

Science, Technology and Sustainable Development: The Challenges on African Countries and their Solutions

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Article DOI: 10.48028/iiprds/ijasesi.v5.i1.08

Abstract

Science and technology hold the key to the progress and development of any nation technology plays a fundamental role in wealth creation and improvement of the quality of life and real economic growth transformation of any society. Despite attempts by Africa government to achieve sustainable development, there is a growing perception that Africa may fail in achieving the goals. This perception is fueled partly by the evidence that while the world is undergoing rapid change which is driven prominently by technology and globalization. Africa remains unprotected and at risk of being exploited without due recognition and remuneration for its resources. The objective of this paper is to know the relationship between science and technology and development in Africa, the contributions that science and technology has towards development of African countries, the status of science and technology development in African and its achievement to sustainable development in African. The necessary measurements to improve and ensure development in Africa through science and technology were suggested. Recommendations and conclusion of the study, in nutshell, are to make science and technological education which are practically oriented along with industrial attachment, to be encouraged at all levels of education, there should be creation of scientific journals, documentation information's in books, and the internment to spread scientific information across borders and also more science journalist should be employed to communicate scientific information

Keywords: *Science, Technology Sustainable development and Africa Challenges*

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Background to the Study

Africa, especially the sub-Saharan regions is challenged with a lot of crises. The immediate problems have made it difficult for this continent to enjoy certain values and comfort. Due to the overgrown population, people are in constant conflicts for the quest of resources and raw materials, there is an increase in disease affluence especially the communicable diseases (World Bank, 1993). Poor agricultural yield due to climate change has promoted hunger and starvation (Friedman & Thomas, 2008). These impediments have led to socioeconomic problems, political instability and poverty which have prevented the development of this continent. Science and technology are one of the major aspects in which most developed nations have highly promoted to foster their development. Though science and technology began as far back as in the time of the first existing human beings, its evolution has greatly revolutionised the world to suit man's desire, improve on his well-being and comfort. Prior to development, certain key elements such as research, biomimetics, communication, partnership etc. are very essential in the advancement of science and technology. These key elements are critical for the growth of science and development in Africa.

In spite of the positive contributions of science and technology to development, the detrimental effects to the society cannot be underestimated. Global warming, depletion of natural resources destruction of the environment and ecosystem and sophisticated weapons are all outcomes of science and technology which are against the promotion and sustenance of humanity (Chukwuma, et al, 2012). In this era, the way forward is to promote those technologies that ensure a sustainable development; that is those technologies that will eliminate the detrimental effects in the society and promote life.

In recent times, there has been a paradigm shift in defining development and the way it is approached. This paradigm shift resulted in the adoption of Sustainable Development (SD), a concept which was highlighted in the Brundtland Report of 1987 and at the Stockholm Conference of 1972 (United Nations Economic Commission for Africa, 2010). The shift was borne out of the global links between environmental problems and socio-economic concerns, and also as a result of the fact that earlier conceptions and approaches to development appeared to focus largely on economics and physical wealth despite the multi-dimensional and complex nature of development. Focusing on economics and physical wealth in the pursuit of development has proven to be unsustainable not only from the environmental perspective but also from the economic, social and employment perspectives because it is resource intensive, hence the need to pursue SD (Ngongi, 2013).

According to Annan (2012) the idea of Sustainable Development (SD) dates back more than 30 years ago, and it was coined by the World Conservation Union (Association of African Universities, 2009). The Brundtland Report defines Sustainable Development (SD) as "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs." The Organization for Economic Cooperation and Development also defines SD as the development path along which the maximization of human well-being for today's generation does not lead to the decline in the well-being of the future generation. These definitions suggest that SD considers the needs of the future and

current generations in tandem, and it is rooted in the pursuit of the welfare and well-being of the people. SD is motivated by the negative externalities that are responsible for natural resource depletion and degradation; it requires screening public goods that are essential for economic development, and it also stresses the importance of retaining the flexibility of the environment to respond to shock (Boateng, 2013). In order to achieve SD, African governments have launched several strategies. In Ghana for instance, the Ghana Poverty Reduction Strategy (GPRS I and II) and the National Environmental Policy (NEP) were designed.

