Management of technology in Ghana – problems prospects

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Abstract: Despite the immense progress that has been made throughout the world in improving the quality of life through applications of technology, large proportions of the peoples of Africa still leave on less than $1.00 per day income. The seven most industrialised democracies of the world, without major resources, except in few cases, import minerals and other industrial and agricultural raw materials and process them through well managed technologies to produce virtually everything around us. On the other hand, Africa, with the largest mineral reserves, in many cases, and the largest biomass potential but without any significant knowledge in how to manage technology, contributes less than 2% of world industrial output and generates very poor gross domestic products. To reverse this trend, African countries must build innovation-based economies using well-managed technologies. This will stimulate industrialization and increase wealth. Proper Management of Technology presents both practical and policy challenges. This paper describes the Ghanaian experience and illustrates the key elements necessary for proper management of Technology in the third world. It also describes the essentials needed for integrating technology into society in an effective, sustainable way so that peoples of Africa can put technology to use to improve their lives.

Keywords: Africa, Ghana, Policy, Innovation, CSIR, Management of Technology

Introduction

On the whole, Africa is sustaining a deep crisis: increasing poverty, worsening environmental problems, dismal industrial productivity, growing food insecurity and a deteriorating public health. These problems have led to a variety of policy responses, ranging from structural adjustment to the ongoing efforts at formulating poverty reduction strategies. Emphasis is largely focused on getting macroeconomic conditions right. While sound macroeconomic management is crucial for achieving economic growth, it is the ability of African countries to generate and manage technology that will ultimately determine its success in fighting poverty and enlarging competitiveness in the world market. Growth is the most powerful weapon in the fight against poverty. But accelerating and achieving it will require policies that deliberately promote endogenous scientific and technological development. This is the point that many of those responsible for development policy and planning for African countries often fail to grasp or sometimes lack the necessary analytical tools to engage with.

Challenges Militating Against Africa's Sustainable Development

Africa is faced with growing food insecurity, a worsening public health, environmental degradation, and deep political and ethnic conflicts. The economies of African Nations have performed miserably in the past two decades and poverty is a marked feature of more than 75% of Africa's human population. In 1998 more than 301 million Africans were living on less than US$ 1 per day compared to 217 million in 1987. Africa has the largest share of people living on less than $1 per day [Mugabe 2000]. Africa's poor economic performance and growth in poverty are closely linked to deepening environmental degradation. Soil depletion, deforestation and associated loss of genetic capital, unsafe water, over-fishing, and inadequate sanitation are some of the environmental problems that the region and its poor population are faced with. Agriculture which is the mainstay of the economies and majority of the poor has witnessed slow growth and in some countries rapid deterioration. Its capital stock per hectare of land is less than one quarter of that in Latin America and one-sixth of that in Asia. More than one-third of Africa's population is faced with starvation. Africa's telecommunications infrastructure is the least developed in the world. In terms of public health, recent estimates show that less than 35% of Africa's population has access to basic health or medical care facilities. Malaria and HIV/AIDS are now major destroyers of human life on the continent. More than 90% of technologies-products and processes-used by African countries are produced elsewhere: in Asia, the United States of America, and Europe. Technological dependence undermines efforts of African countries to transform their economies and meet needs of the majority of the population. It does so in a number of ways. First, it undermines the autonomy of the developing countries to determine their technological needs. Most of these countries tend to react to global technological trends without identifying and articulating their economic needs. Secondly, it inhibits processes of local technological learning essential for development. It also tends to devalue the activities of local scientific and technology institutions.

Ghana

Demography

Ghana referred to, as the Gateway to Africa is located south of the equator in the West African Sub region. With an area of 238, 5378 Sq. km about 23.8 million hectares, the country is inhabited by 18.8 million people (2000) who speak several languages with English as the Official language and the language of Instruction in schools. Ghanaians profess three main religions, Christianity, Islam and African Traditional religion. Ghanaians have per capita income, GNP of US $390 and a GDP per capita of 1,881 (PPP US$) in 1999. Ghana hopes to attain the level of middle-Income country status by the year 2020 [ISSER, 2002]. The Country ranks quite low on the Physical Quality of Life Index (PQLI) 199 and the Human Development Index (HDI) value is 0.542 (maximum of 1.0). The Adult literacy rate of the country is 54%, although very low, is one of the highest in Sub-Saharan Africa. Life expectancy is 56.6 years [UNDP, 2001].

