Title: "An assessment of the Science, Technology & Innovation Indicators in African countries: Ghana, South Africa and Tanzania"

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1. Overview of the research

1.1. Introduction

This proposed PhD research is on innovation indicators that have been useful mainly in advanced countries. The usage of Innovation Indicators within the National System of Innovation has gained ground in academic and policy settings over the past few decades and yet in Africa it has only gained ground over the past few years. The research aim is to understand how Innovation indicators have been applied or not applied in African countries for framing policy and for planning purpose. It will be of importance to assess if innovation indicators in Africa are sensitive to local, social and economic conditions or if they would merely be a replication of what has been achieved elsewhere? **Sub-Saharan Africa**, south of the Sahara, is the term used to describe countries of Africa that are not considered part of North Africa or even some areas of West Africa. It is an area still suffering from the legacies of colonial conquest and occupation, neo-colonialism, inter-ethnic conflict, and political strife. The exact position of the dividing line between the two regions (North and South) is not clearly defined because of discontinuous and blurred breaking-points between national boundaries, ecologies and ethnicities.

However, according to one classification of the two regions, sub-Saharan Africa includes forty-eight nations. Forty-two of these nations are on the African mainland. In addition, four island nations in the southwest Indian Ocean (Madagascar, The Comoros, Mauritius, and Seychelles) and two island nations in the Atlantic Ocean (Cape Verde and São Tomé and Príncipe) are considered part of sub-Saharan Africa. According to this classification scheme, the countries of sub-Saharan Africa are Central Africa, North Eastern Africa, West Africa, Southerner, Eastern and African Islands Nations. Sub-Saharan Africa (SSA) is chosen as a unit of Analysis because SSA has a history, politics and economics different to that of North Africa and such requires a specific attention, therefore choosing SSA as a unit of analysis is not perpetuating colonial or Eurocentric views of Africa but indicating the Geo-political reality. Post colonial period saw SSA with unifying political concerns.

Case countries selected are African countries namely; Ghana, South Africa and Tanzania, all selected on the basis of having a particular political history; all being English speaking countries, with a common British/Anglo Colonial history and a comparable forms of Government

structures, as emerging economies, as well as posing specific 'latecomer development' context. The three countries also had successful transitional democracies and therefore provided some stability over the years since their attained independence. Therefore it is expected that showcasing African Innovation Indicators could shed light on the working of developing countries in similar conditions of the world.

1.2 Definitions, Concepts & Innovation Measurements

This study deliberately draws on and intersects with 'Innovation System' as a concept referring to, 'the search for development, adaptation, imitation and adoption of technologies that are new to a specific context', it is therefore a network of organisations within an economic system that are directly involved in the creation, diffusion and use of scientific and technological knowledge, as well as the institutions responsible for the coordination and support of these processes'. Innovation Indicators have been endorsed by various national bodies and international organisation like the Organisation for Economic Co-operation and Development (OECD), the World Bank and some of the United Nations Agencies, as all those responsible for supporting and funding research, technological development and innovation.

Definitions of the NIS;Innovation System is defined as a system for generating and diffusing new technologies, every country has such a system, even if it is weak or low in capacity**. Freeman** (1987, p. 1) defined the NIS as 'the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies'. **B.-A. Lundvall** (1992, p. 12) **narrowly defined NIS** as 'organisations and institutions involved in searching and exploring such as R&D departments,technological institutes and universities', whilst **broader NIS** includes 'all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring the production system, the marketing system and the system of finance present themselves as sub-systems in which learning takes place'. "The elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and are either located within or rooted inside the borders of a nation state" (**Lundvall**, 1992; p.12). "A set of institutions whose interactions determine the innovative performance of national firms" (**Nelson, Rosenberg**, 1993; p.5).

Patel and Pavitt defined it as, "The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change-generating activities) in a country" (**Patel and Pavitt**, 1994; p.12).

