in addition, to enhance the validity of findings.

- Developing a survey instrument to generate quantitative data based on themes and specific views of participants in the qualitative phase.
- A pretesting of the survey questionnaire and its modification were conducted to ascertain that only relevant questions were asked.
- After entry of data from the survey questionnaire, a final compute edit was carried out so as to weed out inconsistencies by referencing the original questionnaires, and meanings obtained from this source are integrated with data coming from other data sources used in the analysis

However, in presenting results, it was necessary to validate qualitative findings, which were clothed in the narratives of participants. Consequently, in order to narrow the distance between the researcher and object of inquiry, all interview instruments were extensively field edited prior the commencement of qualitative data collection and analysis. In addition, responses, specific themes, and views of participants were further field edited. The process therefore provided the needed opportunity for the interviewer to rectify mistakes that could possibly be made in presenting their responses. Overall, these validation strategies provided the framework for accessing the trustworthiness of both qualitative and quantitative data and findings.

4.3.3 PROCEDURES OF QUANTITATIVE DATA COLLECTION AND ANALYSIS

The second phase of the thesis (Study 2) used standardized survey questionnaires (closed ended) to generate primary quantitative data. It further used statistical methods to test pre-determined hypotheses, which embodied operationally defined variables. The survey questionnaires were administered to an experimental group, which was randomly drawn from the study population. Parametric measures were employed in a quantitative data analysis, which involved tests of the following statements of the hypotheses:

Hypothesis 1 Stating the Null Hypothesis (claim)

- The effect of research governance (scientific committee structures and mechanisms), research practices, and institutional condition on research output/scientific performance is insignificant

Hypothesis 11 Stating the Alternative Hypothesis

The effect of research governance (scientific committee structures and mechanisms), research practice, and institutional condition on research output/scientific performance is significant

Primary and secondary source provided quantitative data used in this study. The survey questionnaires consisting of twenty three statements (Appendix I) were administered to a sample of 650 participants to generate primary data, which were quantitatively analyzed in *Study 2*. In addition, already published works provided secondary quantitative data. These included published works on research policy and governance issues in both industrialized and developing world contexts. Using the logic of multiple sources of evidence under the rationale of data triangulation (Yin 2003), this thesis therefore used different data sources. At the macro level, data were collected from higher education and national research policy documents in the Gambia over the period 2006 and 2010, and within the same period, data were also collected, at the institutional/university level, from university documents such as strategic research plans, financial reports, research policy, and evaluation reports.

The survey questionnaire was developed around qualitative observations (themes and views of participants) to incorporate key variables as outlined in Table 4.2 and Table 4.4, which are considered important in the relevant research policy and governance literature. Table 4.2 below indicates specifications of variable indicators and their measures.

Table 4.2 Variable definition and measures – Models of research governance (indicating governance structures and mechanisms)

Research governance models (or dimensions) ***-Attributes and Indicators (or measures)***	***Research governance structures***	***Modes of coordination and control mechanisms****
1. State regulation/State centric hierarchies and regulation -Does the state have greater control over research and ownership of research output?	Centralized state control and coordination -Hierarchies, top-down authority, roles and communication structures; state regulation	State oriented form of coordination (i.e. state control through centralization, hierarchies, regulation and financing, which is based on the principle of coordination by bureaucracy and politics.

2. State supervision (i.e. State guiding and supervising) model	state supervision and monitoring - Supervision from a distance through communication while higher education and university research is self-steered and managed	Monitoring and feedback. State supervision is imposed to ensure academic quality and accountability
3. Academic self-governance. Hierarchical self-steering by professionals/academics (i.e. academic oligarchy marked by decentralized decision competences over research and by strong internal hierarchies) -Do you think the state's research policy between 1999 and 2007 has produced reduced decision competences of state authorities over research giving researchers greater autonomy? -As a researcher/professional research committee are you free to seek, acquire, or use research funds from external sources or influence decisions of donors? --Do you think there is greater internal hierarchy /decision competence of research units and researchers over research agendas and priorities?	Academic oligarchy -professional committees with limited, though devolved, research decision competence. Dominant role Research Chairs. Peer review committees. Other tools include Research Ethics Committee (responsible for scientific quality, safety, and ensuring that the risks of research have been adequately communicated to research subjects)	Coordination by research chairs characterized by hierarchical self-steering, and employs mechanisms of self-regulation, quality assurance and accountability
4. Market driven model (i.e. by competitive funding) -As a researcher do you compete with your colleagues over research funds, academic prestige/publications in top quality journals, and top position? - Do you think competition can improve the quantum and quality of your research output?	Market forces; competitive research funds Self-regulation through interplay of market forces	Coordination achieved through interplay of market forces, the use of other market mechanisms such as performance-based steering(-e.g. research funding based on performance), and strengthening competition among universities, academics and research units; no one is really in charge
5. Managerial self-governance (i.e. management leadership) model -Is there strong internal hierarchy	Executive leadership structures- Bureaucratic centralization and hierarchies -Dominant role and competence of university leadership and management (e.g. VC and	Coordination by bureaucracy

where management authority (VC and Deans) gain greater controlling power over researchers? -Does the VC/CEO exercise greater de facto influence over research decisions than the Deans and Research units? --Do you have any accounting system monitoring funds movement of research units? -If you are free to seek, acquire and use external resources, are you expected to report progress of your work to internal self-controlling research unit or higher internal hierarchy?	Deans) over research such as strategic planning of research and other influences through executive networking). Other structures may include administrative and accounting procedures and manuals (for management of research structures and resources) including audit and monitoring system	
6. Stakeholder Guidance -Do external stakeholders influence research practice through goal setting or advice?	Lateral governance structures (e.g. Lateral stakeholder relationships and partnerships; relational contracting (i.e. contractual cooperation with external stakeholders). -structures for participation of external stakeholders in the institutional boards or representation of stakeholders in external funding bodies providing grants for research.	Coordination achieved through the advice, guidance and participation in decision making of external stakeholders such as the community, state, external donors/research grant providers, etc

4.3.4 DEFINITION OF VARIABLES

The term **governance** is generally applied to a variety of issues, relationships and institutions concerned with managing public and private matters. Governance covers all that governing bodies must pay attention. The United Nations Development Program (UNDP), in its 1997 policy paper, defined governance as "the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions, through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences". The World Bank defined governance as the method through which power is exercised in the management of a country's political, economic and social resources for development. As the Bank realized that a major part of the crises in developing countries derives mainly from governance, most of its development packages began to emphasize governance issues, particularly the issues of accountability and transparency. For this reason the Bank developed a new way of looking at governance, which is broader than government or governing. Jon (2000) defined governance along this broad line as "sustaining coordination and coherence among a wide variety of actors with different purposes and objectives". These actors include political and institutional players as well as interest groups, civil society, non-governmental and transnational organizations. According to the British Council, governance involves interaction between formal institutions and those in civil society. Governance therefore refers to a process whereby elements in society wield power, authority and influence and enact policies and decisions concerning public life and social advancement. Peters and Pierre (2000) offered a more state-centric definition of governance and argued that "governance relates to changing relationships between State and society and declining use of coercive policy instruments. The author asserted that the State possesses dominant political power and plays a leading and steering role in governance, making priorities and determining objectives. Further, Hirst, (2000) defined governance as the means by which an activity (or group of activities) is controlled or directed, such that it delivers an acceptable range of outcomes according to some established criteria. These definitions embody notions of governance that go beyond the meaning of such related concepts as government, state, regime, and good government. They imply that good government is an integral part of governance. They further imply the related concepts of organizational effectiveness in terms of policy formulation and policy in action, accountability, transparency, participation, openness and the rule of law or non- arbitrariness. This approach to governance emphasizes responsiveness, accountability, openness, and participation of other actors other than the central authority in policy making and policy taking. Governance therefore is not about dominant management and administrative hierarchy but about partnerships involving other actors in the policy process. Governance is the process whereby societies, or organizations, make important decisions, determine whom they involve, and how they render account (Institute of Governance, Canada, 2002). Governance is not about routine administration, it is about collaborations, the ‘’formalization of the relationships among partners, combined with mechanisms for accountability of the collaborative enterprise for its actions" (Tom, 2000:6).

Having defined governance, what then is **research governance**? Research governance is about managing research activities and practices (i.e. governing the behaviour of researchers). In this context, research governance aims at continuous improvements in research practices. However, new approaches and re-thinking in governance have tended to dominate recent literature in public sector reforms, higher education and research. Emphases appear to be shifting (in terms of coordination of public efforts) from traditional centralized pattern of authority and power distribution to redistribution across the various policy levels. According to Leišytė, (2007:28), ‘’In many countries, coordination of organizational operations including research processes has changed from a classical form of regulation dominated by a single actor, the State to forms in which various actors at various policy levels govern the system’’. Van Kersbergen and van Waarden, (2001) described this approach to governance as "multi level, multi actor governance’’. Coordination of activities occurs through interactions at various policy levels as many of the actors engage in a contest over determination of policy (de Boer, Enders, and Leisyte, 2007).

However, (de Boer, Enders, and Schimank 2007) identified and described five governance models and argued that these models offer a perspective to provide an analytical description of shifts in governance. These five dimensions are:

1. State regulation, which concerns the traditional notion of top down authority vested in the state. Regulation refers to the promulgation of an authoritative set of rules.
2. Academic self-governance. This emphasizes the central role of professional communities in determining the course and outcomes of higher education and research practice.
3. Market-driven system where order in the system can be achieved through competition, which influences the quality and allocation of goods and services. Competition in higher education refers to a competition between and within universities for strategic resources and for customers/end-users of their services.
4. Managerial self-governance. This is about hierarchical steering. Here the role of university leadership and management in goal setting and decision-making becomes important.
5. Stakeholder guidance. This is about activities of internal and external actors directed through goal setting and advice. It concerns the provision of general objectives and procedural rules setting the framework within which actors have room to manoeuvre.

It is evident that each of these approaches produces distinctive **governance structures and mechanisms** of coordination of higher education and research, which are designed to achieve specific governance purposes and objectives. A **research governance model** thus describes the structure of relationships of authority, roles, responsibilities and obligations and of communication/information flows in the management of institutional research. **Governance structure** defines the framework for governance processes of decision making, and indicates how the network of governance entities, actors and partners (including stakeholder partnerships) relate and operate. It further defines what governance goals and objectives are determined and how these are to be achieved. Research governance framework, on the other hand, establishes mechanisms for ensuring that research complies with all professional, ethical, legal, and scientific standards. Such mechanisms might include policy rules, regulations and procedures (e.g. ethical rules of research). The central role in the framework may be allocated to the research sponsor, research coordinating/monitoring committee, or some centralized research governing authority such as the State or the institutional management. Coordination mechanisms commonly found in respect of the following governance models include:

1) State oriented form of coordination (i.e. state control through centralization, hierarchies, regulation and financing) based on the principle of coordination by bureaucracy and politics).
2) State supervision, which employs monitoring and feedback. Supervision is imposed in order to ensure academic quality and accountability
3) The market-type coordination takes a businesslike approach to management of higher education and research. Finances sourced from multiple sources through bidding and competition. Coordination is achieved through interplay of market forces, the use of other market mechanisms such as performance-based steering, and strengthening competition among universities, academics and research units; no one is really in charge. Self-regulation through the market based on the principle of coordination by market.
4) The academic oligarchy in which academic self-governance is the domination form of coordination, the most influential but may combine authority distribution with a modest amount of influence from institutional trustees and administrators. Characterized by hierarchical self-steering, this model may employ mechanisms of self-regulation, quality assurance and accountability (based on the principle of coordination by profession).

5) In Executive leadership model characterized by top-down structures, coordination is by bureaucracy (i.e. hierarchical self-steering)
6) In Stakeholder guidance model, coordination is achieved through the advice, guidance and participation in decision making of external stakeholders such as the community, state, external donors/research grant providers, etc)

Research governance structures present in any governance model may vary in importance and emphasis depending on time and space or location. In Africa, particularly West Africa, the organization of university research began with the State playing a dominant role in a context where faculty members were regarded as civil servants subject to similar civil service rules and conditions of service. According to the International Development Research Centre (IDRC) Report, (2009:10) on the state of university research in West and Central Africa, the dominant model of research governance in the Cameroon was state centric, though over the years this has given way to State supervision model in which institutional leadership continues to play significant role in research steering. In the Gambia higher education and research tend to be governed along similar lines, though with slight variations (this trend was discussed in chapter one). Nonetheless, existing research governance structures in most universities in this region appear unable to play a crucial role in driving research and providing the needed technical support. According to a study of university research governance in West and Central Africa by Camara and Toure (2010:2), the guidelines for organizing research systems as well as the accreditation of research units remain largely undocumented and unclear, while research units proliferate and overly exist informally with very limited interactions among them. The authors' situational analysis of governance of university research in six universities in five countries in West and Central Africa demonstrated that though all universities surveyed have decision-making bodies for research issues, these bodies have limited influence on research. Institutional mechanisms for steering research appear to be lacking, and in the absence of strategic steering of research by governments and universities, researchers have tended to ‘’carry out their research, either individually or collectively, primarily to meet their own particular interests and secondarily to meet the requirements of external partners with their own respective research agendas’’ (Camara and Toure, 2010:3). Research governance structures in place in most parts of the region remain therefore largely ineffective in steering research.

Nevertheless, based on the work of (de Boer, Enders, and Schimank 2007) and Leišytė, (2007, this thesis constructed and described **scientific committee model** of research governance for the purpose of quantitatively testing its effects on scientific knowledge production. This model, which is academic or professional self-steering, consists of research chairs and scientific committees at different hierarchical levels with significant degree of autonomy to decide on key research issues. Within the framework of institutional mission and science policy, internal guidelines and inter-institutional agreements, the research chair in the apex scientific committee structure, could deal with strategic research issues providing the necessary institutional research leadership and coordination of research activities. Departmental scientific committees and research sections could provide support on research direction and priorities, and sectoral research leadership. In brief, unlike the governance pattern often described as New Public Management (Braun and Merrien, 1999; Schimank, 2007), the scientific committee model anchors on low degree of control by the state, of external stakeholder control and of management control as well as low degree of state and research chair holder competences. Scientific committees are pivotal in research steering exercising significant but varying degrees of autonomy depending on the point in the hierarchy. However, this model still maintains the spirit of New Public Management as it gives greater steering autonomy to researchers. The potential gains of this model and governance structures lie on the assumption that given these critical autonomous competences over research, and playing supportive role in achieving institutional research agenda, scientific committee governance structures could foster best research practices behaviour among scientists by facilitating both internal and external research collaboration. In brief, the thesis investigated the effects of research governance variables, defined as State centric, State supervision, Management centric, Market forces, Stakeholder structures (see Table 4.2), and Scientific committee structures. However, it is possible, in any given situation and at a particular point in time, that research governance structures in place would reflect a specific combination of characteristics of these models. Besides, it is possible, as in some higher education and public research systems in West and Central Africa, to discern a mix in the modes of coordination and control mechanisms of organization actions (or research processes), in spite of any specific governance structures that may be found in place in any given setting. For instance, the mode of coordination and control mechanisms of higher education and public research in Cameron between 2007 and 2009 displayed a mix in which institutional leadership and public bureaucrats played dominant role in steering research keeping off academics while external donors played only a guidance role. However, the mix appears to be changing from this state, and in some cases management centered, structures towards academic oligarchy, which is a more devolved structure with a mix of state supervision.

Other variables used in the quantitative analysis include **research practices** (or research behaviour), collaborative research exchanges, institutional condition and scientific output. Research practices/behaviour describes the broad behaviour around decisions over research topics, research output preferences (or orientation), mainstream research, publication strategies, collaborative research exchanges, and the distribution of teaching and research activities (where it applies). Collaborative research may result from collaboration and cooperation between research staff, and between the research organization and private organizations. Collaboration could take the form of contract research, which ultimately involves technology transfer activities. Researchers could work together, share resources, and co-author research publications. They could also engage on contracted applied research with private firms. This is an important property of the variable, research practices. **Governance scheme** is a theme found useful in conceptualizing research governance. Each governance model can in fact display specific governance schemes for achieving governance objectives. This thesis assumed the following features of governance schemes to be relevant:

- Support for research infrastructural development
- Extramural programs such as those promoting knowledge and informatics management
- At the top hierarchy of the national innovation system, some kind of institutional arrangement that promotes and provides guidance on research governance issues for instance establishing a research policy and implementation coordination mechanisms, providing guidelines for research ethics, ethical standards/norms for experiments with animals, and a national research policy
- Schemes aimed at improving research capacity such as training in research in selected research areas by providing access to work in state -of -the art facilities both within and outside the country, providing fellowships for training

Research output (or scientific performance) is a response variable used in the quantitative analysis. This thesis defines scientific performance as recognizable output of organized research activity, and consists of a researcher's published record within a given field of research interest. Sometimes, bibliometric indicators as proxies measure research output or scientific performance. However, a broad definition of research output covers several dimensions of the concept. Knowledge and reputation generating dimension of research output has such output indicators as publications, citations, conference articles, international co-publications, and professorial job offers. Another dimension is a cluster of characteristics relating to interaction with business and governmental bodies such as advisory services for companies, cooperation with companies, and membership in advisory boards. Another property of this concept relating to systems maintenance is measured by such indicators as number of doctoral titles, number of supervised doctoral theses, editorships, and scholarships (Leišytė, 2007). Research output is often conceptualized not only in terms of the scientific knowledge production by the individual scientist but also in terms of output of research teams or that of an entire research organization/university. Research productivity is a broader concept often categorized in terms of resources and output of the individual researcher, research teams or the university. Research productivity is recognizable output of organized research. According to UNESCO Global Colloquium on Research and Higher Education, (2006:2), it ‘’can be measured in the published record within a given field, the national and international visibility of individual researchers and research teams, the breadth as well as depth of an institution’s research program, and the number of new researchers being trained’’. However, the focal concern of this thesis is research effectiveness in terms of output at the individual level of the scientist, not necessarily research productivity or efficiency of larger units or the public research organization. Concern with productivity of research institutions would as it were imply comparisons across research institutions, which is not a basic interest of this thesis. However, the thesis used following indicators of scientific performance:

- Number of publications, number of citations as a measure for impact, conference articles, international co-authored publications and patents, which cover the broad task of conducting basic research,
- Number of conferred doctoral degrees, which highlights the task of graduate teaching, and
- Number of advisory services to companies/consultancy and of relational contracting/contractual

cooperation with companies (including contracted evaluation research for external stakeholders and co-patents), all of which relate to community service activity profile of the university.

Institutional condition (for conduct of research) is one of the explanatory variables used in the quantitative analysis. This variable describes the condition for the pursuit of research. It includes the financial and human capacity as well as the state of institutional infrastructural facilities (computer facilities, laboratories, information facilitates such as libraries, archives, databases including opportunities for researchers to travel) necessary for conduct of research.

In summary, the quantitative phase of this thesis tested the following variables:

- **Institutional condition,** which is a variable measured by institutional human and financial capacities (for research) including the existence or non existence of technical facilities for conduct of research such as computer facilities, laboratories, information facilitates (e.g. libraries, archives, databases, and opportunities to travel)

- **Research practices/behaviour** -properties include collaborative research, decisions about time spent on research and teaching (i.e. teaching/research time nexus), selection of research themes, funding decisions, choices about strategies for publications and other research output (e.g. where do you publish what? Use of PhD students and spin offs). Another property is the balance between quality and quantity (decisions about output orientation).

- **Research output/performance** –indicators include number of written monographs, number of articles in peer-reviewed journals, number of editorships in journals and book series, number of conferred doctoral degrees (or, successful PhD dissertations), number of received research prizes/awards, and number of advisory services to companies/consultancy.

- **Research governance structure and mechanisms,** which in addition to the detailed description given in Table4.2, includes governance schemes attribute.

4.3.5 STUDY POPULATION AND SAMPLE SIZE

The study population was drawn from relevant staff list of all public research organizations in the Gambia including the University of the Gambia. The list included not only scientists but also senior management staff of public research organizations, higher educational institutions, and the Higher Education Ministry in the Gambia. It included a new listing of university researchers/faculty members, university research managers (Deans, members of Research and Strategic Committee, and the VC), agricultural researchers, educational, medical and allied sciences research persons as well as education policy makers. The listing was however compiled from data obtained from computer databases maintained by research and related institutions, which were modified up to December 2010. The survey questionnaires used as a major quantitative data source for Study 2 were administered to a sample of 650 participants consisting of seven (7) clusters out of which 520 valid questionnaires were successfully retrieved. The sampling frame available for use in the sample selection was the computerized files maintained by the university administration and those of the other public research organizations in the Gambia. The study population was grouped into seven classes from which sampling elements were drawn from each group. Table 4.3 shows the percentage distribution of the classes.

Table 4.3 Percentage Distribution of Classes and Sample size

	Sample Class	Study Sample	Population sampling elements-No. in Class Sampling frame	% /Relative proportion of population
1	The University of the Gambia	135	250	20.8
2	Medical Research Council (MRC), The Gambia	100	185	15.4
3	National Agricultural Research Institute (NARI),	119	220	18.3
4	Ministry of Health Units (Malaria, Reproductive Health units, etc)	86	160	13.3
5	The internal Trypanotolenrance Centre	76	140	11.7
6	The Educational Research Network for West and Central Africa (ERNWACA)	109	200	16.7
7	The Department of State for Higher Education, Research, Science and Technology (DOSHERST)	25	45	3.8
	TOTALS	650	1,200	100.00%

4.3.6 SAMPLING PROCEDURES

The qualitative phase of this thesis used selective sampling technique since its focus was on the perceptions of informants who are scientists in public research organizations in the Gambia. The study population was first deliberately stratified and selectively drawn. A sample of ten participants was selective drawn from the sampling frame (Table 4.3) to whom semi-structured interview instruments were administered for the purpose of generating qualitative data. In addition, three groups of four each were similarly drawn for group discussions.

However, the quantitative phase employed both selective sampling technique and random systematic sampling. A study sample of 650 participants was drawn from seven stratified sampling frames consisting of 135 academics, 100 medical research staff, 119 agricultural scientists, 86 scientists and resource persons of the Health Ministry. Others include76 scientists of The internal Trypanotolenrance Centre, 109 researchers from the Educational Research Network for West and Central Africa (ERNWACA), and 25 senior management staff/policy players in The Department of State for Higher Education, Research, Science and Technology (DOSHERST). The stratified sampling technique was used first, which may be designated as ‘’non probability sampling technique in which an experienced individual [the researcher] selects the sample based upon his/her judgment about some appropriate characteristics required of sample members …or in other words…the sample has been selected to satisfy a specific objective’’ (Zikmund, 1997:428-9). Thus, this selective sampling technique was used for the purpose of demarcating the population elements into non-overlapping graphs each representing the required characteristic of location and field of research. For this reason, the population was grouped into seven homogeneous subsets (with heterogeneity between subsets), called strata (layers, classes, or sub-groups). The stratification variable used is location/field of research. Subsequently, a single random sample was selected from within each stratum using random, systematic sampling. The discrete groups indicated in Table 4.3 provided sampling frames from which the systematic sample was selected across the entire list of population elements represented by each group. The relative proportion of the population represented by each group in the same proportion of the desired sample size determined the number of sampling elements selected from each group. The purpose of using selective sampling was used to ensure the representation of appropriate characteristics across the population elements and reasonable representation of all the groups involved in the survey exercise. The sample elements in the seven stratified groups were selected because of their knowledge base and relative ease of access to the researcher. This non-probability sampling technique is sometimes described *as convenience sampling* because it ‘’refers to the procedure of obtaining units or people who are conveniently available….to obtain a large number of completed questionnaires quickly and economically’’ (Zikmun, 1997:428). Random, systematic sampling on the other hand ensured significant reduction of bias in the selection of the final sample.

4.3.7 QUANTITATIVE DATA ANALYSIS AND INTERPRETATION

The thesis analyzed quantitative data at multilevel, which includes the macro, organizational (or university) and (shop floor or individual researcher) levels. The purpose of this multi-level analysis was to explain the responses of some institutional actors in relation to their environment and to observe and explain how environmental forces accounted for research practices/behaviour of participants. In this context, the thesis assumed that state research policies could influence university policies and therefore the research behaviour scientists/academics. According to Morris, (2004) examining the within and across level effects and mediating mechanisms can provide valuable information about systemic effects on behaviour. Therefore, in this case the multilevel analysis might be useful in understanding the system wide effect(s) on research output of scientists. However, the individual researcher remained the basic unit of analysis and the central focus of the thesis.

Having completed quantitative data collection, it became necessary to develop statistical measures of association as well as measurement models, which is a process marked by the language of variables (Jean Lee, 1992). The quantitative data analysis and interpretation that followed was basically deductive, a matter of proving or disproving the hypothesis. Hypotheses (see Table 4.4) developed around themes and issues considered important to research experiences of scientists were tested and interpreted through hypotheses testing and statistical analysis. Some of the hypotheses were developed from ideas deriving from the agency and stakeholder theories. Some elements and basic principles of these theories are found in the definition of research capacity and relational statements by the UNESCO Global Colloquium on Research and Higher Education, (2006:2), who defined research capacity as ‘’ the aggregate of the human, institutional, and financial conditions for pursuing research’’, and further stated:

> *research capacity is high when a university has competently trained researchers, institutional and governance arrangements that facilitate the setting of research agendas and the successful implementation of research projects, and the funding necessary to defray both the direct and the indirect cost of research.*

Following from these viewpoints, a derivable theoretical preposition is that research output (of individual researcher, research teams or the university) is a function of ‘research capacity’. However, data used at this quantitative level were essentially primary data generated from the survey questionnaires, though supported by secondary data, which were obtained from already published works in research policy area, existing literature in science as well as institutional sources in the Gambia. The completed valid questionnaires, obtained from the study sample, were compiled and coded and answers/responses transcribed onto frequency table, and consequently tabulated statistically. The thesis employed simple statistical tools, which included frequency counts/distributions, summary of dispersion of responses (or means), standards deviation and 5-point likert scales on which answers to the survey questions were based. The survey questionnaire and other measurement instruments embodied variables representing constructs and their measurement indicators, which Table 4.2 outlined. Table 4.4 below related these variables to the hypotheses of the study.

Table 4.4 Variables and Constructs related to Hypotheses

Variable	Indicators/Measures	Hypothesis
Research governance structure and mechanisms *(Properties include any or a combination of the following control structures and mechanisms for steering research: state centric structures, state supervision and monitoring structures, self-steering/de-centralized research governance structures, executive leadership structures for steering and coordinating research, market forces and competition structures, and multi-actor governance structures. Other properties are* *modes of coordination/control mechanisms of organizational processes*	*Degree of autonomy over research issues- Do you consider your organization's authority or decision competence over research issues overbearing.* *Which of the following has the de factor responsibility and influence in steering research in your organization: the state, Vice Chancellor and Faculty Deans/CEO, self-controlling research units (or researchers/research committee), market forces, external stakeholders?* *Which of the following tools apply in coordinating research process in your institution? –State regulation, internal hierarchies, market forces, research chairs,*	*Research governance model & structure contribute positively to research output of the scientist.*

Structure of research (or research practices) *(Properties include* *collaborative research, time spent on research and teaching, selection of research themes, funding decision, strategies for publications and other research output, and research output orientation*	*Where do you publish what? Do you use PhD students and spin offs?* *Is how you structure your work affected by the kind and regularity of evaluation of research output?* *Is your work structure or how you organize your work affected by what you feel about your field of research?* *How is your research work affected by external and internal pressures for performance, work load, professional competition and pressure for a balance between quality and quantity of output?*	*I) Scientific committees model & structures affect research practices* *2) Research output is a function of research practices*
Institutional condition (for conduct of research)	*-The existence or otherwise of computer facilities, laboratories, information facilitates (eg libraries, archives, databases), including possibilities to travel* *-human and financial capacity for research*	*Accessibility/availability of technical infrastructure such as library, laboratory, archive, and computers affects research* *Research output is a function of institutional research capacity (defined as the human, institutional and financial conditions for pursuing research).*
Research output/performance	*Number of written monographs, Number of articles in peer-reviewed journals, Number of editorships in journals and book series, Number of conferred doctoral degrees (or, successful PhD dissertations), Number of received research prizes/awards, and Number of advisory services to companies/consultancy*	*Research performance is a function of existing institutional research governance structures and coordination mechanisms, research practice, and institutional condition for research*

While descriptive statistics were used to present data in a statistical format to facilitate initial data interpretation and analysis, the thesis introduced inferential statistics in order to make statistical inferences about the population from which the sample was drawn as important patterns, relationships and analysis became more meaningful (Bailey, 1994). Besides, statistical inferences were also made in order to explain the nature and extent of relationships among variables studied using likert measures to predict/infer their effects on research output. The constructs (consisting of a cluster of variables) examined were the objects of investigation, though essentially discrete (rather than continuous), these were often treated as if constructed from ratio data. The statistical program used for the analysis and presentation of quantitative data was the Donald B. Owen Handbook of Statistics, Tables. 1962, Massachusetts: Addison-Wesley Long man Publishing Inc., Table A-5. The analysis involved the use of parametric measures, the use of frequency tables, 5-point likert scale, contingency and ANOVA tables, and matrix table of differences between ordered means. The quantitative analysis involved ANOVA and Tukey's HSD procedures, which were applied in the statistical tests of study hypotheses. The process further included a discussion of the findings, in a recognized format, as to the extent to which findings confirmed or disconfirmed the research questions.

4.3.8 INTEGRATING QUALITATIVE AND QUANTITATIVE RESULTS

The rationale for combining qualitative and quantitative research is to better understand the phenomenon under investigation by triangulating both broad numeric trends from quantitative research and the detail of qualitative research. The post positivists agree that triangulation is not only possible but also necessary since ''claims about reality must be subjected to the widest possible critical examination'' (Guba and Lincoln, 1994: 110). However, Blaikie, (1991: 123) argued that triangulation becomes more difficult given the subjectivist's epistemology. Convergence of results from different methods could mean that ''consensus exists on how reality is viewed, or that a common reality is shared and a lack of convergence may reflect legitimate and different views of reality, or the habituation of different social worlds''. In addition, qualitative and quantitative analyses also differ. The *etic* analysis of a quantitative study is based on a researcher's imposed conceptual frame of reference, whereas an *emic* analysis in a qualitative inquiry aimed at understanding the participants' frame of reference (Fielding and Fielding, 1986; Denzin, 1994; Morris et al., 1999). Based on these differences, the results of each may or may not converge. Nonetheless, the postmodern approach is assumed to display ''increased sensibility to both context and content'' of research results (Cox and Hassard, 2005:122). Where however findings conflict, the postmodern researcher would regard diverging results as alternative explanations. In the specific context of this thesis, the use of multiple data collection methods, multiple methodologies, and multiple levels of analysis produced research findings, considered dual instances of reality (Cox and Hassard, 2005), and discovered through different sources that offer greater depth and breathe of analysis in understanding research experience and practice in the Gambia. Quantitative results expanded the qualitative findings producing thereby a richer and more indebt understanding of the phenomenon under study. The eclectic approach, which underpinned the overall postmodern methodology employed, has meant that the Explorative Study 1 and Quantitative Study 2 produced separate results, each considered situated. In integrating these results using the postmodern approach, the process transcended beyond mere validation of the results obtained separately from qualitative and quantitative studies. Rather results were presented as complementary in which the results of quantitative study expanded understanding and enriched interpretation of research finding produced from the quantitative phase.