Economy

Ghana’s economy is predominantly agrarian and commodity based, with Agriculture dominating in terms of employment, revenue and export earnings. It accounts for 50% of the labour force and 42% of GDP [CEPA, 1996]. Other major exports are minerals (notably gold, diamonds, bauxite & manganese) the tourism Industry is however becoming an important foreign exchange earner. Ghana’s current level of investment in R & D is 0.3% of GDP [MEST, 2000]. This has left large investment in fixed capital and equipment and acquiring natural resources at risk from boom & bust cycles fuelled by global commodity market fluctuations.

Science & Technology Infrastructure

Since the attainment of political Independence in 1957, successive Governments have endeavoured to make Science and Technology a critical basis for the country's development. The National Research Council was established in 1958 with the broad aim of coordinating scientific research to support the country's development. Out of the Council, there is currently the Ghana Academy of Arts & Sciences and the Council for Scientific and Industrial Research (CSIR). The Noguchi Memorial Institute for Medical Research, the Ghana Atomic Energy Commission, the Ghana Standards Board and the Cocoa Research Institute of Ghana have all been established over the years to promote scientific activities geared at Scientific Sectors of the National Economy. Scientific education has also been deemed to be an important aspect of the national program for introducing S & T into the country's development efforts. Other specialized institutions including the Ghana Regional Appropriate Technology Industrial Service (GRATIS) with its Intermediate Technology Transfer Units (ITTUs), The National Board for Small Scale Industries (NBSSI), The Technology Consultancy Centre (TCC) and the Development and Application of Intermediate Technology (DAPIT) also exist for the development and transfer of technologies to all sectors of the national economy, especially the micro, small and medium enterprises. Despite the various actions taken by successive governments, Ghana has not been able to develop the S & T base to address the country's basic human needs of food security, shelter, clothing and transportation, due to lack of proper management of S&T.

Ghana's Science & Technology Policy

Vision: The National Science and Technology Policy of Ghana is to support national socio-economic development goals with a view to lifting Ghana to a middle income status by the year 2020 through the perpetuation of a science and technology culture at all levels of society, which is driven by the promotion of innovation and the mastery of known and proven technologies and their application in industry, and other sectors of the economy.

The Science and Technology Policy Statement is based on the notion and view of the future where all Ghanaians, young and old alike, will enjoy a higher and sustainable quality of life, participate in a liberal competitive economy by means of a fulfilling employment, and share in a democratic culture that tolerates all views [MEST 2000].

Goals: In order to realize the Science and Technology Vision, it is essential to set achievable goals for the creative use and efficient management of science and technology in Ghana. These goals include:

- The establishment of a well coordinated and integrated system of science, technological and social innovation within which:
  a.) the private and public sectors can collaboratively forge partnerships and creative interactions to benefit themselves and the nation at large; and
  b.) all stakeholders are part of a more inclusive and consultative approach to policy decision – making and resource allocation for science and technology activities;
- The encouragement of a culture within which the advancement of scientific knowledge is valued as an essential component of national development; and
- Improved support for all kinds of innovation which are fundamental to sustainable economic growth, employment and socio-cultural development.

Objectives: The basic objectives of the Science and Technology Policy are:

- To seek to master scientific and technological capabilities;
- To develop infrastructures which will enable industry and other sectors of the economy to provide the basic needs of society and for the citizenry; and
- To adopt a science and technology culture

Long-Term Objectives: In the long-term, the main objectives are to acquire endogenous science and technology capabilities appropriate to national needs, priorities and resources, and to create a science and technology culture whereby solutions to socio-cultural and economic problems of the individual, the community and the nation are recognized and sought within the domain of science and technology [MEST 2000].