"That set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies" (**Metcalfe**, 1995;p.462-463). **C.Edquist** (1997)includes, "all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations". **Galli, Teubel** (1997) defined it as "a historically grown subsystem of the national economy in which various organizations and institutions interact and influence each other in the carrying out of innovative activity". NSI as the set of organizations, institutions, and linkages for the generation,diffusion, and application of scientific and technological knowledge operating in a specific country**.**

Key elements of an Innovation approaches: According to Ingelstam (2002): a system consists of two kinds of *constituents*: firstly there are, some kinds of *components* and secondly, there are *relations* among them. These components and relations should form a coherent whole (which has properties different from the properties of the constituents)". The system has a *function* that it performs or achieve and therefore it must be possible to discriminate between the system and the rest of the world; it should also be possible to identify the *boundaries* of the system. If we, for example, want to make empirical studies of specific systems, we must, of course, know their extension either as Players or actors; Organizations or firms (normally considered to be the most important organisation), universities, venture capital organizations and public agencies responsible for innovation policy etc, being the rules of the game**.** Institutions are "sets of common habits, norms, routines, established practices, rules or laws that regulate the relations and interactions between individuals, groups and organizations," (Edquist & Johnson, 1997).

1.3 The Conceptual framework

Innovation Indicators are measurement instruments of results of an outcome within a science, technology and innovation framework and they can be used as an analytical tool for policy, legislation, funding strategy used by various governments in their policy & planning processes.

An international comparison of innovation survey results is an important component for Science and Technology (S & T) Policy development. The OECD review complements the system's approach within the EU (European Union) and as such make use of the International standards of Measuring Innovation namely the Frascati Manual which is the OECD statistical manual for Research and Development (R&D) collected through Research and Development surveys. Its measurement is on gross expenditure on R&D to the Gross Domestic Product (GDP) with the following outputs of; patents, trademarks, publications and citations. Furthermore the OSLO Manual timelines have been; 1992, 1997, 2005. The other measurements used have been the CIS (Community Innovation Surveys) as well as the NERSTI framework and Public Sector innovations. In Africa, the NEPAD Declarations has committed to; "development and adopt common sets of indicators to benchmark our national and regional systems of innovation" (NEPAD: 2003; 12). The indicators were to inform the African Peer review mechanism and for monitoring the success of African countries in the 'effort to commit to the 1% of Gross Domestic Product of public funds for research and development.

The main questions and concerns to be addressed by the research are:

- An assessment of the innovation indicators in Africa.
- An evaluation of the key features of the innovation indicators in the selected case countries.
- A discussion on the application of the innovation indicators in the selected African countries.

The Limitations of the study (research) is that the research focus will be only the 'selected' African countries and only on how Innovation indicators have been used or not used in framing of policy as well as for planning purposes.

Mapping the gap, proposing a conceptual framework of investigation: The Assessment of Innovation Indictors in selected African countries

The previous sections have elaborated on the concepts of innovation system, as the basic frameworks for this PhD research. This is based on the intersection of various concepts, where one conceptual departure point would be an analysis of the linkages between innovation indicators within National Science, Technology and Innovation Policies.

Research Contribution

This research aims to contribute to the theory and practices of innovation indicators, in particular the African Indicator process. Such contributions can be elaborated in a number of levels:

1. At a practical level, it is expected that this study will provide evidence of Innovation Indicators in managing innovation system in Africa.
2. It will also contribute guidance to the Innovation process on how to adopt an Innovation framework in order to facilitate innovation reporting within the countries.
3. At the theoretical level, this study aims to enrich the literatures on Innovation indicators in general.
4. At the policy level, how the adoption of innovation indicators, their development, adaptation and degree at which they are deployed in the service of national policy could be an innovation in itself on building a theoretical base for the political economy on the usage on innovation indicators which can then be utilised within a particular country and perhaps even within the regional or continental context.
5. Mapping and developing a taxonomy of how the political economies within the chosen case studies.

