Transforming Local Technology in Sub - Saharan Africa through Appropriate Engineering and Technological Development to Meet Global Standards

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Abstract: This study presents the transforming of local technology in Sub - Saharan Africa through appropriate engineering and technological advancement to meet global standards. The present state of local technology, issues, challenges, drawback and developmental prospects offered by the transformed local technologies were critically reviewed to see their shortcomings, strength and developmental strides in the technological sector. From the assessment, it was revealed that there were lapses and shortcomings in the developmental and transformational process of local technology in the region to meet global standards of commercialization. Thus, the paper then further proposes the way forward to enhance and strengthen local technologies in Sub - Saharan Africa for optimum transformation and developmental growth.

Keywords—Technology, local, appropriate, advancement, Sub-Saharan Africa, model, 3-I technological development pattern.

1.0 INTRODUCTION

Technological development and management are considered to be the key driving force in the development of any economy [1]. The economic growth of both developed and developing countries depends on upon it [1]. Hence, the concept of local technology transformation and development in Nigeria and her counterpart nations in Sub - Saharan Africa is inevitable, if the fortune of the region must change to technological driven nations.

One of the foremost issues facing the technological advancement of Nigeria and her counterpart nations in Sub - Saharan Africa is the failure of the governments, stakeholders and the people of the region to thoroughly examine the viability of local technology in the region. The answer to this fundamental problem is that the local (indigenous) technology and engineering practices should be given critical consideration and the appropriate place it deserves.

Local (indigenous) industries and technologies constitute important aspect of people's culture, and also they represent the adaptive mechanism through which people survive in any ecological niche they find themselves [2]. It has been noted by some scholars that local technology should serve as the basis for the technological development of any nation [2]. The concepts of Foucault's which always function together but irreducible to one, these concept includes the technologies of production, sign systems, power and technology of the self [3 & 4]. In addition, the words of Peters, says that technology of the self is an approach to the study of ethics of individuality [5]. Transformation and development of local (indigenous) technology is a thing of commitment and self - reliance after passing through the technological advancement cyclic process model. This paper presents transformation of local technology in Sub - Saharan Africa through appropriate engineering and technological advancement to meet global standards.

Sub - Saharan Africa is geographically, the area of the Continent of Africa that lies south of the Sahara desert [6]. Politically, it consists of all African countries that are fully or partially located south of the Sahara [6]. This Sub - Saharan Africa comprises of forty-four (44) countries, and according to Manabete and Umar, "One fundamental problem responsible for the technological backwardness of West Africa and indeed the whole of Africa is the inability of governments, stakeholders and people of the region to explore indigenous (local) viable option [7] available in the region."

The word technology has different representations and meanings to different people and their culture (belief). According to abdulkaream, technology is defined as the art and science of applying man's knowledge in human endeavours' so as to satisfy man's needs [9], the International Technology Education Association defined technology as the use of knowledge, skills and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into

consideration [10]. From the aforementioned, technology can be defined as the application of knowledge towards the design and fabrication of devices, tools, and appliances to better the condition of man [7]. Also, technology can be accepted as putting human knowledge, acquired skills, experiences, philosophy and resources to meet people's or communities' needs and wants.

1.1 LOCAL TECHNOLOGY

The term indigenous (local) simply means native or home - grown while technology can be referred to the art and science of applying knowledge to meet man's need [11]. Therefore, local technology can be defined as technology relating to indigenous, native, tradition or home - grown knowledge, skills and experiences for the production of goods that will meet the local needs and wants. World Bank acknowledged that indigenous knowledge is the basis for local - level decision making in agriculture, health care, food preparation, education, natural - resource management and a host of other activities in rural communities [11]. Indigenous technology can also be accepted as the way the local or native communities do things to meet their daily needs and wants; and their livelihood depends on indigenous knowledge manipulation to make ends meet.