Medium-Term Objectives: In the medium term that is within the first 10 years of implementation, the objective is to accelerate the promotion of innovation through the development and utilization of modern scientific and technological capabilities to provide the basic needs of the citizenry and to compete ably in the global market [MEST 2000].

Short-Term Objectives: In the short term that is within first 5 years of implementation, the government will restructure the entire science and technology machinery, infrastructure and programmes in order to make them more responsive to national needs and priorities in all sectors of the economy. To that end, emphasis will be placed on:

- Restructuring of the National Science and Technology Advisory system;
- Improving basic and applied research infrastructure;
- Restructuring the teaching of a critical mass of middle-level technical personnel to address the provision of basic needs to food, shelter, health, clothing, energy, etc., and to enable the citizenry and the nation to participate in a competitive global economy;
- Acquisition of skills in high technology areas and their integration in industry
- Initiation of mastery of known technologies and their application in industry

Guidelines: The effective implementation of the Science and Technology Policy will be guided by:

- The need to critically examine areas and programmes of relevance to the country's development and use the most cost-effective means to achieve the desired results;
- A multi-disciplinary and cross-sectoral approach to problem-solving; and
- A conscious collaboration and interaction with stakeholders as partners

Policy Measures: In order that science and technology will have the desired impact on society, it must be propelled by an unfettered commitment from Government, private sector and the population at large. Government will, therefore, take a number of actions to ensure that the nation derives maximum benefits from the application of science and technology. Specifically, Government will:

- Create the enabling environment and advocacy for the promotion of science and technology as key factors in Ghana's development process;
- Promote the development and utilization of science and technology capabilities, including entrepreneurial skills development;
- Promote science and technology capacity building;
- Encourage the improvement of the quality of research and development (R&D) activities, especially within private sector institutions;
- Strengthen national engineering design capacity activities;
- Strengthen the protection of intellectual and innovative property rights;
- Ensure environmental sustainability;
- Promote participation of women in science and technology;
- Safeguard the generation, use and application of science and technology;

- Promote international and local co-operation and linkages;
- Promote a science and technology culture; and
- Establish mechanisms for the finance, management and evaluation of the performance of science and technology.

Ghana's National System of Innovation

The Science and Technology Policy outlines to some extent a clear vision, goals and objectives and policy measures which if well articulated will enable Ghana to move towards an Innovation-Based Economy. However the policy needs to be reviewed to reflect current thinking in S & T. Unfortunately, the policy has not been adhered to and has been sidelined. S&T is of little priority to policy makers in the country.

Researchers have wondered if the concept of the national system of innovation (NSI) could be applied to low GDP per capita economies (Niosi et al. 1993). Despite the problems of the measures and difficulties that occur with multiple approaches to the concept of NSI (OECD, 1997), it can be argued that it is applicable to less developed economies. One can assume first that all countries around the world, including Sub-Saharan Africa (SSA), have developed institutions devoted to the production of knowledge, public policies and programs for building technological capacities in enterprises (Davis, 1983; Eisemon et al., 1985; Odhiambo, 1996). Secondly, the concept of NSI assumes that governments can consciously take actions to avoid systemic weaknesses of the NSI (Freeman, 1988; Vinck, 1991). Indeed some innovation process is endogenous and to that standpoint, governments of SSA must develop and use institutional innovations that will strengthen their NSIs.

At present, innovation has not been widely acknowledged as a very significant public policy issue in Ghana. Policy makers in Ghana have not fully recognized the importance of innovation to Ghana's competitiveness. However, understanding of NSI and industrial clusters of Ghana is beginning. There are several issues that need to be thoroughly explored. Methodology to assess Ghana's national innovation performance is necessary. Ghanaian policy makers need better knowledge of processes of innovation and technological change to assist Ghanaian firms to become more innovative, and therefore, achieve greater international competitiveness. They also need to be advised on methods likely to stimulate innovation, and produce greater social benefits and more effective commercial outcomes from R&D and other innovation investment.

There are currently three main elements in the Ghanaian national system of innovation:

- Government Ministries,
- S&T institutes, each of which (except the Ghana Academy of Art & Sciences) is associated with a ministry and
- The Tertiary Educational Sector.