2. Literature Review

2.1 The Evolution of System of Innovation

Historical roots on the evolution of the system of innovation came from, (Friedrich List,1841) which defined 'national systems of production' as a wide set of national institutions including those engaged in education and training as well as infrastructures such as networks for the transport of people and commodities.

Freeman 1982 and Lundvall 1985 went further to define National Innovation System to being an innovation process which should be treated in a systematic manner with a need for a systemic approach, which integrates institutions to create, store, and transfer the knowledge, skills and artefacts. (OECD, 1999) said that Innovation has to be understood as a complex interactive learning process, where learning is important, which is a key element in both the *dynamics* of the system and also as a key agent in *binding* the whole system together. Comparative it should fits different nations with their specific socio-economic, political and cultural background.

Theoretical perspective on innovation and learning: Typologies of the Systems of Innovation: Different categorties of Innovations Systems are: Spatially, sectorally, and functionally differentiated; National Innovation Systems (Freeman, 1987; Lundvall, 1992; Nelson, 1993); Regional Innovation Systems (Camagni, 1991; Cooke et al., 1997; Braczyk et al., 1998; Cooke, 2001; and Asheim & Isaksen, 2002); Sectoral innovation systems (Breschi & Malerba, 1997, Malerba, 2004), "Technological innovation systems" (Carlsson, 1995; Carlsson & Stankiewicz, 1991). **(Lundvall, 1992),** "…it is assumed that the most fundamental resource in the modern economy is knowledge and, accordingly, that the most important process is learning. According to Lundvall, "The fact that knowledge differs in crucial respects from other resources in the economy makes standard economics less relevant", **(Lundvall, 2003:p1),** innovation has been described as a process that is; Cumulative, Nonlinear, Path dependent, Context dependent, Continuous and Interactive. Firms do seldom innovate alone, stating that on innovation and learning you learn from what you do and as such innovation is a joint production of innovation and competence as learning as a socially embedded process making social capital to be important. The current literature defines National System of Innovation to denote an arrangement of the relationship amongst all organisations that are involved in the entire range of innovation activities from enablement through the creative processes to the implementation stage. In short it includes the full value chain ranging from R&D (OECD; 2002) through to 'implemented new products and processes" (Oslo Manual; 1997). Daniele Archibugi (2005) identified different attempts to measure technological capabilities amongst them the World Economic Forum (WEF) Technology Index (WEF, 2001; 2002; 2003; Furman et al., 2002).

2.2. Case Countries literature survey

Introduction & Background

Economic data shows that contribution of science and technology to economic growth among the industrial countries was 70%, among newly industrial countries, 45-55 % and among the developing countries, less than 30 %). According to NEPAD, "investment in science, technology and innovation is increasingly being seen by African countries as an essential element in responding to the continent's socio-economic development needs and challenges", (Mayaki; 2011).

In the first phase the participating countries of the ASTII initiative were; Algeria, Angola, Burkina Faso, Cameroon, Egypt, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Malawi, Mali, Mozambique, Nigeria, Senegal, South Africa, Tanzania, Uganda, and Zambia.

The criteria for selecting countries which participated in the pilot STI Indicators Surveys were the following: Membership of the African Peer Review Mechanism (APRM) and an indication of when the peer review will be conducted ; Demonstrated participation in at least one meeting of AMCOST ; Commitment to adopting and using NEPAD framework guidelines ; Demonstration of an existing overall STI policy process ; Commitment to provision of at least 25% of the total costs or budget for undertaking the national STI survey ; Commitment to making available to NEPAD and sharing with other countries data and statistics as well as the national STI survey reports ; Commitment to allowing NEPAD/AMCOST to use the national STI data and survey report to undertake regional comparisons as well as produce the African Science and Innovation Outlook ; Commitment to use of the national STI data/survey report to improve existing policies and institutional arrangements ; Commitment to the overall ASTII work plan ; and Ensuring of regional balance as much as possible.