1.2 PRESENT STATE OF LOCAL TECHNOLOGY IN NIGERIA AND HER COUNTERPART NATIONS IN SUB – SAHARAN AFRICA

It is regrettable to say that at present and over decades of the existence of Nigeria and her counterpart countries in Sub - Saharan Africa still largely depend on foreign borrowed or imported technologies for their various technological and industrial needs. This is in the midst of numerous and enormous availability of natural resources and indigenous technologies. The Sub - Saharan Africa Region and Africa as a whole is abundantly blessed with natural resources that can be properly harness through appropriate engineering and technology to transform the fortune of the region. According to statistics of the total world mineral resources, Africa mines 90% of the diamond marketed, 81% of cobalt, 62% of platinum, 70% of gold, 50% of magnesium and chromium, 30% of copper, 66% of the world cocoa produce, 66% of sisal, 95% of groundnut, 25% of coffee beans and cotton and other rich reserves of coal, oil and iron ore [11]. Figure 1 below shows the percentage of Africa mines of the world total mineral resource, despite these abundant natural resources in Africa, Africa contributes only 2% of the total industrial output of the world's market economies [11]. This is due to the inappropriate transformation of local engineering knowledge and technology.
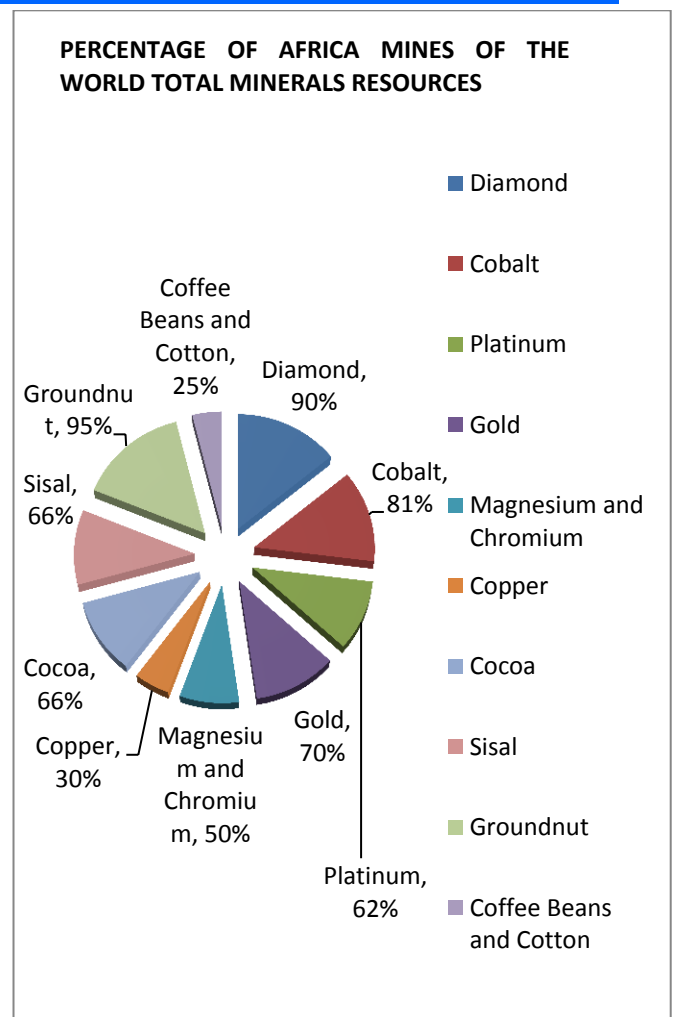

Figure 1: Percentage of Africa Mines Natural Resources

Therefore, we can say as at today, despite the enormous availability of natural resources and indigenous knowledge, the technological development of Sub - Saharan Africa is grossly low and inadequate in terms of her technological development, advancement, and productivity.

Technological wise, Sub - Saharan Africa countries can be said to be technologically backward and in bad shape. A nation is said to be technologically backward and in bad shape today if it cannot do the followings:

i.   It is unable to produce her own military hardware with which to defend herself, if the need arises

ii.   It depends on other countries for the supply of spare parts for industrial machinery

iii.   It is unable to explore and export her natural resources except with the help of expatriates (Foreigners)

iv.   It cannot produce capital goods such as tractors, lathe machines, milling machines, drilling machines, cars, trains and other earth moving equipment.

v.   It exports her raw materials to other nations as against finished product.

A critical examination of Nigeria and her counterpart countries in Sub - Saharan Africa reveals that all points itemized above are present in the nations of Sub - Saharan Africa. Hence, Sub - Saharan Africa as spelt out in the statements listed above, are technological backward nations.