In Tanzania, the National Development Vision (NDV) 2025 was designed. In Egypt, there was the National Strategy for Solid Waste Management (NSSWM). Across the entire continent, there has been an increased number of SD initiatives being implemented in some 28 countries; these initiatives manifested in the transformation of the Organization of African Unity (OAU) to the African Union (AU) in 2001, the establishment of the New Partnership for Africa's Development (NEPAD) and the establishment of Regional Economic Councils (RECs) in the sub-region (Boateng, 2013).

In spite of these attempts by African governments towards SD, there is a growing perception that Africa could fail in achieving SD. This perception is fuelled partly by the evidence that while the world is undergoing rapid change, which is driven prominently by technology and globalization, Africa remains unprotected and at risk of being exploited without due recognition of, and remuneration for, its resources. Additionally, there is the continued escalating trend in poverty and the diminishing strength of the environment to meet current and future needs of African countries. Given the fact that SD appears to be contradicting in between the opposing imperatives of growth and development on one hand, and ecological sustainability on the other, the trend in SD on the African continent has generated some scepticism about whether SD is achievable in Africa. The lack of a coherent literature that documents the challenges and prospects of Sustainable development in Africa underpins the uncertainty of achieving SD in Africa. This paper therefore evaluates the challenges of SD in Africa, and suggests way forward.

Objectives of the Study

- i. The paper is showing the relationship that is between science, technology and development in Africa.
- ii. The contributions that science and technology have towards development of African countries
- iii. The status and challenges of science and technology and development in Africa and its achievement to sustainable development in Africa.
- iv. The achievements and the challenges of sustainable development in Africa.
- v. The various measurements to improve and ensure development in African through science and technology.

Research Questions

This study is going to produce answers to the following questions:

1. What are the relationships between science, technology and development in Africa?
2. What are the contributions of science and technology to development?
3. What is the status and challenges of science technology development in Africa?
4. What are the achievements of sustainable development in Africa?
5. What are the measures to improve and ensure development in Africa through science and technology?

Literature Review

Evolution of Science and Technology

Sciences and technology began as early as the ancient days of the early man who produced fire from sparks of stones which he used for cooking and heating as a means for survival (Human Evolution, 2008). In this Paleolithic age, stone was the material used for most of the items they produced (Thomas, 2004). Even though an explanation on how this happened was unknown, the application was very vital for their sustenance. Since then, man continued to acquire knowledge on how to exploit his natural environment for survival until the Neolithic days of early civilization with arise in technology where blacksmith used metal such as iron, zinc to produce weapons against wars (Alan & Cramb, 2007). With the gradual rise of civilizations in the river valleys of Egypt, Babylonia and other kingdoms, knowledge became too complicated to transmit directly from person to person and from generation to generation. For man to thrive in this complex society, he needs some way of accumulating, recording, and preserving his cultural heritage and pass up to his generations. By 300 BC with the rise of trade, government, and formal religion, man invented writing as a way to document his activities and culture (Thomas, 2001).

Due to first-hand experience in everyday living could not teach such skills as writing and reading, a place devoted exclusively to learning; the school appeared. As schools appeared, a group of adults specially designated as teachers (the scribes of the court and the priests of the temple) passed across this information. The children were either in the vast majority who continued to learn exclusively by an informal apprenticeship or the tiny minority who received formal schooling. In the early days when the word science was not coined, the discipline was term philosophy of nature which was referred to as the way of pursuing knowledge from nature. The early Greek philosophers such as Socrates, Isocrates, and Aristotle thought arithmetic, astrology, philosophy, music, dancing, and gymnastics, physical health and others. Among these philosophers, some were basically interested in the knowledge of nature and the material things which are true for every community which separated them from those who used a specialized way for the pursuit of this knowledge.