Summary and Analysis of the African Innovation Outlook Report

The Innovation outlook reported that; the participation of women in research and development was high only in a few countries, like Tanzania and South Africa, with over 40 per cent representation. Mozambique and Uganda having slightly more than 35 per cent of women involved in Research and Development. Innovation Outlook showed that amongst the countries surveyed, South Africa had the highest number of human resources available for R&D, with a researcher density of 825 per million people, followed by Senegal with 635. At the lower end of the scale were Mozambique, Uganda and Ghana which had a researcher density of fewer than 25 per million inhabitants. South Africa devoted much of its resources to experimental development research (45%), while Tanzania focused on applied research (59%). The situation was different for Malawi, Mozambique and Uganda where basic research accounted for only about 10% of R&D expenditure.

This low science investment and poor funding was identified as the main cause of a crisis of standards in African universities, according to an 18 May document, *Economic Report on Africa*

(2011). The report said that R&D budgets should be increased to more than 1.6% of GDP, and accompanied by effective measures to improve the quality and relevance of educational outcomes to the needs of the job market. Such an R&D budget increase would also help ease the brain drain, retaining skilled people needed for development. The brain drain among African professionals was reported as acute: as an example, more than 40% of medical doctors trained in 25 African countries lived and practiced overseas in 2000. South Africa and Senegal had the highest percentages of PhDs among R&D staff, scoring 32% and 26% respectively. Several countries (Ghana, Malawi, Mali and Mozambique) had very low percentages of PhDs as well as high percentages with no tertiary education. The African share of global science was reported as continuing to decrease and on that the Innovation Outlook argued for the African continent in becoming more competitive and needing an increase in investment on human capital development, strengthening scientific institutions and equipment, and funding science at significantly higher levels. It also presented a strategy for strengthening African competitiveness through boosting science and technology and reviving the quality of university education.

Other suggestions included designating regional centres of excellence and supporting knowledge production and scientific innovation in specific areas by regional and international organisations such as the African Union and UNESCO. National governments would also have to boost their education and research budgets. Building the 21st century African developmental state, the economic report called for countries to promote innovation, technological adoption and entrepreneurship, as well as high value-added and employment-generating manufacturing. It pointed out that the science sector is dominated by academics employed in government research institutes or public university laboratories. The role of the private sector in R&D was found to rank higher in Mali, South Africa and Ghana than in other participating countries. Private non-profit institutions played a very modest role in R&D activities in the surveyed countries, with the notable exception of Malawi.

Furthermore, the *Outlook* pointed to a shift in African research focus from agricultural science to medicine since the 1990s. It also referred to the problems of ageing and a decline in qualification levels among Africa's agricultural research workforce. The report recommended R&D investment focus on three areas: increasing and stabilising research funding, addressing training constraints and improving regional cooperation.

Innovation Outlook found that innovation had been driven more by companies oriented towards client and customer ideas and collaboration, and by acquiring new machinery and equipment rather than by scientific ideas originating from public institutions. It observed that not all innovative organisations perform R&D which raises policy questions about promoting entrepreneurship and R&D, especially among small firms. The document identified a number of problems facing African innovation, including the lack of a qualified workforce and lack of information on technologies and markets, as well as high costs and domination by established enterprises.

In conclusion, if the study and report was to contribute to a better understanding of the interventions required of African government's additional work will be required. The international partners and the STI community should develop and apply innovation and science. This includes the use of STI indicators for policy formulation and implementation, strengthening statistical capabilities to improve the quality of data, and a greater investment in human capital development.

i) Ghana Literature Survey: Introduction and Background

The government of Ghana has finalised its education reforms giving a much needed boost to the role of science and technology. There were various calls by academics like Professor Kwabena Frimpong-Boateng, Director of the National Cardiothoracic Centre, who called on the government to formulate a comprehensive and coherent national science and technology policy as well as to contribute to the achievement of the country's development objectives. He stated that; "This policy is necessary for the effective application of science and technology for development, because for many decades now, the government has not shown any serious commitment to the development of science and technology, even in areas where institutional and legal framework exists", he contended. These reforms have taken two years to prepare by the coordinator of the National Education Review Inspectorate Committee. Comfort Asomaning indicated that, "Science and Technology have the historic record of solving problems and any country that is serious about development has to promote science and technology".

