

Managing Technology Transfer and Innovation: Indispensable Tools in Fostering Sustainable Technological Development in Nigeria- A Review Paper

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Abstract:- The impact of technology and innovation on national growth and development in this increasingly competitive world remain a concede fact. Its impacts can be attributed to a long (time interval) and complex processes which involves mutual reciprocal action or influence of both the transferors (owners of technology) and the recipients (receivers), including academia, research and training institute, market, of course government inputs. For many under-developed countries like Nigeria, many factors affecting the persistence low living standard, oscillatory movement in foreign exchange rate is the highly unequal distribution of technological capacity between the country and the developed ones. These unequal in technological strengths are observed in their capacity to often dictate the terms and degrees in which technologies and foreign aids are transferred to the country. The present empirical study is aimed to contribute to the large existing literature on technology transfer, affirm that skills acquired from technology transfer can be fostered, improved and advanced when individuals, expertise, firms (private and public) are ready to take a major risk of been innovative (ability to utilize, replicate, improve and, possibly re-sell the new technology). It also draws our attention in identifying barriers that mitigate successful acquisition of new technologies. These barriers are in the form of internal, external and international barriers transfer technology and earnestly calling for a close and mutual collaboration, integration and intellectual exchange between the academia, research and training institutes, industries, market and of cause undivided input from the government.

Keywords:- Development; Transferor and Recipient; Innovation; Technology Transfer.

I. INTRODUCTION

There is an appalling limited deployment of inadequate productive technology in production activities such as agriculture, materials, processing of raw materials, construction and manufacturing of basic agricultural and transportation equipment. This problem constitutes what is referred to as the Africa's technology gap problem tree. Pervasive poverty, low rate of productivity which is associated with low salaries and wages, increase in unemployment, can be linked to Africa's technology gap problem tree. It is so logical to conclude or affirm that African especially Nigeria's economies and possibly her technologies cannot witness a roboost economic, technological and national development until the issue of technology gap problem tree is resolved. One important question we should ask ourselves is how can Africa's technology gap problem be solved?

Radical Technological and innovative change is well recognized as the main drivers of long-term national growth. In the coming decades, radical moves for sustainable industrialization, technology transfer and fostering innovation has become so important to be put under the carpet when national and technological development is the ultimate concern. This implies that without the effective utilization of technology transfer, industrialization will remain a mere dream, and without industrialization, development is like chasing shadows. It is an undisputable fact that technology transfer and innovation makes manufacturing or production processes more effective and efficient, thereby increases the chances of competing favourably with the developed world and reduces their risk of instability to market demands but it will demands a radical, structural change from labour-intensive to a technology-intensive economy. In the past decades, only free among the under-developed countries like Malaysia, India and Brazil were successful in developing an advanced technology-intensive industry through technology transfer and effective innovation and are now rated among the influential countries in the worlds.

Though, there are undoubtedly challenges that confront the rapid development in the listed countries, the debate on the underlying challenges/factors deterring these countries from promoting technology transfer, innovation and their ability to scale through these challenges continued to be a thing of concern to the developing country like Nigeria. The long standing craves for most African countries, especially Nigeria (generally refer to as the giant of Africa) to acquire an advanced technology to aid her developmental processes should not and cannot be overemphasized. Over the years, Nigeria has made concession efforts to increase and improve her local production, particularly in the area of manufacturing through the acquisition of foreign technologies [1]. It was unfortunate to state that Nigeria, in this twenty-first century have not been able to improve her technological and innovative capacity in the different sector of her economy. This has left us (as a nation, experts and concern individuals) with pungent questions to answer such as; why have these efforts in support of sustainable development failed to fulfil expectations and meet national needs? What must be done to ensure the success of renewed national sustainable development through innovation and technology transfer initiatives without been truncated or frustrated? Is there a lesson to learn from our counterpart countries like India, Brazil and Malaysia? This paper is aimed at given answers to these questions. This paper is also concerned with how Nigeria can succeed in initiating technology-based economic development through technology transfer. This work is grounded on the view of technology transfer as a systematic and continuous uninterrupted process in which knowledge and skills development at various levels is non-negotiable. This implies that technology transfer requires adequate efforts aimed at technology advancement and a sustainable capacity building on the part of the country.