How can these findings be integrated and presented as a singular conclusion? In the search for a common ground in face of conflicting 'understandings' from disparate theoretical and epistemological perspectives, some authors have suggested the application of ''multiple paradigms to explore their disparity and interplay and, thereby, arrive at an enlarged and enlightened understanding of the phenomena of interest, as well as the paradigms employed'' (Lewis and

Grimes, 1999: 676). However, aim of eclectic or mixed method approach is not simply a search for corroboration, but rather achieving expanded understanding of the phenomenon under study. Greater confidence can be held in a singular conclusion where findings are corroborated across the different approaches but if findings conflict, then greater knowledge can be gained and interpretations and conclusion may be modified accordingly (Onwuegbuzie and Leech, 2004). The findings from both phases of the thesis were integrated at point of interpretation/discussions of results, though the qualitative phase is basically designed to explore while the quantitative phase offered explanations complementing and expanding qualitative results in an explorative sequential model (QUAL → QUAN). Squaring or comparing results therefore involved exploring and harmonizing the differences and similarities as well as interfacing findings from one approach to the other within the theoretical and paradigmatic framework of the two approaches. In the search for a common ground, the thesis used what Lewis and Grimes, (1999: 675) called '*meta-theorizing'* in order to ''explore patterns that span conflicting understandings''.

4.4 CONCLUSION

The study area is the Gambia public research system consisting of public research institutions. The study sports where data were collected and subsequently analyzed included The University of the Gambia and the Educational Research Network for West and Central Africa (ERNWACA) engaged in basic research. Others include The National Agricultural Research Institute (NARI), Medical Research Council (MRC), the Gambia Unit and International Trypanotolerant Centre (ITC) concerned with science and technology activities. The Ministry of Health Units (Malaria, Reproductive Health units, etc) and the Department of State for Higher Education, Research, Science and Technology (DOSHERST), the key player in research policy arena, were further study points. However, the need to enhance understanding of a variety of contextual factors that affect research practices and scientific output informed the choice of the study area. The strategies and tactics that individual 'researchers'/actors and the organizations as a whole apply in order to handle the complex organizational processes were also relevant considerations. The study area further permitted in-depth examination of the significance collaborative research exchanges and its implication of public sector research. In addition, the ease of access to research colleagues who readily responded to the study questionnaires provided further justifications for the selection of the study area. The research design outlined the use of mixed methods research involving both qualitative and quantitative methods. The explorative sequential mixed methods began with a qualitative and inductive phase and ended with a quantitative and deductive phase. The deductive part of the research was designed to explain and expand findings from the qualitative phase. Primary data for both phases of the study came mainly from survey questionnaires, semi-structured interviews, three focus groups' discussions, interview protocols, and personal observations. Secondary data were also taken from research data already published works on research policy as well as institutional data from research institutions in the Gambia. The survey questionnaire was developed around the initial variables shown in Table 4.2, which specified variable indicators and their measures. Though however other variables were expected to be discovered from the participants' point of view as the first qualitative phase progressed. These variables are outlined in Table 4.4.

While the study population was drawn from relevant staff list of all public research organizations in the Gambia (including the University of the Gambia), the sample size set at 650 was drawn from seven (7) stratified sampling frames obtained from computerized files maintained by the university of Gambia administration and those of the other public research organizations in the Gambia. The quantitative survey adopted both non-probability (convenience sampling) and random systematic sampling techniques. Data collection procedure in respect of Study 1 involved joint systematic data collection, coding, and analysis with theoretical sampling to develop a grounded theory of scientific knowledge production. The process involved data coding and summary, reassembling emerging variables and making prepositions about them, and through selective coding process (by which core variables are identified) establishing the basis for formal theory. Quantitative data collection and analysis involved the use of simple statistical tools (frequency distributions, means or modes, standards deviation/standard error of a sampling distribution, percentage tables and a 5-point Likert scale) to test predetermined hypotheses developed around themes and issues considered important to research experiences of participants as well as themes deriving from the investment, principal-agent, and stakeholder theories. Research findings from the mixed methods approach were integrated in a postmodern framework to produce deeper insights and more comprehensive analysis of public research phenomenon in the Gambia.

CHAPTER FIVE

DATA ANALYSIS AND PRESENTATION

5.0 INTRODUCTION

This chapter described the frameworks of analyses as well as details of analyses of qualitative and quantitative data. It further discussed results obtained separately from the qualitative and quantitative phases of this mixed methods research. Qualitative data were generated concerning the opinions, beliefs and experiences of researchers and managers of public research institutions in the Gambia. The chapter is structured in two parts. Part I deals with qualitative analysis while Part II provides details of quantitative analysis and discussions of results from both phases. The qualitative phase of the thesis used a grounded theory method in the collection and analysis of data. The theoretical framework of the qualitative analysis is symbolic interactionism, which provided evolving construct to support the use of grounded theory in the qualitative study of research experiences of public sector scientists in the Gambia. Constructs developed from meanings given by respondents in their symbolic interactions within given research context of the scientists. The construct, **research practices**, evolved through symbolic interaction in specific research situations in the Gambia. Symbolic interactionism assumes that people respond to things, events or situations based on meanings they attach to those things. People create and modify meanings through interactive processes particular to them; and they use these meanings in dealing with their encounters. However, qualitative data were generated from semi-structured interview questions for participants including verbatim tape-recorded and transcribed three focus groups' discussions that consisted of twelve participants. Two separate interview protocols labeled A for researchers/scientists and B for research policy makers provided further qualitative data all of which were simultaneously collected and analyzed. The open-ended, semi-structured interviews and focus groups' discussions allowed participants to elaborate on themes and issues they considered important in their research experiences in their various institutions. Qualitative analysis began by drawing on participants' ideas about how they organized their research work, their understanding of research governance structures and institutional conditions for conduct of research, and ideas about research output indicators. Applying grounded theory method and procedures for data collection and analysis, the qualitative data were inductively analyzed using open-, axial-, and selective-coding procedures. Axial and selective coding followed when open coding ended.

A pilot validation stage preceded the quantitative phase of data analyses. The validation process and strategies were aimed at accessing the trustworthiness of both qualitative and quantitative data and findings. The quantitative study (Study 2) used standardized survey questionnaires to generate data and employed analysis of variance (ANOVA) techniques to test pre-determined hypotheses. Predictor variables assumed to influence scientific performance are operationally defined, and parametric measures were employed in the quantitative data analysis, which was the multi-factor ANOVA test that followed. The chapter ends with summaries, integration and discussions of qualitative and quantitative results.

PART I

5.1.0 QUALITATIVE DATA DESCRIPTION AND CONCEPTUAL ORDERING/DEVELOPING CONCEPTS AND CATEGORIES

The open coding process began by identifying specific concepts and themes in the interview transcripts as well as other interview responses that explained and revealed meanings to the social process of scientific research in an organizational context. The microanalysis process labeled these concepts and grouped like concepts into categories in line with open coding procedures (Table 5.1 Examples of coding). This process produced four categories, which emerged from informants' responses. These were **research practices/behaviour, research governance categories, institutional condition, and scientific performance.**

Table 5.1 Examples of coding

Code List	Thematic codes
selection of topics, research agenda and priorities funding decision research-teaching time connection publication strategies and orientation foreign journals local journals scientific conference papers editorship of student thesis collaborative research exchanges Research steering scientific committees State research policy Institutional research policy Financial capacity/research funding Human capacity Technical infrastructural condition External stakeholder factors	writing based on relevance, needs, time and resources expectations of evaluators and fund providers feeling about field of science Giving quality high priority Management centered research steering Professional research steering

Research output/performance	

Based on Glaser's version of Grounded Theory method, the thesis employed the following techniques for concept coding: a) open-, axial- and selective coding of key themes; b) writing memos for every interview summarizing key themes; and c) recording a 'researcher journal' that puts together key concepts across all the interview protocols. Each data set was separately open coded when collected, and data collection continued until saturation was achieved by the 15th interview. Axial- and selective- coding were performed after open coding. Axial coding consisted of relating categories to one another and transforming the initial categories to their subcategories (Table 5.1). Selective coding permitted the identification of conceptual ideas that integrated the existing categories by making relational statements using memos created during the continuous process of data collection and analysis. As categories, emerging and evolving from data, became structured and saturated, relationships between categories were examined by means of systematic comparison. Memos created as the research progressed in fact directed the creation of diagrams that captured relational statements between concepts formed during axial coding. These memos were collapsed by codes as they began to resemble each other during organization and memo sorting. A resultant theory of knowledge creation emerged as categories saturated and concepts and relational statements connecting them became fully defined and clarified. By taking the whole script and records of all interviews and conducting a line-by-line analysis grouping emerging like themes together, the construct, research practices/behaviour was put together. A research practice (or behaviour) is a concept of work structure, which describes how the scientist/scholar goes about putting his work together. It consists of clustered themes relating to participants' perceptions of choices/decisions about research topics, priorities and agendas, funding, publication orientation and strategies, collaborative research, and research-teaching time nexus (in respect of academics only).

Research behaviour (or practice) construct is developed by grouping together participants' ideas about decisions they made regarding research topics and priorities, research funding, their publication strategies, publication orientation, collaborative research exchanges as well as themes about scientific performance. On participants' perceptions on decisions about research topics and priorities, text analysis of responses show that most of the participants defined choice of research topics, priorities and agenda in terms of relevance and needs, time and resources. Participant 1 constructed choice of topics, research priorities and agenda in terms of writing something ''attractive'', ''useful'' and ''relevant in terms of application''. Participant 7 constructed this in terms of ''needs assessment'', the need to ''assess the situation status on the ground'', and for Participant 8 '' all our research should be based on grassroots needs of the farmers [the end users of research results]''. For Participant 10, '' our research themes are demand driven, which means we involve the farmer who is the end user of the research product''. Defining choice of topics in terms of time and resources Participant 13 said:

> *The determinants of the kind of topics are one, if I have enough time to go into those things vies avis my work load; second, if I have the resources to now pursue them, and thirdly, I have to ask myself how long I am willing to stay in this environment to see this research to its conclusion……so I am not willing to go into a very long term kind of studies; so these are the things that determine my choice of topics*

In addition, Participant 2 said:

> *If you are approaching a donor to seek support, for research funding they have their own aims and priorities. If your research is not falling within their expectations… you make sure that your research seats within their publication ideas; towards ethics and outcome of research to met their requirements before you are entitled to their funding….This being the case obviously you have to choose your topic based on their expectations*

Overall, most participants thought that what influenced their research choices and priorities were time, resources, need, and expectations of funds providers. Ultimately, research behaviour may be related to management of research process.

Participants’ ideas about research funding decisions constitute one of the like themes that were grouped in developing the construct, research behaviour or practice. Informants revealed that research funds came mainly from the government through the relevant ministries, the Ministry of Agriculture in the case of NARI and the Higher Education Ministry in the case of University of the Gambia for instance. Participant 15, who is the Director of Research and planning in the Ministry, revealed that the Ministry coordinates research and provided research funding as the need arose. He said:

> *There is no statutory provision in terms of research except that in the budget, if you look at the budget there is some allocation for research and even for research orientation, but then we are not necessarily going into research. We are coordinating research, sort of managing research, and so institutions like the University come forth, you know, with a research program obviously they have to be funded.*

However, qualitative data further shows that there are limited external sources of funding including consultancy funds from the industry. In a few exceptional cases as in NARI, research is actually externally funded, and much of the research appear to be ‘’donor driven’’. Nonetheless, it would appear that these external funds are though provided in line with local needs, the funding decisions of scientists remain largely constrained and depended in part on the expectations and conditions imposed by ‘donors’ because they have very limited funding options. Ultimately, choice of research interests and priorities are influenced by limited funding options and conditions placed by external fund providers. In this context, Participant 13 perceived research funding decisions in terms of ‘’

things I can find myself''…. <u>so the areas I am hoping to work on, or areas I am not working on are basically things I feel that I can fund by myself.</u> Again, themes about funding decisions add up to the behaviour of the scientist and available funding options and requirements of funders appear to influence this behaviour (i.e. research practice).

On perceptions of research-teaching connection (in respect of academics only), most informants agreed on giving adequate time for research, managing their rather heavy workload, and limiting the scope of research and their efforts to ones less demanding in terms of time. Participant 3, who is a university teacher, believed that quality research needs quality time to produce, responding to the question whether the type of expectations from evaluators affects how much time he devotes to research vs. teaching, said:

> *Actually, it does affect the choice of research topic. In doing research quality must be one of the things that have to be considered….and also teaching is part of the job. In carrying out research I have to maintain quality….irrespective of the fact that we have to teach, I have to devote quality time to engage in research to maintain quality research*

Participant 1 thought that coping with heavy teaching load affected the scope, quality and choice of his research: He said ''in as much as you manage to cope, it affects the scope of your research…Once the time vice avis having to collect data and deal with work load management…..so in future I would like to restrict my scope to ones I can quickly do….it is a <u>challenge''</u>. Believing that workload affected choice over time devoted to research, Participant 1 further said:

> *It seems that because of the nature of the organization, the work load is more on teaching so that at the end of the day you do quantity research and may be an aspect of quality, not that the quality is watered down…but because of lack of facilities and time in terms of motivation, and pressures from work load, we do not give attention to it*

Participant 2 also thought that ''workload has affected not necessarily quality but the scope of research''. Participant I3, who also perceived teaching-research time nexus in terms of heavy workload, said:

> *I actually share the sentiments of my other senior speaker [Participant 12] because I have a lot of work load; the clinical work load is so much ……we don't have the kind of support structures that allow you to delve into a lot of research, for instance, we don't have secretaries, you know, anything that has to be written you do all yourself; there is no other intermediaries or intermediate colleague between us and the very junior Doctors*

In this context, themes relating to teaching-research nexus are further grouped together and with other like themes adding up to the construct, research practice/behaviour. Behaviours relating to these themes include giving adequate time for research, managing heavy workload, and limiting the scope and efforts to less demanding research in terms of time.

Themes relating to publication orientation are grouped and with other like themes further add up to the construct, research practice. From the perspective of a majority of participants, publication orientation is understood in terms of quality research work against quantity (or number of publications). In this context, Participant 2 said:

> *Just to add, you know quality in general….quality in such a situation whenever you receive research funding or research you embark on your own, because if quality is not there you may not get your work published…..so for the sake of publication there has to be quality*

Participant 3 in addition said:

> *I think first of all the ideal research one embarks on at this level must meet quality standards…. and with that, quality has to be given top priority in organizing your research. The issue of whether you publish or perish, I think ehm…it is a known fact that in any university system you must publish …..And with that I have to maintain quality in whatever research I embark on because at the end of the day the research has to be looked at by other professional colleagues. So I can't compromise quality. The pressure that is always there is a kind of catalyst you know to really energize me*

> *either to publish or forget about being an academic. So that is a kind of motivation….it might not be a thing to weigh me down. I look at it as a kind of thing motivating me to publish because the more I publish the more I am recognized as far as academic environment is concerned…..so I think that help my performance and also help in my choice of research topics.*

This quality orientation to publishing appears to relate and explain the publication options of most participants. Participant 1 believed that ‘’publishing encourages competition [among colleagues]’’ and this has meant publishing quality research and conference papers in reputable international journals rather than local in-house journals. He thought that publishing ‘’offshore… ensures that your work meets international standards or quality’’. Another reason for preferring ‘offshore’ publication option is professional recognition. In this context, Participant 2 said ‘’ you go for foreign journals so that the more of these you publish the more recognized the researcher becomes’’. Medical scientists from the School of Medicine also thought that ‘’absence of a local journal here is a big constraint’’, which leaves offshore publication the only option, though some of them preferred making use of ‘’ local conference of health experts’’. Overall, most informants preferred to publish in foreign scientific journals because of limited alternative options. They thought that this publication strategy encouraged them to focus on quality work. In this context, Participant 13 thought that by so doing ‘’ there is a focus on doing it [research work] rightly so as to be accepted for publication’’. Analysis of data show that supervision of PhD students and spin-offs are irrelevant publication strategies because these do not apply to some research institutions including the sole university in the Gambia, which does not offer taught and research based PhD programs. Further, scientists from NARI appeared to have very limited publication options, the major strategy being a central documentation report, the ‘’annual research review report’’ and sometimes ‘’ Field Workers Magazine, *SEWELAA’’*. These are the only sources from which people may access research results. Most of the scientists believed that this limited publication option affected the quality of their research. In this context, Participant 8 said *if we actually start publishing our data, other scientists outside will see the type of research we are doing and that will have an impact on the way we conduct research, on the quality of our research…..so it will obviously have an effect on quality of research''.*

Participant 10 believed that limited opportunities to publish not only diminished the incentive to publish but also the quality of work. Overall, the themes of quality publication and 'offshore' publication preference are included in the category, research practice/behaviour. Analysis of data show that this behaviour (i.e. choice over quality publication and publishing 'offshore') is influenced by participants' concerns over competition and professional recognition as well as limited publication options.

On collaborative research exchanges, most participants constructed collaborative research in terms of 'putting together the best minds', doing something in common, and 'putting together institutions and professionals for creating knowledge'. Analysis of data shows that while external collaborations have been extensive, internal collaboration among research staff/academics including collaboration with industry remained minimal. In this context, Participant 1 said ''consultancy [collaboration with industry] and networking among staff is minimal''

On participants' perceptions of research governance, themes and views of research steering structures differ slightly among informants, though this can be attributed to differences in institutional conditions. Informants thought that scientific committees where they exist have limited control over research management. The dominant research steering structure is the institutional management. Most academics agreed that there were functioning and effective scientific research steering committees before 2009, but currently research governance seems to be management centered. Participant 2 thought that new governance structures were being introduced, and said:

> *We use to have at UTG the Research and Strategy Committee, which was one of the mechanisms [for steering research].....I know that a former colleague, Professor Awason was deeply involved in this Committee. Regardless of any shortcoming as far as the whole system was concerned, certain individuals certainly have a good idea of what is meant by a piece of research work…from 2009 onwards the university system was reorganized and academic structures remained and some of them were merged and it was during this process that new units of governance were introduced. But until now they are not functioning …and this shows that there is still intention to carry on research, and probably the new VC hopes to replace the old with new research policy and guidelines''.*

In addition, Participant 1 perceived research steering structure in terms of dominant control by management through policy pronouncements, and said:

> *There are policy pronouncements encouraging people to go and publish in journals- if you do, you will be rewarded and perhaps publicized and all that……pronouncements have been made by the VC in recent time, but there is nobody coordinating research, though may be they do exist in other research organizations.*

Participant 12 from the School of Medicine, University of the Gambia who thought there are no scientific committees involved in research steering, said '' As far as committees are concerned, normally committees here, Prof Nyang [the Provost] does it; it is a one-man show. So unless it is a committee, I don't know anything about any committee''. Besides, Participant 13, who believed that research governing structures in the University are still rudimentary, said '' Research is not so much of a priority so the structures, if they exist, are still rudimentary; they don't challenge research in any way''. All participants from NARI agreed that research governance structures in NARI are partly government- and partly NARI management-centered, though informal scientific groups exist to review proposals. Coordination of research funding in NARI seemed centralized in the Ministry. In this context, Participant 5 said ‘’ we have a central project coordinating unit in the Ministry that coordinates all the projects within the Ministry’’. Participant 10, who believed that, at the institutional level, NARI management actually steers research, said

> *Ideally, there were structures that actually dictated the work done in NARI but presently the structures are such that it is only management that dictates what one does and when. There is the Director General, the Board and Assistant Director with the Director of Research. These structures more or less influence the scientists' choice to select a topic, but it is to be in line with the principles because if it doesn't meet the principles the committee will reject that one way or the other'', though this professional committee remain largely improvised*

In formants thought that control over research funds is a principal means of steering research, and management in all the institutions sampled appears to control disbursement of research funds. Most participants thought that much of the research funds come from government, though there might be funding coming from external sources. However, in a few exceptional cases as in NARI, research is actually externally funded. In this context, Participant 7 said:

> *In terms of funding also I would say research is not taking place in NARI because we depend mostly on external funding to conduct research because the subventions the Government is giving is mainly for salaries and miscellaneous expenses in the Institute. But in terms of proper research there is no funding from the Government….all these are donor-driven.*

Most NARI informants agreed that both NARI management and government are responsible for funds disbursements and, though accountability monitoring schemes are in place, individual scientists, research teams, and scientific committees do not have control over funds allocations. In this context, Participant 5 said:

> *…even if you actually were able to get research funding externally, it is centrally managed. We have what we call a program budgetary system that each research program will make a list of all programs you want to implement and attach some costs to it, and your funding will be based on your budget and they will be monitoring*

> *how much you have spent and how much is left. But you don't control that; it is controlled by Finance Dept. and Management….you only make your request and they approve and then you go and implement, but not that you are given your own vote to control…..researchers are not given votes to control*

Informant 19 believed that ''sometimes research agendas are influenced by the highest authorities (DG, DDG, and director of Research) but frequently disrupted by the Finance Department''. There are no formal scientific committees in NARI that steer research, but scientists seem to have a measure of flexibility in the determination of basic issues of research. Expressing this view, Participant 10 said:

> *We don't have these committees, evaluation committee within the research system. Scientists are left to coordinate among themselves and decide what things to work on in a particular season, you know, and then they latter come to management to make a final decision. Yes, at program level there is a degree of flexibility that you can determine your own research agenda at your level of program and then you present that to a wider body which can see that this one is genuine one for funding or not*

Overall, informants constructed governance model and structures in terms of two categories namely, **scientific committee** and **management-centric models and structures.** From Grounded Theory analysis of data, these two are the emerging core governance categories, which impact on both research practices and scientific performance at the individual level of the scientist. However, open coding process led this investigation to selectively interview two groups of two each consisting of institutional research managers and research policy makers based on where the emerging relational assumptions (i.e. theory) dictated. This process involved theoretical sampling of policy and management participants from the Higher education Ministry and the University. The evident significance of governance categories for research practices and scientific output informed the decision to expand the study sample in order to observe further from participants who could offer more insights. These groups were interviewed to further observe and confirm whether these governance categories impact on research behaviour and scientific performance; to verify the assumption that governance categories exert intervening effects on research practices. In this context, further data indicated 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 shows that currently, there is no comprehensive '' policy on higher education and a policy direction'', which explains the observed differences in the institutional research governance approaches and structures, the two governance categories emerging from qualitative data. Interpreting and comparing data, this qualitative 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 public research institutions at the national science level, and thus intervening and mediating upon research practices of scientists. Participant 15 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, from coding and interpretation of qualitative data, management centric governance category impacts on research practice by means of defining factors of State and institutional research policies, and by means of mediating influences of procedural values, norms and ethics of scientific research, scientific committee category impacts on research practices/behaviour.

Institutional condition for research is another core category/construct developed from themes and views of participants concerning the financial and human capacities as well the technical infrastructural facilities for conducting research. This category impacts on scientific output of scientists. Participant 1 described institutional research condition for conduct of research in terms of ‘’financial, equipments, group data collection’’, and believed that ‘’generally it is not motivating’’ and if nothing is done about this ‘’ will diminish that drive for research’’. Most informants thought that funding ‘’ is not enough to conduct research that we are required of’’. Participant 8 who also believed that funding is a major problem, said:

> *Financial crisis and whatever, a lot of funding for research is reduced. Donors [research fund providers] for research have drastically declined over the years, and that is not an exception in NARI here...you will find out that most of the time researchers in NARI are not doing anything.*

In addition to the theme of limited research funding or financial capacity for research, the themes of limited access to funds and improper funds disbursement are also evident in this category. Participant 7 believed that funding problem has much to do with management, that is, a human problem in disbursing these funds. Participant 10 also thought that ‘’management is attitudinal’’, ‘’some people can abuse their office by being autocratic, thinking you have the final say’’ providing support only for those ‘’in their good books’’. However, given institutional differences, respondents developed coping responses to the inhibiting financial resources for research by personally funding their work. Describing this situation, Participant 12 said ‘’There is no special dedicated fund for research in the University. If there is, it has not been made clear to us that you can have access to such if you are interested in research…I do those things I can find myself’’.

Themes about human capacity for research are also evident in the category, institutional condition. Most participants thought that development of individual skills and expertise for research is inadequate and non-supportive of research. Participant 1 said ‘’ I think capacity is not very strong, not adequate particularly in the science areas…So capacity aspect is not supportive [of research]’’. However, Participant 7 thought that human capacity may not be a problem because ‘’ training has been provided for researchers at NARI’’. Overall, the evident theme is that human capacity for research is limited. A majority of the participants believed that ‘’even human capacity is limited’’ because ‘’ the number is there but trained specialists are still limited… many people are trained in the same area’’. The theme of non prioritization of human capacity development is also evident in this category. Participant 13 from the School of Medicine, thought that capacity development appears not to be a priority because ‘’ research is not very high priority; service delivery for now is what is important than long time plans’’. Moreover, themes about infrastructural facilities in terms of available libraries, laboratories, databases, archival, and transport necessary for effective conduct of research are also voiced by almost all informants. These themes are clustered in the category, institutional condition. From analysis of qualitative data, undertaking grounded theory approach, the thesis found that state of technical facilities impacts on scientific performance. Participant 3 said,

> *These are the basic infrastructures that are needed for effective performance in any research situation because you need a library, you need relevant information, and you need to engage in practicals; you need laboratory equipments. If these are not there, <u>I think it will really affect output of your research</u>*

Further, Participant 8 said:

> *Go to the labs, we don’t have enough facilities/equipments to do our work. Simple PDA is lacking in our labs ….just imagine two weeks back I had to go to Livestock [section] to beg for salt. They happened to give me 100 grams of PDA so that I could carry on some of the analysis that we were conducting*

Besides, Participant 10 thought that ‘’ even the lab facilities we have are not up to date…and the size of the library is very small and most of the documents are not computerized’’ and believed that ‘’all these things contribute immensely to the low quality of research output’’. Informants from the School of Medicine revealed that basic facilities such as operating theaters and adequately equipped laboratories are lacking. Participant 6 from NARI talked about ‘’white- elephant [computers] in the sense that some of them are not working; they have been in the office for years’’ and ‘’you cannot assess them anymore; they are not functioning’’. Most informants also talked about lack of ‘’internet connectivity for the whole research Institute’’, which they thought ‘’is very serious’’. Most informants voiced concerns over lack of official transport and inadequate transport allowance. Transport costs eat deep into their salaries because ‘’you pay that on transport’’, ‘’taking part of our salary to pay for transportation’’. Participant 10 who thought that lack of transport facility affected his research, said ‘’we don’t have means of transportation’’ and as such ‘***’we are not able to multi-locate our trials’’.*** Finally, on participants’ views on scientific performance, there are evident themes of published peer reviewed journal articles, of scientific conference papers, and of editorship of undergraduate thesis, which are clustered in this category.

5.1.1 DESCRIBING QUALITATIVE RESULTS

Table 5.2 Axial coding sheet

Phenomenon:	**Non-supportive Institutional condition**	**Research practice/ organization**	**scientific committee governance**	**management-centered governance**
Causal conditions:	limited funds and access, management attitude, non prioritization of human capacity development, lack of technical facilities	Peer based evaluation expectations, time, resources, need, and of funds providers, workload, available publication options, concerns over competition and professional recognition	Significant autonomy over research issues by scientific committees; State and institutional research policy, external stakeholder factors	Dominant control over research by institutional management; State and institutional research policy, external stakeholder factors
Context:	Non supportive of research	Defined by needs, exigencies and demands from stakeholders; competitive and challenging	Autonomy for researchers and supportive feedback from research governors	Overbearing management; support from professionals and scientific committees; often stifling research situation

Intervening conditions:	Interface between the scientist and scientific community; intrinsically motivated drive for research	Collaborative exchanges; self-drive for research, and moderating influences from research governing structures	Mediating influences of procedural values, norms and rules; ethical standards of scientific research	Defining factors of State and institutional science and research policies
Action/ Interaction:	Coping with challenges of institutional research condition	Engagements within the national system of science	Conduct of research, interaction with scientific committees; collaborations and networks	Interaction with management and external stakeholders
Consequences:	Diminishing drive for research unless institutional condition improved; ineffective scientific performance	Improved research practices/behaviour; effective scientific performance	Better positioned than other governance models and structures to impact on research practices and scientific performance	Could positively contribute to effective scientific performance provided supported by scientific teams

All the reported results derived inductively from qualitative data, which were generated from semi-structured interviews, focus groups' discussions and two interview protocols. From undertaking a grounded theory approach, it was found that research practices/behaviour impact on scientific output of the scientist. Research practice is also a function of governance categories. For the purpose of this thesis, **research practice** describes how the scientist organized his work, the structure of research process, the doing of research. It is about the scientist's decisions regarding research topics, priorities and agendas. It is also about research funding decisions, decisions about how much time devoted for teaching and research (in respect of academics), decisions about research output orientation in terms of quality vs quantity, publication strategy and collaborative research efforts. It is about research related behaviour of the scientist. This behaviour is affected by expectations of scientific committees, demands from professional competitions and recognition among peers, and pressures arising from peer evaluations. Through similar mediating influences by means of institutional research policies, management centric governance category impacts on research practices. Funding decisions 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. Participant 13 limited his research to 'things I can find myself… so the areas I am hoping to work on, or areas I am not working on are basically things I feel that I can fund by myself'.

