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Science and Technology in Africa: The key Elements and Measures for Sustainable Development

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Abstract- The contributions of science and technology to foster development in the world cannot be over emphasized. Thanks to the evolution and revolution of science and technology, the world has greatly achieved advancement in various sectors such as infrastructure, energy, industrial, health, education, communication, financial, entertainment, transport, agricultural, economic and environmental protection to name a few. While the growth of science and technology is pronounced in the western continents, the pace in Africa is slow. In addition to its contribution to development, science and technology is today a menace to man, the society and ecosystem. This paper highlights on the interdependence between sciences and technology for development with emphasize on the key contributing elements such as research, biomimetics, philosophy of science, communication, innovative fields and global partnership. Possible measures to manage the detrimental effects of science and technology in the society and promote those technologies which are paramount to ensure sustainable development are enumerated. 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 of priority to development.

Keywords: *science, technology, sustainable, research, development, Africa.*

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I. Introduction

Africa, especially the sub-Sahara regions is challenged with a lot of crisis. The immediate problems have made it difficult for this continent to enjoy certain values and comfort. Due to the over grown 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 [1]. Poor agricultural yield due to climate change has promoted hunger and starvation [2]. These impediments have led to socioeconomic problems, political instability and poverty which have prevented the development of this continent.

Science and technology is 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 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 [3]. 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.

II. 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 [4,5]. In this Paleolithic age, stone was the material used for most of the items they produced [6]. 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 a rise in technology where blacksmith used metal such as iron, zinc to produce weapons against wars [7].

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 [8]. For man to thrive in this complex society, he needed 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 [9].

Because first-hand experience in everyday living could not teach such skills as writing and reading, a

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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 [10]. 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 [11]. 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 develop which led to rapid scientific advancement and the successful development of new types of natural science namely mathematics, physics, geology, chemistry, biology etc [12]. 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.

III. 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 [13]. 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 consider 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 [14]. 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 (See Figure 1).

IV. Key Elements of Science and Technology

There are certain key elements within the fields of science and technology that are critical for development. This includes the following;

a) Philosophy of science

Understanding the philosophy of sciences is fundamental in the quest for development. Knowing the philosophy of science will help to expose the evolution of science and shape the minds of new scholars and thinkers how to develop scientific ideas which can be transformed to technologies. Working scientists usually take for granted a set of basic assumptions that are needed to justify the scientific method. This include; (1) that there is an objective reality shared by all rational observers; (2) that this objective reality is governed by natural laws; (3) that these laws can be discovered by means of systematic observation and experimentation. Philosophy of science seeks a deep understanding of what these underlying assumptions mean and whether they are valid.

There are different schools of thought in philosophy of science. The most popular position is empiricism, which claims that knowledge is created by a process involving observation and that scientific theories are the result of generalizations from such observations. Empiricism generally encompasses inductivism, a position that tries to explain the way general theories can be justified by the finite number of observations humans can make and the hence finite amount of empirical evidence available to confirm scientific theories. This is necessary because if the number of predictions those theories make is infinite, it means that they cannot be known from the finite amount of evidence using deductive logic only.

b) Biomimetics

If one takes carefully look on some products of technology like aircraft, the mode of operation resembles how birds fly in the sky. So many of such technology closely resembles either the behaviour or action of a natural existing body, object or system (See Figure 2). It becomes clear that this resemblance did not just occur by chance. It is obvious that their design was an imitation of the natural occurring processes. This observation has defined a new field of studies called biomimetics. Biomimetics is a science that observes real life processes and mimics them to have applications in real life [15]. This concept is based on basic understanding how real life processes occur, their mechanism of action and how they can be applied in developing new technologies. The Renaissance genius Leonardo da Vinci dedicated himself to observing and recording natural phenomena half a millennium ago. His superb graphic renditions of plausible flying machines are based on his direct observations of birds in flight [16] and today it is a reality by the invent of aircraft. Most technologies today are thanks to biomimetics mimicking nature. Advances in computers are being made emulating the operation of the human brain. Organisation of muscle structure in man was replicated to design hanging bridges. The organisation of spider web oriented the designs of the best models of roofs for very large structures such as stadium. Some engineers are using the shell of a seaweed-eating snail as a guide in the development of a new generation of bullet stopping armor [17].