II. CONCEPT OF TECHNOLOGY TRANSFER & INNOVATION

Before exploring the term technology transfer, there is need to understand the meaning of technology. There are numerous definition of technology, according to Hornby, 2002 [2], technology is defined as the acquired, utilization of scientific knowledge in the discovering and designing of new equipment and machineries. Grosse (1996) [3] better defined it as ‘the process of transferring skills, knowledge, technologies, manufacturing methods, samples of manufacturing, facilities among governments and other institutions to ensure that scientific and technological developments are accessible to a wider range of users who can then further develop and exploit the technology into new products, processes, applications, materials or services’. Consequently, technology transfer is referred as the movement of technical know-how, technological procedures and skills from the places of its origin (usually developed countries) to wider distribution to the recipient (usually developing or under-developed countries).

The concept of technology transfer will not be adequately understood without innovation (for this paper is referring to as technological innovation). The ability to

translate and implement new ideas to meet specific need is referred to as innovation. The basic concept of innovation is ‘changes’ it involves changes in the provision of new technology and technological processes; introduction of production with new characteristics; maximum utilization of raw materials. This implies that an innovation is said to be innovative when an idea is replicated economically to meet targeted needs. It involves a deliberate application of information at disposal, creative initiatives in obtaining better or improved values from resources, processes by which new ideas are generated to wider and useful products. Innovations are usually associated with product innovation (products or services that are new or significantly improved in their characteristics or intended uses) and process innovation (new or significantly improved manufacturing or production methods, including significant changes/improvement in techniques, equipments and software). It can be comprehensive or raising. Comprehensive innovation has significant impacts on the economic activity of firms in relation to the market, whereas a raising innovation is majorly concerns on improving existing products, processes, organization or procedures whose performance is significantly enhanced or competitive differentiation (improved). In a developing country like Nigeria, the dominant required is raising innovation. Technology transfer and innovation must be recognised as a broad and complex process which demands radical technological change if it is to contribute immensely to sustainable and equitable nation development and avoid over dependency of the recipient. The recipient at one end must be able to utilize, replicate, improve and, possibly re-sell the new technology. This draws my attention to an important quote concerning innovation.

“America leads the world because of our system of private enterprise and a system that encourages innovation. And it’s important that we keep it that way”. President George W. Bush, April 200

III. NIGERIA AND THE TASK OF TECHNOLOGY DEVELOPMENT

The most ancient of the Nigerian cultures and technology known to us is also that about which least knowledge has been available, among which is the ancient iron-working culture, known as the Nok culture, whose remains, of remarkable artistic values, have been coming to light in the ‘Middle Belt’ region of Nigeria during the past decades. Iron use, in smelting and forging for tools, appears in Nok culture by at least 550 BC and possibly earlier [4]. Data from historical linguistics suggest that iron smelting was independently discovered in the region prior to 1000 BC [5,6]. The next phase of culture and technology transformation is the Igbo Ukwu bronze casting, the casts date from the 9th Century A.D. but first came to light in 1938 while the best known Nigerian artworks are the Benin Antiquities. Legend recounts how the Benin people learned the art of bronze casting from Ile-Ife around 1400 A.D. [7]. This era (before independence) featured significant boom in craft industries which includes artifacts of woods, brass and bronze, leather, textiles, iron works, pottery, canoe carvings,

bronze works, and embroidery [8]. To this end also, palm oil mills, groundnut crushing mills, cotton ginneries, oil seed mills, power-driven sawmills and the likes became pioneer factories, followed by finishing operations factories such as printing, baking, furniture works etc. The nationalist political pressure for independence was accompanied by equal pressure for economic independence following which the colonial government passed the Aid to Pioneer Industries Ordinance in 1952. Similarly, the European trading firms began to expand into manufacturing as a strategy for retaining their markets. The aggregate results of these actions were the establishment of a number of light consumer industries such as food canning, beer and soft drinks, cigarettes [8].

standards, increase level of unemployment and fall in foreign exchange rate is the highly unequal distribution of technological capacity between the 1st and 3rd world countries. These unequal in technology and economic strengths are manifested in their ability to often dictate the terms and degrees in which technologies and foreign aids are transferred to developing countries.

One popular Africa adage says ‘*nothing good comes easy*’ the pathway to technological and national development cannot come without some barriers or challenges, it become necessary to identify and reduce these barriers to the successful acquisition of new technologies. These barriers can be in various forms namely; internal, external transfer technology (TT) and international transfer technology (ITT) barriers. For a clearer understanding on the forms of barriers, there is need to state the differences and similarities that exist between the various transfer technology practices. This is summarised in Table 1 below.