On the other hand, by means of intervening conditions defined by the expectations of peer evaluators for quality, ethical standards, procedural norms and values of scientific research, scientific committee category impacts on research practice, i.e. decisions about how much time is spent on research, and generally how the scientist structured his work. Participant 3 thought that 'quality has to be given high priority in organizing your research'. Most respondents preferred to publish their work in foreign scientific journals, and because of limited publication options available, they believe that this publication strategy encouraged them to focus on quality work. Participant 13 thought that by so doing '' there is a focus on doing it [research work] rightly so as to be accepted for publication''. Offshore publication, and thus publication behaviour, exposed respondents to foreign professional research expertise shaping their research behaviour and consequently positively influenced the quality of their research. It is inductively established that scientific committee category impacts on research practice by means of support for quality of research, peer-based evaluations and supportive feedbacks, and fostering professional competition for recognition among peers and collaborative exchanges. Participant 1 thought that 'publishing encourages competition…and publishing offshore… ensures that your work meets international standards or quality'. Participant 2 added 'you go for foreign journals so that the more of these you publish the more recognized the researcher becomes'. Apparently, the scientist learns through doing, by being exposed to the expertise of 'other professional colleagues'. Thus far, the description of results underpins the process of theoretical integration, and drawing from Glaser's (2005) ideas on theoretical coding during the advanced coding stage, and employing existing theories, it is inductively evident that fluid interface between the scientist and scientific committee governance structures is a necessary condition for improving research practices and scientific performance. Through support provided by professional colleagues in terms of opportunities for collaborative networking and supportive feedbacks, and through doing, exposure and experience, research practices/behaviour improved. Scientific committee category thus impacts on communication behaviour and other research related behaviours of the scientist. Qualitative evidence shows 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 indicates 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 show that all publications by respondents interviewed were 'offshore', that is, papers published in international scientific journals. In this context, most informants agreed collaborative exchanges 'enhanced human capacity' and produced 'quality [research] and added value'. Collaborative research exchanges positively affected the 'capacity' of the scientist to conduct research. Participant 7 believed that collaboration with international research institutions can ''give you insight into other research activities that are taking place elsewhere in the world'' and can 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, Participant 10 thought that ‘’ collaborative research reduced costs and time [spent on research]’’, expanded funding sources and provided opportunities for dissemination of research results. Collaborative research exchanges defined how the scientist organized his work or his communication behaviour being one of several other research related behaviours. In describing results of analysis of institutional condition category, the thesis established that **institutional condition**, defined in terms of financial and human capacities, and state of technical infrastructural condition for conduct of research, was non-supportive of research. Limited research funding and access, management attitude, non-prioritization of human capacity development and lack of technical facilities produced this condition. Participant 8, a Principal Agricultural Researcher, thought that research facility ‘‘is not enough to conduct research that we are required of…and you will find out that most of the time researchers in NARI are not doing anything’’. Participant 7 described management as ‘attitudinal’ and ‘autocratic’, providing support only for those ‘in their good books’. Informants agreed that ‘’trained specialists are still very limited’’ and ‘‘research is not very high priority’’ in their institutions. Besides, Participant 8 stated ‘‘we don’t have enough facilities/equipments to do our work’’. Participant 1 believed that institutional condition for conduct of research ‘generally it is not motivating’. The context of research appeared non-supportive, and would continue to ‘diminish the drive for research’, unless made supportive. Ordinarily, the drive to engage in research, the incentive and motivation, come from financial support, supportive management attitude to research as evidenced from institutional science and research policy, technical support in terms of provision of library, lab, database, transport and archival facilities. However, coding and interpretation of qualitative data indicate that intrinsic factors located in the scientist himself, which are work related also, became significant in driving research. Participant 3 who thought that he is intrinsically motivated in spite of his challenging research situation and the pressures of coping with the non-supportive institution condition, said:

> *The pressure that is always there is a kind of catalyst you know to really energize me either to publish or forget about being an academic. So that is a kind of motivation….it might not be a thing to weigh me down. I look at it as a kind of thing motivating me to publish because the more I publish the more I am recognized as far as academic environment is concerned…..so I think that help my performance*

Evidently, both intrinsic and extrinsic motivational drives and the overall institutional condition for conduct of research impact on scientific output of the scientist.

5.1.2 FACTORS THAT AFFECT EFFECTIVE RESEARCH PERFORMANCE

Most participants agreed that effective research performance is achieved when academics/scientists and their professional committees have significant role in steering research. Autonomy for scientists and scientific committees impact on effective scientific performance. Effective performance is defined in terms of number of published peer reviewed journal articles, of scientific conference papers, and of editorship of undergraduate thesis. Effective scientific performance is possible when scientists and their professional steering committees have important control over those issues they consider important in their research experience. These issues include research funding, technical facilities, ethical and professional standards, norms and values, and issues of coordination and monitoring of research process. Effective research performance is distinct from one-of, sporadic and outstanding scientific performance by the academic/scientist. Respondents thought that provision of technical facilities supports effective performance. In this context, Participant 3 said:

> *These are the basic infrastructures that are needed for effective performance in any research situation because you need a library, you need relevant information, and you need to engage in practicals, you need laboratory equipments. If these are not there, I think it will really affect output of your research#]*

In the analysis of institutional condition, most respondents admitted that research output increased when the research situation is competitive, challenging, and rewarding. Further, in the analysis of governance categories, respondents agreed that scientific performance increased with increased professional exchanges, and when ethical standards as well as procedural norms, rules and values of scientific research governed the research process. In the analysis of management centric category, performance actually decreased with overbearing management and stifling research situation where necessary coordination from management was missing. Participant 5 believed that research process ‘‘has to be actually coordinated, even if we are not using a professional committee’’. Participant 8, a female senior agricultural researcher, thought that they could perform better, if ‘‘we can call for a scientific meeting among ourselves; we just forget about management, seat together, and discuss professional issues’’. Analysis of qualitative data further indicate that Scientific committee structures with significant research steering autonomy tend to play better steering role than Management centric model and structures. Participant 2, a senior academic, said,

> *We use to have at UTG the Research and Strategy Committee, which was one of the structures for steering research. This structure was effective when it existed up to 2009 and within the period excellent research work was done as there was this piece of writing… done by senior members of the Social Sciences Faculty, Dr Suso and Dr Taal and quiet a number of others…certain individuals [within the period] certainly have a good idea of what is meant by a piece of research work*

Respondents agreed that because of

‘‘the way [research] is organized and how research is supported’’, MRC, the Gambia Unit has so far recorded increased research performance. On the other hand, most informants agreed that scientific performance decreased when the research governance structure is management centered, when management control and coordination of research process became overbearing and created stifling and unchallenging, non-competitive and de-motivating research situation. Scientific performance decreased at the School of Medicine, University of the Gambia where research steering appeared centered on the Provost, and where the only existing professional committee, the Ethics Committee seemed concerned only with ‘‘students’ kind of research’’.

In this context, Participant 13, a medical researcher, said ‘‘the structures, if they exist, are still rudimentary; they don’t challenge research in any way’’. Respondents thought that the activities of management ‘‘discourage[d] research’’ and ignored ‘‘capacity development’’. Participant 10, a Principal Research Officer, who thought that a major problem with research in NARI is overbearing management grip on research, said:

it is only management that dictates what one does and when…even if you have a good research agenda or topic you want to implement you are constrained if for instance you are not in the good books of management; they may not want you or see you excel especially if you have all the time in the past been doing better, now they are a bit ahead of you, they want to mask that your ability; they don’t want you to shine; they would not want to fund your activity; they would rather want to fund the activities of other people they can actually dictate to or have control over what they do

Respondents agreed that management centered research steering structure produced decreased research output. Most participants believed that this structure had not created

‘that atmosphere for competition because in having good research there must be an atmosphere of competition’. Respondents thought that management ‘doesn’t mind much, if problems arise… they don’t even scrutinize the outcome of some of the researches that the scientists have produced’.

5.1.3 THEORY OF SCIENTIFIC KNOWLEDGE PRODUCTION (AS DETERMINED BY ASSOCIATION BETWEEN CORE VARIABLES)

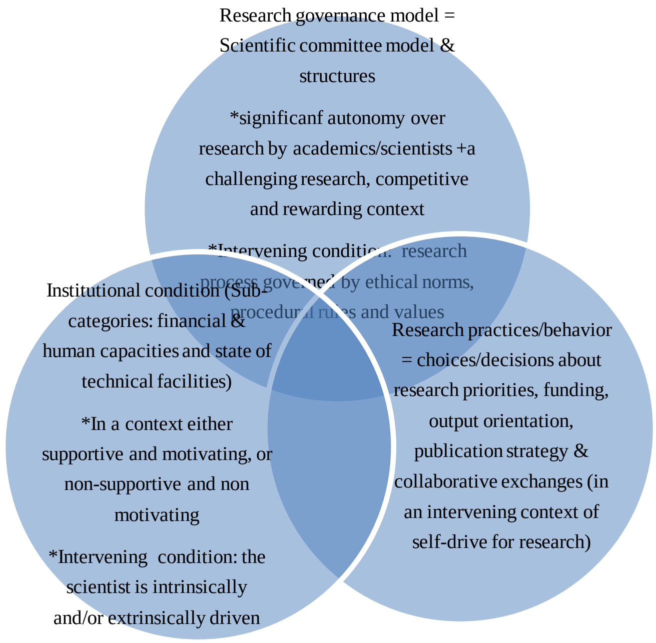


Figure 5.1 Theory of scientific knowledge production

This theory of scientific knowledge production is based on themes, concepts and categories, which emerged from the qualitative study data. The completion of axial- and selective coding procedures permitted the identification of four key concepts, which were research governance categories (i.e. scientific committee and management centric categories), research practices/behaviour, institutional condition for conduct of research, and scientific performance/output. Theoretical integration of these concepts led to the following theoretical postulations. First, fluid interface between the scientist and scientific committee governance structures is a necessary condition for improving research practices and scientific performance. Research practice, through doing and experience, becomes productive as the scientist deepens his professional interaction with professional colleagues. In addition, professional steering of research not only is a prerequisite for productive research practice, but also enhanced research competence. Research practice is also a function of governance categories. It is inductively established that scientific committee category impacts on research practices by means of support for quality of research, peer-based evaluations and supportive feedbacks, and fostering professional competition for recognition among peers and collaborative exchanges. Second, both intrinsic and extrinsic motivational drives and the overall institutional condition for conduct of research impact on scientific output of the scientist. Third, Scientific committee structures with significant research steering autonomy tend to play better steering role than Management centric model and structures. It was further established that scientific performance decreased when the research governance structure is management centered, when management control and coordination of research process became overbearing and created stifling and unchallenging, non-competitive and de-motivating research situation. Integrating these results, the thesis postulates that effective research performance (or increased research output) would occur when scientific committee model and structures, productive research practices and supportive institutional condition coalesced. This condition for effective scientific performance is represented by the shaded area of intersection of the three circles in Figure 5.1 where scientists and scientific committees have significant autonomy over research. It is also a coalescing situation, which is competitive, challenging, and rewarding. This situation would ensure supportive technical facilities and institutional condition where research process involved professional exchanges and networks, and in which procedural norm, rules and values governed the research process.

Findings from analysis of qualitative data are summarized as follows:

1) Research practices contribute to scientific output of the scientist. Research practice is also a function of governance categories.
2) By means of intervening conditions defined by the expectations of peer evaluators for quality, ethical standards, procedural norms and values of scientific research, scientific committee

category impacts on research practices, i.e. decisions about how much time is spent on research, and generally how the scientist structured his work.

3) Scientific committee category impacts on research practice by means of support for quality of research, peer-based evaluations and supportive feedbacks, and fostering professional competition for recognition among peers and collaborative exchanges.
4) Fluid interface between the scientist and scientific committee governance structures is a necessary condition for improving research practices and scientific performance.
5) Both intrinsic and extrinsic motivational drives and the overall institutional condition for conduct of research impact on scientific output of the scientist.
6) Scientific committee structures with significant research steering autonomy tend to play better steering role than Management centric model and structures.
7) Scientific performance decreased when the research governance structure is management centric, when management control and coordination of research process became overbearing and created stifling and unchallenging, non-competitive and de-motivating research situation.

5.2 VALIDATION STAGE

Validity strategies are used in qualitative research to determine whether data and findings are accurate, authentic, trustworthy, or credible (Creswell and Miller, 2000), though it has remained a subject of much debate in literature (Lincoln and Guba, 2000). However, according to Creswell (2007, 2009), validity is a major strength of qualitative research. On the other hand, reliability, validity, trustworthiness, and generalization of data and findings are the bedrock of quantitative research. In this context, validation measures were taken prior to collection and analysis of quantitative data in order to ensure that relevant survey questions were asked and directed towards the quantitative research objectives and, in addition, to enhance the validity of findings. The validity test strategy consisted of member-checks by which, specific descriptions, themes, and the final report were taken back to participants for their responses to determine whether the participants' positions were accurately represented. In addition, the inquirer developed a survey questionnaire for the purpose of generating quantitative data with inputs from the first qualitative phase, which consisted of specific themes and views of participants. This instrument was field tested at the pilot stage using five randomly selected participants in order to establish the content validity of the survey instrument and to improve questions, format, and the scales. Comments from these participants were incorporated into final questionnaire revision before administration. Overall, these tests provided the framework for accessing the trustworthiness of both qualitative and quantitative data and findings. Hence, the pilot validation process consisted of the following steps

- Developing a survey instrument to generate quantitative data based on themes and specific views of participants in the qualitative phase.
- A pretesting of the survey questionnaire and its modification were conducted to ascertain that only relevant questions were asked.
- After entry of data from the survey questionnaire, a final compute edit was carried out so as to weed out inconsistencies by referencing the original questionnaires, and meanings obtained from this source are integrated with data coming from other data sources used in the analysis
- Data source triangulation that consisted of collecting data across the fields of science and research institutions. It also included quantitative and qualitative data from institutional managers and policy makers.
- In addition to member checks, peer review ensured the credibility of the qualitative research process and findings. Two colleagues knowledgeable in qualitative research reviewed the coded

transcripts and a summary/synopsis of findings. The reviewers agreed that the analysis was logical and systematic and the findings reasonable and grounded on data.

In presenting results, it was necessary to validate qualitative findings, which were clothed in the narratives of participants. Consequently, in order to narrow the distance between the researcher and object of inquiry, all interview instruments were extensively field edited prior the commencement of qualitative data collection and analysis. In addition, responses, specific themes, and views of participants were further field edited. The process therefore provided the needed opportunity for the interviewer to rectify mistakes that could possibly be made in presenting their responses. Overall, these validation strategies provided the framework for accessing the trustworthiness of both qualitative and quantitative data and findings.

5.3.0 QUANTITATIVE DATA ANALYSIS

The quantitative Study 2 examined predetermined variables (though with inputs from specific themes and views of participants in the qualitative phase). These variables include **research governance structures and mechanisms, research practices, institutional condition, and scientific performance/output.** Two research governance models and structures, **scientific committee** and **management centric models**, were studied. The **Scientific committee model**, which is academic or professional self-steering, consists of research chairs and scientific committees at different hierarchical levels with significant degree of autonomy to decide on key research issues. Within the framework of institutional mission and science policy, internal guidelines and inter-institutional agreements, the research chair in the apex scientific committee hierarchical structure, could deal with strategic research issues providing the necessary institutional research leadership and coordination of research activities. Departmental scientific committees and research sections could provide support on research direction and priorities, and sectoral research leadership. In brief, unlike the governance pattern often described as New Public Management (Braun and Merrien, 1999; Schimank, 2007), the scientific committee model anchors on low degree of control by the state, of external stakeholder control and of management control as well as limited state and research chair holder competences. Scientific committees are pivotal in research steering exercising significant but varying degrees of autonomy depending on the point in the hierarchy. However, this model still maintains the spirit of New Public Management as it gives greater steering autonomy to researchers. On the other hand, **Management centric model**, often described as Executive leadership, is characterized by top-down structures, and research coordination is by bureaucracy (i.e. hierarchical self-steering). Governance structures, often defined and shaped by state and institutional research policies, are responsible for managing and coordinating research, approving research proposals, release of research grants, ensuring accountability, promoting and providing guidance on research ethical and procedural norms, rules and values.

Research practice or behaviour describes how the researcher goes about organizing his work. It is a process, the activity of doing research, and about making choices. It consists of decisions that the scientist makes about his research priorities and agendas, funding sources, output orientation, publication strategies and collaborative research exchanges. For this study, this variable consists of a number of properties or dimensions, which include communication behaviour (or research collaborations, exchanges and networks), funding behaviour, decisions or behaviour about research priorities, and publication behaviour.

Institutional condition describes the institutional financial and human capacities and the state of infrastructural facilities for conduct of research. The technical facilities for research would include available laboratories, libraries, archives, databases, internet facilities, transport. Financial and human capacities for research consist of the pool of research funds and institutional pool of trained and competent scientists with capacity to conduct research. This condition generally provides the extrinsic incentives for research and thus may be supportive or non-supportive of research. It may also include other environmental factors or conditions created by management attitude and research policy content and direction. Other work related conditions may include both formal structural and informal relations between management and scientists and among colleagues. The import of these work related conditions is their potential to affect extrinsically driven motivation for research.

Scientific output/performance is measured in terms of published scientific works, conference papers, and editorships, and theoretically associated with governance categories, research practices, and institutional condition as explanatory variables considered having sufficient predictive powers. In modelling the response variable, **scientific performance** (Y_i) the following equation represents this conceptual relationship in a multiple regression equation below:

$Y_i = \alpha + \beta_1 (X_í) + \dots \beta_n(Xí_n) + \varepsilon_í$ $\quad í = 1, \dots, n$, *where* $(Y_i.\ X_í \dots X_n)$, $í = 1 \dots n$ *are*

random sample, α is the mean of Y_i when each predictor variable equals 0; $\beta_{ín}$ the slopes of partial relationships or the partial regression coefficient; and ε, the residual predictor variables.

Descriptive statistics facilitated initial data analysis, but this section also subsequently made statistical inferences about the population from the samples (Saunders, Lewis and Thornhill, 2000).

Using statistical tables including analysis of variance (ANOVA) tables, means were compared in a test for significant differences between them. This process involved comparison of means of three samples/variables under study. The technique involved the use of ANOVA F test for analyzing quantitative response and explanatory variables. This was a significance test for detecting evidence of differences among the population/sample means. The analysis of variance was therefore the F test of the following quantitative study hypotheses:

Hypothesis 1- H_0: $\mu_1 = \mu_2 = \mu_3$, and the effect of scientific committee structures, research practices, and institutional condition on research output/scientific performance is insignificant.

Hypothesis 2- H_1: some $\mu_1 \neq \mu_i$ (or at least two means are not equal), and the effect of scientific committee structures, research practices, and institutional condition on research output/scientific performance is significant. Applying Tukey's HSD (honestly significant difference) technique the analysis further made multiple comparisons of means in order to determine where the significant differences lie.

5.3.1 KEY QUANTITATIVE FINDINGS AND RESULTS

This section consists of descriptive statistics that used frequency tables to provide initial information on major demographic variables. Data analyzed were in nominal and ordinal form. Descriptive statistics of the study samples facilitated the direction and integration with the key findings emerging from the research hypotheses. Strong evidence from analyses of empirical data supported the alternative hypothesis tested. The section further deductively conceptualized important results and highlighted emerging trends in the context of the study, which involved the use of parametric measures.

On the spread of research governance variables, there were important differences among respondents in their perception of institutional research governance profile.

Table 5.3 Spread of research governance approach

	(N= 648)	***Response level/frequency %***
State centric	56	9
State supervision	33	5
Management centered	313	48
Professional research Steering structures	212	32
Market forces	22	3
External stakeholder	11	2

p=0.016

Table 5.3 indicates that 48% of respondents believed that institutional research governance is management centered. 2% thought that scientific committees steered research and 9% believed that the state plays a dominant role in the management and coordination of research. Non-parametric test result shows that management, scientific committee structures and the State are key players in the management and coordination of research in the Gambia. However, at the MRC, the Gambia Unit, scientists with significant autonomy directly steered research. Nevertheless, a common trend across research institutions appeared to be that management is in full charge of governing the research process, providing and monitoring research grants, and generally providing policy direction and institutional support for conduct of research. On the other hand, scientific committees, where they exist, appeared to be hindered by lack of funds in discharging their traditional functions of shaping the research process. Ethics committees indulged more with administrative matters than overseeing ethical and normative requirements for research.

From analysis of quantitative data, Table 5.4 reveals that 57% of respondents were not satisfied with technical infrastructural facilities such as libraries, labs, archives, databases, and transport and internet facilities.

Table 5.4 Satisfaction with Technical infrastructure

_ (_N=647___

Response	**Frequency**	**%**
Strongly increase	281	43
Strongly decrease	366	57
Total	647	100

Results of analysis of quantitative data show that the provision of these facilities is a necessary condition for conduct of research. However, results from Table 5.4 support the view that a gap often exist between the actual business support delivered and how firms/staff themselves perceived this support (Autio and Klofsten, 1998).

5.3.2 FACTORS AFFECTING SCIETIFIC PERFORMANCE

Three variables, scientific committee structures, research practices and institutional condition were used in a Likert-type scale to measure and analyze the degree of their impact on research output/scientific performance. This section analyzed quantitative responses on a 5-ponit itemized rating as shown in Tables 5.5, 5.6, and 5.7. Table 5.8 summarized the sample means.

Table 5.5: Influence of scientific committee structures

(N=648)

	x	f	fx	μ	s	%
Scientific committee	5	97	487			15
structures impact on	4	292	1168			45
Research performance	3	195	585	3.62	0.94	30
	2	48	96			7
	1	16	16			3
Management centric	5	28	140			4
Structures support	4	84	336			13
Research performance	3	254	762	2.56	1.10	39
	2	141	282			22
	1	141	141			22

Table 5.6 Influence of Institutional condition

(N=647)

	X	f	fx	μ	s	%
Institutional condition supports	5	185	935			30
Research performance	4	260	1040			40
	3	86	258	3.76	1.14	13
	2	86	172			13

1	28	28	4

Table 5.7 Influence of Research practices

(N=648)

	x	f	fx	μ	s	%
Research practices increase	5	152	760			23
Research performance	4	318	1272			49
	3	96	288	3.81	0.98	15
	2	69	138			11
	1	13	13			2

Tables 5.5, 5.6, 5.7, and 5.8 indicate factors, which affect research or scientific performance measured in terms of number of published scientific works, conference papers, and editorship of graduate thesis. 15 respondents strongly agreed and 45 agreed that scientific committee structures enhanced scientific performance. The mean of 3.62 on the likert scale (Table 5.5), which is close to 4, further supports this position. Tables 5.6 and 5.7 indicate that respondents believed that institutional condition (3.76) and research practices (3.81) increased and supported scientific performance respectively. The measure of dispersion of responses used was the standard deviations (s). The lowest standard deviation, 0.94 for scientific committee structures and 0.98 for research practices showed that respondents did not differ much in their responses in respect of these factors. The highest standard deviation (s) 1.14 for institutional condition and 1.10 for management-centric structures indicated that respondents varied in their responses towards these factors.

Table 5.8 Summary of Means

Predictors/ Explanatory variables	N	Mean	Std. Deviation	Min.	Max.
Scientific committee Structures	648	3.64	0.94	1	5
Management centered Structures	648	2.56	1.10	1	5
Institutional condition	647	3.76	1.14	1	5
Research practices	648	3.81	0.98	1	5

The calculated means of 3.62, 3.81, and 3.67 respectively, which are close to 4, support the view that each of these three variables positively affects scientific performance. However, from Table 5.5, about 84 of the selected interviewees agreed and 254 disagreed (while 141 strongly disagree) that management centric structures enhanced research performance. This result therefore indicates that management centered research steering structures (2.56), which is > 3 does not support scientific performance. From all indications, the results of analysis of quantitative data show that scientific committee structures, research practices, and institutional condition positively influenced research output (scientific performance).

However, using Table 5.9 (simultaneous comparison of means of several samples) and Table 5.10 (analysis of variance, ANOVA Table), this section further investigated the association between scientific committee structures, research practices, institutional condition (as explanatory variables or predictors) and research performance (as response or independent variable). Table 5.9 simultaneously compared the means of the three (predictor) samples while Table F shows an ANOVA *F* test for analyzing the quantitative response and explanatory variables. This is a test of significance, aimed at detecting any significant differences among the sample means. Table E summarizes observations on scientific performance for three samples, based on structured survey of the population. These were samples for scientific committee structures, research practices, and institutional condition as predictors. The response variable, scientific performance was measured on a 5-point scale ranging from 1= No view, 2= strongly disagree, 3=Disagree, 4= Agree, to 5= strongly agree, indicating response levels of agreement on predictor impact on research performance. The Table 5.9 further shows the number of respondents (sample size), the mean score and standard deviation for each group.

Table 5.9 Comparing means: scientific performance by predictors (explanatory variables)

Group / Predictors	Research performance/output 1	2	3	4	5	Sample Size	Mean	Standard Deviation
Scientific committee structures	16	48	195	292	97	648	3.62	0.94
Research practices	13	69	96	318	152	648	3.81	0.98
Institutional condition	28	86	86	260	187	647	3.76	1.14

Note: 1= No view, 2= strongly disagree, 3=Disagree, 4= Agree, 5= strongly agree

By assigning the score 1, 2, 3, 4 and 5 and comparing mean scores, result from Table 5.9 indicates that the mean scores for all three samples fall close to 4, the score for agree, which implies positive or significant impact on scientific performance.

Table 5.10 shows the result of ANOVA test for evidence of significant difference among the sample means. It tested the null hypothesis, H_0: $\mu_1 = \mu_2 = \mu_3$, which is a test of independence of the response variable (scientific performance) and explanatory variables (scientific committee structures, research practices and institutional condition).

Table 5.10 ANOVA Table for Result of *F* Test for Table 5.9

Source	Sum of Squares	DF	Mean Square	*F*	Prob > *F*
Between Estimate	12.57	2	6.29	5.99	P< 0.5
Within Estimate	2023.22	1940	1.05		

Obtained *F* ratio = 5.99

Table *F* ratio = 2.99

$Df_{1=}$ 2

Df_2 =1940

$\alpha = 0.5$

Between Estimate (6.29) > Within Estimate (1.05), which is six times as large, and the *F* statistic > 1

Since the obtained or calculated *F* ratio is greater than table/tabulated *F* value, 5.99 > 2.99, and p < 0.5, we reject the null hypothesis, accept the research hypothesis, and conclude that the effect of scientific committee structures, research practices, and institutional condition on scientific performance is significant. However, more inferences that are detailed became necessary in order to determine the nature of differences among the sample mean scores. It was also necessary to obtain information on how large the differences in means really were. In other words, it had to be determined in what order these differences occurred, or more precisely, the order in which differences in the impacts or power of prediction of these three explanatory variables occurred? Applying Tukey's HSD (honestly significant difference) procedure, this thesis was able to determine the precise significant differences in the levels of impact that the predictor variables have on scientific performance. Table 5.11, which is a matrix table of differences between ordered means, shows the multiple comparisons of means, after the *F* ration was obtained, and this was necessary in order to pinpoint where the differences lie.

Table 5.11 Matrix Table of Difference between ordered Means

	$\ddot{X}_3$=3.62	$\ddot{X}_2$=3.76	$\ddot{X}_1$=3.81
$\ddot{X}_3$	-	0.14	0.19
$\ddot{X}_2$	-	-	0.05
$\ddot{X}_1$	-	-	-

The rank order of means (from the smallest to largest) is 3.62 (scientific committee structures), 3.76 (institutional condition), and 3.81(research practice). From Table 5.11, the difference between $\ddot{X}_1$ and $\ddot{X}_3$ is 0.19, the difference between $\ddot{X}_1$ and $\ddot{X}_2$, is 0.05, and the difference between $\ddot{X}_2$ and $\ddot{X}_3$ is 0.14. Assuming a 0.05 level of significance and using a percentage Table of points of the standardized range (q) for .05 level of significance (Person and Hartley, 1996), HSD value is 0.31. Since $\ddot{X}_1 – \ddot{X}3 = 0.19 > 0.13$ (HSD value) and $\ddot{X}_2 - \ddot{X}_3 = 0.14 > 0.13$, these mean differences are statistically different at 0.05 level.

The analysis of variance table for the effects of predictor variables on scientific performance yields a significant F ratio of 5.99. Tukey's multiple comparison of means indicates that research practices with a mean of 3.81 is significantly different from the other two predictors with means 3.76 and 3.62 for institutional condition and scientific committee structures respectively. This reflects the fact that research practices remain a principal prerequisite for effective scientific performance. Clearly, while the mean for research practices (3.81) is significantly greater than that for institutional condition (3.76), the later is significantly greater than that for scientific committee structures (3.62) suggesting that productive research practices and supportive institutional condition for research are necessary requirements for increased research output (i.e. effective scientific performance). In this context, the thesis finding is that scientific performance of the scientist/scholar tends to be largely influenced by research practices, which describes the choices the makes concerning his work. These decisions are about research interests, priorities and agendas, funding sources, output orientation, publication strategy and collaborative research exchanges. Such choices constitute one single most important factor that contributes to increased research output, and thus is a most important predictor of research performance.

Results from quantitative data further suggest that institutional condition for conduct of research is another basic prerequisite for effective scientific performance, though this variable is ranked second in importance. The result implies that effective research performance of the scientist requires supportive state of institutional infrastructural facilities, and appropriate levels of human capacity development and financial resource for conduct of research. It means that there must be available well-equipped laboratories and libraries, archives, databases, internet facilities, transport, pool of research funds, and institutional pool of trained and competent scientists with capacity for research. Research supportive attitude by management including productive management of employee relations could create this situation. Such supportive work related condition for conduct of research has obvious potential to foster the extrinsic drive of the scientist for research. A study by the official agency of the government of United Kingdom managing aid to poor countries, (UK Department for International Development), which found that ‘’the effectiveness of researchers is… compromised by unreliable finance, poorly paid and managed staff, weak and unreliable infrastructure, and sometimes a lack of security’' (DFID, 2004; cited in Pound and Adolph, 2005:1) supports this view.

Moreover, finding from analysis of quantitative data shows that the steering of research by scientists/scholars, which allows them to shape and direct the entire institutional research process, could increase scientific performance. Scientific committee structures for research governance (scientific committees, ethics committee, and proposal review committees) could take responsibility for managing, monitoring and coordinating research, approving research proposals, release and monitoring of research grants, ensuring accountability, promoting and providing guidance on research ethical and procedural norms, rules and values. Scientific committee governance appears more technically positioned than other research governance models and structures to advance institutional research. In this context, it is not suppressing that most respondents believed that management centric research governance structures, not supported by scientific teams, do not support effective scientific performance. A common trend across research institutions appeared to be that management takes direct charge of research process providing and monitoring research grants. In most cases, management displayed irresponsible attitude and abuse of administrative powers in dealing with those issues most important to scientists/researchers. Management often suppressed scientific committees where they exist. The obstruction of research funding or non-use of competitive research funding often prevented scientific committee structures from discharging their traditional functions in shaping the research process. In some cases Ethics Committees indulged more with administrative matters than overseeing ethical and normative requirements for research.

5.3.3 SUMMARY OF KEY QUANTITATIVE FINDIDS

Tables 5.3 and 5.4 present descriptive data. Table 5.3 shows the spread of research governance approach across research institutions in the Gambia and indicates that most respondents (48%) believed that research governance is management centric, though however professional research committees and the state seemed to play limited role in research steering and organization. Table 5.4 presents estimate of satisfaction with technical infrastructure indicating strongly decreasing satisfaction. In addition, the mean scores of 3.62 for scientific committee structures and 2.56 for management-centered structures (Table 5.8) support the finding that management centric structure of research governance decreased scientific performance, a result that could be attributed to poor management of staff and resources.

In addition, Table 5.9 compared mean scores and standard deviations for the three explanatory variables: scientific committee structures, research practices, and institutional condition while the analysis of variance table, Table 5.10, tested the null hypothesis at 0.5 level of significance. The estimated *F* ratio is 5.99, $Df_{1=}$ 2, Df_2 =1940, $\alpha = 0.5$ and $p < 0.5$, and finds a significant correlation between research output (scientific performance) as response/independent variable and scientific committee structures, research practices and institutional condition as predictors.

