FACTORS AFFECTING TECHNOLOGICAL INNOVATION IN NIGERIAN INDUSTRY

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ABSTRACT
This paper evaluates the role of technology innovations in development. It considers very briefly the relationship between technological innovation and development, and also the sources of technological innovation. The paper discusses why Nigeria is lacking behind in technological innovations. In doing so, it looks into the influences of the national economic, behavioural and cultural factors on technological innovations. The conclusions reached suggest that government should invest more on human capital or education, reasonable percentage of the revenue from oil should be ploughed back into the development of the industrial infrastructure, firms should be at the centre of technological innovations, government should build a favourable environment for innovative activities. Finally Nigeria should learn from the newly industrializing countries especially in the area of promotion and protection of inventions.

INTRODUCTION
The importance of technological innovation and technical change in industrial development has long been recognized. Innovation can lead to greater profit and for the innovator and affect industrial market structure (Mountjoy, 1983). Minimum scale for production may rise or fall as a result. Innovation may provide a means of entering an industry or of increasing an existing firm's market power (Gomulka, 1990). Major industrial companies owe their continued existence to the successful application of technological innovation in evolving new products and improved manufacturing processes.

Nowadays, it is fashionable to attack technology because of its effect upon the environment, its continuing contribution to the quality of twentieth-century life must not undervalued. The need to ensure that it is effectively managed in meeting the needs of society will become more pressing and should absorb an increasing proportion of our national resources. For many organisations, built-up on past success, the impact of technological innovation can present a threat.
Companies which have failed to maintain their innovative momentum have been overtaken by more youthful and vigorous organizations. Not infrequently they have gone out of business. A comparison of today’s industrial leaders with those of twenty or even more years ago shows how many of the once great names have declined in importance or disappeared from the business scene. The so called ‘Asian Tigers’ - the Republic of Korea, Hong Kong, Singapore, Taiwan Province China, Indonesia, Thailand and Malaysia and some of the new industrialized countries like Brazil, Mexico, India, Argentina and South Africa were regarded as underdeveloped countries before, but today they are widely recognised in the industrial world because of their rapid development through technological innovations. These countries anticipated the effect of technology and seized the opportunity for growth which it had offered.

It is rather unfortunate that Nigeria with multi-billion dollars received from petroleum is lacking behind these countries in technological development. This led to this research work that is why is Nigeria lacking behind in technological innovation and what remedy is available to correct the situation. It is becoming increasingly accepted by economist that technical change plays a major role in causing economic growth. Technical change, of itself, is not sufficient to guarantee such growth: economic growth derives from the commercialization of new technical know-how, through innovation. Innovation, and in particular successful innovation is, therefore, of prime importance to economic progress, both at the national level and at the level of the individual industrial organisation.

In addition to the economic knowledge a successful innovation needs the positive contribution of many disciplines like technology, psychology, science and so on. This topic is treated with such a perspective in view.

TECHNOLOGICAL INNOVATION AND RESEARCH AND DEVELOPMENT

It is useful to draw a distinction between the terms ‘technological innovation’ and research and development’. Although it is commonly supposed that they cover the same range of activities within an organisation. But technological innovation implies an organisational wide approach to the profitable application of technology rather than a description of the activities of one department responsible for R&D; it stresses the importance of the whole innovation process through commercial exploitation; and it leaves door open to new technology which originates outside the organisation (Twiss, 1986). For the only justification
for devoting scarce financial resources to research and development is the belief that they will generate innovations which will contribute to the organisation’s survival and continued profitability.

Furthermore, it must lead to the attainment of these objectives more cheaply than if the money were spent in some other ways.

SOURCES OF TECHNOLOGICAL INNOVATION

A major affecting industrial performance is the rate of technnovation and its application to efficient production processes and organisation. These are three major channels for exploitation of new technology;

(i) established companies and their subsidiaries
(ii) new companies set up by an individual or group of individual for the purpose of exploiting an invention or new technology new technology based firms (NTBFs),
(iii) the public sector, including government departments, local authorities and nationalised industries.

Established companies

In terms of economic output, established companies are still the most important channel for the exploitation of new technology (Ross, 1993). However, in line with the situation in other nations (Davidson, 1974; English, 1984; Dominique, 1993). The established companies in the country are often unwilling to exploit new technology for the following reasons.

(i) they may not appreciate the potential importance of a new breakthrough,
(ii) initial sales may be too small in relation to the rest of their business; many companies are unwilling to take on new products with a low sales volume
(iii) in allocating its capital resources, the company may have to give higher priority to its existing produce and businesses,
(iv) some major companies are willing to develop a new product unless they can expect to get a 30 or 40% share of the Nigerian market; this may be impossible if foreign competitors have already entered the market,
(v) the company may have a huge sunk investment in existing technology and methods of production which it cannot afford to scrap,
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(vi) existing plant and equipment are depreciated at historic cost or may even have been down to zero; paradoxically, a switch to new technology could make the company uncompetitive because of the increase in depreciation cost and interest charges,

(vii) the management structure of the company and the promotional ladder may encourage managers to avoid risk,

(viii) trade unions may be unwilling to accept new technology.