Currently there is little data on investment by the private sector in S&T on which to draw any meaningful conclusions, but the level is, at present, very low or non-existent. The developing Ghanaian industry imports technologies, mostly embedded in production equipment and processes, with very few moving on to adapt and develop their own technologies. In the public sector, foreign donors are major sources of technologies and the funding to adapt and develop some basic technologies. Although many of the institutes run by government ministries are described as research institutes, it appears the immensity of their activities are scientific and technical services: that is not to say that there is no research and innovative activities being undertaken. Thus the Ghanaian national system of innovation is, at present, primarily an S&T services system (as defined by UNESCO). At this time the primary policy interest must lie in considering S&T investment and in measuring S&T inputs and outputs.

Management of Technology in Ghana

In the 1990s, science systems in nearly all countries including countries of Sub-Saharan Africa experienced increasing pressures for change. These pressures reflect new challenges that go beyond the important issue of ensuring sustained funding for the research enterprise, and need to be addressed in the broader perspective of *Management of science & Technology systems*. This includes the decision-making processes for priority setting, funding, the management of research institutions and the assessment of their performance in terms of contribution to knowledge creation, economic growth and responses to societal needs.

Main challenges are: responding to a more diverse set of stakeholders, exploiting emerging opportunities, and ensuring the long-term sustainability of the research enterprise.

In Ghana the Minister of Environment & Science is supposed to be the principal adviser to the Government on all issues relating to S & T. He has the overall responsibility for the Management of S & T in the country. This role over the years has not been well executed. In line with increasing pressures for change, the Government of Ghana put several structures in place to restructure the publicly funded research institutes. The restructuring of the Council for Scientific and Industrial Research (CSIR), Ghana's main R&D Institution is used as case study in this paper. The restructuring, management of the change and the commercialization process is discussed below

Management of Technology in Ghana - The CSIR as a Case study

The Council for Scientific and Industrial Research is Ghana's main R&D Organisation. It was established in 1968 as a public organization to undertake and coordinate Ghana's Scientific and Technological Development. It is made up of 13 Institutes each specializing in specific scientific and technological discipline. By an Act of Parliament of the Republic of Ghana CSIR Act 521 of 1996, the CSIR was re-established with a new mandate to conduct market-oriented, demand–driven research and also to commercialize the research results and technologies developed [Parliament, 1996]. The CSIR was tasked to recover three-quarters of its annual operating expenses through contract research and services. The Implementation process started in 1997 with different consultants recruited to restructure the CSIR with support from the World Bank, the ODA and other donor agencies. It was mandated that by December 2001 the CSIR should generate 30 % of its Annual Budgetary Requirement (ABR) and that Government support to the CSIR would be slashed by 30% [PSDP, 1996]. Many structures were put in place including

- Creation of Central Commercialization and Information Division (CCID) at CSIR Secretariat and Commercialization and Information Division (CID) at all the Institutes of the CSIR.
- Training programs in business management for Directors and Research Managers
- Recruitment of a Commercial Director and commercial managers
- Promotion criteria were revised with more emphasis placed on technology transfer and Commercialization.
- Three Sectional Coordinating Committees were also established within the CSIR with a view to providing comprehensive overview of the use of S & T as well as the implementation of research programs among all institutions in the country. These Committees areas of operation cover all sectors of the national economy.

However, the implementation process was flawed from the beginning.

- Research and Technological Organization transformation process is a continuous and iterative process and it can be divided into three phases, namely: *diagnosis, planning,*

and *implementation* [WAITRO, 1999]. The South African consultants engaged to facilitate and direct the process were highly incompetent [PSDP, 2002]

- Until 2001, Ghana had no explicit National Science Policy, so the transformation was not done within any proper policy framework. This actually contributed to the poor planning before the implementation.
- The commercialization process was not linked directly to intellectual property protection. The knowledge level on Intellectual Property Rights among scientists even after six years of commercialization is very low. Most technologies developed have found their way to the end users without any gain to the developers.
- Poor commitment from the leadership of the CSIR and its institutes and all levels of staff. This is as a result of poor communication as to why the change is necessary and the benefits the change will bring. Research Scientists did not see the reason why they had to commercialize, because they were trained and employed as scientists and not marketing executives. Many saw it as one of the bad policies of the Government.
- There was and there is no reliable and systematic method for collecting, storing and utilizing data that measure performance.