The reforms intentions were to address both a lack of resources for science teaching and poor training in science for teachers. For the first time, students at kindergarten and primary level will

be taught science in local languages. At secondary level, the emphasis in science teaching will be on innovation and problem-solving. The country also appointed a science minister in 2009 after three years without one, and re-established its Ministry of Environment, Science and Technology, as part of Ghana's President John Evans Atta Mills' drive to restore the science sector. Other critics have noted that progress has been slow particularly regarding the funding of research.

Ghana has about 0.3% to 0.5% of the Gross Domestic Product (GDP) set aside for research and development with consequences that all the indicators of the level of development of science and technology in Ghana were not favourable. In Ghana the number of scientists and technologists who were involved in science and technology in the country were inadequate and not only that, they had little opportunity to update their skills and knowledge. Researchers in the various institutions, including the Council for Scientific and Industrial Research their scientific publications and research conferences were few and far in between. In industry, the state of science and technology could only be seen in the quality of locally manufactured or processed products.

ii) South African Literature Survey: Introduction and Background

According to nature, (2011), South Africa outdoes some African countries in absolute terms spending nearly 30 times more than Malawi and more than 8 times more than Nigeria, the runner up. For the rest of the countries surveyed, research and development (R&D) intensity was between 0.20% and 0.48% of their GDP.

South African has explicitly expressed itself as "…….striving to become an innovative society, indicating that it is essential to support the public understanding of science and technology as well as and engagement with science. South African's government's starting point is that the members of the public are not merely passive recipients of science and technology, but are important players in the processes that shape the focus and patterns of science, technology and development". (Innovation towards a Knowledge-Based Economy Ten-Year Plan for South Africa (2008 – 2018).

iii) Tanzania Literature Survey: Introduction and Background

Tanzania has experienced drastic structural adjustments of its macro-economic in the 1980s followed by a kind of multi-party democratisation process. The first initiative in the recognition of science and technology as a tool for socioeconomic development was spearheaded by the UN Educational, Scientific and Cultural Organization (UNESCO), which initiated and organized the first UN Conference on the Application of Science and Technology (UNCAST) for developing countries held in Geneva in 1963 in which Tanganyika now Tanzania participated. Following this Geneva conference, UNESCO sponsored the International Conference on the Organization of Research and Training in Relation to the Study of Conservation and Utilization of Natural Resources that was held in Lagos, Nigeria on 6 August 1964.

In 1974 the First Conference of Ministers responsible for Science and Technology in Africa (CAST-AFRICA I) was held in Dakar, Senegal. A follow up to the 1963 Geneva Conference, the Second United Nations Conference on the Application of Science and Technology for Development (UNCSTD) was held in Vienna, Austria in 1979. The most important output of UNCAST was the Vienna Programme of Action (VPA), which led to the setting up of the Intergovernmental Committee on Science and Technology (IGCST) that informed the establishment of the present UN Centre for Science and Technology for Development (UNCSTD) whose ideals were dashed when the United States withdrew from UNESCO. In Africa, the Organization of African Unity (OAU) rekindled the UNESCO initiative by a series of meetings in Monrovia and Lagos whose final act was the promulgation of the joint 1980 declaration of the "Lagos Plan of Action for the Economic Development of Africa: 1980 to 2000.

The Contents of the Lagos Declaration was an indication of the seriousness of the political willingness to utilize science and technology in all its forms as a vehicle for development. The declaration called for three major actions for effective application of science namely:

(1) Formulation of national science and technology policies that will contain essential elements contained in the UNESCO call of 1963. It was the UNESCO call that gave birth to OAU declaration.