The Matrix Table of difference between ordered Means, Table5.11, using Tukey's multiple comparison of means procedure, and the estimate, HSD = 0.31 indicates that research practices with mean (3.81) is significantly different from the other two predictors with means 3.76 for institutional condition and 3.62 for scientific committee structures. Since $\ddot{X}_1 - \ddot{X}3 = 0.19 > 0.13$ (HSD value) and $\ddot{X}_2 - \ddot{X}_3 = 0.14 > 0.13$, it is reasonable to assert that research practices variable is one single most important factor that explains scientific performance at the individual level of the scientist. However, this thesis recognizes that other residual factors, though included in the regression model but unaccounted for in this study, may possibly have some predictive powers over the nature and level of performance of scientists, research teams and research organizations. Nonetheless, the non inclusion of these residual factors in the calculation of determinants of scientific performance is not considered a limitation because they were held to be constant.

Overall, findings from both phases of the thesis were integrated at point of interpretation and discussion of results from analyses of qualitative and quantitative data in the next section. Integration involved using quantitative results to complement and expand findings from the exploratory qualitative phase. It involved exploring and harmonizing the differences and similarities as well as interfacing findings from the quantitative analysis to findings from the qualitative analysis of data within the theoretical and paradigmatic framework of the two approaches.

5.4 DISCUSSION OF RESULTS

Empirical discussions in literature concerning the effects of research governance models and structures in literature appear limited and mixed. However, none of the previous empirical studies including Schubet (2009), which is closest focusing on the contributions of governance models and structures to scientific output, have tested the impact of scientific committee model consisting of research steering chair and hierarchies of scientific committees holding decision competencies with greater autonomy. Schubet found that strengthening internal hierarchy, (i.e. increasing management grip on research and as well as control over research by Deans and Chancellors/Presidents of research institutions), contributes positively to research efficiency. Nevertheless, empirical discussions are still ongoing concerning the impact levels of different governance models. There appears however to be implicit doubts on the benefits of *internal hierarchical self-control* (i.e. management centric model), and of *academic self-management (which measures the degree to which research chairs can decide autonomously)*. The benefits or positive impact of management centric governance model and structures are sometimes doubted ‘’because it is argued that research is not a routine task and the most empowering setting is that of academic freedom’’ (Schubert, 2009: 1225). However, there is no empirical proof showing that either *academic self-management* or **scientific committee model** actually has positive influence on scientific performance.

Besides, empirical discussions in literature concerning the impact of governance structures on scientific and their mediating effects on other explanatory factors particularly research practices appear very limited. Apart from (Horta et al, 2007; Horta and Lacy, 2011) that discussed the importance and contribution of communication behaviour to knowledge production, there appears to be no systematic study of other research related behaviours and their impact on scientific output. Thus, there appears to be a missing gap in literature on a possible association between scientific committee model and structures of governance and research practices. It is also important to consider, apart from the question of whether a particular predictor or explanatory variable exerts significant influence on scientific output, the relative significant impact of these causal factors on the response variable. In addition, most recent studies focusing on determinants and hampering factors of scientific output employed one measure for research output at a time, without testing the effects of considering different variables simultaneously. Such works include Lissoni et al. (2009) on factors of size and nature of projects, authors 'age and gender and (Breschi et al. 2005; Van Looy et al. 2006; Stephan et al. 2007) on patenting activities.

On this background, this thesis analysis contributes to literature on these issues, using a mixed methods approach including grounded theory to explore and interpret individual and organizational determinants that influence research at the individual level. In addition, the thesis employed quantitative ANOVA *F* test and Tukey's HSD technique to determine the significant differences among the explanatory factors that influence scientific output. In order to overcome the limitations of a one-sided approach, this thesis further combined both individual and organizational determinants of research at the individual level similar to Horta and Lacy, (2011). The thesis therefore innovatively examined simultaneously the relative significance of the explanatory power of variables under study considering that, as most social phenomena, multiple factors tend to influence research performance. In this context, major contributions of this thesis to literature on research policy and management arise from analyzing the relative effects of governance structures, research practices, and institutional condition, on scientific knowledge production. Moreover, the response variable, scientific output has multiple causes. Both phases of this thesis found that scientific committee structures of research governance, institutional condition for conduct of research and research practices have causal influences on scientific performance, and results further show that research practices variable is one single most significant causal factor in research. Further, the thesis established statistical interaction existing between research practices and scientific output because the association between the two changes as a third factor, which is scientific committee structure, is introduced or its value changed. This implies that the association between research practices/behaviours and effective research performance tend to be strong or weak, depending on other conditions, which is varying 'values' of scientific committee structures. Though technically treatment of quantitative data involved variable control, the degree of interaction was not tested by comparing the variability in association. However, the section on discussions of conclusions (see chapter six) provides further insights into the rather complex association linkage between these multiple factors influencing research performance, though how and why become apparent in the discussions that follow. Meanwhile, each passage in the discussions ends with numbered conclusions in catch phrases (in italics).

Clearly, a consensus, common ground finding from both phases of the study showed that scientific committee committees of research governance positively influenced scientific performance of the scientist across research institutions in the Gambia. Consistency of results supports this finding. Mean score of 3.62 (close to 4) on the impact of research governance (scientific committee structures) indicates a significant effect. Besides, a majority of respondents in the qualitative Study 1 believed that effective research performance would occur when scientists/academics and their professional committees play significant role in steering of research. However, this thesis further found that Management centric structures could in fact decrease performance where overbearing management controlled research creating thereby stifling and unchallenging research situation. From the quantitative analysis of data, the mean score of 2.56 (below 3) on the impact of management-centered structures indicates insignificant effect. These results suggest that across research institutions in the Gambia the insignificant contribution of this research governance model and structures to scientific performance resulted from ineffective management systems and poor management of staff and resources. Other plausible explanations may include management ineptitude and non prioritization of research, ineffective research governance structures and weak coordination of research activities ((Kirigia and Wambebe, 2006; D'Souza and Sadana, 2006). Another contributing factor could be very limited investment in research and development (GOTG, 2006). Overall, it is not surprising that under these conditions management centric structures of governance produced decreased scientific output. Nonetheless, this finding does not suggest that management centered structures of research governance may not produce important research output. On the contrary, Schubert, (2009) found positive impact for research steering by management authorities. Besides, according to European Commission, JRC-IPTS Report, 2009, given necessarily a number of hierarchical levels of research decision competences and external stakeholders providing supportive role in driving research, executive leadership in research governance would promote higher quality education and more relevant research output. These hierarchical structures and support from scientific teams are found at the University of Melbourne where there are several levels of research hierarchies with the Deputy Vice Chancellor (Research) at the apex providing academic leadership in research and delivery of the university's research agenda. The Pro Vice Chancellor (Research) responsible for research performance and research ethics and integrity, and the Pro Vice Chancellor (Research Collaboration) and Pro Vice Chancellor (Graduate research) supports him. At the Faculty level, Associate Deans (Research) provide 'local' leadership in research planning, target setting, research development and performance review. Heads of academic departments provide important leadership in research and research training. Most Faculties have Faculty Research Mangers to manage the administration of research activities within the faculty. Two committees report directly to the Deputy Vice Chancellor (Research), one, an advisory group of senior academics providing advice on strategic issues such as research investments and priorities. The other, the committee of Associate Deans provides advice on research policy and operational matters. There are a number of other research sub committees, reporting through the Committee of Associate Deans, those are concerned with policy development and review, and engagement with external regulators (http://www.research.unimelb.edu.au/structure#university). An important feature of these management centric structures is the conspicuous absence of scientific committees with significant autonomy, that is, committees with fully-fledged research competences over the determination of research investment, policy development, research ethics and peer review. Every other point in these hierarchies ultimately reports to the Deputy Vice Chancellor (Research) while the so-called scientific and technical advisory committees play only but professional advisory roles.

In contrast to the situation at Melbourne University, the management centered governance structures in the particular context of public research institutions in the Gambia appeared to be highly centralized. At the same time, support from scientific committees/teams remained very limited. Research policy development, research investment and funding, and other significant research issues including research collaboration and partnerships, research initiatives and intellectual property (IP) management, if any, are determined and treated as administrative matters without the important inputs from scientists. At the University of the Gambia, Research and Strategic Committee consisting of professionals/scientists existed, and while it did, actually steered research until 2009. Within this period, academics produced significant research output. Currently, this committee and other sub departmental/faculty scientific committees seem to have become either redundant or moribund. In the National Agricultural Research Institute, the Director General, Deputy Director General and the Director of Research manage research. Scientific committee structures with significant research competences appeared to have disappeared within the same period in the Institute. In this context, a majority of respondents in the qualitative survey of data agreed that,

> *We do not have these committees, evaluation committee within the research system. Scientists are left to coordinate among themselves and decide what things to work on in a particular season, you know, and then they latter come to management to make a final decision*

Respondents agree that ‘it is only management that dictates what one does and when’ and ‘if…you are not in the good books of management… they would not want to fund your activity’. It is thus understandable why in this context, management centric governance structures of research governance, without supportive research steering roles from scientific committees, actually decreased research output. This finding therefore suggests that management centered governance structures have not created ‘‘that atmosphere for competition because ‘’in having good research there must be an atmosphere of competition''. Since scientific committees do not exist management ''does not mind much, if problems arise… they do not even scrutinize the outcome of some of the researches that the scientists have produced''. Overall, these findings suggest that scientific committee model and structures of research governance tend to be better positioned than management centric model and structures to steer research and handle critical research issues of peer review/evaluation and governing of behaviours of researchers. A plausible explanation is that scientific committees with significant autonomy could create a more enabling and challenging research situation, best foster research collaborations and exchanges of information among colleagues, understand and resolve critical research issues, and make and implement more informed research decisions than institutional management. The key strength of scientific committee structures appear to lie in consultation and consideration of wider range of options in decision making and implementation as inputs may be taken from scientists across hierarchical levels of the structure. Besides, another plausible explanation for a better steering role by scientific committee structures derives from traditional peer-based evaluation of the work of scientists and scholars. Research steering scientific committees would appear more inclined to accept reforms suggested by Osterloh and Frey, (2009) in favour of a combination of qualitative peer reviews and bibliometrics, which can balance the advantages and disadvantages of the two methods of measures of the scientist's performance (Butler, 2007; Moed, 2007; Weingart, 2005). While bibliometric indicators/counts provide extrinsic incentives for performance, and qualitative reviews, anchored on quality, outstanding and creative work, provide intrinsic motivation, the combination of the two methods could possibly improve rankings as instruments for monitoring and sanctioning, or precisely, governing the behaviour of scientists. This approach would generally improve the governance system and give greater room for creative research to blossom. Consequently, within the context of this thesis, the argument is that scientific committees consisting of mainstream scholars/scientists who understand the process and content of research would more readily introduce qualitative peer evaluations (or better still, a combination quality and quantity based evaluation), foster creative research and generally improve the governance system. However, these advantages may not be easily realized because of pressures that can arise from expectations of peers, which may include biases based on views contradicting those of the mainstream scholars. Another obstacle may be discouragement among scholars from conducting and submitting creative and unorthodox research (Armstrong, 1997; Gillies, 2008).

Conclusion 1: Management centric model and structures can positively contribute to scientific performance, provided supported by advisory group of mainstream scientists/academics at key hierarchical levels of governance. With appropriate competences and steering autonomy, scientific committees could take and implement more informed research decisions than institutional management or even research chairs who, when acting alone, may either ignore or overrule professional advice and inputs. Scientific committee structures with significant research steering autonomy tend to play better steering role than management centric model structures

The thesis finding further shows that scientific output is positively correlated with research practices. Research practice is about the doing of research, the choices that the scientist makes about his funding sources, research priorities, what, where and how he publishes and his decision to get involved in research collaborations, in exchanges of information and materials with several other stakeholders. It includes all research related behaviours. Findings from both phases of the study indicate significant impact of research practices on scientific output. From analysis of quantitative data, Tables 5.9, 5.10 and 5.11 indicate that research practice (with mean score 3.81, calculated F ratio 5.99, and mean difference > than calculated HSD value 0.31) is one most significant factor that explains scientific performance of the scientist. In interpreting this result, some interesting patterns emerge warranting some general observations. First, a plausible explanation for the most significant contribution of research practices to scientific output is that research activity or scholarly behaviour is generally directed at creating or generating new knowledge and technological innovations. This activity calls for the creativity and innovative thinking on the part of the researcher. Existing organizational routines, cultural path or localized approaches to doing things (Singh, 2005) and 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 (ie, the behaviour of the scientist) and the outcome of research. Individuals including scientists develop perspectives and behaviours through learning, organizational socialization or social networks that they enter. However, scholarly practices that block out external exchanges of information but indulge in ‘business as usual’ such as academic inbreeding (Horta et al, 2007) tend to produce academic parochialism (Berelson, 1960; Pelz and Andrews, 1966). Such practices also tend to forestall the benefits of new methods and approaches to generating knowledge. Consistent with (Horta et al, 2007), and exercising caution in interpreting the result, this thesis argues that scholarly practices that can produce most significant research outputs are those conditioned by openness, linkages and external exchanges of information. This is because the generation of knowledge requires not only existing pool of knowledge but also emerging, new knowledge most of which come from external sources, outside the institution (Kogut and Zander, 1992; Fleming and Sorenson, 2004). 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. Scientific collaboration takes place within a social context and involves sharing of meaning and completion of tasks directed towards common goals and objectives (Sonnenwald 2007). Most often, these collaborations emerge from both informal and formal social networks, which also sustain them. Collaboration networks can be instrumental in determining the extent to which scientists involved in information exchange networks achieve their goals (Abbasi and Altmann 2011). Collaborative research exchanges have potential to shape how the scientist actually organized his work and as these collaborations with professional colleagues and linkages with external peers broadened and deepened, the scientist may acquire expertise in doing research. It becomes possible to access new information and knowledge as well as new methods and approaches. It is also possible to expand research experience and confidence and ultimately open up opportunities to generate new knowledge. Results of this thesis analysis thus provide a strong confirmation of the argument by (Abbasi, et al, 2012:12) that ‘’connecting with new and diverse research groups (e.g., inter-disciplinary groups) and fostering collaborations would ‘’improve research publication and prolificacy’’. Scientific collaboration would also result in the generation of new knowledge, new method and new approaches (Stokols et al. 2005). Openness and external linkages and collaboration in deed can explain why research experience and expertise is growing across research institutions in the Gambia. This is because, though limited research is currently taking place and public and private sector linkages and support for research are still expanding, institutional science policy nevertheless encouraged collaborations, while external networks and contacts with external educational and scientific institutions appear to be growing rapidly. Qualitative evidence further tends to suggest high degree of preference among respondents to interact with colleagues from other universities and external Research and Development units. There is also evidence of some degree of internal co-authorship networks. Publication data and information obtained from institutional databases show that all publications by respondents interviewed were ‘offshore’, that is, papers published in international scientific journals. Analysis of these results thus provides a more insightful perspective on individual research performance given that research behaviour/practice is a most important predictor of scientific performance. It offers a more insightful explanation, showing that scholarly/research practices that can produce most significant research outputs are those conditioned by openness, collaborations among peers, linkages and external exchanges of information. Such information could concern research, publications, scientific articles and knowledge diffusion. Research institutions in the Gambia can therefore improve research competences of the individual researchers/scientists by developing research and development strategies that support and sustain appropriate research behaviours among scientists. Such strategies could include expanding existing institutional framework for collaborations and external exchanges of information among scientists as well as recruiting star scientists from outside to enhance research competences, enhance performance and prop up institutional research ratings. Others could include training workshops and the use of mentors or lead or principal investigators to foster suitable behaviours for research among scientists and research teams.

Conclusion 2: The contribution of research practices to scientific output is the most significant among all casual factors. Scholarly practices that can produce most significant research outputs are those conditioned by openness, linkages and external exchanges. Communication behaviour tends to have a mediating effect on scholarly/research practices, which thus makes a significant contribution to scientific performance.

Relating further the analysis of the effects of scholarly/research practices to previous empirical studies, (Adams et al. 2005; Abbasi et al, 2012, Song et al. 2003, Lacetera et al 2004, Thornsteinsdottir, 2000) demonstrated that the scientists' communication behaviour tend to maximize resources, find complementary skills, and expand the organization's ability to generate and access new knowledge. This social behaviour (i.e. communication behaviour) of scientists allows them to open up communication not only within but also outside their institutions. The arguments of these authors support the result of qualitative analysis of this thesis, which shows that

‘’ collaborative research (communication behaviour) reduced costs and time [spent on research]’’, expands funding sources, provides opportunities for dissemination of research results, and ‘’expanded the scope of [research] interests’’. Collaborations with international research institutions can ‘’give you insight into other research activities that are taking place elsewhere in the world’’ and can also help to ‘’build relationships between researchers in the international arena’’. These results further ego the assertion in literature that a research or innovation system grounded in collaborative exchanges is likely be more effective in terms of production of knowledge. In this context, Velho (2002: 26) argued that,

> *A national system of innovation made up of actors which are not particularly strong, but where the links between them are well developed, may operate more effectively (in terms of learning and in generating innovations) than another system in which one or other actor is strong, but the links between them are weak*

Moreover, according to prior studies (Shinn, 1982; Chompalov et al. 2002; Vasileiadou and Vliegenthart 2009), meetings between researchers, or collaborative research for that matter, prove the most important predictor of research productivity. Vasileiadou and Vliegenthart, 2009:1261) found 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 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). Access to information and networks are critical to knowledge generation (Horta, et al., 2007). In brief, consistent with (Song et al., 2003; Lacetera et al. 2004, Stokols et al. 2005), the results of this thesis analysis show that collaborative research exchanges or external linkages can bring in new research questions, new theories, new publications, new methods and new forms of thinking and of doing research. Yet, the thesis analysis goes further, showing that research related behaviours are multi dimensional and, apart from communication behaviour, other important forms of doing research (or practices/behaviours) could have profound impact on scientific performance. In this context, the thesis in contributing to empirical discussions on the subject, argue that other research related behaviours, which include publication behaviour, funding behaviour, choices about research priorities, could make important contributions to scientific performance. The decisions that the scientist makes about his funding sources, time spent on research, publication orientation (quality vs quantity), and research priorities, which apart from communication behaviour, are also research related activities. These decisions or behaviours are equally important forms and aspects of the doing of research. Put together, these individual actions/decisions of the scientist concerning the doing of research have profound influence on research output. From analysis of qualitative data, it is deductively found, in a context of limited funding options, that the scientist may be constrained to work on ‘’ things I can find myself***… so the areas I am hoping to work on, or areas I am not working on are basically things I feel that I can fund by myself’’***. A reasonable inference from this result is that limited funding situation generated a choice on research priority. Moreover, result from qualitative analysis further shows that in the situation before 2009 when competitive research funding was in vogue in most research institutions in the Gambia, compositing proposals for reviews positively influenced the quality of research. This implies that the scientist’s decision on publication orientation (i.e. publication behaviour) influences the outcome of his research. This is also true of professional competition for recognition where publication behaviour appeared to be determined by extrinsically mediated motivation. Not only does ‘’publishing encourage competition…publishing offshore… ensures that your work meets international standards or quality’’. Professional recognition also results from publishing because ‘’ the more of [high quality works] you publish, the more recognized the researcher becomes''. These results indicate that the choices, which the scientist makes concerning publication orientation (on whether to go for quality or quantity research), which is publication behaviour, could influence research effectiveness in terms of number of scholarly publications or quality of research. Closely related to this argument is that decisions on the amount of time spent on research, could possibly affect the quantity and quality of research work. Thus, in this context, the thesis contribution is that publication behaviour, publication orientation, funding behaviour, decisions about research priorities and agenda as well communication behaviour, are critical for knowledge production. However, result from the thesis analysis suggests that the scientist's communication behaviour conditions and exerts mediating influence on other research related activities or behaviours. This is because information coming from communication activities of the scientist could determine or inform his publication and funding decisions as well as his output orientation. Overall, these discussions have attempted to relate the results of the thesis analysis to literature underpinning the importance and contribution of social communication behaviour (including external research linkages/networks) to generation of knowledge (Horta et al, 2007, Gruenfled et al., 2000). However, apart from the common ground findings on the empirical association between the scientist's communication behaviour and scientific output, the analysis of this thesis goes beyond communication behaviour to isolate other forms of research related behaviours or practices that affect research output. It relates research practices of the individual scientist, nevertheless conditioned and driven by both organizational practices or routines and external collaboration and linkages, to research output. In this context, significant effects of other research related behaviours of individual researcher yields the insight that research institutions and universities can increase research effectiveness by choosing their governance models and structures wisely in ways that foster important research choices/behaviours at the individual level. This argument appears to answer '' new questions to the literature on further exploring the role of individual practices on its contribution to and impact in new knowledge generation'' (Horta et al, 2007:21). However, more work is still needed in this regard to further explore, or better still, test for the relative impact of each of these other research related behaviours/choices of the individual researcher on scientific production.

Conclusion 3: Research related behaviours are multi dimensional and, apart from communication behaviour, other important forms of doing research (or practices/behaviours) could have profound impact on scientific performance. Publication behaviour, funding behaviour, choices about research priorities could make important contributions to scientific performance. The scientist's communication behaviour conditions, or has mediating influence on, other research related activities. Research institutions and universities can increase research effectiveness by choosing their governance models and structures wisely to facilitate important research choices at the individual level.

Turning to the finding that there is a connection between research practices/behaviour and scientific committee model and structures, results of the thesis analysis suggest that autonomous scientific committee structures exert moderating effect on research practices, and for this reason, can improve research competences of individual scientist. This moderating influence of scientific committee structures on research behaviour appears to account to some extent the nature of association between some of the multi causes of knowledge production.

After a detailed examination of the qualitative evidence, this thesis can assert that, in the context of institutional research, scientific committee structures of research governance have greater impetus to encourage and enhance collaborative exchanges, foster important research expertise and behaviours and ultimately improve the scientist's performance effectiveness. As deductively derived from data, the connection (or interaction) between research practices and scientific committee structures implies that these structures support the doing of research for this reason, scientific committee model and structures of research governance is a necessary condition for productive research practices. The argument is that the association between research practices/behaviours and effective research performance tend to be strong (or otherwise weak), depending on other conditions, which is varying 'values' of scientific committee structures. This implies that the effect of research behaviours on scientific performance would increase (or otherwise decrease) depending on varying levels of autonomy in steering research by scientific committees. The effect of this association changes in intensity or direction when these conditions occur. It further implies that different levels of, or changes in, decision making competences of scientific committee structures could produce corresponding changes in the association between research practices and scientific performance. The following explanations seem reasonable. First, an important observation is that none of the previous empirical studies including Schubet (2009), which is closest focusing on impacts of different governance models and structures, have tested the contribution of the influence of scientific committee model and structures to scientific output. This governance model consists of research chairs and scientific committees holding autonomous decision competencies. Rather, Schubet, (2009) found that the influence of Deans and chancellors, and Presidents of research institutions have positive impact on research efficiency (provided they use their power and influence wisely). The author was concerned with linking relationships between inputs and outputs in terms of efficiency (i.e. FDH scores, defining production frontier as the maximum output that can be produced with a given input level) to governance structures, and examined the association between NPM governance mechanisms and efficiency. On the contrary, this thesis examined the mediating effects of autonomous scientific committee structures on research practices and outcomes of research using publication counts (number of scientific publications and citations) as proxy for scientific performance (i.e. output effectiveness). Publication counts were used because comparisons were not made across research institutions, which could distort results in disfavour of research institutions specializing in activities measured by other output indicators. Hence, the thesis argues that, in the context of institutional research, scientific committee model and structures of research governance, more than most other governance models and structures, could create enabling and more challenging research situation. This governance model and structures could best foster research collaborations and shape not only individual research behaviours/practices but also the entire institutional research process. In this model described as professional self-steering, research chairs and scientific committees at different hierarchical levels could have significant degree of autonomy to decide on key research issues. However, within the framework of institutional mission and science policy, internal guidelines and inter-institutional agreements, the research chair in the apex hierarchy, could deal mainly with strategic research issues providing the necessary institutional research leadership and coordination of research activities. Departmental scientific committees and research sections could provide support on research direction and priorities, and sectoral research leadership. In brief, unlike the governance pattern often described as New Public Management (Braun and Merrien, 1999; Schimank, 2007), scientific committee model anchors on limited control by the state, external stakeholder control and management control as well as limited state and research chair holder competences. However, this model still maintains the spirit of NPM as it gives greater steering autonomy to researchers and research reams. Thus, given these critical competences over research, and playing supportive role in achieving institutional strategic research agenda, scientific committee governance structures could mould research behaviours at the individual level of the scientist by facilitating both internal and external research collaborations. Not distracted by exigencies of institutional management and administration, but concerned primarily with research and research related activities (e.g. teaching), research leaders speak the language of peers and understand their concerns. It would thus appear that they are in better position and preoccupation to understand and resolve such critical research issues as governance, professional information, research management and administration, grant conditions of award and research related contracts, contacts with relevant stakeholders, and opportunities, responsibilities, risks and benefits associated with collaborative initiatives. With appropriate competences and steering autonomy, scientific committees could take and implement more informed research decisions than institutional management or even research chairs who, when acting alone, could either ignore or overrule professional advice and inputs. For these reasons, this thesis argues that scientific committee structures of research governance, more than other governance structures, could better facilitate the establishment of information exchange networks that enable researchers make important choices concerning research topics and priorities, funding sources, publication orientation and strategies as well as communication options. Besides, in providing professional research services, which might promoting the preparation of high quality proposals and information to researchers on research integrity and ethics by means of guidelines, individual assistance, websites, training and workshops, scientific committees could enable scientists improve their research and their competences. In support of this view, Osterloh and Frey (2009) argued that a governance system based qualitative evaluation of peers and supportive feedback, would be able to inform researchers on how to improve their research and their competence. Peer reviews or ‘’evaluations are a reasonable mechanism to enhance publishing activities’’ (Schubet, 2009:1233), and based on this argument, scientific committees could encourage the development of appropriate publishing behaviour by scientists. In brief, by fostering linkages, effective communication, institutional socialization, and by means of peer reviews, scientific committees could mould and sustain appropriate research behaviours/practices and competences of individual researchers and research teams. However, there may be a technical problem in determining the precise mediating effect of scientific committee structures on research practices since the association is qualitatively determined.

Conclusion 4: Scientific committees could mould and sustain appropriate research behaviours/practices and competences of individual researchers and research teams by fostering linkages, effective communication, and institutional socialization and by means of peer reviews

Results of analysis on publication counts of scientists in the period before and after 2009 further relate to the research question on the nature of association among the multi causes of scientific performance of scientists. The results show that publication counts for scientists across research institutions in the Gambia, which were significantly high before 2009, fell sharply thereafter. A possible explanation is that before 2009, scientific committee structures actually steered research to achieve significant results. However, after 2009 management began to lose genuine commitment to research and development. Other setbacks were non-prioritization of research and very limited investment in research. The implication of this trend was a shift towards management centric form of research governance, which weakened the position of formal scientific structures and in some cases rendered them moribund. Besides, the same period witnessed high labour turnover across research institutions in the Gambia as many scientists left their jobs for better offers in the sub region and overseas. The University of the Gambia in particular witnessed the exit of almost all its professors and core scholars. It also meant that after 2009, the exit of the more competent and experienced scientists apparently created a gap in the mentoring process and in the already limited internal research collaborations. The situation produced a consequent lose of morale/confidence in doing research. In addition, the moderating influence of scientific committee structures within this period either disappeared or became weakened, consequently limiting the contribution of research behaviour to scientific output. These findings provide a strong confirmation of the argument that scientific committee structures with significant research steering autonomy could have profound impact on research practices and scientific output. Thus, this result suggests that scientific committee steering structures, going beyond merely monitoring and sanctioning (e.g. peer evaluation), could improve research practices by fostering research linkages, effective communication, and institutional socialization in the process of governing the behaviour of scientists. The results further prove the insight that research institutions should wisely choose their governance system because of the far-reaching implications it might have for research practices or behaviours of their scientists and their scientific output.

Conclusion 5: ***Research practices become productive in a research context in which there are significant degree of professional steering autonomy, openness and communication networks, and intervening contributions of scientific committee structures and control mechanisms to scientific output.***

Concerning the research questions of the causal and motivational factors that affect research performance of scientists, results from analyses of both qualitative and quantitative data established a correlation between institutional condition (defined by financial and human capacity as well as technical infrastructural facilities for conduct of research) and scientific output. Quantitative analysis established that institutional condition with mean score of 3.76 (see Table 5.8) supports scientific performance. Table 5.10 and Table 5.11 indicate a significant correlation between institutional condition and scientific output (with calculated F ratio 5.99, $p < 0.5$). Besides, results of comparisons of means (with mean difference $\ddot{X}_2 - \ddot{X}_3 = 0.14 > 0.13$, which is the estimated HSD value statistically different at 0.05 level of significance) suggest that institutional condition could be a necessary condition for effective scientific performance. The result implies that the use of technical facilities could improve, or otherwise retard, research work. This finding thus provides a strong confirmation of the argument in literature that the use technical facilities such as internet can improve research work by providing access to resources and facilitating the sharing of files, data and ideas (Walsh et al., 2000; Garvey, 1979; David and Steinmueller, 2003; Nentwich, 2003; Hiemeriks and Vasileiadou, 2008). The findings also ego the argument in literature that the effectiveness of researchers in developing countries ‘‘is… compromised by unreliable finance, poorly paid and managed staff, weak and unreliable infrastructure, and sometimes a lack of security'’ (a study by DFID, 2004; also cited in Pound and Adolph, 2005:1). Besides, results of qualitative analysis show that institutional condition is not supportive of research. Overall, respondents agreed that institutional condition ‘generally … is not motivating’, is non-supportive, and will continue to ‘diminish the drive for research’, unless made supportive. Results from analysis of qualitative data thus suggest that technical aids to research could affect effective scientific performance. In this context, it is important to observe that institutional condition for conduct of research is consistent with Herzberg *et al.* (1968) categorization of extra-job factors that deal with work context including salary, interpersonal relations, supervision, company policy and administration, working conditions, status and job security, though the focus of this thesis is on working condition. Within the institution, this condition provides the extrinsically mediated incentive framework that could affect the doing of research and outcome of research. Interpreting this result on the theoretical framework of Herzberg’s theory of motivation, it implies that institutional condition provides externally driven and mediated motivation that could influence scientific performance. However, other factors, which include personal characteristics, area of research (Fiona Wood, 1990) including intrinsically motivated curiosity (Amabile, 1996, 1998; Stephan, 1996), could be of decisive importance in academic research. Consistent with these suggestions is the argument in literature that both intrinsic and extrinsic motivational factors could positively contribute to scientific performance (Osterloh and Frey, 2009; Aydin, 2012).