IV. OBSTACLES AND WAY-OUT TECHNOLOGY TRANSFER & INNOVATION

For many less developed countries like Nigeria, significant factors affecting the persistence low living

Table 1: Difference/Similarities between Internal, External and International Technology Transfer (TT)

Internal TT	External TT	International TT
Owner of technology retains ownership and usage.	Technology is passed from the transferor to the recipient.	Technology is passed from the transferor to the recipient.
Exist within a sector in the country	Exist between two private or public firms or companies within same country or firms from different countries	Exist between the developed country to a firm in another country
NIL	occurs in a form of joint ventures or licensing technology to another company or entity	licensing of intellectual property rights and extending property rights, technical expertise to developing firm located in other countries
NIL	Not as International TT	For developed countries, ITT is mostly a strategy to commercialize their technologies and to attain larger economic powers.
Not applicable	Not compared to ITT	ITT gives the recipient rooms for making problem-solving innovations through imitations, absorption, adaptation, improvement, reconfiguration, modification or rebranding of a transferred technology

In order to decide about the type of TT to adapt to a given recipient, the major actors must have to ponder on some of the following questions: When is the right time to introduce new technology? Where to transfer this new technology? Who should be involved in transfer process? What communication techniques should be adopted to facilitate the transfer? [9].

A. Barriers/Way-Out to Internal TT Acquisition:

Barriers or challenges are inevitable sometimes irrespective of the level of preparation in the transfer processes. Barriers that can impede Internal TT include the following:

- (1) Unclear or Lack of R&D goals by the recipient
- (2) The challenge of stopping current operations to test new technological processes
- (3) Lack of necessary infrastructures
- (4) Change resistance of the core R&D Department and

- (5) Absence of linkage between new technologies and marketing of products [9].

To overcome these barriers stated above, there is need to implement certain strategies such as:

- (1) Zero acceptances to corruption and selfishness
- (2) Full participation and support of Top management in the transfer process
- (3) Use of multi-functional teams in the transfer process
- (4) Ensure effective communication in the organization
- (5) Bring R&D closer to core business
- (6) Involving marketing/customer elements in the transfer process [9].

B Barriers/Way-Out to External TT Acquisition:

Though external TT involves the transfer of already developed technology to the recipient, on the side of recipient, time and energy of acquiring the new technology is conserved. However, most firms, companies decides to acquire this type of technology due to what is called ‘self-justification’ this justification may be due to;

- (1) If the competitive goals cannot be reached through internal development
- (2) Lack of interest to take necessary risk for innovations
- (3) Lack of internal resources for research and innovation
- (4) Lack or little available man-powers to stand the changes with complex technological developments
- (5) The need to keep up with competitors. Moreover, external TT can serve as company’s strategy - purchasing technology developed by others so as to avoid taking big R&D risks [9].

Several factors serve as barriers to external TT; these barriers can be viewed in two perspectives (i.e. Transferors and recipients). From the recipient (receiver), these barriers include;

- (1) High purchasing costs associated with external TT acquisition
- (2) Appropriateness of technology (i.e. its suitability to the consumers)
- (3) The danger of over dependence on foreign technology and associated conditions issued
- (4) Lack of mutual trust between two parties.

On the side of transferor (owner of technology), these barriers include;

- (5) The risk of losing total control over her technology and inconsistent or unpredictable use technology by the recipient
- (6) The fear of rendering existing technology and its related products/services and processes obsolete
- (7) The fear of recipient becoming potential competitor in future
- (8) Differences in organizational cultures
- (9) Lack of effective communication or agreement between parties [9].

C. Barriers/Way-Out in International TT Acquisition:

The role played by international technology transfer (ITT) in spearheading national economic development cannot be understated. It is highly influenced by the type of national policies and international agreements both parties signed [10]. The desire to accept, acquire, utilize, and effectively diffuse technology is majorly associated in the recipient’s national policies and in its legal and institutional arrangements for implementation. The absorption, diffusion

and effective utilization of a new technology is a step towards subsequent creation of new home-based innovations. Regarding international agreements, recipient nations must be absolutely careful in ending agreements with developed or experienced companies that are ready to offer these technologies. There is the danger of getting undesirable results if agreements are not properly scrutinized before signing, lopsided international agreements will give advantage to technology owners at the expense of technology recipients [11]. Other challenges associated with ITT are: Information deficiency and monopoly power.

1) Information Deficiency

This is a major challenges faced by the recipients, the owners of technology at some level of technology refuse to disclose all the available information to the recipient for the fear or consciousness of overtaking in same technology. Hence, the recipients are unable to fully comprehend or appreciate the extent of technology acquired.

2) Monopoly Power

According to OECD glossary of statistical terms, it is the ability of a firm (or group of firms) to raise and maintain price above the level that would prevail under competition. Technology owners possess absolute power than the recipient due to their accumulated skills, monopoly of patents and supports from other international organization. Hence, technology owners may lose benefits that may later occur when the well diffused technology produces spillovers.