New technology-based firms (NTBFs)
The second channel of exploitation, new technology-based firms, is very important because NTBFs do not suffer from the barriers to industrial innovation which affect established companies. Unfortunately, companies in this group are not yet fully established in Nigeria.

The public sector
The third channel of exploitation, the public sector, is becoming decreasingly important because more technology-based industries and companies have taken into private ownership through the Structural Adjustment Programme (SAP) of the government.

However, there is need for a greater co-ordination between the remaining companies under the government and the sources of new technology-research and development (R&D) department - whether public or private. In particular, where the sole user of a major piece of new technology is a public-owned monopoly it is essential that the company make an early and specific commitment to adopt the new technology. Since the public-owned company should not stand back and compel the source of the new technology to bear the risks of development. If the present arm’s length relationship which exists in certain industries continues, there may not be a flow of the new technology from the R&D departments into the public-owned industries.

MACRO-ECONOMIC INFLUENCES
The major macro-economic factors that affects innovations in Nigeria can be discussed under the following:

General Economic Conditions
The rate of technological innovation in Nigeria industries is closely related to the level of industrial investment and the rate of economic growth. In most cases industrial investment and technological innovation are two sided of the same coin. An economy without a very low level of industrial investment and
economic growth cannot expect to achieve a high level of technological innovation (Hennessy, 1986). Inflation, high rates of interest and repeated stop-go cycles must also bear some of the responsibility.

It is obvious that economic conditions in some developing countries like Japan and Brazil have been much more profitable towards industrial innovation than in Nigeria. The profitability of industrial investment may well be most important factor determining the rate of industrial innovation, yet in Nigeria it is normally ignored, however such factors may be the consequences in industrial failure and lack of innovation rather than its cause. This is very much a chicken-and-egg situation because favourable economic conditions have in turn been caused by a high rate of industrial innovation. The result is a virtuous circle.

Size of market
The size of the immediate domestic market has a major impact on the ability of companies to introduce new technology products (Lazonick, 1992). Nigeria corporations obtain an enormous advantage from the fact that the Nigerian market is the largest in Africa, with about 25 percent of the African population. It may be argued that Nigeria’s membership of the economic Community of West Africa (ECOWAS) has opened up a very large 'domestic' market. Unfortunately, this is not so because the ECOWAS has only succeeded in reducing the entry problems of member states to some extent. There are still some major barriers like:

1. language barrier - some belong to the franco-phone group of countries, while others belong to anglo-phone group of countries. Not this alone, there is problem of understanding different native languages,
2. trade barriers such as tariffs and quantitative restrictions
3. cultural tendency of purchasers and suppliers to think in national terms,
4. differences in technical standards between countries, more so that some of these standards are inherited from different colonial masters,
5. lack of common distribution channels between the community,
6. poor transportation system and communication facilities within the community,
7. problems of currency convertibility; and
8. dearth of organised centres of information on product availability within the sub-region.
As long as these barriers remain, the ability of ECOWAS members to exploit the technology from other members states will be substantially restricted. In the same vein, intra-regional trade in Africa is very low despite the existence of organisations like the organisation of African Unity (OAU) and African Economic Community (AEC). Similar organisations like Organisation for Economic Cooperation and Development (OECD) and European Union (EU) in Europe, North American Free Trade Agreement (NAFTA) in North America and Asian-Pacific Economic Cooperation (APEC) in Asia have led to a greater economic development of their regions and the member states, accompanied by strong trade links between them (Marroni, 1992). Intra-regional trade in African is the lowest in the world. The average percentage of intra-regional trade to total merchandise trade (based on value) between 1990 and 1995 are as follows; Western Hemisphere, 69; Asia, 43; North America, 35; Latin America, 18; Eastern Europe, 20; and Africa, 8 (International Monetary Fund, 1995).

**Privatization**

The privatization scheme was announced in early 1986 and was incorporated as an essential element within the Structural Adjustment Programme (SAP) announced later that year. A basic objective of the privatization strategy is to attract capital into manufacturing which is crucial to the attainment of many of the policy goals to the government. The SAP was designed with the explicit objective of increasing the inflow of foreign capital into Nigeria. However, SAP has not achieved much in this respect.

**Sources of finance**

When comparing sources of finance in the Nigeria with other industrial countries, it is necessary to distinguish between finance for established companies and finance for new companies. In most cases, large established companies find it fairly easy to obtain finance for industrial innovation (Schulmann, 1991). These companies seem to benefit from a very close relationship with their major banks who are willing to provide large quantities of long term capital when required by the company.