The requirements of CSIR to generate 30% of annual budgetary needs by December 2001 could not be achieved based on the 5-year corporate average of 5.49% as shown in the Table below. Similarly, at the individual institute level, only CSIR-OPRI has consistently operated high returns with a 5-year average of approximately 30%, and surpassed the stated goal very slightly for some years. The averages for the rest of the institutes are under 5.0% [CSIR-CCID Task Team, 2002].

Institute's of the CSIR	**Internally Generated Funds (IGF) as a percentage of Annual Budget Requirement (ABR)**					
	1997	**1998**	**1999**	**2000**	**2001**	**Average Performance**
ARI	4.80	0.11	1.10	1.11	1.54	1.73
BRRI	1.50	2.40	1.94	7.80	7.64	4.24
CRI	2.30	2.01	1.45	0.20	1.44	1.53
FRI	4.55	4.20	3.24	2.60	2.07	3.20
FORIG	3.00	2.94	1.60	2.90	35.97	8.28
IIR	1.15	1.20	13.13	0.80	0.59	3.16
INSTI	4.90	5.14	1.00	10.84	2.00	4.18
OPRI	21.71	43.74	37.71	23.12	29.12	31.08
PGRC	4.00	5.60	4.00	6.60	2.70	3.8
SARI	0.52	1.70	0.40	0.32	1.80	0.78
SRI	2.00	1.82	0.80	0.30	0.40	1.12
STEPRI	1.01	1.51	1.31	2.21	0.58	1.10
WRI	3.20	5.02	4.64	23.60	4.46	7.2
SECR'T	-	-	-	-	-	-
TOTAL	3.5	5.0	4.1	6.34	6.94	**5.49**

Source: Central Commercialization and Information Division, CSIR (2002).

Several reasons can be assigned to the failure of the CSIR and Ghana as a Country in achieving it technological development goals. Management of Technology within the CSIR and Ghana as a whole is a serious obstacle, which ironically has not been given the needed attention. The major obstacles to proper and efficient Management of Technology in Ghana fall into definable categories namely Financing, Management, Marketing, Education and Infrastructure The first step in the commercialisation process consists of learning the obstacles lying between the Scientist or Technologist and the market; the second step involves learning to plan a strategy that will see you safely through the barriers--in effect, learning to navigate; the final step requires actually making such a plan and executing it. All these steps require good management. There are very few experienced technology transfer and commercialisation managers in Ghana – there is a general lack of people with entrepreneurial flair and the managerial capacity to overcome the hurdles to successful commercialisation. Although there is the know-how and the capacity for technological innovation, the small size of Ghana's technology industries, means that there just are not that many good managers to manage the know-how and the innovation process. There is general acknowledgment that management ranks need to be strengthened; the challenge is how.

One problem Ghana faces is that the size of the technology industry does not provide the capability for gradual progression of increasingly senior managerial positions. Another managerial problem especially within the CSIR, which is adversely affecting the commercialisation process, is that many of the Directors and commercial managers have a technology background, however because of their current position they tend to leave the technology area for the managerial area. The technology area loses the attention it needs to maintain advantage, while at the same time the managerial area is led by a person who often does not have the managerial skill set. Directors within the CSIR need to recognize this problem and develop appropriate staffing. The CSIR has experienced little success when endeavouring to recruit management personnel to manage the commercialisation process.

Managerial Shortfalls within the CSIR: There are some specific managerial shortfalls within the CSIR. One is the lack of ability to make value statements. A typical problem of scientists and technologists in the country creating technology is their lack of ability to express the value that technology will bring to their customers. In simplistic terms, the focus is on technology features rather than customer benefits. That is not to say the benefits are not necessarily there - the problem lies in attitudes that are not customer focused, and even where they are, the CSIR is unaware of how to manage that focus into a successful sales campaign.