These two schools of thoughts shaped the field of science and philosophy respectively. By the middle age period, sciences became documented; theories were developed and tested experimentally to prove them (Ursula, 2007). In trying to use the knowledge of nature to imitate nature, these philosophers discovered a new field which they named called technology. From this era, scientist began to develop laws and theory such as the laws of nature, Newton's laws of motion etc. It is during this period that the word "science" gradually became more commonly used to refer to a type of pursuit of knowledge which focuses on

nature and material objects. Around the 17th and 18th centuries, new laws of nature were developed which led to rapid scientific advancement and the successful development of new types of natural science namely mathematics, physics, geology, chemistry, biology etc (Ursula, 2007). The interdependence between science and technology in this era called the industrial revolution marked a tremendous rise in the invention of machines and creation of industries. This era was marked by great achievements in material sciences with the production of various materials that were paramount to the development of the globe. By the 20th century the world observed the era of the second industrial revolution with the expansion of information science and rise in information technology. Today, the world we live in is a computerized one where any activity of human engagement can be programmed to facilitate labour and communication. Thanks to globalization of the 21st century, science and technology is readily made available to everyone in the society.

Research Question One: What is Relationship between Science, Technology and Development?

It is obvious when one thinks of development, the terms science and technology cannot be set apart. Sometimes, the terms, science and technology are interchangeably used in normal day life to describe certain activities simply because they are interdependent on each other. To clearly understand the relationship between science, technology and development, one needs to define them individually and link them up to understand their coexistence. Science from Latin *scientia*, meaning "knowledge" is a field that systematically builds and organizes knowledge in the form of testable explanations and predictions about the universe. In an older and closely related meaning, "science" also refers to a body of knowledge that can be rationally explained and reliably applied. Two aspects of sciences that are fundamental to its definition is the ability of a concept to be tested and provide result using a scientific method. A scientific result could be such that no application is attributed but may apply to the basic underlining concepts of the field. On the other hand, some scientific studies or research may produce results which have an immediate application in real life. This application is that which drives us to the term technology.

Technology is mostly described as applied science which can be organised to have practical implication in life. However, because technology must satisfy societal requirements and values such as utility, usability and safety, technology cannot be considered as an exclusive product from science. Most technologies in the past were discovered without a scientific background. One of such was the production of fire or heat energy from sparks of stones without any scientific dependence. Also, the invention of stone weapons for wars and stones axes as agricultural tools were the technologies within the Paleolithic era when the basic concepts of sciences were not yet laid. Today, because of the advancement in science, almost all recent technologies have a scientific background. When a new technology is discovered, it needs to be made available to the society. This process of providing a technology or its product to the masses is what is known as engineering. Engineering is therefore the goal-oriented process of designing and making tools and systems to exploit natural phenomena for practical human means, often (but not always) using results and techniques from science. The fundamental objective of developing a technology is to provide good or services that will meet

the demands or improve on the needs of the society, hence development. This implies that for development to be achieved there must be some inputs which will have a positive impact or changes to improve on the well-being of man, some of such inputs are applied science and technology. Thus science, technology and development are symbiotic in their relationship as they are interdependent to each other.

Research Question Two: What are Scientific and Technological Contributions to Development?

For a society to be described as developed there is a minimum level of comfort or well-being that is necessary to overcome the challenges incurred so as to meet the immediate demands and needs of the society. This minimum well-being is what I describe as development. Science and technology have contributed significantly in the development of most nations and society at various sectors which are of great importance to the society.

Science and technological progress have had impact in sectors such as infrastructure, energy, industrial, health, education, communication, financial, entertainment, transport agricultural, and environmental protection to name a few. These effects have not been limited to the improvement of society's material wealth, but have also extended in altering the existing paradigms under which society operates. Information technology (IT) is one example of a paradigm-changing technology. The world has move from an analogue to a digital system where any information can be computerised and easily diffuse into the society. With information technology, new means of communication such as the internet, mobile phones have been introduced using satellite transmission in addition to the existing ones. These advances in mobility, joined with inventions in the area of telecommunications technology, such as the telephone and radio, have served to broaden the range of human activities and to expand the scope of human exchanges. Computerised programming has increased the versatility of machine to perform numerous and various functions improving on the efficiency and efficacy of production. Information technology and communication has greatly pronouns the entertainment industries in the world digitalising the products as videos, audios etc.