Results from analysis of qualitative data further established that though limited access to technical aids to research including opportunities to travel generally remained non-supportive of research even before 2009, publication counts for scientists were high before 2009 though declined sharply thereafter. A possible explanation for this result is that, in addition to the mediating influence of scientific committees on research practices, the situation before 2009 presented a challenge for scientists, acting as a catalyst to trigger the intrinsically motivated drive for research. On the other hand, the decline in publication counts after 2009 could be attributed to other factors such as missing of moderating influence on research practices from scientific committees, which had become either ignored or moribund. As shown in Table 5.4, 57% of respondents indicated strongly decreasing satisfaction with technical facilities. Analysis of these results suggest that other non-technical incentives (i.e. intrinsic preferences) could be important in driving research, which could explain why scientific performance was relatively higher before 2009 even in spite of decreasing satisfaction with technical infrastructures. Thus, the result of this analysis is consistent with the argument in literature that, depending on the circumstances, persons are driven not only by external rewards, but also by intrinsic preferences. This argument appears to contradict the idea implied in the agency theory that individuals respond systematically in a self-interested way to extrinsic incentives from outside disregarding thereby their intrinsic preferences. Reasons lying within people may in fact drive their actions, for instance, it could simply be curiosity. Intrinsically motivated curiosity is critical in driving creative research and innovation. Therefore, in the context of this thesis analysis, it becomes apt to make the following observations. The results of analysis showing negative contribution of non-supportive institutional condition and positive contribution of non technical incentives located within the researcher suggest far reaching implications for competiveness of West Africa and a country like the Gambia still working to build and improve its science and technology base. This is because universities and research institutions are principal sources for generation of new knowledge and of technological innovations (Heitor and Horta, 2004). In the Gambia the current governance system of research institutions, based on the principles and assumptions of agency theory, really does not match the conditions for scientific work mainly because it disregards the intrinsic motivation of the scientist. Anchored on peer-based evaluation and pay-for-performance schemes, the system results in crowding out of ‘’intrinsic curiosity to do research… by extrinsic motivation to score high rankings’’ via quantity of publications (Osterloh and Frey, 2009:20). Research institutions and the University of the Gambia should therefore wisely choose their governance system, reform the present peer-based evaluation to include qualitative measures (which loosens the pressure on scientists to publish), and deploy appropriate governance mechanisms that increase autonomy of researchers to choose their own goals, which is important for innovative research. The present peer-based evaluation system based on bibliographic measures tends to heighten the pressure to publish and thus could be perceived as controlling instead of supportive of creativity because the system undermines intrinsically motivated curiosity. It is important to increase the scientist’s autonomy to follow own scientific goals rather than monetary rewards, because it is the most important precondition for intrinsic motivation (e.g. symbolic rewards). This is also important because, when given autonomy, intrinsically motivated people tend to raise their efforts, when they perceive that they could be trusted (Gneezy and Rustichini, 2000; Osterloh and Frey, 2000; Fong and Tosi, 2007). A working condition that permits a wide range of decision competences, responsibility, autonomy and trust for the researcher (Amabile, 1998; Amabile et al., 1996; Mudambi et al., 2007) is necessary for creative and innovative research.

Conclusion 6: institutional condition may be a necessary condition for effective research performance. Technical incentives or aids could affect effective research performance. Other non-technical incentives are important in driving research

5.5 CONCLUSION

This chapter discussed the collection and analyses of both qualitative and quantitative data in this mixed methods research. The mixed methods strategy for data collection and analysis was exploratory sequential (Creswell, 2009), which meant that first qualitative data were collected and analyzed, followed thereafter by collection and analysis of quantitative data, and both phases were given equal priority or weight in the processes. Qualitative and quantitative data and findings are integrated at the point of data interpretation and discussion of results in thesis implying that data and findings from the qualitative phase were compared and supported with data, findings and conclusions from the quantitative phase. This strategy enabled the thesis not only to explore the phenomenon under study, but also to elaborate, enhance, illustrate, clarify, and expand the qualitative results with results from the quantitative method (Greene, et al. 1989; Johnson and Onwuegbuzie, 2004; Creswell, 2007, 2009). It became possible to test some elements of the emerging theory of scientific knowledge production from the qualitative phase and generalize results to the study population.

Qualitative data collection and analysis involved the use of Glaser's Grounded Theory method, and key findings from this phase include:

1) Research practices contribute to scientific output of the scientist. Research practice is also a function of governance categories.
2) By means of intervening conditions defined by the expectations of peer evaluators for quality, ethical standards, procedural norms and values of scientific research, scientific

committee category impacts on research practices, i.e. decisions about how much time is spent on research, and generally how the scientist structured his work.

3) Scientific committee category impacts on research practices by means of support for quality of research, peer-based evaluations and supportive feedbacks, and fostering professional competition for recognition among peers and collaborative exchanges.
4) Fluid interface between the scientist and scientific committee governance structures is a necessary condition for improving research practices and scientific performance.
5) Both intrinsic and extrinsic motivational drives and the overall institutional condition for conduct of research impact on scientific output of the scientist.
6) Scientific committee structures with significant research steering autonomy tend to play better steering role than Management centric model and structures.
7) Scientific performance decreased when the research governance structure is management centric, when management control and coordination of research process became overbearing and created stifling and unchallenging, non-competitive and de-motivating research situation.

A validation stage preceded the quantitative data collection and analysis in order to ensure that relevant survey questions were asked and directed towards the quantitative research objectives and, in addition, to enhance the validity of findings. Validation measures consisted of member check, developing a survey instrument based on specific themes and views of respondents in the qualitative phase for the purpose of generating quantitative data, pretest of the survey instrument, and data source triangulation. Quantitative data analysis involved the examination of the following variables: scientific committee model and structures (of research governance), research practices, institutional condition, and scientific performance. The analysis further involved the use of descriptive and inferential statistics, employing ANOVA F and Tukey's HSD techniques in testing the following hypotheses:

Hypothesis 1- H_0: $\mu_1 = \mu_2 = \mu_3$, and the effect of scientific committee structures, research practices, and institutional condition on research output/scientific performance is insignificant.

Hypothesis 2- H_1: some $\mu_1 \neq \mu_i$ (or at least two means are not equal), and the effect of scientific committee structures, research practices, and institutional condition on research output/scientific.

Key quantitative findings include:

1) management centric structure of research governance decreased scientific performance
2) a significant correlation between research output (scientific performance) as response/independent variable and scientific committee structures, research practices and institutional condition as predictors
3) research practices variable is one single most important factor that explains scientific performance at the individual level of the scientist

The section on discussion of results highlights conclusions in catch phrases drawn from both qualitative and quantitative results and written in italics. These conclusions underpin the major contributions of this thesis to literature, though chapter six discussed how and why as well as comments on how the thesis analysis meets the objectives of this study and how the findings stated in this chapter answers the research questions.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 INTRODUCTION

This thesis contributes to the ongoing, though limited and mixed empirical discussions in literature concerning the benefits and impact levels of different governance models by demonstrating that management centric model and structures can positively contribute to scientific performance, provided supported by advisory group of mainstream scientists/academics at key hierarchical levels of governance. However, in the context of the thesis analysis, the argument is that, with appropriate competences and steering autonomy, scientific committees could take and implement more informed research decisions than institutional management or even research chairs acting alone.

When acting alone, management and research chairs might either ignore professional advice and inputs. Thus, the thesis argues that scientific committee structures with significant research steering autonomy tend to play better steering role than management centric model and structures. Other major contributions to literature on research management and performance lie in the analysis of relative significant effects of those causal factors that contribute to scientific output. The thesis employed innovative method of simultaneously testing the relative significance of the explanatory power of variables under study considering that, as most social phenomena, multiple factors tend to influence research performance. By so doing, this thesis contributes to discussions in literature showing that the contribution of research behaviour/practices to scientific output is the most significant predictor among all the causal factors that influences research performance at the individual level. Research institutions can therefore enhance performance by developing research and development strategies that support and sustain appropriate research behaviours at the individual and operative level.

In the context of explaining the nature of association among the causal factors that affect scientific output, the thesis analysis fills a missing gap in literature by discussing the complex intervening and moderating influence of governance structures on research behaviour/practices of researchers and their scientific output. In exerting moderating influence on behaviour, scientific committee structures could mould and sustain appropriate research behaviours/practices and competences of individual researchers and research teams by fostering linkages, effective communication, and institutional socialization and by means of qualitative peer reviews. The thesis further innovatively proved that research related behaviours are multi dimensional and, apart from communication behaviour, other important forms of doing research (or practices/behaviours) could have profound impact on research performance. Publication behaviour, funding behaviour, choices about research priorities could make important contributions to scientific performance. The scientist's communication behaviour conditions, or has mediating influence on, other research related activities. The analysis therefore gives the insight that research institutions and universities can increase research effectiveness by wisely choosing their governance models and structures in order to support important research choices at the individual level. A further argument is that results showing negative contribution of non-supportive institutional condition and positive contribution of intrinsically driven curiosity could have far reaching implications for competiveness of West Africa and a country like the Gambia still working to build and improve its science and technology base. The argument therefore yields the insight that research institutions in the Gambia should wisely choose their governance system, reform the present peer-based evaluation to include qualitative evaluation, and deploy appropriate governance mechanisms that increase autonomy of researchers to choose their own goals, which is important for innovative research.

However, this chapter begins with comments on conclusions taken from Chapter 5 in catch phrases, which underpin the major contributions of the thesis to knowledge on research management, science policy and scientific performance. These conclusions in catch phrases precede each passage of the discussions. The chapter also includes comments on how the thesis analysis meets the objectives of this study as well as how the findings stated in Chapter 5 answers the research questions. The chapter further includes comments on areas for further research as well as the limitations of this study, and ends with recommendations to achieve the study objective by proffering solutions to problems that inhibit scientific knowledge production in the Gambia.

6.1 CONCLUSIONS AND DISCUSIONS

Since Chapter 5 extensively discussed the results of the thesis analysis underpinning major conclusions, the discussion in this section will not depart far from the conclusions already drawn, though it contains some notable comments on how the thesis analysis, results and conclusions contribute to literature on research governance and scientific performance.

Conclusion 1: Scientific committee structures with significant research steering autonomy contribute not only directly to scientific output but also indirectly through mediating/moderating effects on research practices/behaviour. Management centric model and structures can positively contribute to scientific performance, provided supported by advisory group of mainstream scientists/academics at key hierarchical levels of governance. With appropriate competences and steering autonomy, scientific committees could take and implement more informed research decisions than institutional management or even research chairs. When acting alone, management and research chairs might possibly ignore professional advice and inputs. Scientific committee structures with significant research steering autonomy tend to play better steering role than management centric model and structures.

Recent studies focusing on determinants and hampering factors of the scientific output of researchers include Lissoni et al. (2009) on size and nature of projects, authors' age and (Turner and Mairesse, 2003) on gender. (Breschi et al. 2005; Van Looy et al. 2006; Stephan et al. 2007) identified patenting activities as one of the determinants and factors hampering scientific output. (Horta and Lacy, 2011) discussed the impact of research unit size on academics' scientific output and communication behaviour. (Gonzalez-Brambilla and Veloso, 2007; Von Tunzelmann *et al*., 2003; Long and McGinnis, 1981), looked for determinants of scientific productivity at the individual level, others at the organizational/university level ((Valadkhani and Ville, 2009) and at laboratory levels (Carayol and Matt, 2004). (Horta and Lacy, 2011) combined both individual and organizational determinants that affect research at the individual level. However, none of the previous empirical studies including Schubet (2009), which is closest focusing on the effects of governance models and structures on scientific output, have tested for the possible contribution of professional self-steering model to scientific effectiveness. Schubet, (2009) found positive impact for *academic self-management* on scientific efficiency. There appears also to be a gap in literature on the question of the relative significant impact levels of the causal factors of research output as well as possible association between or among these factors. Ongoing empirical discussions in literature on the contribution of different governance models and structures to scientific output appear mixed and limited. Besides, previous studies employed one measure for research output at a time, without testing the effects or considering different variables simultaneously. In this context, the thesis analysis, contributes to empirical discussions on research governance, showing that scientific committee structures with significant research steering autonomy contribute not only directly to scientific output but also indirectly through moderating effects on research practices/behaviour. By generally contributing positively to the development of appropriate research behaviour, this model and its governance structures could have profound impact on scientific output of the researcher. In precise terms, the thesis findings established that scientific committee structures with significant research steering autonomy has mediating/moderating effects on research practices/behaviour, and is positively correlated with scientific output. Autonomous scientific committees could mould and sustain appropriate research behaviours/practices and competences of individual researchers and research teams by fostering linkages, effective communication/exchange of information among peers, institutional socialization and by means of qualitative peer-based evaluations. Therefore, the finding that scientific committee structures with important steering autonomy contribute not only directly to scientific output but also indirectly through moderating effect on research behaviour of scientists answers the research question of how research governance affects scientific knowledge production in public research institutions in the Gambia. The Thesis **further presents results for the research question** on the nature of association among the multi causes of scientific performance of scientists. Publication counts for scientists across research institutions in the Gambia were significantly high before 2009 (i.e. 2006-2009) when scientific committee structures actually steered research to achieve significant results. Thereafter, 2009-2010, publication counts fell sharply when the apparent shift towards management centric form of research governance resulted in a lack of management genuine commitment to research and development and non-prioritization of research as well as very limited investment in research. Besides, the same period witnessed high labour turnover across research institutions in the Gambia as many scientists left their jobs for better offers in the sub region and overseas. The University of the Gambia in particular witnessed the exit of almost all its professors and core scholars.

A plausible explanation for decline in scientific output of researchers is that after 2009, the exit of the more competent and experienced scientists apparently created a gap in the mentoring process and in internal research collaborations, and lowered morale/confidence in doing research. In addition, the moderating influence of scientific committee structures either disappeared or weakened, consequently limiting the contribution of research behaviour to scientific output. Analysis of these results shows that scientific committees with significant research steering autonomy could have profound impact on research practices and scientific output. It follows that the two causal/explanatory variables, scientific structures and research practices/behaviour, are associated where scientific structures directly influence research output as well as indirectly through moderating impact on research practices/behaviour. In this context, the thesis contribution is that scientific committee structures go beyond merely monitoring and sanctioning (e.g. by means of peer-based evaluation/pay-for-performance incentive scheme) to directly influence research behaviour consequently impact on performance. This model and structures could also foster linkages, effective communication, and institutional socialization in order to govern the behaviour of scientists and by so doing shape research behaviour directly and influence performance indirectly. The analysis further yields the insight that research institutions, considering their missions, should wisely choose their governance system because of the far-reaching implications it might have for research practices or behaviours of scientists and their knowledge generation.

The thesis analysis further shows that scientific committee structures with significant research steering autonomy tend to play better steering role than management centric model and structures. Major benefits of scientific committee model and structures lie in consultation and consideration of wider range of options in decision-making and implementation as inputs could come from researchers/scientists at all hierarchical levels of the governance structure. This governance system would appear to be more open to accept reforms, generally improve the governance system, and give greater autonomy to researchers for creative research to blossom. Scientific committees consisting of mainstream scholars/scientists who understand the process and content of research could more readily adopt qualitative peer-based evaluations (as a means of governing the behaviour of researchers), foster creative research and generally improve the governance system. The traditional system of governing the behaviour of scientists based on bibiliometric indicators (ie, quantity of publications) for measuring performance appears to undermine the conditions for creative research. This is because the system supports ''extrinsic motivation to score high rankings'' and crowds out intrinsically motivated curiosity to do research'' (Osterloh and Frey, 2009:20). The system thus sacrifices quality for quantity research, and professional/ scientific committee system seems more likely to reform it. The analysis involved simultaneous consideration/treatment of the different causal factors of the response variable. However, the thesis further argues that, provided supported by advisory group of mainstream scientists/academics at key hierarchical levels of governance, management centric model and structures can positively contribute to scientific performance. Based on these arguments, the thesis analysis has largely achieved its objective of identifying and explaining factors in research governance that influence research output of public sector scientists in the Gambia.

Overall, since genuine research, and in particular creative research and innovations require autonomy, individuality and freedom on the part of researchers, research teams, and governors of research, research institutions must wisely set up suitable governance model, which provides for significant decision-taking autonomy at key hierarchical levels of governance. Depending on their missions, a national research council, in order to guide and focus research activities to the needs of society and industry, could support the governance structures. In this context therefore, the contribution of the results of analysis and *Conclusion 1* is that scientific committee approach to research governance has promising potentials to enhance knowledge production by researchers/scientists. However, there is a possible danger of `using this recipe to create a governance model hijacked by professional oligarchs. Besides, the thesis considers as a limitation lack the crucial data to investigate the precise moderating effects of scientific committee structures on research behaviours of scientists; this could be considered as an area for future research.

Conclusion 2:** **The contribution of research practices to scientific output is the most significant among all casual factors. Scholarly practices that can produce most significant research outputs are those conditioned by openness, linkages and external exchanges. Communication behaviour tends to have a mediating effect on scholarly/research practices, which thus makes a significant contribution to scientific performance.

The thesis finding further shows that, among all causal/explanatory factors, research practices/behaviour makes the most significant contribution to scientific output. In the context of this study, the finding addresses the research question of how research practices/behaviour including communication behaviour affects scientific output of scientists. However, the thesis analysis of results shows that scholarly practices/behaviour, which can make most significant contribution to research outputs are those conditioned by openness, linkages and external exchanges of information. This is because communication behaviour supports the conditions for generation of knowledge, which require drawing from both existing pool of knowledge and emerging, new knowledge most of which come from external sources, outside the institution (Kogut and Zander, 1992; Fleming and Sorenson, 2004). Collaborations and exchanges of information about research, publications, and knowledge diffusion tend to strengthen and support other research related activities/behaviours, and thus enhance research competence of the scientist. Communication behaviour could in fact determine the extent to which scientists involved in information exchange networks achieved their goals (Abbasi and Altmann 2011). External linkages and research collaborations offer a plausible explanation of why research experience and expertise appear to be growing across research institutions in the Gambia. This is because, though limited research is taking place and public and private sector linkages and support for research are still expanding, institutional science policy nevertheless encouraged collaborations, while external networks and contacts with external educational and scientific institutions appear to be growing rapidly. Moreover, analysis of qualitative data tends to suggest high degree of preference among academics and scientists to interact with colleagues from other universities and Research and Development units. There is also evidence of some degree of internal and external co-authorship networks. Further, publication data and information obtained from institutional databases show that all publications by respondents interviewed were ‘offshore’, that is, papers published in international scientific journals. In this context, this result of the thesis analysis contributes to empirical discussions by elaborating, and providing a more insightful explanation and perspective, on individual research behaviour and outcome of research given that communication and collaborative networks can improve research practices/behaviour, which is a most important predictor of scientific performance. Collaborative research especially external exchanges have potential to shape how the scientist actually organized his work and could enable the scientist acquire expertise, experience and confidence in doing research, and ultimately open up opportunities to generate new knowledge.

The Thesis analysis further yields the insight that research institutions in the Gambia can improve research competences particularly at individual and operative team levels and enhance performance by developing and implementing research and development strategies that foster appropriate research practices. Expanding existing institutional framework for collaborations and external exchanges of information among scientists, recruiting star scientists from outside, training workshops, and the use of mentors or lead investigators are reasonable mechanisms to foster suitable research behaviour among scientists and research teams. Such mechanisms could enhance research competences and performance of scientists, and prop up institutional research ratings. Thus, the thesis analysis has achieved its objective of determining the extent to which collaborative research exchanges contribute to generation of knowledge in the Gambia, given the argument that communication behaviour could have profound impact on other research related behaviours and ultimately on knowledge production.

Conclusion 3: Research related behaviours are multi dimensional and, apart from communication behaviour, other research related behaviours/practices could have profound impact on research performance. Publication behaviour, funding behaviour, choices about research priorities could make important contributions to scientific performance. The scientist's communication behaviour conditions, or has moderating influence on other research related activities. Research institutions and universities can increase research effectiveness by choosing their governance models and structures wisely to facilitate important research choices at the individual level.

Deductively derived findings from qualitative data indicate that the choices, which the scientist makes concerning his research, combine to influence research performance in terms of effectiveness. The number of scholarly publications is a measure of research effectiveness. These decisions, described in terms of behaviours, are about the researcher's publication orientation (whether to go for quantity or quality research), his publication options (where to publish what), funding options, and decisions about research priorities and agenda. These choices affect either the quantity or quality of research. Decisions about publication orientation and strategy for instance affected the quality of research output. For instance, decisions to publish ‘’offshore’’, in reputable international scientific journals, or choices to ‘’game the system’’ and increase ones' publication count at the expense of quality, can affect research effectiveness. Decisions on research priority, whether to go for short or long-term research, and decisions about research collaboration with other peers can also affect research effectiveness. Decisions to collaborate with other peers, the scientist's communication behaviour, which fosters learning and permits efficient use of knowledge, can bring in new methods, new perspectives, new research questions, new forms of thinking and of doing research, and ultimately new publications. Funding options, whether to go for self-funding, competitive funding, research grants or consultancy) and eventual choice, on the other hand, could limit what the researcher works on, the quality and quantity of research. In the context of this research, the thesis established that research practices or research related behaviours, described in terms of the decisions or choices that the scientist makes concerning his research, influenced research output. These findings further answer the research question of how research practices/behaviour including communication behaviour affects scientific output of scientists.

Overall, the thesis analysis of results shows that research related behaviours are multi dimensional and, apart from communication behaviour, other important behaviours concerning the doing of research (research practices/behaviours), could have important impact on research performance. Prior studies, (Gruenfled et al., 2000; Song et al., 2003; Lacetera et al. 2004; Stokols et al. 2005; Horta et al, 2007) have demonstrated the importance and contribution of communication behaviour to generation of knowledge. In contributing to empirical discussions on research behaviour and knowledge generation, the thesis analysis goes further, isolating other research related behaviours apart from communication behaviour of the scientist and associates them with scientific performance. The thesis thus argues that publication behaviour, publication orientation, funding behaviour, decisions about research priorities and agenda as well as communication behaviour of the scientist are critical for knowledge generation. However, both organizational practices or routines and external collaborations and exchanges of information nevertheless condition and drive research behaviour of the scientist. This is because influences from these sources, for instance, information coming from communication activities of the scientist could determine or inform publication and funding decisions as well as publication orientation. In this context, the contribution that other research related behaviours are critical for knowledge generation further provides a more insightful perspective on individual research behaviour and performance. The analysis further yields the insight that research institutions and universities can increase research effectiveness by choosing their governance models and structures wisely in ways that foster important research choices/behaviours at the individual level. To some extent the thesis contribution to literature in this context appears to answer ‘’ new questions to the literature on further exploring the role of individual practices on its contribution to and impact in new knowledge generation’’ (Horta et al, 2007:21). Nevertheless, since quantitative data were not generated, it was not possible to determine and analyze the precise contributions of publication and funding behaviours as well as decisions on research choices and agenda to scientific output. Besides, demographic and other information about researchers such as age, gender, race, nationality, field of science may be required as other moderating variables/influences on behaviour in order to categorize researchers and analyze each category for their impact on scientific output. Unavailability and non-use of such information for use in this study can be considered a limitation. Since the thesis did not study and analyze research behaviour and performance for each discipline and across disciplines, results could possibly vary for different fields of science/disciplines. For this reason, this too could be a limitation of the thesis analysis. There is therefore the need for systematic investigation of the precise effects of research related behaviours other than communication behaviour; this constitutes an area for future research.

Conclusion 4: institutional condition may be a necessary condition for effective research performance. Technical incentives or aids could affect effective research performance. The use of technical facilities can improve or otherwise retard research work. Other non-technical incentives are important in driving research. The drive for research comes not only from external rewards but also from intrinsic preferences.

Addressing the research questions of what are the causal and motivational factors that affect research performance of scientists, results from both studies established a significant correlation between institutional condition (defined by financial and human capacity/resources as well as technical infrastructural facilities for conduct of research) and research performance. Findings from analysis of qualitative data show that institutional condition is not supportive of research, and unless made supportive, will continue to ‘’diminish the drive for research’’. Results from analysis of qualitative data also show that though limited access to technical aids for conduct of research including opportunities to travel generally remained non-supportive of research even before 2009. Publication counts for scientists were high before 2009 but declined sharply thereafter. Table 5.4 indicates strongly decreasing satisfaction with technical infrastructures/incentives between 2006 and 2010. A possible explanation for the relative high publication counts for scientists before 2009 even in spite of decreasing satisfaction with technical incentives and the sharp decline thereafter is that institutional research condition before 2009 possibly were more challenging for researchers, in addition to a measure of autonomy for researchers and supportive feedback from peers encouraged by research governing scientific committees. These happen to be necessary conditions for intrinsic behaviour (Gagne and Deci, 2005; Osterloh and Frey, 2009) and as such possibly acted as catalyst to trigger their intrinsic drive for research. On the other hand, the period after 2009 witnessed high labour turnover across research institutions in the Gambia as many scientists left their jobs for better offers in the sub region and overseas. The University of the Gambia in particular witnessed the exit of almost all its professors and core scholars. Factors such as missing moderating influence on research practices/behaviour from scientific committees, which had become either ignored or moribund after 2009, could account for the sharp decline in publication counts. The decline could have resulted even in spite of competence enhancing influence on research practices from external linkages and communications because of the gap created by moribund scientific committees. This means that the moderating influence of scientific committee structures either disappeared or weakened, consequently limiting the contribution of research behaviour to scientific output. In addition, the exit after 2009 of the more competent and experienced scientists apparently created a gap in the mentoring process and in internal research collaborations, and lowered morale/confidence in doing research. In brief, the conclusion of the thesis analysis of these findings egos the arguments in literature that, depending on circumstances, the drive for research comes not only from external rewards but also from intrinsic preferences (Osterloh and Frey, 2009; Aydin, 2012).

However, the thesis conclusion that both extrinsic motivation and intrinsic preferences are important for genuine research seems to contradict the idea suggested in agency theory that individuals respond systematically in a self-interested way to extrinsic incentives from outside disregarding thereby their intrinsic preferences. Nevertheless, the fact remains that, in the context of the thesis analysis, results show that intrinsically motivated curiosity is crucial in driving creative and innovative research. For this reason, results of analysis showing negative contribution of non-supportive institutional condition and positive contribution of intrinsic motivation suggest far reaching implications for competiveness of a country like the Gambia still working to build and improve its science and technology base. Thus, within the context of this research, the thesis may suggest that the University and research institutions in the Gambia, as key sources for generation of new knowledge and of innovations (Heitor and Horta, 2004), should wisely choose their governance system. They could reform the present peer-based evaluation to include qualitative evaluation, which loosens the rush or pressure on scientists to publish, and deploy appropriate governance mechanisms that increase autonomy of researchers to choose their own goals. This is because the governance of research in the Gambia, based on peer review and principles and assumptions derivable from agency theory, appears not to support the conditions for creative and innovative research. By disregarding the intrinsic motivation of the scientist and supporting extrinsic motivation to score high rankings through quantity of publications, the present peer based evaluation sacrifices quality of research for quantity as it undermines the conditions for creativity. Thus, reform becomes necessary in order to downplay the impact of rankings and encourage symbolic benefits/awards for research, which give supportive feedback to the researcher (Osterloh and Frey, 2009). The reform measures especially in academia could include introducing institutional science policy that encourages the development of ‘‘taste for science’’, which is a special incentive system where higher premium on peer recognition and autonomy than the importance of monetary incentives provides the attraction for scientists to do research (Merton, 1973). (Osterloh and Frey, 2009:20-21) describes the system thus;

> *People are attracted to research for which, at the margin, the autonomy to satisfy their curiosity and to gain peer recognition is more important than money. They value the possibility of following their own scientific goals more than financial rewards. These scholars are prepared to trade-off autonomy against money, as empirically documented by Stern (2004): scientists pay to be scientists.*

The policy initiative could also include careful selection and socialization of a core of scholars/scientists in ways that ensure that this core of scientists are grounded in the methods and spirit of science, and possess the creativity and intrinsically motivated curiosity for research. This group could start the process of mentoring the less competent and experienced, and eventually support the transformation of institutional research process and governance.

However, there remains an open issue in research governance, which is, as to what extent in a researcher's career material interests, intrinsic element, social status, desire for peer recognition, or even age begins to be important in the drive for research. These issues need more systematic investigation and further elaboration.

6.2 RECOMMENDATIONS

Based on the findings and conclusions made in the context of this research, the thesis makes the following bullet point recommendations. These recommendations seek to achieve one of the key objectives of this study, which is to identify and offer solutions to problems that inhibit scientific knowledge production in the Gambia public science system.

- It is evidently clear that there has not been any specific state 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 national research, science and technology policy could provide guidelines for developing institutional research strategic goals and a national research council, which oversees and regulates national science and research in line with national development goals.

- Given the low performance of researchers/scientist, research institutions in the Gambia, considering their missions, should wisely choose their governance system because of the far-reaching implications it might have for research practices or behaviours of their scientists and their knowledge generation. Since genuine research, and in particular creative research and innovations require autonomy, individuality and freedom on the part of researchers, research teams, and governors of research, research institutions must wisely set up suitable governance model, which provides for significant decision-taking autonomy at key hierarchical levels of governance. The thesis recommends increasing autonomy, a shift towards scientific committee approach to research governance, which has promising potentials to enhance knowledge production by researchers/scientists. Depending on their missions, a national research council, in order to guide and focus research activities to the needs of society and industry, could support the governance structures.

- Research is a serious enterprise that requires huge funding, and investments in research and development have proved rewarding for a nation pursuing strategic development goals. It is therefore necessary to improve institutional research funding, expand their funding sources, and introduce competitive research funds and partnerships with external stakeholders. At the institutional level, scientific structures could promote effective grant seeking, preparation of high quality research proposals, and diversification of competitive research funding as well as negotiation of research related contracts and consultancies.
- Given that research practices/behaviour and collaborative exchanges could have profound

impact on knowledge production, research institutions in the Gambia can improve research competences particularly at individual and operative team levels and enhance performance by developing and implementing research and development strategies that foster appropriate research practices. Expanding existing institutional framework for collaborations and external exchanges of information among scientists, recruiting star scientists from outside, training workshops, and the use of mentors or lead investigators are reasonable mechanisms to foster suitable research behaviour among scientists and research teams. Such mechanisms could also enhance research competences and performance of scientists, and prop up institutional research ratings.

- Collaborative research exchanges and external linkages could generally improve research practices and expertise, save time and resources, expand sources of funding, the overall organization of research, and facilitate the coordination of research tasks. It is important to strengthen collaborations with industry, other local research institutions, and international research related organizations. The Thesis suggests the creation of scientific structures with responsibility for facilitating the establishment of partnerships with external stakeholders, the engagement of researchers with external organizations for the purpose of collaboration and encouragement of collegiality among staff. The Gambia needs not only to develop its scientific and technological base, but also must necessarily keep pace with scientific progress at both individual/researcher's and national levels. For this reason, the Gambia government, as most governments are, must be interested in enhancing the level of international collaboration through appropriate policies (Katz and Martin 1997; van Raan 2004). Moreover, in the context of the Thesis conclusion that research practices/behaviour is the most significant predictor of scientific performance, research institutions in the Gambia and the University can increase research effectiveness by choosing their governance models and structures wisely in order to foster appropriate research choices/behaviours at the individual level.

- Human capacity for research is very limited across research institutions in the Gambia. In addition to international collaborations, research institutions should urgently give high priority to development of staff capacity, aimed at developing research skills and expertise and ultimately improving research effectiveness and productivity of scientists. Carefully designed training programs, mentorships, attendance in seminars and scientific conferences are reasonable strategies for enhancing research capacity at the micro/individual level.