(2) The establishment of national science and technology systems comprising of ministries and councils for effective administration and implementation of the national science and technology policies.

(3) Commitment of funding of R&D activities in Science and Technology to a minimum of 1 per cent GDP (set up previously by UNESCO) in 1980 rising to 3 per cent GDP (as seen in most developed countries) by the year 2000.

Tanzania funding of the Science System; Tanzania was set to increase its funding for science research and development (R&D) from 0.3 per cent to one per cent of gross domestic product (GDP) in 2012, seven years ahead of schedule.

3. Research Design and Methodology

3.1. Objective, Questions, and Hypotheses;

The research methodologies will be in the form of qualitative approaches with specific focus on case study methods, whilst quantitative approaches will be limited to statistical information and secondary data for analytical purposes.

Selection of Case African countries; Ghana, South Africa and Tanzania, all are selected on the basis of having a particular political history being; all being English speaking countries, with a common British/Anglo Colonial history and similar forms of Government structures. The three countries also had successful transitional democracies and therefore provided some stability over the years since they attained independence. The differences amongst Ghana, South Africa and Tanzania are that the political ideologies, the structure of the economies and the adoption of the social policies vary; therefore critical support systems, policy environments and national capacities will be evaluated. That Innovation plays a more significant role in today's national system of innovation seems to be obvious. However, to what extent indicators are managed in African countries remains to be an unexplored territory. Therefore, we need to look more deeply into the extent to which Innovation indicators actually impacts and is impacted by innovations activities within an African context. For this purpose the research aspires to seek for answers to the following research questions:

a. **To what extent, in what ways, and for what purposes have Innovation Indicators been implemented in Africa?** How do African countries manage innovations processes? What do they expect from the use of Indicators in their specific countries and in the region?

b. **What are the processes by which Innovation Indicators are adopted and used by the selected countries?** What factors affect such adoption; how Innovation indicators are devised in Africa; what drives and hinders Innovation and policy uptake; is there a sequence in the strategy and implementation of different policy applications in Africa?

c. **How does Africa report on the application of Indicators and why?** How do innovation indicators and practices in Africa impact policy implementation and vice versa? How can implementation of Innovation Indicators be understood and conceptualised from the perspective of innovation in countries and what strategic areas of policy implementation can be mapped?

3.3. Data collection strategy and instrument

It should also be noted that when evaluating Science and Technology there are various evaluation methods available and identified by various authors like Gibbons and Geoirhio in 1987, Danila in 1989, Capron in 1992 and Kostoff in 1993-1994 identified and distinguished between various types of evaluation tools namely; qualitative methods to include peer reviews, semi-quantitative methods like historical tracing of scientific events and quantitative methods to include cost benefit analysis and econometrics.

Quantitative data will largely be gathered through existing database and datasets on Innovation Indicator, particularly in the sectors relevant to this study. As a case this research, takes three case countries in Africa, i.e. (1) Ghana, (2) South Africa, (3) Tanzania. Datasets; hopefully available in official African and other statistical bureaus as well as databases of industry associations will be the main resource and analysed quantitatively. Qualitative data will largely be gathered through in-depth, ***semi-structured interviews*** and ***case studies***. Additionally, this research relies on the strength of ***case studies***, which can take an example activity and use multiple data sources to explore it, to achieve a rich description of phenomenon (as argued by Stake, 1995) in order to represent it from the participants' perspective. In this cases, the study expects to be able to generate a rich and nuanced explanation of the role of Innovation Indicators

in facilitating Science, Technology and Innovation reporting, because case study can aspire to 'tell-it-like-it-is' from the participants' point of view (Stark and Torrance, 2005). It is apparent, that case studies are particular, descriptive, inductive and heuristic as it seeks to illuminate the readers' understanding of an issue (Stake, 1995; Stark and Torrance, 2005).