c) Research

Research is a process whereby natural situations are observed and translated using a systematic approach to give an understanding or explanation to them. In scientific research, observation on the natural processes is usually questioned such that they can be tested in an organised systematic manner to produce meaningful results which can answer these questions. The outcomes of a research can either have an immediate application or apply to the basic concepts of science which may not have an immediate application but contribute in developing new theories, principles or law. Based on these outcomes, research can be grouped into four categories (See Figure 3);

- Category I: Research that neither apply to the basic concepts nor have application.
- Category II: Research that apply to the basic concept but do not have application.
- Category III: Research that do not apply to the basic concept but have application.
- Category IV: Research that both apply to the basic concept and have application.

Category I research is usually repetition of studies which do not have any particular question to be addressed. Such research may lay the basis for routine mastery of techniques, principles or theories but do not contribute much in the development of a nation or community. Such research is common in Africa where researcher most of the times do not really carry out research to address particular problems or issues pertinent to the discipline or society. Rather are involved in repeating studies done elsewhere just as a means of producing articles which enhance their promotion in their various jobs and institutions.

Category II research is that which contributes to the basic concepts of that field or area of studies even though applications may not be attributed. They may either support or disagree with some of the existing concepts or postulates new concepts or theories. The concept of nuclear translation is an example of this category of research. Nuclear translation is a new paradigm that is changing the existing concept of the absence of protein synthesis (translation) in the nucleus. Recent research shows the presence of nascent

proteins in the nucleus confirming the presence of nuclear translation which is estimated to be over 11% [18].

Category III research usually does not contribute to the basic principle but have a direct application. They do not usually have an explanation to the results obtained but rather have very useful applications in the society. The researcher who discovered fluorescent light produced it just by passing current across electrodes but had no explanation to the phenomenon [19].

Category IV research is that which contributes or applies to the basic principles and equally have application. This is the most productive research which greatly contributes to development. Newton's research led to the creation of the newton's laws of motion which applied to the concepts of physics with direct application in the production of automobiles, aircraft. Louis Pasteur, the father of microbiology laid the concept of microbial growth and applied the concept of microbial culture in industries for the production of alcoholic beverages, yogurts and biopharmaceuticals such as antibiotics, vaccines etc [20]. Recent discovery of prions has changed the paradigm of viruses as the smallest infective agent. Prions which are proteins in nature are now none as the smallest infective agents [21, 22]. Due to their very small size and the ability to change conformation, this concept has now been exploited by nanotechnology for their use as drug delivery system to serve as drug protein carriers for target specific drug directed treatment of diseases such as cancer with minimum toxicity.

d) Emerging Innovative Scientific Field or areas of Study

The early discoveries of science were concepts and theories which were solely dependent on the natural materials found in nature. Most of these materials were both those of living things such as man, animals, plants and microorganisms and the non-living things found in the earth crust like the natural existing elements such as metals and non-metals. In understanding the fundamental principles, concepts and processes that led to their existence and functioning, the major scientific disciplines such as mathematics, chemistry, physics and biology were developed. Mathematics intercepted all cross the fields since it was fundamental laying the basic principles. Within the era of industrial revolution, technological application in the area of material sciences in combination with the existing disciplines gave rise to new sets of disciplines such as engineering (electrical, chemical, petrochemical, electronics) and architecture. After this era, around the 20th century other fields like biochemistry, biotechnology, and nanotechnology emerged.