Quoted companies are easily assessed by banks through their regular report sent to the security and exchange commission. Also they can raise fresh capital from the market by issuing new stocks on the market. However, a company’s development may therefore be held back if the market conditions are not right for raising capital when the company really needs it. The position for a new technology based company is totally different. If anything, there are problems of
getting fund to finance such companies, as they do not have any track record. A good number of innovative companies started by a talented or group of talented individuals belong to this group.

Government expenditure on R&D

Since government account for above 80% of Nigeria expenditure on research and development, it is obvious that where and how the government spends this money can have a major effect on industrial innovation and the exploitation of technology. Since 1970s, government has made a substantial effort to focus more of its R & D expenditure on innovation in some industries in the agricultural, forestry and some allied sectors. Many research institutes was established for this purpose. It will soon be necessary to start measuring the benefits achieved in relation to the increased public expenditure on industrial innovation. Government expenditure on R&D in some developed countries like Germany and United States of America and in developing countries like Japan is already strongly oriented towards industrial innovation (Singer and Ansari, 1992). There is also no doubt that America’s world-wide lead in many areas of technology can be attributed to enormous Federal expenditure on defence and the space programme, a large and active government procurement programme in high technology areas provides major opportunities for technological innovation.

Another point to be borne in mind is that for every naira spent on research and development, between ten naira and one hundred naira may have to be spent on its exploitation in industry, like production plant, working capital and marketing. When allocating resources, it is therefore essential to choose the industrial objectives first. If R&D priorities are chosen first, the commercial exploitation may never be achieved (Steward, 1992). It is really impossible for the scientist or engineer employed in industry to choose the avenue for R & D expenditure until he has been told what a company’s objectives are.

Patents and licensing

The effect of patents and licensing on industrial innovation varied greatly from one product to another and it is difficult to generalise (Sutcliffe, 1981). In an area like chemistry or pharmaceuticals, patents and licenses have a vital role to play; without patent protection, many ideas would never be developed into marketable products and without licensing, it would be impossible to obtain the full financial return from the development. However, in engineering or
electronics, patents and licensing are normally less significant. In these fields it is usually impossible to recover development costs from licensing alone; in order to make money out of the invention it is necessary to make and sell the product itself. Many innovation in engineering and electronics are not based on patented inventions and, even where patent protection can be obtained, the company's technical know-how is often of much greater value than the strength of its patents. The success of the business really depends on its ability to develop second and third generations of products in order to grow and remain competitive.

In matters of patents and licensing, Nigeria companies do not have any particular disadvantages over their international competitors.

**BEHAVIOURAL AND CULTURAL FACTORS**

These factors are impossible to quantity but they undoubtedly have an extremely important effect on industrial innovation in any country. They include:

**Implementation Failures**

The most common and disturbing features of technology development in Nigeria is that it remains in a perpetual state of planning. Concern is often voiced for upgrading the status of science and technology: plans are enthusiastically drawn up, priorities exuberantly defined, reappraisals eagerly made, commissions frequently formed. But at the critical stage of implementation, the urgency and enthusiasm disappear and task is entrusted to the next generation of planners. And astute technology planners, a rare breed in the developed world, are even rarer in the developing countries like Nigeria.

**Bureaucratic high-handedness**

Bureaucracy has always stultified technological enquiry (Tolentino, 1993). Much to chagrin of the researcher, bureaucrats act to seriously distort the priorities of a research programme. They adopt an even more high-headed approach all over the country where democracy, a friend of technology development, makes only an elusive appearance and bureaucracy enjoys a freed hand.

**Industrial research inadequacies**

Industrial research in Nigeria has a low priority. The reason are not difficult to find. Most big industrial concerns in the country like Lever Brothers Nigeria PLC, Cadbury Nigeria PLC, Nestle Nigeria PLC, P.Z. Industries PLC, Nigerian Bottling Company PLC and a host of others are subsidiaries of big multinational firms and depend on the R & D effort undertaken in the home country.
Indigenous research is considered superfluous and a drain on company profits. Even the local firms with no foreign links often shy away from investing in R & D as they are little conscious of the benefits.

**Inadequate sources of the technical and industrial information**

Source of industry-related information range from conferences and university research institutions (normative information) to information agents continually disseminating factual business information about patents, industry profiles, commodity prices and exchange rates. Information is disseminated in various forms, from books, periodicals and conference proceedings to electric channels in global networks.