1.3 FACTORS MILITATING AGAINST LOCAL TECHNOLOGY AND ITS APPLICATION

As a matter of fact, the factors militating against the local technology advancement in Nigeria as a nation and her counterpart in Sub - Saharan Africa are enormous. To mention but few highlight of factors pressing the local technological drive and development.

i. **Infrastructural Decadence**: The rate of infrastructural decay of Nigeria public infrastructure and her counterpart nations in Sub - Saharan Africa posed a prime frustration to the local (indigenous) technological development and advancement in the region. The pace at which public infrastructure decay in the region is bothersome. A state where there are no good public facilities such as good roads, pipe borne water, good schools, good library of world class standard, healthcare etc., because they are in a state of decadence. This has lead to struggle and frustration of the development of local technology in the region.

ii. **Inadequate Synergy**: The synergy between the industries and academic institutions in the region is inadequate to foster technological development. In Nigeria today, there is no proper or serious synergy between the industries and research institutes as it stands now. This lack of synergy has lead many good types of research and inventions in the institutions to end up in the office shelves of the researchers in the research Institute. This is because the government has not put down the enabling environment for the bilateral relationship.

iii. **Over - Reliance on Foreign (Imported) Technology**: The over-dependent on imported technologies constitute a serious threat and setback to the development of indigenous technology [7]. Consequently, most of the technology in the markets of developing countries in Sub - Saharan Africa is imported (foreign) [7]. In other words, many Nigerians and people of her counterparts in Africa are just the people of India having a penchant for foreign technologies [7].

iv. **Non - Commercialization of Academic Research**: The non - commercialization of academic research from institutions is a prime challenge. Today, academic research papers and publications are obtained mainly for the purpose of routine academic promotions and recognitions. But the producer/user synergy and bilateral relationship determine the commercial values of these research papers. The commercial values of most research papers and publications are very low and less market value in relation to the industries.

v. **Operations of Research Institutes**: Almost all the research institutions and other higher research Institutes operate and conduct researches outside the relevance of industries today; perhaps one of the prime reasons industry/academic synergy remains very weak today in the Sub - Saharan Africa.

vi. **Inadequate Funding**: The inadequate funding of engineering and technological institutions and other research Institutes is a major setback factor to technological development in the region. The funding of technological sector in Sub - Saharan Africa is grossly poor. In the case of Nigeria for instance, between 1985 and 2000, research funds averaged only 0.08% of the Gross National Product (GNP) which is a far cry from the UNESCO recommended the target of 1.0% [12 &13].

vii. **Exploitation of Knowledge**: The exploitation of indigenous knowledge and technology by foreign technologies [7], is another setback to technological drive in the region. A case study of Kinodo basket of Kenya though the basket was weaved and used in the Kikugu and Kamba communities but the Kenya communities received none of the proceeds that accrued from the trade [7].

viii. **The Death of Unwritten Technology**: Most local technology is unwritten and if not transfer by the time the man (originator) die, the technology dies with him/her. The Sub - Saharan Africa have lost indigenous technologies and knowledge through the death of this unwritten local technology originator.

ix. **Low Human Capacity Building**: The failure of the government to recognize potential local technology within the region and encourage it by adequately supporting the local intellectual has led to the low human capacity building in the region. This has exacerbated the backwardness of local technological development and drive in the region of Sub - Saharan Africa today.

x. **Policy Instability**: The instability of government system in policy making and keeping (continuity) has jeopardized the development of local technology in the region due to lack of continuity in the governmental system in the region. One government will make policy and another will step - it down. This has grossly hindered local technological advancement in the Sub - Saharan Africa.

xi. **Decadence**: Corruption is like a cancerous plague that has eaten deep into the Sub - Saharan Africa nations. It is generally known that Nigerian government measures progress and achievements in terms of funds allotment [14], but what they do with this funds allocated or shared are not accounted for. This has led to serious corruption in the governmental system in the region which has grossly hindered the advancement of local technology in the region.

xii. **Poor Patronage of Local Technology**: The goods manufactured using traditional (local) technologies has been jettisoned by individuals and government from the region. There is low patronage from locally made goods from the region and this has led to low morale of local intellectual and also, hindered the advancement of local technology. Although, recently in Nigeria, the government and individual have started campaigning for locally made goods patronage which is a welcome development.

xiii. **The Attitude of Government**: The attitude of government towards potential local knowledge and technology in Sub - Saharan Africa is worrisome today. They failed to recognize potential local technology and knowledge, like the case of Boko Haram and the Niger Delta activities in the North - East and South - South of Nigeria where mini industries were setup to produce Improvised Explosive Device (IED) in the North - East, and illegitimate oil bunkering and mini-refineries in the South - South of Nigeria. These negative activities can be a blessing in disguise if the government of the day can properly transform and channel this local knowledge appropriately.