Around the mid-twentieth century, the world invested more on how to improve on communication leading to the development of information science. The application of information science from the primary disciplines such as mathematics, chemistry, biology, and physics led to the creation of information technology, bioinformatics, chemioinfomatics etc. These emerging innovative fields are the key to the development of countries in the western world. This new technologies are at the forefront in meeting the demands of our present society. One of the leading technologies in the world is information technology which is very much applicable in almost all sectors of life for communication.(See Figure 4)

e) Communication

New concepts, ideas and research discoveries need to be documented and made accessible so that it can disseminate across the scientific community to researchers and scholars or feature generations. This could be done by writing of articles, text book, creation of journals and publication of research works, as well as calling for proposals to present new research ideas.

f) Global Partnership for Transfer of Knowledge and technology

Any nation that intends to improve on its level of development must be ready to welcome new technologies or permit a flexible exchange. This permits the transfer or gain of technology. Creating a global partnership whereby knowledge and technology can flow is fundamental for development. This can be done through exchange studies cross countries, training individuals from various locations to become experts, invite experts in various fields to train the younger generation. Also, the organisation of international conferences, conventions, symposium, workshops, seminars and meetings would help to share and exchange ideas across various nations and societies.

V. 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 has 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 has 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 computerise and easily diffuse into the society [23]. 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 increase 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 [24]. 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 [25]. 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 supress 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 emerge 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 (Figure 4). 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.

VI. The Destructive Aspects of Science and Technology

Meanwhile, progress in science and technology has contributed enormously to the growth and development of the society, the detrimental aspects cannot be minimized. Science and technology, though worth meaning is one of the greatest challenges the world is facing. Advancement in nuclear technology has not only promoted the production of nuclear energy but also more sophisticated nuclear weapons which are responsible for major destructions. The rise in industries has increased the level of greenhouse gases that are released to the ecosystem and depleted the ozone layer [26]. Global warming is one of the major problems of the society today as a result of technological growth. The ecosystem has been destabilised; there is loss of variety and species of various biological flora, deforestation is highly promoted, natural resources are depleting and diminishing, environmental pollution is increasing all as a result of technology. In the health care and biotechnological sector, there is high risk of creating new infective strains of diseases with new available technology of genetic engineering in vaccine production and gene therapy [27]. Genetically modified products continued to be questioned from the ethical point of view against nature [28]. The rise in information technology and communication has increase crime wave using the internet and other social networks of communication. There is a discriminative balance of wealth and technology across the globe. The great nations that have developed the new technologies continue to exploit other nations who are in need.

VII. Sustainable Development through Science and Technology

With all the contributions in various sectors that promote development, science and technological also contain some negative aspects within the society. To make the world a better place, there is need to separate the good from the bad technology and propel just the good ones for sustainable development. Sustainable development implies those qualities and values that can continue to sustain the society in future will be properly managed and propagated. Science and technology can be made sustainable by managing and promoting those technologies that do not have detrimental impact in the environment and society but also eliminating the bad technologies and providing solutions. The following measures can be implemented to ensure sustainable development.

a) Education and Public Awareness

Educating and teaching the society on the nature of this interdependence of the ecosystems and human sustenance is fundamental for sustainable development [29]. This understanding of the origins of the components of our urban environment can result in more careful utilization of natural resources and enable individuals to take informed and responsible decisions and actions, now and in the future by also realizing the impacts of their decisions on others. Improving awareness of sustainability includes such issues as the life-cycle impacts of human activities on Earth systems, control of greenhouse gases, land and energy use, consumption patterns, pollution and transport, all of which have direct connections to education for sustainable and responsible development. Promote new academic discipline in the area of sustainable development to develop idea on how technology can be managed to ensure sustainable development.

b) Promote new Approaches to Sustainable Energy

New forms of renewable resources of energy from water, land, air, soil, etc. form the basis of the entire living processes in the present and in the future. More emphasis and focus should be laid on these new sources rather than relying on the non-renewable existing resources. This can be achieved by promoting sustainable scientific research which encourages more active and responsible investment in alternative energy even though this may not be currently profitable, but its continued development would be an important gift to future generations.