Another area of changing paradigm is the medical or health sector. The shift of biomedical process from structural to molecular basis has greatly contributed in identifying new disease-causing agents such as viruses and prions responsible for illnesses whose origin was unknown. The mode or mechanisms of action of most diseases processes have been established and new diagnostic methods of high throughput technologies with high sensitivity and specificity have been developed for various diseases and illnesses and made possible appropriate treatment. New technologies also have identified new drug targets for Drug discovery and expanded the pharmaceutical industries. The discovery of recombinant DNA technology has boosted the biopharmaceutical industries. Biomolecules such as antibiotics, vaccines, hormones which were not available due to the cost implication and complexity of the fermentation processes are now made available to the society. The improvements of various control measures such as vaccines have eradicated so many infectious diseases in the world and greatly reduce morbidity and mortality. Health care.

delivery system has been improved making available, diagnosis and treatment to the society. At the molecular level of biomedical sciences, sciences and technological advancement have changed the existing paradigm. Prions; pathogenic proteins whose conformation is changed to cause an infection have been discovered to be responsible for some diseases such as the mad cow disease and are now known as the smallest infective agents and no longer viruses. Also, about 11-20% of nuclear translation is possible and it is now known that protein synthesis can occur in the nucleus. The discovery of these new concepts in biology can greatly improve the understanding of diseases mechanisms, and facilitating diagnosis and treatment. The discovery of new sources of energy especially renewable sources has almost suppress the myth of depleting ores of crude oil. Energy can readily be trapped from the sun, wind, water, vegetal organic sources and others natural renewable sources. Nuclear energy from nuclear plant and thermal energy are other new sources of energy which greatly meet the demands of the overgrown population. Infrastructural development has risen substantially in the world. Intermesh transport systems of roads and rails as well as GPS technology have reduced traffic congestions. Cities with sophisticated buildings are well planned to reduce overcrowding and make them assessable to all.

Science and technology have laid the foundations for progress in society, and have helped to make people's lives more materially prosperous. In particular, after the industrial revolution, there has been a tremendous rise in the industrial sector. Industries of all sort of production are available today. The diversity of product has provided man with the utility to make choice to their desire. Industries have created new jobs and alleviate the state of unemployment. In addition, inventions in machine tools have been linked to advances in energy technology to achieve automation and acceleration of manufacturing processes. The result has been large-volume production of goods in ever shorter periods of time. Moreover, progress in materials technology has resulted in the ability to produce diverse types of material items. Progress in materials technologies has given rise to a variety of new transport modes, such as the railroad, the automobile, and the airplane, vastly improving human mobility in terms of both time and space.

The contributions of biotechnology and genetic engineering have massively improved the agricultural sectors in the continent. There is improvement in agricultural yield and the quality of food stuff to be resistant to diseases. This has reduced problems of food shortage and scarcity, as well as starvation and hunger in the globe. Furthermore, as progress in science and technology has broadened and enlivened human activity, new issues have appeared in society, and these have in turn led to demands for new sciences and technologies capable of resolving the new issues arising from the changes in society. The advancement of science and technology has promoted education. New technologies have permitted the creation of new innovative academic field. The interdependence of science and technology, and the evolution of material to information science, new professional disciplines from the basic scientific fields such as chemistry, biology, physics, mathematics, geology have emerged to permit a mastery of the new technology and make them available to meet the demands of the challenging economic society. The new innovative academic fields include genetic engineering, nanotechnology, engineering, information technology, computer engineering etc. The

creation of these new disciplines has greatly promoted literacy. More peoples can now read and write, manipulate phones and computers and get connected in the global village.

Above every other thing, the overall success of science and technology has been the economic and financial bloom of the entire globe. The most developed countries which are economically and financially stable are those ones with a strong scientific and technological background. The gross national income as well as the per capital income of this countries are usually high and sufficient enough to foot the bills of their basic needs.

Research Question Three: What is the Status and Challenges of Science, Technology and Development in Africa?