1.4 DEVELOPMENTAL PROSPECT OF LOCAL TECHNOLOGY

In spite of low patronage of goods and services produced and delivered by local technology in Sub – Saharan Africa, the indigenous (local) technology still have several prospects for development in Sub - Saharan Africa [7], if properly activated (harnessed). According to the Innomantra Consulting Private Limited [8], if the transformation of indigenous technology is pursued vigorously through appropriate participation of stakeholders in engineering and technology. Indigenous technology offers the following developmental opportunities [8]:

i. Local technology helps a nation to attain self - reliance in the technological arena.

ii. Local technology stimulates industrialization and domestic capacity building.

iii. Local technology provides ample opportunities for innovation, modernization, and technological competitiveness.

iv. Local technology catalyzes the economic growth of a nation along with proving employment opportunities for the citizens.

v. Local technology revolutionizes the economy of a nation if properly harnessed

vi. Local technology civilizes the nation economy and the wellbeing of the people

vii. Local technology if harnessed properly, increases the standard of living of the nation, thereby developing the nation economy.

viii. Local technology increases capacity building of technical skills and entrepreneurship development of a nation.

For West Africa, what this means is that indigenous knowledge and technology offers a wide spectrum of opportunities for development [7]. In fact, all these opportunities are indicative of the developmental needs of Sub - Saharan Africa Region [7].

1.5 ADAPTATION AND DEVELOPMENT MODEL OF LOCAL TECHNOLOGY

The developmental process of local technology can be mirror as a cyclic process. Most of the developed countries advance their technologies through the adoption of the spiral process model cyclic during the developmental stages. The technological innovation of most advanced countries pass through this cyclic process. First, the local firms start their technology innovation process from international transfer of technology, implementation or duplicative imitation. Second stage is the adaptation of the imported technologies by assimilation and makes it more improved and developed, which is sometime called creative imitation stage [15]. According to Park, Ali and Chevalier [15], "these imported technologies are further improved upon by processing the imported technologies using their own indigenous knowledge, local initiatives and technological capabilities"; and this is done using the spiral process model of technological advancement. Also, according to Park, Ali and Chevalier, countries like Japan, Korea, China, Singapore and Taiwan have developed their local technology to advanced stage through the adoption of this spiral process model [15].

Japan after the post world war II was able to develop their technology due to imported technologies and in the 1950s, many Japanese companies started their own technology innovation by implementing and assimilating the imported technologies which enabled them to challenge the industrial leadership in the US and Europe today [15]. Also, American mechanical capacities were developed due to implementation and assimilation of British technology, in late eighteen century, when US imported steam engine technology from the Great Britain [15]. So it is evidenced that the US technological innovation capabilities also passed through the same pattern [15]. This pattern is called spiral process model of technological advancement and the spiral model is shown in figure 2 below:
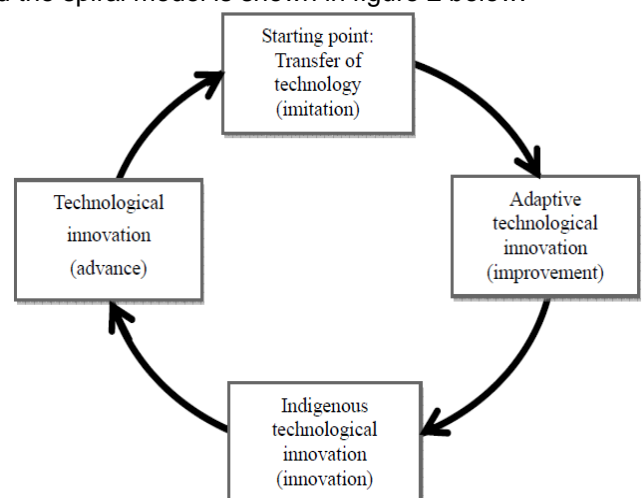

Figure 2: Spiral Process Model of Technological Advancement, Source: [15].