c) New Technologies for Pollution Reduction and Environmental Protection

Most existing technologies usually have negative impact on the environment especially by pollution. New technologies which can manage and reduce pollution should be promoted and made mandatory in industries as part of their quality control units. Technologies which can reduce the release of greenhouse gases should be introduced in the industrial sectors, automobiles industries and other sectors of related application.

d) Science, Technology and Ethics for Sustainability

Ethics; the philosophical study of the moral value of human conduct and the rules and principles

that ought to govern it allows us to better analyse such intergenerational interactions in the critical context of the social, economic and natural environment. Ethics monitors how the values at the core of our social contracts are evolving and can address the crucial issue of consumption of the present versus the needs of future generations. Promoting ethics both in research and education will guide scientist and technologist to consider human and ecological moral values when developing new technologies.

VIII. 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 Arad 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-Sahara 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 resources are 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 polices of the government do not encourage invests and promotion in this sectors. Scientific projects are hardly supported due to the high cost of implementation. Corruption and poor governance is 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 mentally towards science and technical education and scientific research. The African mentally 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 mentally 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 equality observed in South Africa which is developed and has the strongest economy. One may things 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.

IX. 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 mentally 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 encourage and promoted to identify new technologies that can manage their immediate resources and place the economy in competition with others 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 creations of scientific journals, documenting information in books and the internet will spread scientific information across borders and also more science journalist 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 encourage 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 mother institutions, well establish 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.

X. Conclusion

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 has 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.

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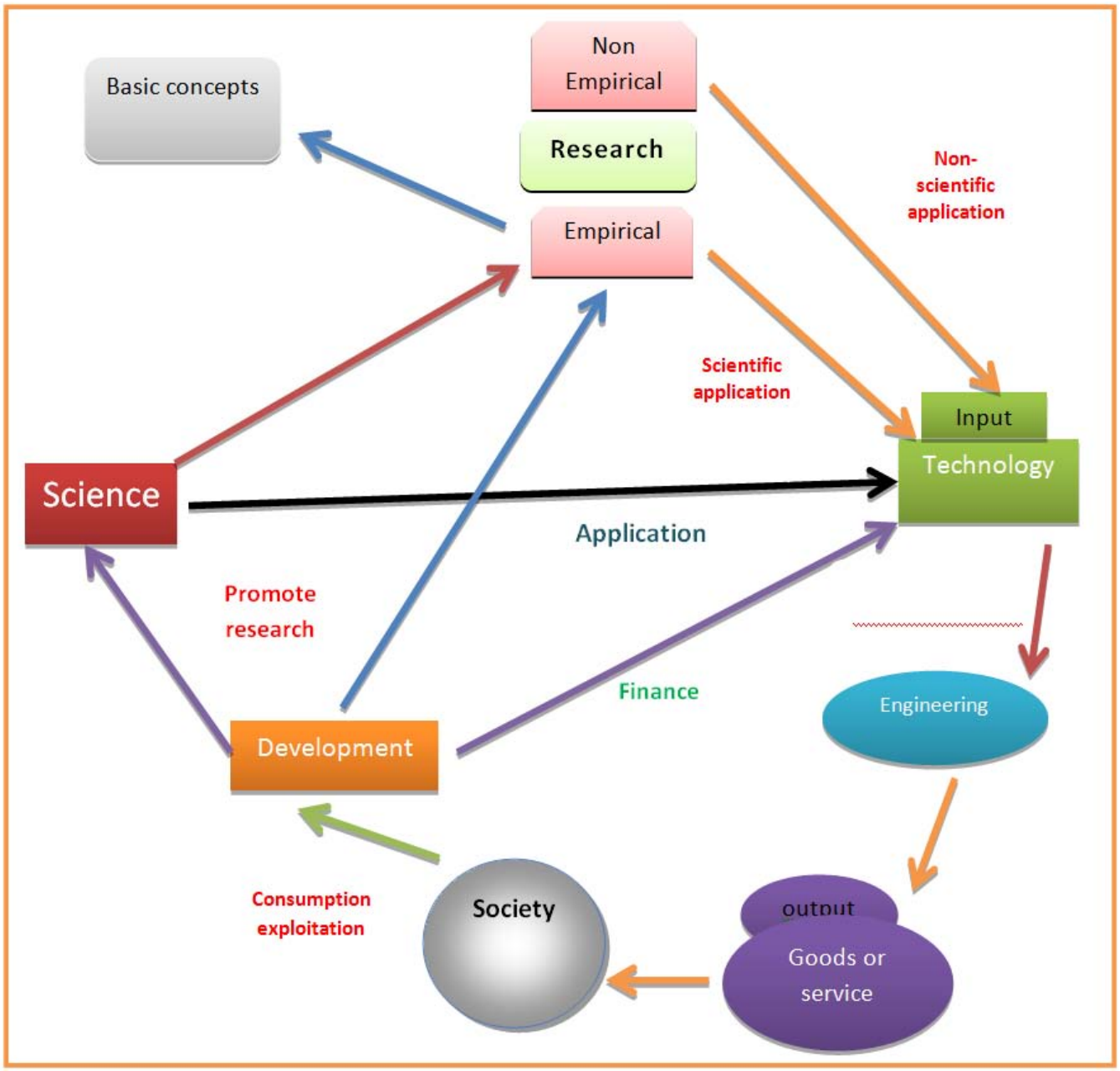