Another managerial shortfall, more widely applicable, is the need for managers not just to have general management skills, but the benefit of being networked. This is a major problem within the CSIR and the entire Ghanaian society.

Non-traditional organizational and management styles are also a barrier. Although different organizational designs and styles might work very well commercially, non-traditional approaches to management of technology are treated with scepticism by the investment community - perhaps another evidence of lack of receptivity to new ideas.

Finally, there is a lack of useful industry and competitive information as a barrier to successful commercialization, and that this is a void that government could help to fill.

Managing the Innovator

Recent ethnographic studies of workplace practices indicate that the ways people actually work usually differ fundamentally from the ways organizations describe that work in manuals, training programs, organizational charts, and job descriptions [Barley, 1988]. Nevertheless, organizations tend to rely on the latter in their attempts to understand and improve work practice. Working, learning, and innovating are closely related forms of human activity that are conventionally thought to conflict with each other [Bartunek, 1984]. Work practice is generally viewed as conservative and resistant to change; learning is generally viewed as distinct from working and problematic in the face of change; and innovation is generally viewed as the disruptive but necessary imposition of change on the other two. To see that ***working, learning,*** and ***innovating*** are interrelated and compatible and thus potentially complementary not conflicting forces requires a distinct conceptual shift [Adler, 1987]. Ghana needs such a shift. With a unified view of working, learning, and innovating, it should be possible to re-conceive of and redesign the National System of Innovation to improve all three. Research managers need special orientation on new techniques of business management under conditions of global change.

Training in Management of Technological Innovation

Management development needs to take place in the heat of the work place. However, the universities in Ghana have not fulfilled their role in terms of formal training in management of technology. Infact none of the Ghanaian Universities; private or public is undertaking Management of Technology as a discipline of study. The development of modern technology has reshaped the way we do business and the way we live our lives. To

gain competitive advantages, modern firms must constantly bring new innovations to the world and quickly adopt new technologies developed by others to survive. Universities in Ghana need to blend technology with business management from a system's perspective. The training should build from the fact that technology has become the most important strategic weapon industries and national development. Some scholars call the brave new world as the knowledge economy or Innovation-Based economy to stress the importance of technology or knowledge for the next wave of economic growth. The traditional R&D management approach is not enough to describe the business function of developing, utilizing, commercializing, and replacing technological knowledge in this ever-changing business world. Management of technology and innovation has become the core discipline for the professional managers of the next generation.

Therefore Ghanaian Universities in developing their curricula in Management of Technology should focus on the planning and development of technology for the growth and profits of technology-oriented enterprises. The students will gain a firm understanding and the competence in the area of management and technology. Dissertations should further elaborate on particular aspects of the course according to the student's own objectives and background. Dissertations would help to consolidate theories and best practices from the western countries to the context of Ghanaian industries.

Conclusion

The pursuit of scientific inquiry and the utilization of technology can be enhanced through innovative structures and mechanisms which help enforce product quality, distribute information, facilitate the access to knowledge sources and the financing of business, deliver the requisite business development services and required work spaces. An existing institution may be radically re-structured, or totally new structures may have to be established to cope with new environment. Many developing countries and those in transition from command systems to market economies are characterized by insufficient business infrastructure, weak management and marketing skills, poor productivity of research and inadequate tools for its commercialization, high rates of inflation, taxes and interest, and limited financial resources. In addition, there are cultural constraints such as repressed creativity, reluctance to share information or delegate responsibility.

Yet, in order to mobilize the opportunities of the technological revolution and cope with the challenges of globalization now upon us, Ghana and for that matter Africa would have to develop new strategies to stimulate innovation and entrepreneurship. Proper Management of Technology will move Ghana and Sub-Saharan Africa from Commodity– Based economies to Innovation– Based economies. Proper Management of Technology will strengthen National Systems of Innovation in Africa by helping to integrate technology into society in an effective, sustainable way so that peoples of Africa can put technology to use to improve their lives

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