The spiral process model of technological advancement has three stages. These three stages can be adopted by developing countries in Sub - Saharan Africa to develop their local or traditional technology. According to Park, Ali, and Chevalier, they said most developing countries like Sub - Saharan Africa lacks the ability in the selection of appropriate technologies to be acquired for driving technological sector, in selecting the appropriate technologies to be developed for evolving and emerging technologies to develop for the leading sector [15]. They also said, the first stage for developing technology is by importing foreign

technology. After successfully identifying the appropriate technology from the imported technologies, the next step (second) for the recipient country is the adoption of the technology, and the third stage is for the developing countries to establish their own technological innovation by using their own local knowledge [15]. The last stage of this technological advancement is called the derivatives platform and is the breakthroughs of technologies in the developed countries today, and this is called technological advancement [15]. Many developing countries in Sub - Saharan Africa can adopt this spiral process model of technological advancement to develop their own local knowledge base on imitation (implementation), improvement (assimilation) and innovation pattern [15].

1.6 ENHANCING LOCAL TECHNOLOGY THROUGH APPROPRIATE TECHNOLOGY TRANSFORMATION AND SUPPORT

To facilitate the growth, development and transformation of local technology in Sub - Saharan Africa to meet global standards is something that is achievable if all hands are on deck. Most countries in Sub - Saharan Africa have failed to develop their own local technological and engineering capabilities because they were not successful in adopting, imitating and improving the imported technology (borrowed) using their local knowledge to meet their local needs and wants.

Nigeria has made giant strides in design, fabrication, refining and development of local technologies, especially in the agricultural sector, which includes cassava planter, cassava harvester, maize shelter, cassava peeling machine, cow pea thresher, crop transplanter, cocoa plantation weeding machine, groundnut harvester etc., [7]. Manabete and Umar also said; that many African countries, are unfortunate that research and development (R & D) efforts are left with the academia and perceived as a mere academic exercise [7], while many useful R & D develop by institutions in Sub - Saharan Africa Region waste away in the office shelve of the researcher because of negligence on the part of stakeholders (government) and weak academic/industries synergy in Sub – Saharan Africa region.

Enhancing local technology through appropriate technological transformation and support can be mirror or comprised of two sections. The sections are classified as primary section and secondary section in this paper. The primary section will consider the role of the government (stakeholders) in supporting the transformation of local technology to meet local needs and as well as global standards for sustainable economic growth in Sub - Saharan Africa, while the secondary section will adopt the 3 - I pattern or strategy of local technological development and transformation by Park, Ali and Chevalier [15].

In order to transform the local technologies and bring global standards to bear in local technology of Sub - Saharan Africa, the stakeholders in the region (government) should support and put into consideration the following:

i. **Adequate Funding of Research and Development (R & D):** The present state of leaving researches to waste away in institutions library shelves is bad and is a drawback to the technology advancement in the region. The government should adequately fund and encourage a bilateral relationship between the industries and the research institutions in the region.

ii. **Commercialization of Research and Development:** The results of R & D should not be allowed to rot away in the institution's library shelves. The government should promote meaningful R & D in the academic sector and see how to cement the relationship between industries and institutions in the region by giving incentive and research scholarship.

iii. **Synergy and Sustenance of Public - Private Partnership (PPP):** The government of the region most see how to revamp the PPP sector and encourage it by adequate funding, promotion, and sustenance by the strong synergy between the two sectors. The strong domestic researches are facilitated by the PPP in acquiring, absorbing and adapting new technologies that evolved.

iv. **Strengthening Capacity Building**: The government should strengthen the capacity building of science, technology, and innovations in the region, as well as basic technical skills for both men and women which are also a prerequisite for the future development of local technology in the region.

v. **Technical Policy**: Policies that are technically inclined should be promulgated by policy makers in the region. Stakeholders should make policies that will drive the technological sector and jettison any policy that will hinder local technological development.

The secondary section of technological transformation through appropriate technology imitation, improvement, and innovation of foreign or imported technology which is called 3 - I technological advancement strategy or pattern is the best option for many developing countries like Sub - Saharan Africa to start the spiral process model of technological advancement [15]. There are successful cases like China, Korea, Japan and other developed countries that adopted the 3 - I technological advancement strategy or pattern which can be emulated by Sub - Saharan Africa, so that they can replicate same procedure to develop and transform their local technology to meet global standards that can compete favourably in the (global commercialization of transformed local technology) global market.

With the availability of enormous natural resources in the region of Sub - Saharan Africa and their wealth of local knowledge and technology, they can develop and advance the local technological sector by adopting the 3 - I technological advancement pattern, and is the best option for the Sub - Saharan Africa countries to implement[15].