- Supportive institutional condition for research will improve scientific performance of researchers and research teams. This means that research institutions must urgently improve the limited research funding situation, limited technical infrastructural facilities such as laboratories, libraries, databases, archrivals, transportation, and internet connectivity. However, results of analysis showing negative contribution of non-supportive institutional condition and positive contribution of intrinsic motivation suggest far reaching implications for competiveness of a country like the Gambia still working to build and improve its science and technology base. Thus, within the context of this research, the thesis recommends that the University and research institutions in the Gambia, as key sources for generation of new knowledge and of innovations (Heitor and Horta, 2004), should wisely choose their governance system. They could reform the present peer-based evaluation to include qualitative evaluation, which loosens the rush or pressure on scientists to publish, and deploy appropriate governance mechanisms that increase autonomy of researchers to choose their own goals. This is because the governance of research in the Gambia, based on peer review and principles and assumptions derivable from agency theory, appears not to support the conditions for creative and innovative research. By disregarding the intrinsic motivation of the scientist and supporting extrinsic motivation to score high rankings through quantity of publications, the present peer based evaluation sacrifices quality of research for quantity as it undermines the conditions for creativity. Thus, reform becomes necessary in order to downplay the impact of rankings and encourage symbolic benefits/awards for research, which give supportive feedback to the researcher (Osterloh and Frey, 2009). The reform measures especially in academia could include introducing institutional science policy that encourages the development of ‘‘taste for science’’, which is a special incentive system where higher premium on peer recognition and autonomy than the importance of monetary incentives provide the attraction for scientists to do research (Merton, 1973). The policy initiative could also include careful selection and socialization of a core of scholars/scientists in ways that ensure that this core of scientists are grounded in the methods and spirit of science, and possess the creativity and intrinsically motivated curiosity for research. This group could start the process of mentoring the less competent and experienced and eventually, of transforming the institutional research process and governance.

LIST OF REFERENCE

Abbasi, A., Altmann, J., and Hwang, J. (2010). "Evaluating Scholars Based on Their Academic Collaboration Activities: Two Indices, the Rc-Index and the Cc-Index, for Quantifying Collaboration Activities of Researchers and Scientific Communities," *Scientometrics* (83:1), pp. 1-13.

Abbasi, A., and Altmann, J. (2011). "On the Correlation between Research Performance and Social Network Analysis Measures Applied to Research Collaboration Networks," *Hawaii International Conference on System Sciences, Proceedings of the 44th Annual*, Waikoloa, HI: IEEE.

Abbasi, A., Chung, Kon S. K., and Hossain, L. (2012) ''Egocentric Analysis of Co-authorship Network Structure, Position and Performance''. Available at: http://works.bepress.com/alireza_abbasi/18

Adams, J D., Black, G. C., Clemmons, J. R., and Stephan, P. E. (2005). ''Scientific teams and institutional collaborations: evidence from US universities, 1981–1999''. *Research Policy*, 34, pp. 259-285

Adams, J. D., and Clemmons, J. R., (2008). ''The original of industrial scientific discoveries''. National Bureau of Economic Research, Working paper 13823.

Adams, J., and Griliches, Zvi, (1997). "Research Productivity in a System of Universities". Working Paper No. 5833, National Bureau of Economic Research Inc

Adams, J.D., (1990). "Fundamental stocks of knowledge and productivity growth". *Journal of Political Economy*, 98, pp. 673–702

Agres, T., (2002). ‘'Euros for Discoveries?'’ *The Scientist*, 16(9), p. 42.

Aksnes, D W, Rip, A. (2009) ‘‘Researchers’ Perceptions of Citations’’. *Research Policy*, 38, pp. 895-905.

Alston, J.M., C. Kang, M. Marra, P. Pardey, and Wyatt, J. (2000). "Meta-analysis of rates of Return to Agricultural R&D: Ex Pede Herculum", IFPRI Research Report 113, Washington, DC

Amabile, T. (1998).’’ How to kill creativity’’. *Harvard Business Review*, 76, pp. 76–87.

Amabile, T. M., Conti, R., Coon, H., Lazenby, J. & Herron, M. (1996). ‘’Assessing the work *and Application, 41*(1), 25-42.

Amaral, A., Jones, G. A., and Karseth, B. (2002). "Governing Higher Education: National perspectives on Institutional Governance". Dordrecht/Boston/London: Kluwer academic Publishers.

Annells, M., (1996). **‘’**Grounded Theory Method: Philosophical Perspectives, Paradigm of Inquiry and Postmodernism’’. *Qualitative Health Research*, 6(3), pp. 379-393, Sage Publications Inc. Available at http://qhr.sagepub.com/content/6/3/379

Arnold, E. and Bell, M., (2001). "Some New Ideas about Research for Development, Partnership at the Leading Edge: A Danish Vision for Knowledge". Research and Development (Danish Ministry of Foreign Affairs), pp. 288-316.

Arudo, J., Kamau R., Kamanzi D., and Kennedy. A. (2009). "Health research policies and priorities in 19 African low income countries". Available at http://portal.unesco.org/education/en/files/58049/12246675435Arudo.pdf/Arudo.pdf.

Autio, E. and Klofsten, M. (1998). ‘’A comparative study of two European business incubators’’. *Journal of Small Business Management*, 36(1), pp30-34

Aydin, T O., (2012). ‘’The Impact of Motivation and Hygiene Factors on Research Performance: An Empirical Study from a Turkish University’’. *International Review of Management and Marketing* 2 (2), pp.106-111

Babchuk, W. A. (2008). ‘’Variations on a theme revisited: Operationalizing grounded theory for research and practice’’. In M. L. Rowland (Ed.), *Proceedings of the 27th Annual Midwest*

Babchuk, W.A. (2011) ‘’Grounded Theory as a “Family of Methods”: A Genealogical Analysis to Guide Research’’. *US-China Education Review,* A 3, pp. 383-388

Bacon, F., (2000). "The New Organon". Lisa Jardine and Michael Silverthorne, eds., Cambridge: Cambridge University Press, xiv, 66

Baker, C., Wuest, J. and Stern, P. (1992). ‘’Method Slurring: the grounded theory/phenomenology example’’. *Journal of Advanced Nursing,* 17(11) pp. 1355-60.

Bandara, W., Gable, G. G. and Rosemann, M. (2005). ‘’Factors and Measures of Business Process Modeling: Model Building through a Multiple Case Study’’. *European Journal of Information Systems* 14 (4), pp.347-360

Barjak, F and Robinson, S., (2007). ‘’International collaboration, mobility and team diversity in the life sciences: impact on research performance’’. *Social Geography Discussions,* 3, pp.121–157

Baum, J., Li, X., Usher, J. (2000). ‘’Making the next move: How experiential and vicarious learning shape the locations of chains’ acquisition’’. *Administrative Science Quarterly,* 45 pp. 766-801

Becher, T., and Trowler, P. R. (2001). ‘’Academic Tribes and Territories’’. (2nd ed.), Buckingham and Philadelphia: SRHE and Open University Press.

Benoliel, J. Q. (1996). ‘’Grounded theory and nursing knowledge’’. *Qualitative Health Research*, 6(3), pp. 406-428.

Bentz, V. M., and Shapiro, J. J. (1998). ‘’Mindful inquiry in social research’’. Thousand Oaks, CA: Sage.

Benz, M., and Frey, B. S. (2007). ‘’Corporate governance: What can we learn from public governance?’’ *Academy of Management Review*, 32 (1), pp. 92–104.

Berelson, B. (1960). ‘’Graduate Education in the United States’’. McGraw-Hill: New York.

Berg, Bruce. (2007). ‘’Qualitative Research Methods for the Social Sciences’’ (6th ed). Boston: Pearson Education.

Berg, Bruce. (2007). ‘’Qualitative Research Methods for the Social Sciences’’ (6th ed). Boston: Pearson Education.

Bhagwan, M.R., (1995). "Technological implications of structural adjustment: the case of India". *Economic and Political Weekly*, 18–25, M2-M12, February.

Biglan, A., (1973). "The Characteristics of Subject Matter in Different Academic Areas". *Journal of Applied Psychology*, 57(3), pp. 195-213.

Binsbergen, P., De Boer, H., and Van Vught, F. A. (1994). "Comparing Governance structures of Higher Education Institutions". In L. Goedegebuure and F. A. Van Vught (eds.), ‘Comparative Policy Studies in Higher Education’, Utrecht: Lemma, pp. 219-247.

Bishop, A.P. (1994). "The role of computer-networks in aerospace engineering". *Library Trends*, 42, pp. 694–729.

Blaikie, N. (1991) ‘‘A Critique of the Use of Triangulation in Social Research’’, *Quality and Quantity* 25, pp. 115–36.

Blaikie, N. (2000). ‘’Designing Social Research’’. London: Polity.

Blasi, P. (2005). "The contribution of higher education and research to the Knowledge Society". In Luc Weber and Sjur Bergan (eds), 'The public responsibility for higher education and research' , Strasbourg Cedex: Council of Europe Publishing, p.122

Bleiklie, I., Hostaker, R. (2004). ‘’Modernizing Research Training-Education and Science Policy between Profession, Discipline and Academic Institution’’. *Higher Education Policy* 17 pp. 221-236

Boardman, P C and Corley, E. A. (2008). ‘’University research centers and the composition of research collaborations’’. *Research Policy,* 37, pp. 900-913

Bogdan, R.C. and Biklen, S. K. (2007). ‘’Qualitative research for education: An introduction to theories and methods’’. (5th ed.), Boston: Pearson Education.

Bonaccorsi, A and Daraio, C. (2005). ‘’Exploring size and agglomeration effects on public research productivity’’. Scientometrics

Bonaccorsi, A., Daraio, C., and Simar, L. (2006). ‘’Advanced indicators of productivity of universities: an application of robust nonparametric methods to Italian data’’. Scientometrics

Bönte, W., 2004. "Spillovers from publicly financed business R&D: some empirical evidence from Germany" Research policy, 33(10). pp 1635-11655

Bowers, B, and Schatzman, L. (2009). ‘’Dimensional analysis’’. In J.M. Morse, P.N. Stern, J. Corbin, B. Bowers, K. Charmaz, and A.E. Clarke (Eds.), *Developing grounded theory: The second generation* (pp. 186-126). Walnut Creek, CA: Left Coast Press, Inc

Bowker, Natilene (2000). ‘’Journeying through IRC: A postmodern encounter?’’ In Kris Knauer (Ed.), ‘On the move: the net, the street and the community’ [Online]. London: Write Online. Available: . [Broken link, May 2002].

Bowker, Natilene Irain (2001). ‘’Understanding Online Communities Through Multiple Methodologies Combined Under a Postmodern Research Endeavour’’ [70 paragraphs].Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 2(1), Art. 19, http://nbn-resolving.de/urn:nbn:de:0114-fqs0101194.

Bowonder, B. and Miyake, T., (2000). "Technology Management: a Knowledge Ecology Perspective". International Journal of Technology Management, 19(7/8). pp. 662-684

Bradach, J. L., and Eccles, R. G. (1991). "Price, authority and trust: from ideal types to plural forms’'. In G. Thompson, Frances, J., Levacic, and R., Mitchell, J. (eds.), 'Markets, Hierarchies and Networks’. London, New Delhi: Sage Publications.

Brady, H. E., and David Collier, (eds.) (2004). ‘’Rethinking social inquiry: Diverse tools, shared standards’’. Lanham, MD: Rowman and Littlefield.

Braun, D. and F. X. Merrien (eds.), 'New Managerialism and the governance of Universities in a Comparative Perspective’, 53rd ed., London and Philadelphia: Jessica Kingsley Publishers, pp. 934.

Braun, D., and Merrien, F. X. (1999). "Governance of Universities and Modernization of the State". In D. Braun and F. X. Merrien (eds.), 'New Managerialism and the governance of Universities in a

Comparative Perspective', 53rd ed., London and Philadelphia: Jessica Kingsley Publishers, pp. 934.

Brim, J.A. and Spain, D.H. (1974). ''Research design in anthropology: paradigms and pragmatics in Testing of hypothesis''. New York: Holt, Rinehart and Winston.

Bryant, A. (2002). ''Re-grounding grounded theory''. *Journal of Information Technology Theory and Application, 41*(1), pp. 25-42.

Bryant, A. (2003). ''A constructivist response to Glaser''. Forum Qualitative Sozialforschung Forum: Qualitative Social Research. CSA Abstracts http://www.csa.com/factsheets/socioabs-set-c.php.

Bryant, A. and Charmaz, K. (2007a). ''Grounded theory research: Methods and practices''. In A. Bryant and K. Charmaz (Eds.), *The Sage handbook of grounded theory* (pp. 1-28). Thousand Oaks, CA: Sage.

Bryant, A. and Charmaz, K. (2007b). ''Grounded theory in historical perspective: An epistemological account''. In A. Bryant and K. Charmaz (Eds.), *The Sage handbook of grounded theory* (pp. 31-57). Thousand Oaks, CA: Sage.

Burrell, G. and Morgan, G. (1979). ''Sociological paradigms and organizational analysis: elements of the sociology of corporate life'' London: Heinemann.

Camara, A and Toure, K. (2010). '' African universities strategize and struggle to research and make research matter'' International Development Research Centre/ *West and Central Africa*

*Regional Office (*IDRC/WARO) Available at www.globalrmn.org/publication.asp and *www.idrc.ca/fr/ev-147729-201-1-DO_TOPIC.html*.

Carayol, N and M Matt, M., (2006). ‘’Individual and collective determinants of academic scientists’ productivity’’. *Information Economics and Policy*, 18, pp. 55–72.

Carayol, N. and Matt, M. (2004). ‘’Does research organization influence academic production? Laboratory level evidence from large European university’’. *Research Policy*, 33, Pp. 1081-1102

Carson, D., Gilmore, A., Perry, C. and Gronhaug, K. (2001). ‘’Qualitative Marketing Research’’. Sage: London.

Cesaroni, F and Piccaluga, A. (2002). "Patenting activities of European Universities: Relevant? Growing? Useful?" Paper presented at SPRU NPR net Conference Rethinking Science Policy, 21-23 March

Charmaz, K. (1983). ‘’The Grounded Theory Method: an explication and interpretation’’. In: Emerson, R. (Ed), ‘Contemporary Field Research: a collection of readings’, Boston: Little Brown Company.

Charmaz, K. (2000). ‘’Constructivist and objectivist grounded theory’’. In N. K. Denzin and Y. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 509-535). Thousand Oaks, CA: Sage.

Charmaz, K. (2006). ‘’Constructing grounded theory: A practical guide through qualitative analysis’’. London: Sage.

Charmaz, K. (2009). ‘’Shifting the grounds: Constructivist grounded theory’’. In J.M. Morse, P. N. Stern, J. Corbin, B. Bowers, K. Charmaz, and A.E. Clarke (Eds.), *Developing grounded theory: The second generation* (pp. 127-193). Walnut Creek, CA: Left Coast Press, Inc

Charmaz, Kathy (1995). Between positivism and postmodernism: Implications for methods. Studies in Symbolic Interaction, 17, 43-72.

Chesbrough, H. W. and Teece, D.J., (1996). "When is virtual virtuous? — Organizing for innovations". *Harvard Business Review, pp.* 65–73 (January–February).

Chia, R. (1995), ‘‘From Modern to Postmodern Organizational Analysis’’. *Organization Studies* 16, p 579

Chiovitti, R. F. and Piran, N. (2003) “Rigor and grounded theory research”, *Journal of Advanced Nursing*, 44(4), pp. 427-435.

Chompalov, J. and Shrum, W. (2002). "The organization of scientific collaborations". *Research Policy* 31, pp. 749–767

Clark, B. R. (1983). ‘‘The Higher Education System. Berkeley". Los Angeles: University of California Press.

Clarke, A. E. (2005). ‘’Situational analysis: Grounded theory after the postmodern turn’’. Thousand Oaks, CA: Sage.

Clegg, S. R. and Hardy, C. (1996) ‘‘Conclusion: Representations’’, In S. R. Clegg, C. Hardy and W. R. Nord (eds) Handbook of Organization Studies, London: Sage, pp. 676–708.

Clough, P. and Nutbrown, C. (2002) ‘’A Student’s Guide to Methodology: Justifying Inquiry’’. London: Sage Publications.

Coffey, A., and Atkinson, P. 1996. ‘’Making sense of qualitative data: Complementary research strategies’’. Thousand Oaks, CA: Sage.

Collins, H. M., (1985). "The Possibilities of Science Policy". *Social Studies of Science*, 15, pp. 554-558.

Conrad, C. F., (1982). ‘’Grounded theory: An alternative approach to research in higher education’’. *Review of Higher Education*, ***5*** (4), pp. 239-249.

Coombs, R. and Georghiou, L., (2002). "Business-university linkages -A New Industrial Ecology", *Science*, 296 P. 471

Corbin, J., and Strauss, A. (2008). ‘’Basics of qualitative research’’. (3rd ed.), Thousand Oaks: Sage.

Cox, J. W. and Hassard, J. (2005). "Triangulation in Organizational Research: A Re-Presentation". *Organization*, 12(1), pp. 109–133. Available online athttp://org.sagepub.com/cgi/content/abstract/12/1/109.

Creswell, J. W. (1994). ‘’Research design: Qualitative and quantitative approaches’’. Thousand Oaks CA: Sage.

Creswell, J. W. (1998). ‘’Qualitative inquiry and research design: Choosing among five traditions’’. Thousand Oaks, CA: Sage.

Creswell, J. W. (2003). ‘’Research design: Qualitative, quantitative, and mixed methods approaches’’. London: Sage.

Creswell, J. W. (2005). ‘’Educational research: Planning, conducting, and evaluating quantitative and qualitative research’’. (2nd ed.), Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

Creswell, J. W. (2007). ‘’Qualitative inquiry and research design: Choosing among five Approaches’’. Thousand Oaks, CA: Sage.

Creswell, J. W., (2009). ‘’Qualitative, Quantitative and mixed methods approaches’’. (3rd Ed.), Thousand Oaks, California: SAGE publications, Inc.

Creswell, J. W., Plano Clark, V. L., Guttman, M., and Hanson, W. (2003). ‘’Advanced mixed methods research designs’’. In A. Tashakkori and C. Teddlie (Eds.), *Handbook of mixed methods in social & behavioral research* (pp. 209-240). Thousand Oaks, CA: Sage.

Currie, J., De Angelis, R., De Boer, H., Huisman, J., and Lacotte, C. (2003). ‘‘Globalizing Practices and University Responses’’. Westport, Connecticut, London: Praeger.

Cutcliffe, J., (2000). ‘’Methodological issues in grounded theory’’. J*ournal of Advanced Nursing,* 31

Daily, C. M., Dalton, D. R., and Cannella, A. A. (2003). ‘’Corporate governance: Decades of dialogue and data’’. *Academy of Management Review*, 28, pp. 371–382.

Dainty, A. (2007) “A Call for Methodological Pluralism in Built Environment Research”, *Proceedings of the Third Scottish Conference for Postgraduate Researchers of the Built and Natural Environment*, Glasgow Caledonian University, November 20-22, pp. 1-10, PRoBE.

Dantas, E. (2005). "The 'system of innovation' approach, and its relevance to developing countries". Science and Development Network, (http://www.scidev.net/dossiers/index.cfm?fuseaction=policybrief&policy=61&section=362&dossier=13)

David, P.A. and Steinmueller, W.E. (2003). "Introduction". *Economics Innovation and New Technologies* 12 (1), pp. 1–3.

De Boer, H., Enders, J., and Schimank, U. (2007). "On the Way towards New Public Management? the Governance of University Systems in England, the Netherlands, Austria, and Germany". In D. Jansen (Ed.), 'New Forms of Governance in Research Organizations-Disciplinary approaches, Interfaces and Integration'. Dordrecht: Springer, pp. 137-154.

De Bruin, T., (2007). "Insights into the Evolution of Bpm in Organisations". In 18th Australasian Conference on Information Systems (Toleman, M. and Cater-Steel, A. and Roberts, D., Eds), the University of Southern Queensland, Toowoomba, Australia. pp 632-642

De Toqueville, A., (1848/1966). "Democracy in America". (George Lawrence, trans.). New York:Harper and Row.

De Waal, C. (2005). ‘’On pragmatism’’. Belmont, NJ: Wadsworth.

Deem, R. (2004). ‘’The knowledge worker, the manager-academic and the contemporary UK University: New and old forms of public management?’’ *Financial Accountability and Management*, 20(2), pp. 107–128

Dempsey, P. and Dempsey, A., (2000). ‘’Using Nursing Research: Process, Critical Evaluation, and Utilization’’. Baltimore: Lippincott

Denscombe, M. (2003) ‘’The Good Research Guide: For Small-Scale Research Projects’’. (2nd ed.), Buckingham: Open University Press.

Denzin, N. (1978). ‘’The Research Act: A Theoretical Introduction to Sociological Methods’’, 2nd edn. New York: McGraw-Hill.

Denzin, N. K and Lincoln Y. S., (2005). ''Introduction: The Discipline and Practice of Qualitative Research''. In N. Denzin and Y. S Lincoln (eds), The SAGE Handbook of Qualitative Research, 3rd edition, London: SGAE Publications

Denzin, N. K. and Lincoln, Y. S., (2007). ''A Handbook of Qualitative Studies''. Thousand Oaks, CA: Sage

Devadas, U. M, Silong, A. D., and Ismaila, I. A. (2011). ''Application of Grounded Theory method in researching rural entrepreneurship development''. *The Journal of International Social Research*, 4(19), pp.317-329 Available at www.sosyalarastirmalar.com

DFID (2004). Department for International Development research funding framework 2005-7 DFID UK

Dills, C. R., and Romiszowski, A. J. (1997). ''The instructional development paradigm: An introduction''. In C. R. Dills, and A. J. Romiszowski (Eds). 'Development paradigms'. Englewood, NJ: Educational Technology Publications, Inc.

Dix, K. L., (2007). **''**DBRIEF: A research paradigm for ICT adoption''. *International Education Journal*, 8(2), pp. 113-124. Available at http://iej.com.au

DoSE, Education Policy 2004-2015, May, 2004. Available at http://planipolis.iiep.unesco.org/upload/Gambia/Gambia_Ed_Pol_2004-2015.pdf

Dosi, G., Llerena, P., and Labini, M. S. (2006). "The relationships between science, technologies and their industrial exploitation: An illustration through the myths and realities of the so- called ‘European Paradox''. *Research Policy*, 35(10), pp. 1450-1464.

D'Souza C. and Sadana R. (2006). "Why do case studies on national health research systems matter? Identifying common challenges in low- and middle-income countries". *Social Science & Medicine*, 62, pp.2072-20

D'Souza, C, Sadana, R. (2006). ''Why do case studies on national health research systems matter? Identifying common challenges in low- and middle-income countries". *Social Science and Medicine*, 62, pp. 2072-2078

Dvir, R. and Pasher, E. (2004). "Innovation engines for knowledge cities: an innovation ecology perspective". Journal of Knowledge Management, 8(5) pp. 16-27

Egan, T. M., (2002). ‘’Grounded Theory Research and theory building’’. *Advances in Developing Human Resources*, 4 (3) pp. 277-295 Sage Publications

Eich, D., (2008). ‘’A Grounded Theory of High-Quality Leadership Programs: Perspectives From Student Leadership Development Programs in Higher Education’’. *Journal of Leadership & Organizational Studies*, 15, pp. 176-187, Enders, J., (2001). "A Chair system in transition: appointments, promotions and gate-keeping in German higher education". *Higher Education,* 41, pp. 3-25

Etzkowit, H. and Leydesdorft, L., (2000). "The dynamics of innovation: from national systems and 'model' to a triple helix of universityu-induestry-government relations. Research" *Policy*, 29(2), pp.109-123

Etzkowitz, H. (2003). ''Innovation in Innovation: The Triple Helix of University-Industry-Government Relations''. *Social Science Information* 4(3), pp. 293-337

European Commission, Report of ERA Expert Group. (2008). "Challenging Europe's Research: Rationale for European research Area (ERA)". Luxembourg: European Communities. Available at http://ec.europa.eu/research/era

European Commission-ERAWATCH, (2009). "Trends in R&D policies for a European knowledge-based economy". European Commission- JRC Scientific and Technical Report, G. Veltri, A. Grablowitz, and F. Mulatero (eds), European Commission-ERAWATCH Project. Luxembourg: European Communities

FAO (Food and Agriculture Organization of the United Nations), (1993). Les systèmes nationaux de recherche agronomique en Afrique occidentale et centrale. Rome.

Fielding, N. G. and Fielding, J. L. (1986). ''Linking Data: Qualitative and Quantitative Methods in Social Research''. Beverley Hills, CA: Sage.

Firat, A. Fuat and Venkatesh, Alladi (1995). ''Liberatory postmodernism and the re-enchantment of consumption''. *Journal of Consumer Research*, 22, pp. 239-267.

Fong, E. A., and Tosi, H. L., Jr. (2007). ‘’Effort, performance, and conscientiousness: An agency theory perspective’’. *Journal of Management*, 33, pp. 161–179.

Foster, R., (1997). ‘’Addressing epistemologic and practical issues in multi-method research: A procedure for conceptual triangulation’’. *Advances in Nursing Science*, 20(2), 1-12.

Fransman, M., (1992). "AT&T, BT and NTT: Vision, Strategy, Corporate Competence, Path-dependence and the Role of R&D", Vol. 8. Institute for Japanese–European Studies, University of Edinburgh, Edinburgh.

Frey, B. S., and Neckermann, S. (2008). ‘’Awards – A view from psychological economics’’. *Journal of Psychology*, 216, pp. 198–208.

Gagné, M., and Deci, E. L. (2005). ‘’Self–determination theory and work motivation’’. *Journal of Organizational Behavior*, 26, pp. 331–362

Gall, M. D., Borg, W. R., and Gall, J. P. (1996). ‘’Educational Research: An Introduction’’ (6th ed.). White Plains, NY: Longman.

Gambardella, A., (1995). "Science and Innovation: The U.S. Pharmaceutical Industry During the 1980s". Cambridge: Cambridge University Press

Garvey, W.D., (1979). "Communication: The Essence of Science". Oxford: Pergamon Press

Gersick, C. G. (1991) ‘‘Revolutionary Change Theories: A Multilevel Exploration of the Punctuated Equilibrium Paradigm’’, *Academy of Management Review* 16, pp. 10–36.

Gersick, C. G., Smith, J. K., and Heshusius, L. (1986). ‘’Closing down the conversation: The end of the quantitative–qualitative debate among educational inquires. Educational Researcher’’, 15(1), 4-12.

GESDRI/ ERNWACA, 2006/2007. "Study on the extent to which social policy development is informed by research evidence". Gambia National Commission under UNESCO Participation Program

Geuna, A. and Nesta, L. (2003). " University Patenting and its Effects on Academic Research". SPRU Electronic Working Paper Series, Paper No 99 Available at: http://www.sussex.ac.uk/spru/

Ghauri, P. and Gronberg, K. (2002). ‘’Research Methods in Business Studies’’, 2nd edn. London: Prentice Hall.

Gittelman, M., and Kogut, B. (2003). ‘’Does good science lead to valuable knowledge? Biotechnology firms and the evolutionary logic of citation patterns’’. *Management Science* 49 (4), pp. 366–382.

Giuri, P., Mariani, M., Brusoni, S., Crespi, G., Francoz, D., Gambardella, A., Garcia-Fontes, W., Geuna, A., Gonzales, R., Harhoff, D., Hoisl, K., Le Bas, C., Luzzi, A., Magazzini, L., Nesta, L., Nomaler, Ö., Palomeras, N., Patel,P., Romanelli, M., and Verspagen, B. (2007). "Inventors and invention processes in Europe: Results from the PatVal-EU survey". *Research Policy*, 36(8), pp. 1107-1127

GLASER, B. G. (2002a). “Conceptualization: On theory and Theorizing Using Grounded Theory”. *International Journal of Qualitative Methods,* 1(2). htt://www.ualberta.co/~ijqm/

GLASER, B. G. (2002b). “Constructivist Grounded Theory?” Retrieved Nov., 20, 2012, from Forum: Qualitative Social Research: http://nbn-resolving.edu/urn:nbn:de0114-fgs0203125.

GLASER, B. G. (2004). "Naturalist Inquiry and Grounded Theory". Retrieved Nov., 20, 2012, from Forum: Qualitative Social Research: http;//nbnresolving.de/urn:nbn:de:0114-fgs040170.

Glaser, B. G. and Holton, J. (2004). ''Remodeling Grounded Theory [80 paragraphs]. Forum qualitative Sozialforschung / Forum: Qualitative Social Research, 5(2), Art. 4. http://nbn-resolving.de/urn:nbn:de:0114-fqs040245

Glaser, B. G. and Strauss, A. L., (1967). ''The discovery of grounded theory: Strategies for qualitative research''. New York: Aldine.

Glaser, B. G. and Strauss, A., (1997). ''Discovery of Grounded Theory: Strategies for Qualitative Research'', *Sociology Press,* 4

Glaser, B. G., (1978). ''Theoretical Sensitivity: Advances in the methodology of Grounded Theory''. *Sociology Press* **5,**

Glaser, B. G., (1998). ''Doing Grounded Theory - Issues and Discussions''. *Sociology Press* **11,**

Gneezy, U., and Rustichini, A. (2000). ''Pay enough or don't pay at all''. *Quarterly Journal of Economics*, 115, pp. 791–810.

Godoe, H., (2009). "Innovation regimes, R&D and radical innovations in telecommunications". *Research Policy*, 29(9) pp. 1033-1046

Goffman, E. (1959). ''The Presentation of Self in Everyday Life'', New York: Doubleday.

Goffman, E. (1961). '' Asylums''. New York: Holt, Reinhart and Winson.

Goffman, E. (1970). ''Strategic Interaction'', Oxford: Basil Blackwell.

Gonzalez-Brambila, C and Veloso, F. M. (2007). ‘’The determinants of research productivity: a study of Mexican researchers’’. *Research Policy*, 36 (7), pp. 1035–1051.

GOTG, (2006). ‘’The Education Sector Strategic Plan 2006-2015’’. Department of State for Education, Republic of the Gambia

Goulding C., (2009). ‘’Grounded Theory perspectives in Organizational Research’’. In Alan Bryman and David Buchanan (Eds.), The Sage Handbook of Organizational Research Methods, Sage Publications Ltd

Goulding, C., (2005). ‘’Grounded theory: a practical guide for management, business and market researchers’’. Sage Publications: London.

Goulding, C., (2001). ‘’Grounded theory: a magical formula or a potential nightmare’’. *Marketing Review* 2 (1), pp. 21-34.

Goulding, C. (2002) ‘’Grounded Theory: A Practical Guide for Management, Business and Market Researchers’’. London: Sage Publications.

Goulding, C., (2000). ‘’Grounded theory methodology and consumer behavior, procedures, practice and pitfalls’’. *Advances in consumer research*, 27 (1), pp. 261-266.