Science and technology among other things have contributed substantially to the development of the world. However, the distribution of this development is not evenly spread across the globe because some nations have intensively exploited this knowledge to enhance their well-being. These parts of the world, termed to be developed are well grounded with this knowledge of science and technology and practically manifest it to enhance their economic and financial status. Other emerging economies like China, United Arab Emirates, and Brazil are current utilising this knowledge to improve on their level of the development. In Africa, except for South Africa and a few countries of the south African region which are exploiting the knowledge of science and technology to foster their development, most parts of Africa especially the sub-Saharan region are among the least developed nations with less focus and interest in science and technology. Africa is one of the richest continents with natural reserves of raw materials, yet this resource is either exploited by foreigners of the developed world simply because the necessary technology to convert them to finish products are not available. This is as a result of certain challenges which impede the growth of science and technological advancements in the continent.

The nature of African political systems and governance greatly limits the growth of science and technology. Most policies of the government do not encourage invests and promotion in this sector. Scientific projects are hardly supported due to the high cost of implementation. Corruption and poor governance are the key to the underdeveloped state of most of these nations. Another critical factor for poor scientific and technological development is generally due to the African man's mentality towards science and technical education and scientific research. The African mentality has mostly projected issues of social science than those of natural science and technology. Even when these nations promote natural science and technical education, most studies are theoretical and the practical applications are usually not implemented. One of such mentality is in the investment of scientific research.

Scientific research is one of the key aspects of development in the developed worlds. Billions of dollars are invested yearly in research both by the government and private institutions, organization or industries in most of the leading economies like, USA, England, Germany, France, Italy, Japan and in some emerging economies like China, India, Brazil etc. In Africa, such investment is equally observed in South Africa which is developed and has the strongest economy. One may think the other nations in the underdeveloped world do not have

programmes that sponsor research or promote it at all but it is not the case. Most research in underdeveloped world are usually repetition of previous works or studies which do not contribute to the basic concepts or have an application and fall under category I research.

Research Question Four: What are Achievements and Challenges of Sustainable Development in Africa?

Economic Growth and Poverty Reduction: Economic sustainability requires countries to be on a broad-based quality economic growth which focuses on reducing poverty and inequality, supporting investment, and building inefficient social services system towards SD. By 2012, the International Monetary Fund (IMF) estimated that “with a Gross Domestic Product (GDP) growth rate of 35%, Sierra Leone was the fastest growing economy in the world and that over the ten years, six of the world's fastest growing economies were in sub-Saharan Africa”. These six African countries include: Angola, 11.1%; Nigeria, 8.9%; Ethiopia, 8.4%; Chad, 7.9; Mozambique, 7.9%; and Rwanda, 7.6% (UNECA, 2012). Additionally, forecasts by the IMF also suggests that seven African countries are likely to be among the top ten over the next half decade, 2011-2015 (Ethiopia, 8.1%; Mozambique, 7.7%; Tanzania, 7.2%; Republic of Congo, 7.0%; Ghana, 7.0%; Zambia, 6.9%; and Nigeria, 6.9%). Given the current prospects, there is a strong likelihood that Africa will surpass Asia in growth in the next decade. This is further supported by evidence that from 1990-2002, the average real GDP in Africa grew by 3.3% and from 2003-2004, the average real GDP growth was 3.8%. Central Africa had the highest growth rate (4.2%) North Africa (3.9%); East Africa (2.9%); and West Africa (2.4%).

After the initial slump in growth from 1991-1992, Africa's growth began to improve peaking in 1996. (UN, 2010). Available data suggest that “government debt in sub-Saharan Africa was around 70-80% of GDP ten years ago but that has been halved to about 45-40% of GDP currently; Foreign Direct Investment (FDI) in sub-Saharan Africa, which is now a diversified portfolio of investment in the banking, tourism, textiles, communication and other sectors has improved since the late 1990s translating into 2.4% of GDP”. At the turn of the Millennium, “Africa's GDP was \$600 billion; today, it is \$2.2 trillion adjusted for inflation, Africa's GDP has doubled in 10 years” (Gibson, 2001). It has been argued that “currently, many African economies are strongly growing in comparison to the industrialized world, with a continental economic growth of 6% in 2012; sub-Saharan Africa is now in a position to compete with other energy markets in some labour-intensive areas”. In Cote D'Ivoire, for instance, “the service sector accounts for about 50% and rising; this is expected to grow by 13.7% in 2013, and in June 2011 the country was restored to eligibility status of the African Growth and Opportunity Act (AGOA) after it was suspended in 2005; beyond 10.5% in 2012, economic growth is expected at 9% in 2013 and 10% in 2014 and beyond” (Gibson, 2001). It can be deduced from these statistics that African countries are making great strides towards building robust economies for the current generation, but more importantly for future generations. Even though the statistical figures put Africa in a positive light, how has such efforts directly translated into poverty reduction, infrastructural development, and improved sanitation? These are critical questions that demand immediate answers if the perceived economic growth on the continent will have any meaning. These questions appear difficult to answer