In line with other countries in the African region, Nigeria is also lacking behind in this area (Mundy-Castle, 1993). Most publications about industrial and technical subjects originate in the industrialized world. The origin, number of periodicals and percentage of the world total with industrial and technical content in 1984 was Africa, 4 (0%); USA and Canada, 7472 (52%); Latin America, 242 (2%); Asia, 1563 (11%); Europe, 3721 (26%) and USSR, 1320 (9%) (UNESCO, 1989).

The relative poor representation of developing countries with regard to the publication industrial and technical reports, periodicals and scientific papers, can partly be explained by the absence of data collection mechanisms in industry. This is due mainly to the lack of adequate finance for research work. Most of the information used in the south flows from the north, from the developed to the developing countries.

**The brain drain**

It was estimated that more than 40,000 Nigerians with qualification of first degree and above had been lost to the developed countries like USA Britain and Germany (Hussain, 1996), in their search for greener pasture due to the poor condition of service at home. Less than half of the Nigerian postgraduate students who went abroad ever returned home to take a permanent job. Renown scientists, engineers and other academia are leaving the country every day. No computation have been made to work out the losses on this count.

**Lack of international support**

Scientists in the developed world have little or no interest in the development of the so called "third World countries. These scientists want to commercialize their results and they make it difficult for others to understudy their methodology.
and procedures. One way of doing this is to stop attending international conferences. It was reported as far as 1986 that only 0.1% of the total strength of the US research community, participated in international conference, symposia, and meetings during the last decade (Naushad, 1996). They find little appeal in international science, and technical assistance occupies a 'less-distinguished-position' in the American Congress. What is true for United States is, by and large, also true for most of the European countries.

Other behavioural and cultural factors that make the differences between Nigeria on the one side and the fast developed and developing countries on the other side are as follows:

i engineering and production have a much higher status in Brazil than in Nigeria,

ii the prevailing attitude toward entrepreneurship is more favourable in United State of America than any other country.

iii the mix of skills possessed by Japanese engineers (production, marketing, finance) is general greater than in Nigeria.

iv industrial discipline is much stronger in Germany and Japan and their is more cooperation between management and employees in achieving productivity through new technology,

v industries in most developed and fast developing countries show much more aggressive interest in taking up new technology, industries in Nigeria have to be persuaded to take an interest. Most of the research results in the Nigerian institutions today end up in the library due mainly to this factor.

CONCLUSIONS AND RECOMMENDATIONS

Perfect and practical solutions are difficult to find to the problem of slow rate of technology innovation in the country. However, there are a few remedies which can be pursued. In view of this, the following recommendations are made

i The most important role of any government in technology development is investment in human capital, or education. Education at the level of primary and higher education matters much to indigenous technology capability and innovation. Nigerian academia that hitherto carried out most research work in the country should be adequately compensated in other to reducing the brain drain paralysis that is killing the development of the nation. Also in order to strengthen the ability of the graduates from Nigerian engineering and science based faculties, they should be exposed to the problems of
management, including organisational behaviour and culture and business related courses. Further investigations into to the problems of behavioural and cultural attitudes on industrial innovations should be made in our higher institutions.

ii Countries which successfully industrialize, generally being with an existing base. For some it may be oil and gas and chemicals; for others, minerals or forest products and agriculture. From essentially an agrarian country before the second world war, Japan moved to an industrialized country, Botswana used its diamond revenue to develop its industrial infrastructure, Mauritius with a mono-crop economy (sugar exportation) made transition to a manufactured good economy. For a successive technological take up of the country, revenues earned from Nigerian current base commodity - oil, must be ploughed back into the development of the industrial infrastructure, health and education systems.

(iii) Technological innovation happens with few exceptions in firms. As such companies should be at the centre of industrial innovation in the country. And there should be a strong link between government (the technology policy formulator), Universities and other higher institutions (major base of R & D resource and provider of industrial manpower requirement), and the industry (user and transformer of R & D results to innovations). Firms should build an absorptive capacity, so that the firm can effectively gain access to work done elsewhere.

(iv) Government should endeavour to build a favourable environment where innovation occurs. Educational institutions, individuals and companies should be provided with the resources, incentives and opportunities to carry out their functions as regards the technological innovation process. This can be in form of tax incentives for the companies, more grant for the institutions, behavioural attitudes which motivate individuals and companies to take new incentives and so on. It should also be noted that a stable political environment is important to technological innovation.

iv Finally, it has been the perceived wisdom of leading Western financial institutions that markets should be open, free from intervention and export oriented, some of the success story of today’s newly industrialized countries disprove this theory. Countries such as Japan, the Republic of Korea and India, to name but a few, started off with protectionist policies that
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strengthened their domestic economies. Later, they adjusted their policies to place a far higher priority on exports, and allowed controlled free economy. Nigeria should learn a lessons from these countries. In line with this, patient, right and licensing laws should be more strengthened to prevent the foreigners from stealing Nigerian inventions easily.

REFERENCES

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