Goulding, C. (1999). ‘’Grounded Theory: some reflections on paradigm, procedures and misconceptions’’. Working Paper Series June 1999, No. WP006/99. Wolverhampton: University of Wolverhampton

Graham, B. and Thomas, K. (2008). “Building Knowledge – Developing a Grounded Theory of Knowledge Management for Construction.” *The Electronic Journal of Business Research Methods*, 6(2), pp. 115 - 122, available online at www.ejbrm.com

Graham, E., (1992). ‘’Postmodernism and paradox. In Joe Doherty, Elspeth Graham and Mo Malek (Eds.), ‘Postmodernism and the social sciences’. London: Macmillan Academic and Professional, pp.196-211

Greene, M. (1997). ‘’The lived world, literature and education’’. In D. Vandenberg (ed.), ‘Phenomenology & education discourse’ Johannesburg: Heinemann, pp. 169-190

Grey, C., Knights, D. and Willmott, H. (1996) ‘‘Is a Critical Pedagogy of Management Possible?’’, In R. French and C. Grey (eds) ‘Rethinking Management Education’, pp. 94–110. London: Sage.

Groenewald, T., (2003). ‘’The contribution of co-operative education in the growing of talent’’. Unpublished doctoral dissertation, Rand Afrikaans University, Johannesburg, South Africa.

Groenewald, T., (2004). "A Phenomenological Research Design Illustrated". *International Journal of Qualitative Methods* 3 (1). pp. 1-26 Stanford Encyclopedia of Philosophy., 2004. Available at http://plato.stanford.edu/entries/phenomenology/

Gruenfled, D., Martorana, P.V., Fan, E.T. (2000). ‘’What do groups learn from their worldliest members? Direct and indirect influence in dynamic teams’’. *Org. Behavior & Human Decision Proc.* 82 pp. 60-74

Guba, E. and Lincoln, Y. (1994) ‘‘Competing Paradigms in Qualitative Research’’, In N. K. Denzin and Y. S. Lincoln (eds) ‘Handbook of Qualitative Research’, pp.105–17. Thousand Oaks, CA: Sage.

Guba, E. G. and Lincoln, Y. S. (2000), “Competing paradigms in qualitative research”. In N. K Denzin and Y.S. Lincoln (Eds), *Handbook of Qualitative Research,* Sage: Thousand Oaks, CA.

Gummesson, E. (2005), “Qualitative research in marketing”. *European Journal of Marketing,* 39(3/4), pp. 309-29.

Hackett, E.J., 2005. "Introduction; special guest-edited issue on scientific collaboration". *Social Studies of Science* 35 (5), pp. 667–671

Hanson, D and Grimmer, M., (2007). ‘’The mix of qualitative and quantitative research in major marketing journals, 1993-2002’’. *European Journal of Marketing*, 41(1/2), pp. 58-70

Hara, N., Solomon, P., Kim, S., and Sonnenwald, D.H. (2003). "An emerging view of scientific collaboration, *Journal of the American Society for Information Science* 54 (10), pp. 952–965

Hardy, C., Phillips, N. and Clegg, S. (2001) ‘‘Reflexivity in Organization and Management Studies: A Study of the Production of the Research Subject”’, Human Relations 54, pp. 33–32.

Hardy, C., Phillips, Smith, J. K., and Heshusius, L. (1986). ‘’Closing down the conversation: The end of the quantitative–qualitative debate among educational inquires’’. Educational Researcher, 15(1), pp. 4-12.

Harris, Eva (2004). "Building scientific capacity in developing countries". EMBO Reports No.5, 1, pp. 7-11 (http://www.nature.com/emobor/journal/vs/ni/full/7400058.html).

Healy, M. and Perry, C. (2000), “Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm”. *Qualitative Market Research*, 3(3), pp. 118 26

Heimeriks, G. and Vasileiadou, E., (2008). "Changes or transition? Analyzing the use of ICTs in sciences". *Social Science Information* 47 (1), pp. 5–29

Heitor, M.V. and Horta, H. (2004). ‘’Engenharia e desenvolvimento científico: O atraso estrutural português explicado no contexto histórico. M. Heitor, J.M.B. Brito, M.F. Rollo. eds. *Momentos de Inovação e Engenharia em Portugal no seculo XX*, D. Quixote, Lisboa.

Henderson, R. and Cockburn, I. (1994). "Measuring competence? Exploring firm effects in drug discovery". *Strategic Management Journal* 15 (winter special issue) (1994), pp. 63–84

Henning E, Van Rensburg W and Smit B (2004) Theoretical frameworks. Ch 2 In: Henning E, Van Rensburg W and Smit B (2004) Finding your way in qualitative research. Van Schaik Publishers. Pretoria.

Henry, J., (2002). "Knowledge is Power; Francis Bacon and the Method of Science". Cambridge: Icon Books, pp.6-8.

Herzberg, F. (1987). ‘’One more time: How Do You Motivate Employees?’’. *Harvard Business Review*, 65(5), pp. 109-120

Hesse, M (1980). ‘’Revolutions and Reconstructions in the Philosophy of Science’’. In Guba, E.C. (1990) (ed). ‘The Paradigm Dialogue’. Sage, pp. 17-31.

Higher Education Strategy Paper, 2007-2017, Republic of the Gambia Round Table Conference, London 5th-6th February 2008

Higón, D. A., (2007). "The impact of R&D spillovers on UK manufacturing TFP: A dynamic panel approach’’. *Research Policy, 36*(7), pp. 964-979

Holloway, I. (1997). ‘’Basic concepts for qualitative research’’. Oxford: Blackwell Science.

Hood, J. C. (2007). ‘’Orthodoxy vs. Power: The defining traits of grounded theory’’. In A. Bryant and K. Charmaz (Eds.), *The Sage handbook of grounded theory* (pp. 151-164). Thousand

Horta, H. and Lacy, T A., (2011). ‘’How does size matter for science? Exploring the effects of research unit size on academics’ scientific productivity and information exchange behaviors’’ *Science and Public Policy*, 38(6), pp. 449-460.

Horta, H., (2010). ‘’The role of the state in the internationalization of universities in catching-up countries: an analysis of the Portuguese higher education system’’. *Higher Education Policy,* 23, pp. 63-81

Horta, H., Huisman, J., and Heitor, M. V. (2008). ‘’Does competitive re-search funding encourage diversity in higher education?’’ *Science and Public Policy,* 35(3), pp. 146-158.

Horta, H., Veloso, F., and Grediaga, R. (2010). ‘’Navel gazing: academic inbreeding and scientific productivity’’. *Management Science,* 56 (3), pp. 414–429.

Horta, Hugo; Veloso, F., and Grediaga, Rocio, (2007) "Navel gazing: Academic inbreeding and scientific productivity". *Department of Engineering and Public Policy*. Paper 118. http://repository.cmu.edu/epp/118.

Horton, D., Alexaki, A. and Bennett-Lartey, S. (2003). "Evaluating Capacity Development: Experiences from Research and Development Organizations around the World". The Hague: ISNAR

Hoshmand, L. T., (1989). ''Alternative research paradigm: A review and Teaching proposal''. *The Counseling Psychologist*. 17, pp.3-79

Howe, K and Eisehart, M. (1990) ''Standards for qualitative and quantitative research: A prolegomenon''. *Educational Researcher*, 1994), pp.2-9

Howell, K. E., (2000). ''Discovering the Limits of European Integrations: Applying Grounded Theory''. Huntington, New York: Nova Science Publishers, Inc.

Howell, K. E., (2004). ''Europeanization, European Integration and Financial Services- Developing Theoretical Frameworks and Synthesising Methodological Approaches''. Palgrave: Macmilla

Hultgren, F. H. and Coomer, D. L. (1989). ''Alternative modes of inquiry in home economics''. Peoria, IL: Home Economics Association.

IDRC (International Development Research Center), (2009). Report on the State of University Research Governance in West and Central Africa: Case of the University of Buea. Y. B., Signing, S. Nguiessi, and C. Koumo (Eds), Available on website: www.agesfo.com

Indulska, M., Recker, J. Rosemann, M. and Green, P. (2009). ‘’Process Modeling: Current Issues and Future Challenges. In Advanced Information Systems Engineering – Caise’’. Amsterdam, The Netherlands: Springer

Intarakumnerd, P., et. al. (2002), National Innovation System in Less Successful Developing Countries: the Case of Thailand_ Research Policy, 31 (8-9), 1445-1457.

International Foundation for Science, (2003). "Scientific research capacity in Cameroon: an assessment of IFS support". Sweden : IFS

Jaffe, A. (1986). "Technological opportunity and spillovers of R& D: evidence from firms’ patents, profits, and market value". *American Economic Review,* 76(5), pp.584–1001.

Jaffe, A. (1988). "Demand and supply influences in R& D intensity and productivity growth". T*he Review of Economic and Statistics*, 70(3), pp. 431–437.

Jaffe, A. B. and Trajtenberg, M., (1996). "Flows of knowledge from universities and federal labs: modeling the flow of patent citations over time and across institutional and geographic boundaries", *Proceedings of the National Academy of Sciences* 93 (1996), pp. 12671–12677

Jaffe, A., Trajtenberg, M. & Fogarty, M. (2000). "Knowledge spillovers and patent citations". *American Economic Review*, 90(2), pp. 215–218.

Janesick, V. (1994) ‘‘The Dance of Qualitative Research Design: Metaphor, Methodology, and Meaning’’, In N. K. Denzin and Y. S. Lincoln (eds) Handbook of Qualitative Research, pp. 209–19. Thousand Oaks, CA: Sage.

Jansen, D., Wald, A., Franke, K., Schmoch, U., Schubert, T., (2007). "Third Party Research Funding and Performance in Research. On the Effects of Institutional Conditions on Research Performance Teams". *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 59, pp. 125–149.

Jean Lee, S.K. (1992), "Quantitative versus qualitative research methods: two approaches to organization studies", Asia Pacific Journal of Management, Vol. 9 No. 1, pp. 87-94.

Jick, T. D. (1984) ''Mixing Qualitative and Quantitative Methods: Triangulation in Action'', In J. S. Bateman and T. R. Ferris (eds) 'Methods and Analysis in Organizational Research', Reston: Reston Publishing, pp. 364–72.

Johnson, B. and Onwuegbuzie, A. (2006). ''Mixed methods research: A research paradigm whose time has come''. *Educational Researcher, 33*(7), 14-26.

Johnson, R. B. and Onwuegbuzie, A. J. (2004). ''Mixed Methods Research: A Research Paradigm Whose Time Has Come''. Educational Researcher, 33(7) pp. 14–26 Available at http://www.aera.net/uploadedFiles/Journals_and_Publications/Journals/Educational_Researcher/Volume_33_No_7/03ERv33n7_Johnson.pdf

Jones, R. and Noble, G. (2007) "Grounded theory and management research: a lack of integrity?" *Qualitative Research in Organizations and Management*, 2(2), pp. 84-96.

Kafouros, M. I. and Buckley. P. J. (2008). "Under what conditions do firms benefit from research efforts of other organizations". *Research Policy*, 37(2), pp. 225-239.

Kaiser, U. (2002). "Measuring knowledge spillovers in manufacturing and services: an empirical assessment of alternative approaches". *Research Policy*, 31, pp. 124–144.

Katz, J., and Martin, B. (1997). "What Is Research Collaboration?" *Research policy*, 26(1), pp. 1-18

Kealey, T., (1996). "The Economic Laws of Scientific Research". New York: St. Martin's Press, pp. 3-5

Keim, J. (1993) ''Triangulation and the Art of Negotiation'', Journal of Systemic Therapies 12, pp. 76–87.

Kensit, D. A. (2000). ''Rogerian theory: A critique of the effectiveness of pure client-centered therapy''. *Counseling Psychology Quarterly*, 13(4), pp. 345-342.

KFPE (2001). "Enhancing research capacity for development", Part V Overview of donors main activities related to research for development. Swiss commission for research partnerships with developing countries

Kidd, S.A. (2002), "The role of qualitative research in psychological journals". *Psychological*

Kirigia, J. M., and Wambebe, C. (2006). "Status of national health research systems in ten countries of the WHO Africa Region". *BMC Health Services Research*, 6, p.135. Available at http://www.biomedcentral.com/1472-6963/6/135

Kuhn, T. S. (1962). ''The structure of scientific revolutions''. Chicago, IL: University of Chicago Press.

Kuhn, T. S. (1977). ''The essential tension: Selected studies in scientific tradition and change''. Chicago, IL: University of Chicago Press.

Kuhn, Thomas S. (1970), ''The structure of scientific revolutions'', 2nd ed., Chicago, University of Chicago Press.

Labinger, J., and Collins, H. (Eds.). (2001). ''The one culture: A conversation about science''. Chicago: University of Chicago Press.

Lacetera, N., Cockburn, I., Henderson, R. (2004). ‘’Do firms change capabilities by hiring new people? A study of the adoption of science-based drug discovery’’. In J.A. Baum and A.M. McGahan. (eds.), *Business strategy over the industry life cycle – Adv. in Strategic Management, 21*, JAI Press: Oxford

Larédo, P., (2007). "Revisiting the third mission of Universities, toward a new categorization of university activities". *Higher Education Policy*, 20(4), pp. 441-456.

Lavy, V. (2007). ‘’Using performance-based pay to improve the quality of teachers’’. *Future of Children*, 17 (1): 87–109.

Layder, D., (1990). ‘’The Realist Image in Social Science’’, New York: St. Martin's Press

Leahy, D and Neary, J. P. (1999). "R&D spillovers and the case for industrial policy in open economies’’. *Oxford Economic Papers*, 51 (1), 40-59[Available at http://oep.oxfordjournals.org/]

Leišytė L., (2007). "University Governance and Academic Research: Case Study of Research Units in Dutch and English Universities". PhD Dissertation, at the University of Twente.

Lewis, M. W. and Grimes, A. J. (1999) ‘‘Meta-triangulation: Building Theory from Multiple Paradigms’’, *Academy of Management Review* 24, pp. 672–90.

Leydesdorff, L. (2006a). "The Knowledge-Based Economy: Modeled, Measured, Simulated". Boca Raton, FL: Universal Publishers

Leydesdorff, L. (2008). "Caveats for the Use of Citation Indicators in Research and Journal Evaluation". *Journal of the American Society for Information Science and Technology*, 59(2), pp. 278-287

Leydesdorff, Loet (2008, June 4). "Measuring Research Output with Science and Technology Indicators". *SciTopics*. Retrieved March 3, 2010, from http://www.scitopics.com/Measuring_Research_Output_with_Science_Technology_Indicators.html
.

Lincoln,Y., and Guba, E. (2000). Paradigmatic controversies, contradictions, and emerging confluences. In N. Denzin and Y. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 163-189). Thousand Oaks, CA: Sage.

Lincoln, Y. S. and Cuba, E. G.. (1985). ‘‘Naturalist Inquiry’’. Newbury Park, CA: Sage

Locke, K. D. (2001). ‘’Grounded theory in management research’’. Thousand Oaks, CA: Sage.

Long, J. S and McGinnis, R. (1981). ‘’Organizational context and scientific productivity’’. American Sociological Review, 46, pp.422-442

Long, R.G., White, M.C., Friedman, W.H. and Brazeal, D.V. (2000), “The ‘qualitative’ versus ‘quantitative’ research debate: a question of metaphorical assumptions”. *International Journal of Value-Based Management*, 13(2), pp. 189-97.

Loosemore, M., (1999). “A grounded theory of construction crisis management”, *Construction*

Louis, K. S., Jones, L. M., Anderson, M. S., Blumenthal, D. and Campbel, E. G. (2001). '‘Entrepreneurship, secrecy and productivity: A comparison of clinical and non-clinical faculty'’, *Journal of Technology Transfer*, 26(3), pp. 233-45

Lusthaus, C., Anderson, G. and Murphy, E. (1995). "Institutional assessment. A Framework for Strengthening Organizational Capacity for IDRC's Research Partners". Ottawa: IDRC

Lynham, S. A. (2002). The general method of theory-building research in applied disciplines.

Lyon, D., (1994). ‘’Postmodernity’’. Bristol: Open University Press.

Maassen, P., and Van Vught, F. A. (1994). ‘‘Alternative Models of Governmental Steering in Higher Education’’. In L. Goedegebuure and F. A. Van Vught (eds.), 'Comparative Policy Studies in Higher Education'. Utrecht: Lemma.

Mahoney, J. and Goertz, G. (2006) ‘’A Tale of Two Cultures: Contrasting Quantitative and Qualitative Research’’. *Political Analysis,* 14, pp. 227-249

Mahoney, James, and Gary Goertz. (2004). ‘’The possibility principle: Choosing negative cases in comparative research’’. *American Political Science Review*, 98, pp. 653–69.

Malshe, A. and Sohi, R.S. (2009). ‘’Sales buy-in of marketing strategies: exploration of its nuances, antecedents, and contextual conditions’’. *Journal of Personal Selling & Sales Management* 29 (3), pp. 207-225.

Mamuneas, T. P., (1999). "Spillovers from publicly finance R&D capital in high tech industries." *International Journal of Industrial Organization*, 17(2), pp. 215-239

Mansfield, E., (1972). "Contribution of R&D to economic growth in the United States". *Science* 175 (1972), pp. 477–486

Manning, P and Smith, G., (2010). ‘’ Symbolic Interactionism’’. In A. Elliot, (Ed.), The Routledge Companion to Social Theory. New York: Routledge

Mansfield, E., (1991). "Academic research and industrial innovations". *Research Policy* ***20***, pp. 1–12

Mansourian, Y. (2006) “Adoption of grounded theory in LIS research”, *New Library World*, 107(9/10), pp. 386-399

Marx, K., (1844/ 1975). "Economic and philosophical manuscripts". In R. Livingstone and G. Benton (trans./eds.), 'Early Writings', New York: Vintage Books, pp. 279–400.

Mason, J. (1996). ‘’Qualitative researching’’. London: Sage.

Maypole, J., and Davies, T. G. (2001). ‘’Students’ perceptions of constructivist learning in a community college American History II’’. *Community College Review, 29*(2), pp. 54-80.

McCallin, A. M. (2003) “Designing a grounded theory study: some practicalities”. *Nursing in Critical Care*, 8(5), pp. 203-208

Mendling, J., Reijers, H. A. and Recker, J. (2009). ‘’Activity Labeling in Process Modeling: Empirical Insights and Recommendations’’. *Information Systems* 35 (forthcoming)

Mertens, D. (2003). ‘’Mixed methods and the politics of human research: The transformative-emancipatory perspective’’. In A. Tashakkori and C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 135-164). Thousand Oaks, CA: Sage.

Mertens, D. M., (2007). ‘’ Transformative Paradigm Mixed Methods and Social Justice’’. Journal of Mixed Methods Research**,** 6(3) pp 212-225

Merton, R. K. (1973). ‘’The sociology of science: Theoretical and empirical investigation’’. Chicago, IL: University of Chicago Press.

Miles, M. B., and Huberman, A. M. (1984). ‘’Qualitative data analysis, a source book of new methods’’. Newbury Park, CA: Sage.

Miller, G. (1997) ‘‘Building Bridges: The Possibility of Analytic Dialogue between Ethnography, Conversation Analysis and Foucault’’, In D. Silverman (ed.) ‘Qualitative Research: Theory, Method and Practice’, London: Sage, pp. 24–44.

Moed, H. F., Glänzel, W., and Schmoch, U. (2004). "Handbook of Quantitative Science and Technology Research: The Use of Publication and Patent Statistics in Studies of S & T Systems". Dordrecht: Springer

Morgan, D. L. (2007). ‘’Paradigms Lost and Pragmatism Regained: Methodological Implications of Combing Qualitative and Quantitative Methods’’ *Journal of Mixed Methods Research*, 1(1), pp.48-76

Morse, J.M. (1994). ‘’Emerging from the Data: the cognitive process of analysis in qualitative enquiry’’. In: J. M. Morse (Ed) ‘*Critical Issues in Qualitative Research Methods’*, Thousand Oaks: Sage.

Moustakas, C. (1994). ‘’Phenomenological research methods’’. Thousand Oaks, CA: Sage.

Mouton, J. and Waast, R., (2009). "Mapping Research Systems in developing countries". Country review Template. Available at http://www.unesco.org.

Mowery, D. C. and A. A. Ziedonis, (2002). "Academic patent quality and quantity before and after the Bayh-Dole act in the United States", *Research Policy* **31**, pp. 339–418.

Mowery, D. C. and Sampat, B.N. (2001). ‘'University patents and patent policy debates in the USA, 1925-1980'’, *Industrial and Corporate Change* 10(3), pp. 781- 815

Mowery, D. C., B. N. Sampat and Siedonis, A. A. (2001) '‘Learning to patent: institutional experience, learning, and the characteristics of US university patents after the Bayh-Dole Act, 1981-1992’'. *Management Science* 48(1), pp. 73-89.

Mowery, D. C., Nelson, R. R., Sampat, B. N. and Ziedonis, A. A. (2001). ‘‘The growth of patenting and licensing by US universities: an assessment of the effects of the Bayh-Dole act of 1980'’. *Research Policy* 30(1), pp. 99-119.

Murphy, S. (1989) ‘‘Multiple Triangulation: Applications in a Program of Nursing Research’’, Nursing Research 38, pp. 294–297.

Narin, F., (1995). "Patents as indicators for the evaluation of industrial research output" *Scientomatrics*, 34(3) pp. 489-496

Nath, P. and Kumar, S. (1993). "Industries response to the draft new technology policy: a report". *Journal of Scientific and Industrial Research,* 52, pp. 747–751

Neave, G., and Van Vught, F. A. (1994). "Government and higher education relationships across three continents: the winds of change". Oxford: IAU, Pergamon.

Neimeyer, G., and Resnikoff, A. (1982). ''Qualitative strategies in counseling research''. *The Counseling Psychologist*, 10, pp. 75-85

Nelson, R.R. (2001) ''Observations on the Post-Bayh-Dole rise of patenting at American universities'', *Journal of Technology Transfer*, 26, pp. 13-19.

Nentwich, M., (2003). "Cyberscience; Research in the Age of the Internet". Vienna: Austrian Academy of Sciences Press.

Neuman, W. L. (2003). ''Social Research Methods''. (5th ed.), Pearson Education: Boston, MA.

Newman, M.E.J. (2004). "Co-authorship Networks and Patterns of Scientific Collaboration," *PNAS* (101:suppl_1), pp. 5200-5205.

Noll, A.M., (1991). ''The future of AT&T's Bell Labs and telecommunications research". *Telecommunication Policy*, pp.101–105.

OECD Fact book, (2008). Economic, Environmental and Social Statistics [website] Available at http://puck.sourceoecd.org/vl=6386059/cl=12/nw=1/rpsv/factbook/070101.htm (cited May 7, 2012, OECD, Research & Development Database, December 2009. Available at http://dx.doi.org/10.1787/836005248761

Oermann, M. H., Nordstrom, C. K., Wilmes, N. A., Denison, D.,Webb, S. A., Featherston, D. E., Bednarz, H., and Striz. P. (2008). " Information sources for developing the nursing literature". *International Journal of Nursing Studies*, 45(4), pp.580-587

Organization for Economic Cooperation and Development (OECD), (2010). Main Science and Technology indicator database. Available at http://dx.doi.org/10.1787/836005248761

Orlikowski, W. J., (1993). ‘’Case Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development’’, *MIS Quarterly*, **17** (3), pp. 309-340.

Osterloh, M. and Frey, B. S. (2000). ‘’Motivation, knowledge transfer, and organizational forms. *Organization Science*, 11, pp. 538–550.

Osterloh, M., and Frey, B. S., (2009). ‘’Research Governance in Academia: Are there Alternatives to Academic Rankings?’’ CESIFO WORKING PAPER NO. 2797 CATEGORY 1: PUBLIC FINANCE Available at http://www.cesifo-group.de/portal/page/portal/DocB ... 9/cesifo1_wp2797.pdf

Palmer, A., Anya, S. E. and Bloch, P. 2009. ‘’The political undertones of building national health research systems – reflections from The Gambia. Health Research Policy and Systems’’ 7(1),

Palmer, R. A., Anya, S. E., and Bloch, P. (2009). "The political undertones of building national health research systems – reflections from The Gambia". *Health Research Policy and Systems***,** 7(13). Available online at http://www.health-policy-systems.com/content/7/1/13.HYPERLINK "

Pardey, P.G., and Beintema, N.M. (2001). "Slow Magic: Agricultural Research a Century after Mendel". Washington: IFPRI

Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods* (2nd ed.). Newbury Park, CA: Sage.

Pavitt, K., (1991). *"*What makes basic research economically useful*?". Research Policy,* ***20****,* pp. 109_119

Pelz, D.C., Andrews, F.M. (1966). ‘’Scientists in Organizations’’. Wiley: New York

Polanyi, M. (1962). ‘’The republic of science: Its political and economic theory’’. *Minerva*, 1. pp. 54–73.

Pot_, B. and Reale, E. (2005) ‘‘The patenting regime in the Italian public research system: What motivates public inventors to patent’’. WORKING PAPER CERIS-CNR Anno 7, N0 10 Autorizzazione del Tribunale di Torino N. 2681 Del 28 marzo 1977 Available at m.zittino@ceris.cnr.it

Pound, B. and Adolph, B. (2005). "Developing the Capacity of research systems in Developing Countries: Lessons learnt and guidelines for future initiatives’’. Study commissioned by the Central Research Department of DFID

Poyago-Theotoky, J., Beath, J. and Siegel, D.S. (2002). _'Universities and fundamental research: Reflections on the growth of university-industry partnerships'_, *Oxford Review of Economic Policy*, 18(1), pp. 10-21

Price, D.D., Barrell, J.J. and Pierre Rainville, P. (2002). "Integrating experiential phenomenological methods and neuroscience to study neural mechanisms of pain and consciousness Original Research Article". *Consciousness and Cognition*, 11 (4), pp. 593-608

Quantz, R. A., (1992). ''On Critical Ethnography with some Postmodern Considerations''. In Margaret D. LeCompte, Wendy L. Millroy and Judith Preissle *(eds) 'The Handbook of Qualitative Research in Education'*. San Diego: Academic Press, Incorporated, pp. 447-505.

Raduescu, C., Tan, H. M. Jayaganesh, M. Bandara, W. Zur Muehlen, M. and Lippe, S. (2006). ''A Framework of Issues in Large Process Modeling Projects''. In J. Ljungberg, and M. Andersson, (eds.) 14th European Conference on Information Systems. Sweden: Association for Information Systems,

Recker, J., (2008). ''Understanding Process Modeling Grammar Continuance: A Study of the Consequences of Representational Capabilities''. Unpublished PhD Dissertation. Queensland University of Technology, Brisbane, Australia.

Reichertz, Jo (2009). ''Abduction: The Logic of Discovery of Grounded Theory'' [39 paragraphs]. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *11*(1), Art. 13, http://nbn-resolving.de/urn:nbn:de:0114-fqs1001135

Reijers, H. A. and Mansar, S. L., (2005). ''Best Practices in Business Process Redesign: An Overview and Qualitative Evaluation of Successful Redesign Heuristics''. *Omega*, 33 (4), pp. 283-306.

Richardson, L. and E. Adams St. Pierre (2005). ‘’Writing: A Method of Inquiry’’. In N. K. Denzin and Y. S. Lincoln (eds.)., *The Sage Handbook of Qualitative Research. (Third Edition)*. Thousand Oaks, London and New Delhi: Sage, pp. 959-978.

Riley, R. (1996). ‘’Revealing Socially Constructed Knowledge through Quasi-Structured Interviews and Grounded Theory Analysis’’, *Journal of Travel and Tourism Marketing,* 15(2) pp. 21-40.

Robinson, D., & Reed, V. (Eds.). (1998). ‘’The A – Z of social research jargon’’. Aldershot, UK: Ashgate.

Rosemann, M., De Bruin, T. and Power, B. (2006). ‘’BPM Maturity’’. In J. Jeston, and J. Nelis’’, (eds.) ‘Business Process Management: Practical Guidelines to Successful Implementations’. Oxford: Butterworth- Heinemann, pp 299-315.

Rosemann, M., Recker, J. and Flender, C. (2008). ‘’Contextualization of Business Processes’’. *International Journal of Business Process Integration and Management,* **3** (1), pp. 47-60.

Sadala, M. L. A., & Adorno, R .deC. F. (2001). ‘’Phenomenology as a method to investigate the experiences lived: A perspective from Husserl and Merleau-Ponty’s thought’’. *Journal of Advanced Nursing*, 37(3), pp. 282-293.

Salter, A. and Martin, B. (2001). "The economic benefits of publicly funded basic research: a critical review". *Research Policy,* 30(3), pp. 509-532.

Scandura, T. A. and Williams, E. A. (2000) ‘’Research Methodology in Management: Current Practices, Trends, and Implications for Future Research’’, *Academy of Management Journal* 43, pp. 1248–64.

Schimank, U. (2005). ‘’New public management and the academic profession: Reflections on the German situation’’. *Minerva*, 43, pp. 361–376.

Schimank, U., (2007a). ‘’Die Governance-Perspektive: Analytisches Potential und anste-hende konzeptionelle Fragen’’. In T. Brüsemeister et al., eds. ‘*Governance, Schule, Politik- Zwischen Antagonismus und Kooperation’.* VS-Verlag: Wiebaden, pp. 231–261.

Schimank, U., (2007b). ‘’Ökonomisierung der Hochschulen—Eine Makro-Meso-Mikro-perspektive’’, internal communication.

Schoen, A. et al. (2006). "Strategic Management of University Research Activities, Methodological Guide". PRIME Project 前bservatory of the European University_, www.prime-noe.org.

Schubert, T. (2009). ‘’Empirical observations on New Public Management to increase efficiency in public research—Boon or bane?’’. *Research Policy* 38, pp.1225–1234

Schwandt, T. A. (1994). ‘’Constructivist, Interpretivist Approaches to Human Enquiry’’. In: N. K. Denzin and Y. S. Lincoln (Eds) ‘Handbook of Qualitative Research’, Thousand Oaks: Sage.

Schwandt, T. A. (2000). ‘’Three epistemological stances for qualitative inquiry: Interpretation, hermeneutics, and social construction’’. In N. K. Denzin and Y. S. Lincoln (Eds.), ‘Handbook of Qualitative research’ (2nd ed.), Thousand Oaks, CA: Sage, pp. 189-213

Schwandt, T. A. (2001) ‘’Dictionary of Qualitative Inquiry’’. Second Edition, London: Sage Publications

Seidel, S. and Recker, J., (2009). ‘’Using Grounded Theory for Studying Business Process Management Phenomena’’. 17th European Conference on Information Systems

Seidel, S., (2009). ‘’A Theory of Managing Creativity-Intensive Processes’’. Unpublished PhD Dissertation, University of Muenster, Muenster.

Seidel, S., Rosemann, M. and Becker, J. (2008). ‘’How Does Creativity Impact Business Processes?’’. In European Conference on Information Systems, Galway, Ireland.

Senlar, J., (2001). *Changing organization of public sector research in Europe-implications for bench-making human resources in RTD*. Paper presented for Human resources in RTD session of Conference on the contribution of European socio-economic research to the bench making of RTD policies in Europe, Brussels, 15-16 March

Shinn, T., (1982). "Scientific disciplines and organizational specificity: the social and cognitive configuration of laboratory activities". In: N. Elias, H. Martins and R. Whitley, Eds., 'Scientific Establishments and Hierarchies'. *Sociology of the Sciences. A Yearbook Volume VI*, D. Reidel, Dordrecht, pp. 239_264

Shrum, W., Genuth, J. and Chompalov, I., (2007). "Structures of Scientific Collaboration". Cambridge: The MIT Press

Skodol-Wilson, H. and Ambler-Hutchinson, S. (1996). ‘’Methodological Mistakes in Grounded Theory’’, *Nursing Research,* 45(2), pp. 122-4.