Figure 1 : Relationship between Science, Technology and Development

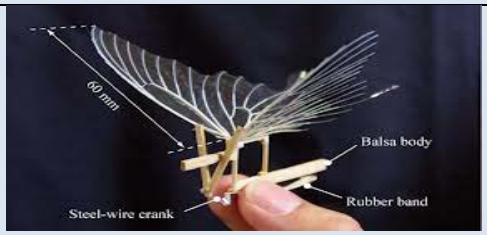
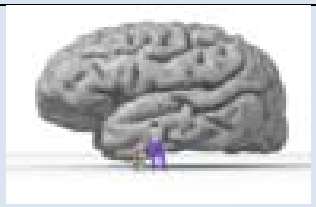
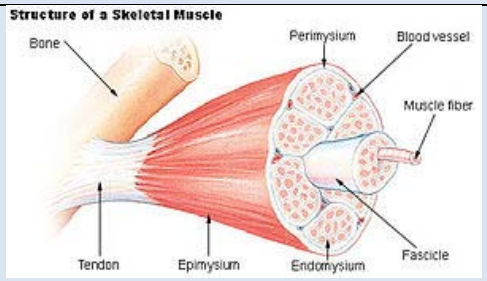
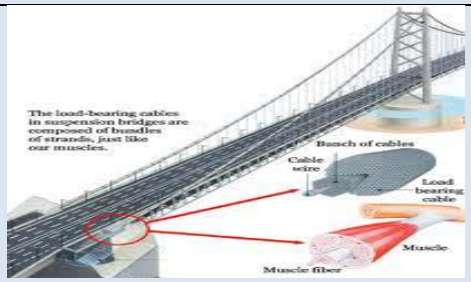
NATURE	TECHNOLOGY
 BIRD	 AIRCRAPT
 SPIDER WED	 ROOF OF A STADIUM
 BRAIN	 COMPUTER
 MUSCLES	 BRIDGE