given the fact that only 10% of Africa's trade is within the continent. Africa exports only 18% of manufactured goods and imports 65%. The level of private sector investment currently stands at 5-8%, but that needs to be drastically increased. Africa's share in the \$130 trillion global trade has remained a minimal 3% over the years and intra-trade is a meager 10%. On the global platform, of the 1.2 billion living in extreme poverty, 25% are from sub-Saharan Africa. The World Commission on Environment and Development identified that one of the issues that is fundamental to overcoming the challenge of SD is the overriding state of poverty on the African continent. The Millennium Assessment suggests that not only does the level of poverty remain high, but inequality is growing. Consequently, it concludes that the overarching SD challenge in Africa is poverty eradication. This is a barrier that African government must remove if the pursuit of SD is to be achieved.

Research Question Five: What are the Measures to Improve and Ensure Development in Africa through Science and Technology?

To acquire a significant development through science and technology, the African people must be willing and ready to change certain existing factors which restrain the progress of technology in the African society. For this to be achieved, African people should change the mentality of their immense phobia against sciences and technology. This should be accompanied by improving on the governance systems and policies which can promote and financially sponsor scientific and technological processes including research and scientific projects. Research especially empirical research needs to be encouraged and promoted to identify new technologies that can manage their immediate resources and place the economy in competition with other nations. Means by which future scientists can be trained and scientific ideas are projected and shared such as conference, seminars, convention, workshops should be promoted.

Africans need to improve on the ways to communicate scientific ideas. The creation of scientific journals, documenting information in books and the internet will spread scientific information across borders and also more science journalists should be employed to communicate scientific information. This will help to popularize scientific ideas and create public awareness. Science and technological education which are practically oriented along with industrial attachments should be encouraged at the level of basic education on subjects such as physics, chemistry, mathematics, biology and at the secondary and tertiary level. Technical courses such as engineering and applied sciences at the tertiary level should be introduced as well as new emerging innovative academic fields. A global partnership with other institutions, well established industries and associations which can permit the transfer of information across will encourage technology transfer. Above all, the participation of everybody and not only the government is paramount to foster development. With all this suggestion and the full commitment of the society, development can be achieved through sciences and development.

Recommendations

Science and technology cannot be denied to have immensely contributed to development. The evolution of science and technology has witnessed so many revolutions from the Neolithic to

industrial and now to the present computer age. There have been great achievement of science and technology in various sectors such as the medical, industrial, entertainment, education, infrastructure for development whose success lies on the key elements such as research, global partnership, new disciplines etc. Most of the countries that have exploited this knowledge and technique have seen their socioeconomic and financial status improved along development. Though science and technology have some detrimental effects to the society, the way forward is to promote sustainable development; a strategy to separate the bad from the good technology and promote good one is presently been encourage worldwide for effective development that will support the sustenance of man and his environment. In addition to the challenges faced in Africa, the advancement of science and technology will only be achieved if Africans can change their mentality and lay emphasis on those key elements and measures that are paramount for development.

Conclusion

The relationship between science and technology has been explain with its contribution towards development of African nation and its achievement to sustainable development. Conclusively, Sustainable development can be achieved in Africa. However, there is need for major policy shifts and implementation of policies. Similarly, it is noteworthy to state that SD is strongly interlinked, and this has far-reaching implications for policies and processes. Hence, SD must be viewed as an integrative concept across fields, sectors and scales, and governments must move from concepts to action. It is therefore imperative for African government to look beyond narrow policy implementation process and rather focus on implementing programs and projects that have strong linkages that will ensure the attainment of SD in Africa.

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