Smith, J. K. (1993). ‘’After the demise of empiricism: The problem of judging social and educational inquiry’’. Norwood, NJ: Alex Publishing.

Smith, M. L., and Kleine, P. L. (1986). ‘’Qualitative research and evaluation: Triangulation and Multi-methods reconsidered’’. In D. D. Williams (ed.), ‘’Naturalistic evaluation -New Directions for Program Evaluation’’, San Francisco: Jossey-Bass.

Smyth, R. (2004). ‘’Exploring the usefulness of a conceptual framework as a research tool: A

Song, J., Almeida, P. and Wu, G. (2003). ‘’Learning-by-Hiring: When Is Mobility More Likely to Facilitate Inter firm Knowledge Transfer?’’. *Management Science*, 49(4), pp. 351-365

Sonnenwald, D.H., (2007). "Scientific collaboration: A Synthesis of Challenges and Strategies". In: B. Cronin, Ed., *Annual Review of Information Science and Technology* vol. 41, Information Today, Medford, NJ., pp. 643_681

Sorenson, O and Fleming, L. (2004). "Science and the diffusion of knowledge". *Research Policy*, 33(10), pp.1615-1634

Spiggle, S. (1994). ‘’Analysis and Interpretation of Qualitative Data in Consumer Research’’, *Journal of Consumer Research, 21*(3), pp. 491-503.

Stads, Gert-Jan and Manneh, F., (2010). "Recent Development in public agricultural research". Country Note, Agricultural Science and Technology Indicators (ASTI)-National Agricultural Institute (NARI), The Gambia

Stads, Gert-Jan, Fatajo. F. S. and Kunjo, E. M., (2004). "Agricultural Science and Technology Indicators". The Gambia Country Brief No. 25, Washington, D.C. : International Food Policy Research Institute and the National Agricultural Research Institute.

Steckler A, McLeroy K. R., Goodman R. M., Bird S. T., and McCormick, L. (1992). "Toward Integrating Qualitative and Quantitative Methods: An Introduction." *Health Education Quarterly*, 19, pp. 1-8.

Stephan, P. E. (1996). ‘’The economics of science’’. *Journal of Economic Literature,* 34, Stern, S. (2004). ‘’Do scientists pay to be scientists?’’ *Management Science*, 50, pp. 835–853.

Stokols, D., Harvey, R., Gress, J., Fuqua, J., and Phillips, K. (2005). "In Vivo Studies of Trans disciplinary Scientific Collaboration: Lessons Learned and Implications for Active Living Research’’. *American Journal of Preventive Medicine,* 28(2), pp. 202-213.

Strauss, A. and Corbin, J., (1990). ‘’Basics of Qualitative Research Grounded Theory Procedures and Techniques’’. London: Sage

Strauss, A. L. and Corbin, J., (1997). ‘’Grounded Theory in Practice’’, London: Sage

Strauss, A. L. and Corbin, J., (1998). ‘’Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory’’, London: Sage

Strauss, A., and Corbin, J. (1998). ‘’Basics of qualitative research: Grounded theory procedures and techniques’’. (2nd ed.), Thousand Oaks, CA: Sage.

Streubert, H. and Carpenter, D., (1999). ‘’Qualitative Research in Nursing: Advancing the Humanistic Imperative’’, Philadelphia: Lippincott, Williams, and Wilkins, pp. 117-143.

Suddaby, Roy. (2006). ‘’From the Editors: What Grounded Theory Is Not’’. *Academy of Management Journal*, 49 (4), p. 633

Sveikauskas, L., (1981). "Technological inputs and multi-factor productivity growth, *Review of Economics and Statistics,* 63, pp. 275_28

Swiss, J. E. (2005). ‘’A framework for assessing incentives in results-based management’’.

Public Administration Review, 65(5), pp. 592–602.

Tashakkori, A., and Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches.* Thousand Oaks, CA: Sage.

Tashakkori, A., and Teddlie, C. (2003). ‘’Major issues and controversies in the use of mixed methods in the social and behavioral sciences’’. In A. Tashakorri and C. Teddlie (Eds.), *Handbook of mixed methods in social & behavioral research* (pp. 3-50). Thousand Oaks, CA: Sage.

Tewksbury, R. (2009) ‘’ Qualitative versus Quantitative Methods: Understanding Why Qualitative Methods are Superior for Criminology and Criminal Justice’’. *Journal of Theoretical and Philosophical Criminology*, 1 (1), pp. 38-58

THE COUNTRY REVIEW TEMPLATE, CREST-IDR Project, (2009). ‘’Mapping Research systems in Developing Countries’’ eds. J Mouton and R. Waast, UNESCO Forum for Higher Education, Research and Knowledge. CREST: Center for Research on Science and Technology, University of Stellenbosch, South Africa. IRD: Institute for Research on Development, France

The Daily Observer (Banjul), 21 October, 2010. "Gambia: First National Conference on Research for Health Held".

Van Der Aalst, W. M. P., Rosemann, M. and Dumas, M. (2007). ‘’Deadline-Based Escalation in Process-Aware Information Systems’’, *Decision Support Systems,* 43 (2), pp. 492-511.

Van Kersbergen, K., and Van Waarden, F. (2001). ‘‘Shifts in Governance: Problems of legitimacy and Accountability". Hague: Social Science Research Council.

van Raan, A. (2004). "Measuring Science. Capita Select of Current Main Issues". *Handbook of quantitative science and technology research. The use of publication and patent statistics in studies of S&T systems*, pp. 19–50.

Vasileiadou, E. and Vliegenthart, R. (2009). "Research productivity in the era of the internet revisited". *Research Policy*, 38(8), pp.1260-1268

Velho, L. (2002). "Research capacity building in Nicaragua: from partnership with Sweden to ownership and social accountability". INTECH Discussion Series. Maastricht: The United Nations University.

Vidich, A.J. and Lyman, S.M. (2000). ‘’Qualitative Methods: Their History in sociology and anthropology’’. In N.K Denzin and Y.S Lincoln (Eds) Handbook of Qualitative Research (2nd edition), Thousand Oaks, CA: Sage, pp.38-84

Villani, C., Kapulski, N and Bogomolova, S. (2010). ‘’Application & Procedure of Grounded Theory: Gaining Insight into Brand Choices’’. Conference paper, ANZMAC Annual Conference 2010-Doing more with less Christchurch, New Zealand 29 November-1 December 2010 Available at http://arrow.unisa.edu.au:8081/1959.8/119208

Von Tunzelmann, Ranga, N. M., Martin, B., and Geuna, A. (2003). ''The Effects of Size on Research Performance'.' A SPRU Review, report prepared for the Office of Science and Technology, Department of Trade and Industry.

Walsh, J. P., and Roselle, A. (1999). "Computer networks and the virtual college". OECD STI Review No. 24, Special Issue on 'The Global Research Village', pp. 49–77.

Walsh, J.P., Kucker, S., Maloney, N. G., and Gabbay, S. (2000). "Connecting minds: computer-mediated communication and scientific work". *Journal of the American Society for Information Science* 51 (14), pp. 1295_1305.

Weick, K. E. (1999). ''Theory Construction as Disciplined Reflexivity: Tradeoffs in the 90s'', *Academy of Management Review* 24, pp. 797–806.

Weinreich, N. K., (1996/2006). ''Integrating Quantitative and Qualitative Methods in Social Marketing Research. Social Marketing Quarterly''. Cited from Weinreich Communications 2006 Available at http://www.social-marketing.com/research.html

Welman, J. C., and Kruger, S. J. (1999). ''Research methodology for the business and administrative sciences'', Johannesburg, South Africa: International Thompson.

Wilson, J. B. and Natale, S. M. (2001), "'Quantitative' and 'qualitative' research: an analysis".

Wilson, P. (1995). "Unused relevant information in research and development". *Journal of the American Society for Information Science* **46** (1), pp. 45_51

World Bank, (2000). Implementation completion Report Republic of the Gambia agricultural service project (credit 2453-GM). Report No. 20579-GM, Washington, DC

World Bank. (1992). Staff appraisal Report: The Gambia agricultural services project. Report No. 11093-GM. Washington, D.C.

Worrall, J. L. (2000). ‘’In defense of the ‘quantoids’: More on the reasons for the quantitative emphasis in criminal justice education and research’’. *Journal of Criminal Justice Education*, 11 (2), pp. 353-360.

Worrell, D. (2009). ‘’Assessing business scholarship: The difficulties in moving beyond the rigor-relevance paradigm trap’’. *Academy of Management Learning*, 8, pp. 127–130.

Wulf W, (2007). "Refreshing the Innovation Ecology". AAAS-CSPO S&T Policy Review: Highlights of the 2007 Forum on S&T Policy. US National Academy of Engineering

Zucker, L. G. Darby, M. R. (2006). ‘’Movement of Star Scientists and Engineers and High-Tech Firm Entry’’. NBER Working Paper No. 12172

Zucker, L.G., Darby, M. R. and Armstorng, J. (2010). "Geographically localized Knowledge: Spillovers or Markets?" *Economic Inquiry*, 36(1), pp65-86

APPENDIX

Appendix I

PhD Science and Technology Policy Studies (St Clements University)
Survey Questionnaire on the Effects of Research Governance Structures and Mechanisms on Scientific Knowledge Production in the Gambia

Dear Sir/Madam,

I am doing a PhD Science and Technology Policy Studies at St Clements University. I am conducting a study on the impact of research governance mechanisms on scientific knowledge production within the public research organizations in the Gambia. This questionnaire is required to generate primary data for analysis on the subject matter of study. Kindly complete the questionnaire and return to me. Please be assured that the information derived from this questionnaire will be treated with utmost confidence and names will not be shown in the summary of findings. The summary of findings from this research will be made available to everyone who completes this survey questionnaire.

I sincerely appreciate your time and co-operation in completing this form. Please see page 2 - 6 for the main survey questionnaire questions.

Thank you

Frederick Ozor
E-mail: fred_oz_or@yahoo.co.uk; fozo@utg.edu.gm
St Clements University

Personal Information: (Your answers will be treated in confidence and personal information will not be included in the study)

Name...

E-mail Address...

What is your status in your organization?

A: Top Level [ ] B: Middle Level [ ] C: Supervisory [ ]

How long have you been in your organization?

A: [1 -5 years], B: [6 -10 years], C: [11 -15 years], D: [16 years and over]

Last academic qualification obtained below:

[Fist degree] [Masters Degree] [PhD] [Professional] [Other]

Sex: [Male] [Female]

What is your age?

[20 or younger] [21-24 years] [25-29 years] [30-34 years] [35 or older]

What is your field of science/area of research interest?
A: [Human medicine and allied medical sciences] B: [Agriculture] C: [Biological/Life sciences] D: [Engineering sciences] D: [Social sciences] E: [Physical sciences] F: [Other, please specify.....................]

(Please tick one answer only Yes, No or other where applicable)

- Do you agree that the state has dominant control over public sector research in the Gambia? [ ] Yes [ ] No

- Do you think the state's research policy between 2006 and 2010 has resulted in reduced government control over research giving public research organizations and researchers greater autonomy to steer research? [ ] yes [ ] No

- Do you agree that, in your organization, management (eg. Deans and the Vice-Chancellor) has dominant influence in steering research? [ ] Yes [ ] No

- Do you agree that the state's role in public sector research is limited only to supervision, monitoring and feedback designed mainly to ensure academic quality and accountability?

  [ ] Yes [ ] No

- Would you agree that academics/researchers/professional research committees in your institution have greater power to steer research? [ ]Yes [ ]No

- If yes, are you expected to report progress of your work to internal self-controlling/monitoring research unit? [ ]Yes [ ]No

- Is research in your organization steered by the advice and goal setting, guidance, and participation of external stakeholders (such as community, state, external donors/research grant providers, etc) in decision-making? [ ] Yes [ ] No

•Is your research (ie, your funding decisions, publication strategies, selection of research topics/priorities, research output orientation, etc) influenced by external stakeholder guidance and participation [ ] Yes [ ] No

•Do market forces direct research in your organization, which includes competition for limited research resources/funds and competition for academic prestige such as competing for university funding to attend conferences, competition for publications in top quality journals, competition for external grants, and competition for a permanent prestige conferring position? [ ] Yes [ ] No

•Please indicate a possible mix of research governance structures in your organization as defined in Q/Ns 1, 3-5, 7-9……………………………………………………………….
……………………………………………………………………………………………….
……………………………………………………………………………………………….

•If your research work is evaluated (eg, by the Research Ethics Committee), does this evaluation affect how you organize your work? [ ] Yes [ ] No

•Is your work structure (how you organize your research work) affected by what you feel about your field of research (eg such feelings that derive from work load pressure, demand for performance, professional competition, accountability, quality and/or quantum of research output)? [ ] Yes [ ] No

•Do you have an accounting system monitoring research grants to individual researchers or research resources/funds movement within research teams? [ ] Yes [ ] No

Please tick one answer: Strongly-agree, Agree, Disagree, and Strongly-disagree, No view

5 4 3 2 1

Type of Organization: University ( ), Public research institute ( ), Private/Local research center ( ), International research unit ( ), others ( ).

14. In your organization structures and mechanisms employed in research governance (eg. structures for the control and steering of research, resource controlling and performance oriented payment schemes, etc) have operated in ways that consistently increased your research output indicators as indicated in question No. 23.

Ans 1 2 3 4 5

15. In your organization greater control and steering of research by academics/professionals has produced changes to enhance research output in your field of science since 2006 up to 2010

Ans 1 2 3 4 5

16. Your research output is influenced by the level of authority/freedom you have to determine your research agendas and priorities, funding sources, and all other issues that matter most to you as a researcher

Ans 1 2 3 4 5

17. Research output of your institution is affected by the overall research environment, which is defined by your institutional governance profile, state research governance policy, influences from other stakeholders such as industry and the local communities, and your institutional research policy

Ans 1 2 3 4 5

18. In your organization collaborative research exchanges with other researchers/companies (knowledge flows) increased the number of coauthored publications/patents

Ans 1 2 3 4 5

19. What is your satisfaction with the technical infrastructure?

- Satisfaction with the computer facilities

  Ans 1 2 3 4 5

- Satisfaction with the laboratories (facilities)

  Strongly decrease Strongly increase

Ans 1 2 3 4 5

Strongly decrease Strongly increase

•Satisfaction with the facilities to get information (libraries, archives, databases)

Ans 1 2 3 4 5

•Satisfaction with possibilities to travel

Strongly decrease Strongly increase

Ans 1 2 3 4 5

20. In your institutional, conditions for conducting research, as defined by technical infrastructure, influenced research output.

Ans 1 2 3 4 5

21. In your organization, greater control by research teams and researchers over personnel (recruitment and training of new researchers) has positively increased research output

Ans 1 2 3 4 5

22. Research output (of individual researcher, research teams or the university) is a function of research capacity, which is defined in terms of the sum total of human, institutional, and financial conditions for pursuing research.

Ans 1 2 3 4 5

23. Performance/research output Indicators (Between 2006 and 2010). Please provide details of your publications as indicated hereunder:

a.) Number of written monographs…………………………………………………………………

b.) Number of articles in peer-reviewed journal ………………………………………………...

c.) Number of editorships in journals and book series………………………………………

d.) Number of conferred doctoral degrees (or, successful PhD dissertations)…………………….

e.) Number of received research prizes/awards………………………………………………..

d.) Number of advisory services to companies/consultancy……………………………………

I sincerely appreciate your time and co-operation in completing this form. Confidentiality is assured. Personal details will not be included in any part of the research or made public. If you are prepared to take part in an interview on this issue that will enable me gather more information for this study, please tick this box. **[ ]**

Thank you

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St Clements University

Appendix II

PhD Science and Technology Policy Studies (St Clements University)

Semi-Structured Interview Questions on the Effects of Research Governance Structures and Mechanisms on Scientific Knowledge Production in the Gambia

To: Prof./Dr/Rev./Mr./Mrs.…………………………..

Date …

Dear Sir,

As part of my data collection for a PhD Research Project in Science and Technology Policy Studies of St Clements University on the Effects of Research governance structures and mechanisms of scientific knowledge production in the Gambia, I am conducting an interview in your institution. I will be very grateful for your kind support in making yourself and time available for this exercise and providing your responses to the questions below.

The interview questions are based on research governance situation within your institution. Your answers to the following twelve questions will enable me carry out comprehensive analysis of the effect of research governance on scientific knowledge output in your institution. The findings and recommendations from this study would provide the management of the Institution with information on the effectiveness of good governance of research

Thanking you for your help

Yours sincerely

Fred. Ozor

PhD Dissertation Researcher

St Clements University

E-mail: fozor@utg.edu.gm; f_oz_or@hotmail.com

PART A: *Structure/organization of* research

Please answer these questions about how you organize your research work.

Question 1:

If your research work is evaluated, how would you describe the kind of consequences which the type and regularity of this evaluation may have on how you organize your work (eg Does this determine how you select your research themes, your funding decision, output orientation, teaching/research time nexus)?

Question 2:

Is your work structure (how you organize your work) affected by what you feel about your field of research? In addition, does this result from external/internal pressure for performance. Such demands mat come from workload, professional competition, accountability, and the demand for balance between quality and quantity.

PART B*: Research governance structure***-** Please respond to these questions on how your institutional research governance affects your research.

Question 3:

How much room for manoeuvre do you have as an individual researcher in deciding what and how to research (eg. Can you influence the procedure for selection of research themes and projects)?

Question4:

What are the problems or constraints you encounter as a result of governance model and structures in place in your organization?

Question 5:

In what significant ways have your level of decision competences over research funds, agendas and priorities affected your research (e.g. Does the level your research competence influence your research agendas and priorities influence your research)?

Question 6

Does how and where you get funding for your researches influence your research? …………..

Question 7:

How is your research influenced by the overall research environment, which is defined your institutional research governance profile, state research governance policy, influences from other stakeholders such as industry and the local communities, and your institutional research policy?

……

PART C: *Infrastructural facilites*

Question 8

How has the accessibility/availability of the infrastructure such as library, laboratory, archive, and computers influenced your research?

……

Question 9 How have you coped with any of the needs, constraints, or even facilities that hinder or otherwise promote research process in your institution?

……

PART D: Research output/performance indicators

Question 10:

How would you describe your publication strategies (where do you publish what?) and strategies for other research output (e.g. supervision of PhD students, patents, spin offs). In doing so, please indicate the number of your publications (e.g. *Number of written monographs, Number of articles in peer-reviewed journals, Number of editorships in journals and book series, Number of conferred* *doctoral degrees (or, successful supervised PhD dissertations), Number of received research prizes/awards, and Number of advisory services to companies/consultancy)*

……………………………………………………………………………………………………

PART E: Reflections

Question 11

Is there anything your institution can learn from your experience in coping with your institutional research experience?

Q***uestion 12***

How would you describe the themes and issues that you consider important to your research experience within your institution?

Appendix III

PhD Science and Technology Policy Studies (St Clements University)
Focus group discussion on the Effects of Research Governance Structures and Mechanisms on Scientific Knowledge Production in the Gambia

To: Prof./Dr./ Rev./Chief/Mr./Mrs./Ms……………………………………

Date…

Dear Sir/Madam,

As part of my data collection for a PhD Research Project in Science and Technology Policy Studies at St Clements University, I am conducting a study on the Effects of Research Governance

Structures and Mechanisms on Scientific Knowledge Production in the Gambia. I will be very grateful for your kind support in making yourself and time available for group discussions on ten issues/questions listed in the questionnaire below. This questionnaire is required to generate data for analysis on the subject matter of study. Please kindly study the questionnaire in accordance with given guidelines as we enter into the discussions on the issues raised. Please be assured that the information derivable from this questionnaire will be treated with deserved confidence.

The date, time and venue of the group discussions will be scheduled with you on phone.

Thank you.

Fred Ozor, B. Sc. (Hons.) Political Science; M .Sc. Public Administration (University of Nigeria, Nsukka)

The focus group discussions will consist of a total of twelve (12) participants consisting of three groups of four each (as described in the methodology) aimed at addressing the following ten (10) main questions/issues:

1. How does the type and regularity of research work evaluation affect how the researcher organizes his work (e.g. his/her selection of research themes, funding decision, output orientation, teaching/research time nexus)?

2. How do pressures from work load, professional competition, accountability and ethical requirements, balance between quantity and quality, and pressure for performance affect the researcher's work structure (i.e. how the researcher organizes his/her work)?

3. How effective is the research governance structures and mechanisms within the public sector research organizations in The Gambia?

4. Does your institutional research governance increase or otherwise decrease the decision competences of the researcher over those issues that matter most to him (e.g. Determination of research agenda and priorities, funding decisions, and publication strategies)

5. How does the overall research environment (defined by existing institutional governance profile, state policy on research governance, influences from other stakeholders such as industry and the local communities, and institutional research policy) affect research output within public research organizations in the Gambia?

6. In what significant ways has the state's science and technology policy within the period 1999 and 2007 influenced research in the Gambia?

7. How has the accessibility/availability of technical infrastructure such as library, laboratory, archive, and computers influenced research in the Gambia?

8. How have publication strategies, ie, where you publish what (and strategies for other research output such as PhD students, patents and spin offs) influenced research in the Gambia?

9. In what ways can the themes and issues you consider important to research experience in the Gambia be resolved?

10. Do collaborative research exchanges (eg. between industry and the university/public research organizations, international collaborations, etc) and knowledge spillovers influence research in the Gambia?

I sincerely appreciate your time and co-operation in taking part in this discussion forum. Confidentiality is assured. Personal details will not be included in any part of the research or made public.

Thank you

Frederick Ozor

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St Clements University, British West Indies.

Appendix IV

Examples of interview protocols

PhD Science and Technology Policy Studies (St Clements University)

IV a. Interview protocol with respect to research governance effects on scientific knowledge production in the Gambia: the University/research organization/Ministry level

Part one: Brief introduction by the interviewer regarding the overall project and explain the reason of the visit:

Part two: Profile of the respondent

1. Would you be so kind to give me an overview of your main responsibilities and your role in the decision-making processes of this university/public organization?

• *For how many years have you been in this position?*

• *Are you coming from this university/* public *organization or have you been appointed 'from outside'?*

2. To what extent are you engaged directly (or indirectly) in decision-making regarding the university (or your public organization's/Ministry's research policies?

3. To what extent are you engaged in decision-making regarding research policies outside this university/ public organization/Ministry?

• *Are you, for example, involved in committees, networks or groups at the (sub) national or international level that are having an impact on research agenda's, research priority setting etc.?*

Part 3: Profile of the university/ public organization/Ministry

The next set of questions concern the general profile of your university/public organization/Ministry.

4. How would you characterize this university/research organization/Ministry? How do this university/ public organization/Ministry profile itself in terms of its research, science and technology policies and achievement of policy objectives?

• Name of your university/ public organization/Ministry

What is (your reading of) the public *organization/university/ministry's mission? What are the most striking strategic goals of this organization/ministry?*

• *Is this organization, for instance, known for its research, teaching and/or service orientation?*

• *Is your organization regionally, nationally and/or internationally focused?*

- *Describe the structural relationship between the ministry and public research institutions in the Gambia including UTG(RELEVANT ONLY THE MINISTRY LEVEL OF THE INTERVIEW)*

5. Have there been significant changes in the overall strategic orientation of the university/public organization or Ministry? Why, or why not?

6. Has the context of the organization/ministry changed between 2006 and 2010, that is, changed the in terms of conditions and resources for doing research and science related activities?

This last question provides the opportunity to shift the focus more concretely to the research policies of the organization.

Part 4: Research policies of the university or public organization/Ministry

7. A) Have the objectives of the research policies of this university or public organization/Ministry been changed between 2006 and 2010? Why or why not?

8. What kinds of initiatives or instruments do you use in this university/Ministry to achieve these objectives?

• *What are the main levers (instruments/drivers) of change to implement policies?*

• *Structural reorganizations?*

• *Strategic funding policies?*

• *Personnel policies?*

• *Creating specific research conditions for certain groups/research organizations/University?*

• *Rewarding certain kinds of research outputs?*

• *Using performance-based contracts (with faculties, individual researchers, research groups or institutes)?*

9. What is your impression about the impact of the research policies and strategies in the university? Do you think they (ie, policy and strategic impacts) really make a difference at the shop floor/individual researcher's level?

10. In recent years, have things/research situation, in your opinion, developed for the better or for the worse for your university/research organizations over which you have policy responsibility?

Part five: Reflection

We would like you to consider the overall environment for research and to ask about the consequences for the research policies of this university/research organization/Ministry.

11. Does the Ministry provide competitive research funds for researchers and research institutions?

12. If yes, how in your opinion is the competition for resources influencing the research of this university and that of the individual researcher?

• *Is the competition for research grants, excellent researchers, state of the art labs or high quality PhD programs, for instance, enabling or facilitating the research objectives, strategies and policies of this university/research organization/Ministry?*

13. How are the regulations of the state (in the case of DHERST, coming through your Ministry) influencing the research of the University of the Gambia and other research organizations?

• *Are the kinds of regulation, the number of regulations, and the level of detail of the regulations or the issues that are regulated enabling or facilitating the research objectives, strategies and policies of the University and research institutions in the Gambia?*

13. How are the academics/researchers of the university or research organizations influencing their institutional research policy?

• *How do you see the role of the academics/researchers and their academic/professional self governance (if applicable) in setting strategic research priorities, developing strategies, funding and staffing?*

14. Apart from the state and the academics/scientists, how are other stakeholders influencing the research policies in the Gambia?

• *The others stakeholders can be national industry, local communities and institutional partners who show some concerns for research, science and technology in the Gambia*

15. How are the institutional leaders and managers of this university/research organization/Ministry influencing research policies?

Thank you for this interview!

IV b. Interview protocol for researchers

Part one: Brief introduction by the interviewer regarding the overall project, and explain the reason of the visit:

Part two: Getting acquainted

1. What kind of research are you doing?

2. What kind of contract do you have and what are your major responsibilities in this research group/center/institute?

3. How would you characterize your research unit/group as a whole? How are research matters organized here?

4. How does your research group fit to this university?

• *How would you typify the university context with respect to your research and the research of your group?*

• *Is it from your point of view a stimulating work environment or would you be better off elsewhere?*

• *Has the university/research organization influenced you and the research group, if applicable?*

5. How is the field of research of ….doing in general?

• *What are the major trends and players in your field of research?*

• *What policies are influencing your field of research?*

• *Dynamics/complexity: (what is 'happening'?)*

• *What about the resources for doing research in your field of research? Is it hard to get your research projects funded?*

Part 3: Stability and change in respect to research activities

Now we would like to talk about how do you organize your work? We would like to hear about selecting research themes and priorities, funding, infrastructure, publication strategies and the like.

6. How are the research themes and research projects selected?

- *What does the selection procedure look like?*
- *Can you as an individual researcher influence the procedure for selecting research themes and projects?*
- Does your power over selection of research themes and projects influence your research?

8. Does how and where you get funding for your researches influence your research?

• *From whom do you get funding?*

• *What kind of considerations do you follow?*

• *Do you apply for funding yourself?*

8. a. Have there been changes in funding or not? Why?

8. b. Does this influence your research?

9. How are your projects staffed?

9. a. has that changed or not? Why?

• *e.g. do staff members have different professional background compared to some years ago?*

• Does this influence your research?

10. With whom do you cooperate inside and outside the university/research organization?

10. a. Have there been changes or not in this collaboration? Why?

10. b. Does this influence your research?

11. What kind of technical infrastructure do you need for your research?

• *Library*

• *Laboratory*

• *Archive*

• *Computers*

11. a. Has the accessibility/availability of the infrastructure changed or not? Why?

11. b. Does this influence your research?

12. What are your publication strategies?

• *Where do you publish what?*

12. a. Has that changed or not? Why?

12. b. Does this influence your research?

13. What are your strategies for other research output?

• *e.g. PhD students, patents, spin- offs*

13. a. Has that changed or not? Why

13. b. Does this influence your research?.

14. Is your research due to some kind of regular evaluation?

14. a. If so, what does this evaluation look like?

• *Internal/external*

• *Level of observation/who carries it out?*

• *Frequency*

14. b. What kind of consequences does this evaluation have for you?

• C*hoice of research themes*

• *Funding decision*

• *Output orientation*

• *Teaching/research nexus*

• *Cooperating/sharing research resources with colleagues*

15. If you look at your own career as a researcher so far. How does it feel to be a researcher in this field of research, and how has this changed?

• *External pressure to perform*

• *Work intensification*

• *Growing competition*

• *Accountability*

• *Quantity versus quality*

16. If you think about the next generation of researchers (e.g. the present doctoral students) – are they being brought up in a different research environment?

17. In recent years, have things developed for the better or for the worse for your research or research group?

Part four: Reflection

Finally, I would like to ask you to reflect briefly more in general on how your research looks now and how it has changed within the period 1999 and 2007

18. Are you involved in basic and applied research? What is the balance between the two? Has this changed and how?

19. Are you involved in teaching? How about the relationship between teaching and research in terms of time spent on each? Has this changed and how?

20. How would you describe your research in terms of working on long- term themes and working on more short-term themes? Has this changed and how?

21. How would you describe your research in terms of more safe or more risky research? Has this changed and how?

12. How much room for maneuver do you have as an individual researcher in deciding what and how to research? Has this changed and how?

Thank you for this interview!

(Adapted from Leišytė, (2007, ISBN 978-90-365-2586-2)

Appendix V: List of Interviewees

<u>Cited interviewees in Chapter 4</u>

University of the Gambia

Top management –Vice-Chancellor responsible for research policy

Middle management – Dean of Faculty of Art and Sciences,

Dean of School of Agriculture,

Dean of School of Medicine and Allied Medical Sciences,

Dean of School of Education,

Dean of School of Business and Public Administration,

Dean, School of Law.

Two senior officers at the university central library responsible for research archrivals

Director of Research and Strategy Committee,

Director of International Affairs,

Two members of Research Ethics Committee,

Department of Humanities – a junior researcher who did his PhD in Linguistics and Gambia Languages

Researchers in the fields of Art and Sciences, Agriculture, Education, Business and Public Administration, Medicine, Nursing and Reproductive Health, Public Health, and Law

Medical Research Council (MRC), the Gambia

Chief Executive of the Medical Research Council (MRC) - the GAMBIA

Researchers in tropical diseases

National Agricultural Research Institute (NARI),

Top Management- Director of NARI-Two Principal Research Officers, and three Senior Research Officers

Ministry of Health Units (Malaria, Reproductive Health units, etc)

The internal Trypanotolenrance Center

The Educational Research Network for West and Central Africa (ERNWACA)

The Department of State for Higher Education, Research, Science and Technology (DOSHERST)

The Ministry of Higher Education, Research, Science and Technology – a senior officer at Research and Science Management Department