Additionally, policy makers and planners may be faced with difficulty in interpreting, analyzing, measuring and cost of complex ITT processes resulting to an ineffective ITT. Together with that challenge is the intricate issue of technology imitation. Imitation is hardly reported or documented properly; hence, making the capture of innovation spillover difficult. These measurement challenges leads to another complication for policy makers of how to formulate adequate TT targets for the national policies and programs in the complex ITT undertakings [12].

Impacts of innovative industrial policy can be measured in various perspectives involving the use of data, charts and interpretations. Table 2, shows the methods in measuring the impacts felt when innovative policies are fully or partially utilized or diffused.

Table 2: Measuring Impacts of Innovative Policy on Technological Development

Government support to private R&D	Total amount of research and development (R&D) subsidies
Foreign technology transfer	Number of licensing agreements, imports of capital goods and number of joint ventures with foreign firms
Quality and quantity of technical tertiary education	Share of public expenditure on tertiary education, share of engineers in total tertiary government disbursements for training programmes and public support to universities and research centres
Number of domestic research institutes	Number of domestic research institutes
Innovation human capital	Employed personnel with science and technology qualifications
Innovation infrastructure	Support activities for R&D, capital and investment in technology-based equipment
Labour market	Employment in creative sectors as a share of employment
Diffusion of new technologies	Business use of mobile internet, 3G (and higher) coverage, e-Intensity Index

Source: UNIDO Industrial Development Report 2016

Other ways of measurement its impacts include the following:

- Number of available new technology products
- Number of patents
- Number of new processes techniques introduced
- Number of high-tech products export of the country
- Share of innovative firms in the economy development and
- Number of firms engaged in new and high-tech sectors

The measuring of technology development remains difficult to ascertain due to the context of technological products and possibly its processes. Patent in the past decades has been the traditional means of measurement, especially in low and middle income countries, than the use of R&D. This is because patent data are recorded and kept for longer time intervals. Other methods of measuring technology development include the assessment of research undertaken by various institutions, number of patents pools, new products and consumer satisfaction. This also involves assessing the level of supports rendered by the public sector for technology development; assessment of number of citations to scientific papers in context of patent applications; assessment of diffusion technology programs and of course the outcome from R&D support programs.

V. CRUCIAL POINT(S)

- Reaching advanced level of inclusive and sustainable industrial and national development requires a conscious efforts (radical technology change) to sustain economic growth
- Technology transfer is the total not partial movement of technical knowledge, technological methods/procedures and skills from the technological advanced countries to wider distribution to the recipient (usually developing or under-developed countries).
- Transfer technology can be referred to be effective when the recipient was able to utilize, replicate, improve and, possibly re-sell the new technology.
- Skills acquired from technology transfer can be fostered, improved and advanced when individuals, expertise, firms (private and public) are ready to take the risk of been innovative

- The basic concept of innovation is 'changes' it involves changes in the provision of new technology, technological processes, introduction of production with new characteristics and a maximum utilization of raw materials at disposal.
- On the pathway to technology development in any given country, the pathway to technological and national development cannot come without some barriers or challenges. It is of necessity to identify and reduce or eradicate these barriers to the successful acquisition, utilization and advancement of new technologies.
- The issues of a close marking (mutual collaboration and understanding) between the research and training institutes, companies or firms (both private and public) and of course the market make acquired transfer technology to be easily analysed, interpreted and manipulated
- The role of government is of paramount important in fostering technology development.

VI. CONCLUSION & RECOMMENDATIONS

The main goal of appropriate technology development, therefore, is its ability of a country to improve the quality of life of her people. Unfortunately, the country is still much under the influence of the developed countries who dictate the progressive pace of their developments and the economic activities due to our inability to take full advantage in transfer technology and be technological innovative. Government, been an integral part of technology development/change are unable to develop integrative approaches to the full range of consequences of technological change, partly because of knowledge and implementation gaps. These had made the country still dependent on the developing countries for her sustenance.

- *Recommendation(s)*;
- 1) Support long-term research through adequate, honest and equity provision of funds with sole aim to build capacity.
- 2) Provide permanent incentives to innovative and diffuse technologies that support sustainable technology development objectives by expanding the use of market-based approaches.
- 3) Encourage effective public-private dialogue

- 4) Strengthen political leadership
- 5) Encourage and foster transfer technology by sincerely tackle all internal and external barriers mitigating technology development in the country. Fighting corruption should be on the country's, individual priorities
- 6) There should be a close collaboration, integration and intellectual exchange existing between the universities, research, training institutes, industries and above all government support.

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