Figure 2 : Technologies Mimicked from Nature

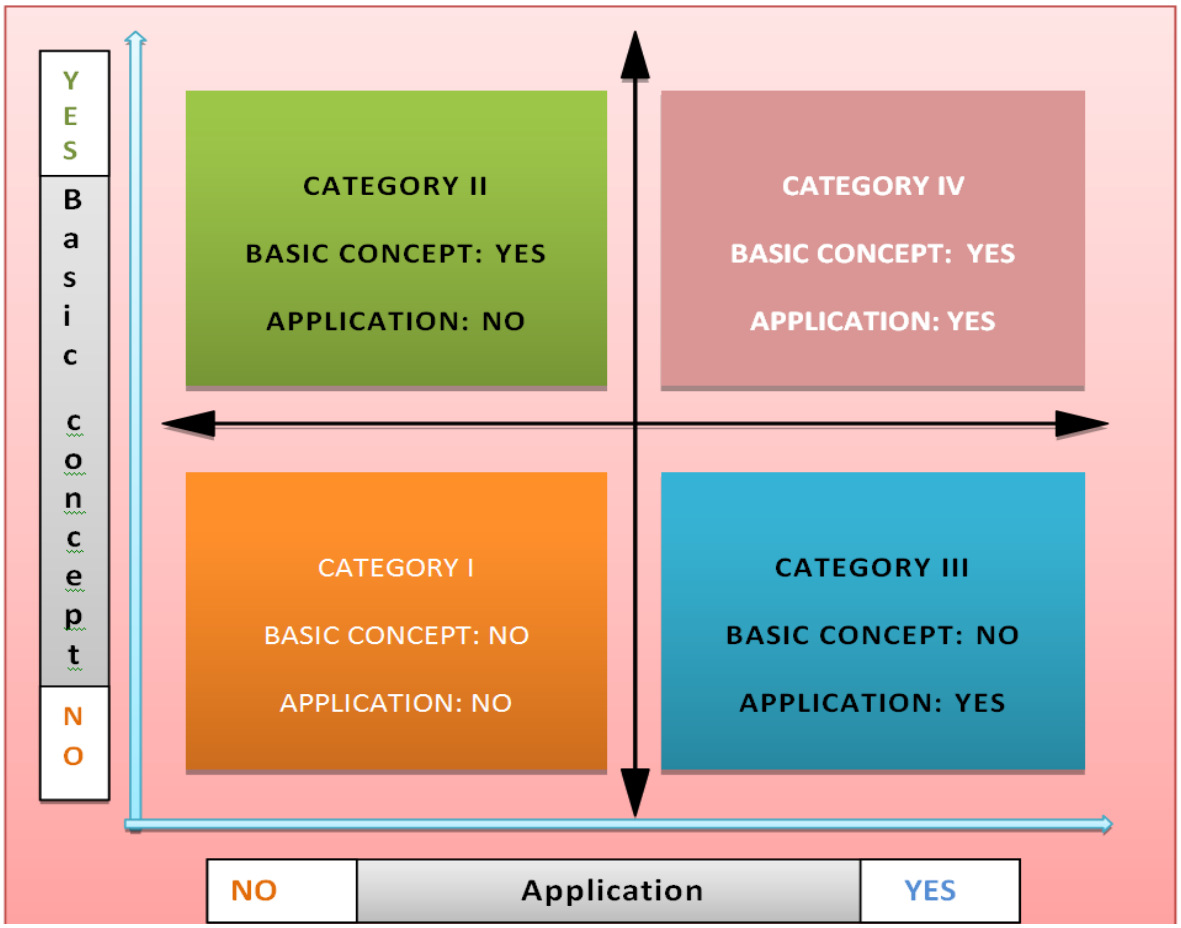


Figure 3 : Categories of Empirical Research

	BASIC SCIENCES			
BASIC CONCEPT	BIOLOGY	CHEMISTRY	PHYSICS	GEOLOGY
	MATHEMATICS			
	MOLECULAR BIOLOGY/ BIOCHEMISTRY		GEOPHYSICS	
APPLICATION	APPLIED SCIENCES/ TECHNOLOGY			
MATERIAL SCIENCE	BIOTECHNOLOGY/ GENETIC ENGINEERING	CHEMICAL ENGINEERING INDUSTRIAL CHEMISTRY	NANOTECHNOLOGY ELECTRICAL ENGINEERING	PETROCHEMICAL ENGINEERING
INFORMATION SCIENCE	BIOINFORMATICS	CHEMIOINFORMATICS	INFORMATION TECHNOLOGY	

Figure 4 : Innovative Academic Fields

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