Strengthening the local knowledge and technology, the role of transfer of technology, educational institutions, technology managers/technical skilled people and government supports are inevitable at this stage [15]. Also, the government is a veritable organ

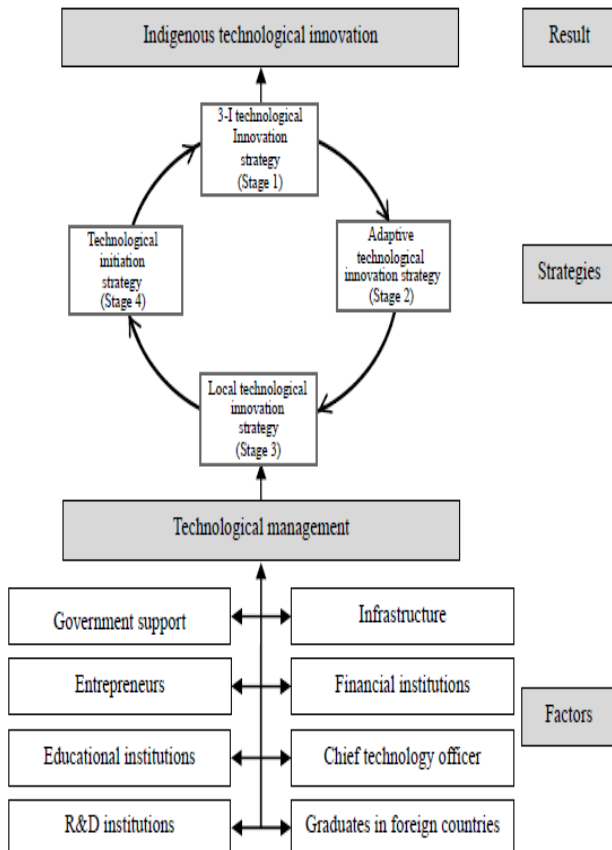of technological development as shown in Figure 4 below.

Figure 3: Local Technology Advancement Building Model, Source: [15].

Local technological innovation can be commercialized successfully as entrepreneurs that will benefit the users which will lead to the prosperity of the society as shown in this cyclic model of local technological advancement in Figure 4below [15].
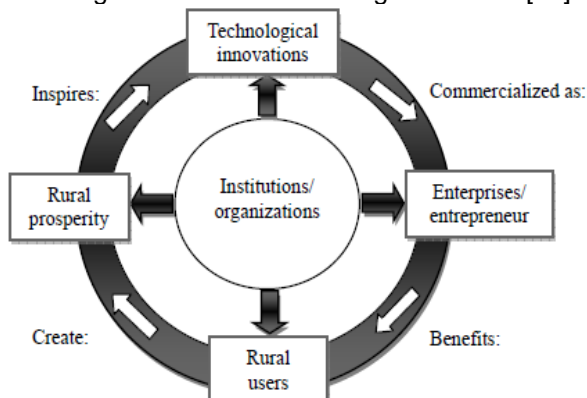

Figure 4: Local Technological Advancement Cyclic Model, Source: [15].

A critical examination of Figure 4 above shows that a strong and evincing bilateral relationship between the research institutions and industries in Sub – Saharan Africa will lead to inspirations of local technological innovations, commercialization of local technology innovation as enterprise/entrepreneur, benefits rural users and creates rural prosperity thereby developing the local technological content of the region. If these models proposed in this paper are judiciously implemented in Sub – Saharan Africa

Region, the study believes the region will soon walk her way into industrialized nations of the world.

1.7 CONCLUSION

It is no more in doubt that the greatness of a nation is closely linked to its technological capabilities [11], and not the abundance of untapped natural resources, local engineering knowledge, and technology. According to Adeodu, Daniyan, Omohimoria and Afolabi [16],"some of the challenges bedeviling the third world countries have been identified as inefficient use of available resources (human, financial, material etc.), low human capacity building, absence of good and safe infrastructure, and epileptic power supply amongst other."

Nigeria as a nation and her counterpart in Sub - Saharan Africa have made some tremendous efforts, and at the same time attempted to transform and advance local knowledge and technological capabilities without a resounding success. The potential barriers that actually hindered the attainment of this wonderful desire have been thoroughly dealt with, it is suffice to mention that the Sub - Saharan Africa Region still stands better chance of getting it right by overcoming the so-called barriers that have hindered the technological drive of the region and walk her way into the league of industrialized nations by appropriate transformation of local technology through the adoption and application of the 3 - I technological advancement pattern proposed in this paper.

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