3.2. Expected Results

On the one hand, it is expected that the study would offer an understanding on the extent to which Indicators has been implemented in Africa, and what has shaped this process. Furthermore, it anticipates a provision on additional insights in the ways knowledge is managed in Africa and how these processes have been facilitated by the Indicators process. On the other hand, by understanding how and the reason why countries develop innovation indicators for policy process the study looks forward to mapping some implications, future potentials and challenges ahead.

3.3. Expected Outcomes;

- An assessment of the main contributions of the innovation indicators and their impacts to policy making of scientific, technological and innovation in Africa,
- A discussion on the applications of the innovation indicators in the selected African countries.

4. Research Plan

Outline of the Chapters/Thesis

1. **Title of the Research:** An assessment of the Science, Technology & Innovation Indicators in African countries: Ghana, South Africa and Tanzania".

2. ABSTRACT

3. **Chapter I:** Introduction & Background: Chapter I of the thesis will be the road map/blue print for the research project detailing the scope, the research question, the justification for the study, the research design and methodological framework, the research methods, the justification and rational for case selection of countries and the research plan.

4. **Chapter II:** Theoretical Framework and Literature Review: Chapter I will then be followed by Chapter II with the theoretical framework which details all the relevant theoretical and the literature underpinning the study, what they say, what the limitations of the theories are, an analysis of the African STI policy in general as well as Innovation Indicators. The chapter will conclude with the author's critical analysis of the literature based on major studies to date.

5. **Chapter III: Research Methodology & Methods:** The Methods will precede the methodological justification as to why be the chosen methods are appropriate for this particular study, field preparations for specific methods, usage of methods for data collection. The methodological chapter would then outline the methodological justifications for the research on a higher level.

6. **Chapter IV: Empirical:** The empirical chapter will provide full details of case countries for the study starting off with the historical and political analysis of the country, the macro-economic frame-work, the Science, Technology and Innovation policy framework as well as the STI indicators process to date.

7. **Chapter V: Data Analysis**: This chapter will then follow up with the analyses on all the data collected on the Empirical section, check for any comparisons on none comparability of cases.

8. **Chapter VI:** Conclusions and Recommendations: The thesis will end by making policy recommendations/framework and or theory building whilst the conclusion section would link all the chapters to an appropriate summation.

It is envisaged that the research duration will be three years, in general depicted in the management chart below.

Research Activity	Time-Frame in Years
Research Proposal and Preliminaries i.e. Chapter 1	Year 1 (2009 - 2011)
Literature Review and Methodological Chapter II & III	Year 1 & 2 (2010 - 2012)
Empirical work; Data collection & Analysis and Interpretation	Year 2-3 (2012-2012)
Policy Recommendation	Year 3 (2013)
Research Finalisation and Submission of the final report	Year 3 (2012-2013)

Bibliography/Sources

Cooke, P. (2004), "The role of research in regional innovation systems: new models meeting knowledge economy demands *Int. J. Technology Management, Vol. 28, Nos. 3/4/5/6,* Centre for Advanced Studies, Cardiff University.

Department of Science & Technology (DST) (2002), "South Africa's National R&D Strategy", Pretoria: Government Printer.

Freeman, Christopher and Soete, Luc (2007), "Developing Science, Technology and Innovation Indicators: What we can learn from the Past, in Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs", Paris: OECD.

Gault, F., (2007), "Assessing International S&T Co-operation for Sustainable Development: Towards Evidence-Based Policy, in International Science and Technology Co-operation for Sustainable Development", OECD: Paris,

Gault, F., (2011), "Social Impacts of the Development of Science, Technology and Innovation Indicators", UNU-MERIT, Maastricht, the Netherlands

Gerryts, B and Buys A., (2010), "R&D as a source of Innovation in South Africa", Graduate School of Technology Management, University of Pretoria, South Africa.

Grimble, R. (1998). "Socio-Economic Methodologies Best Practice Guidelines". University of Greenwich: DFID.

Mouton, J. (2006), "Science for transformation: Research agendas and priorities in South Africa", In L. Box and R. Engelhard (Eds.), Science and Technology Policy for Development: Dialogues at the Interface, London: Anthem Press.

Mouton, J. (1996). "Understanding social research". Pretoria: J.L. van Schaik.

National Advisory Council on innovation (NACI) (2002a), "Audit of South Africa's National Advisory Council on Innovation", Pretoria: NACI.

NEPAD Office of Science and Technology (2006), "African Science, Technology and Innovation Indicators (ASTII) – A Discussion Document: Towards African Indicator Manuals", Pretoria: NEPAD. www.nepadst.org/doclibrary/ Accessed 28 April 2011.

National Treasury (2007), "Framework for Managing Programme Performance Information", Pretoria: National Treasury.

Organisation for Economic Cooperation and Development (OECD) (2006), "OECD Science, Technology and Industry Outlook", Paris: OECD.

Organisation for Economic Cooperation and Development (OECD) (2007), "Review of the South African Innovation Policy", Paris: OECD.

OECD (2002), "Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development", Paris: OECD.

OECD (2005a), "Measuring Globalization: OECD Economic Globalization Indicators", Paris: OECD.

OECD (2007a), "Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs", Paris: OECD.

OECD (2007b), "Main Science and Technology Indicators", Volume 2007/2, Paris: OECD.

Rogers, E.M. (1995), "Diffusion of Innovations", Fifth Edition, Free Press, New York.

Schumpeter, J. (1934), "The Theory of Economic Development", Harvard University Press, Cambridge, MA.

Viotti, E., (2010), "Measuring innovation requires more that R&D indicators", Science and Development Network, www.scidev.net/en/latin-and-caribbean/opinions/measuring-innovation-requirements, accessed 9 May 2011.

Websites

www.assaf.org.za (Academy of Science of South Africa

www.dti.gov.za (Department of Trade and Industry)

www.dst.gov.za (Dept of Science and Technology)

www.hsrc.ac.za (Human Science Research Council)

www.naci.org.za (National Advisory Council on Innovation

www.resbank.gov.za (South African Reserve Bank)

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Appendix A: South African Science, Technology and Innovation System Profile by the World Bank

Science, Technology and Innovation System Profile Country	South Africa

Key indicator	Measurement/Rating
Foreign Direct Investment (FDI) as percentage of GDP	34.3% (UNCTAD World Investment Report 2008)
Total expenditure on R&D as a percentage of GDP	0.9% (20010/2011)
Firm level technology absorption	5.3/7 and country ranked 30 out of 128 countries by the Global Competitiveness Report 2006-2007
Private sector spending on R&D	Approximate 56% of total R&D expenditure 2006/2007
Technology exports as a percentage of manufactured exports	6% (World Development Report 2009)
UNDP 2001 Technology Achievement Index (TAI)	Ranked 39 with TAI value of 0.340 in the group Dynamic adopters
Number of institutions providing technical training	Many including more than 10 public universities
Number of Researchers in R&D	
Researchers in R&D per million population	135 (Cestii))
Science and engineering enrolment ratio (% of tertiary level students)	3.4% 1995 - 1997 UNDP 2001
Number of SET graduates per million population	
Scientific and technical journal articles published	5,896 ISI papers in 2007 (SARUA)
Scientific and technical journal articles per million population	
University-industry collaborations	
% Imported technologies used in domestic market	
Royalty and license fee payments	
Patent applications granted by the USPTO per million population	
Strategies and Policies	**Details**
Key documentation (provide actual documents, links or URLs if possible)	National R& D Strategy, 10 year innovation plan, Biotechnology Strategy
Existence of a national ministry or department of science and technology	Department of Science and Technology (DST)
Explicit science and technology (R&D) policy	Yes. White Paper, National R&D Strategy
Explicit innovation policy and strategy	Technology/Innovation Strategy 2007
Science, Technology and Innovation focus areas	Biopharma, Hydrogen cells, Climate Change, Space science