2002

Acquisition of Technological Capability in Africa: A Case Study of Indigenous Building Materials Firms in Nigeria

Yomi Oruwari
Margret Jev
and
Opuene Owei

ATPS Working Paper Series No. 33

Table of Contents

Abstract

Throughout the world, developing countries are facing severe problems with regard to the supply of building materials, the core of the construction sector. As populations grow and interactions improve and as aspirations to higher living standards rise, so the demand for buildings both quantitatively and qualitatively grows even more rapidly. In the provision of shelter especially, the rising cost of building materials has made it impossible to provide affordable housing for the low-income residents.

A lot of policies and programs have been put in place to alleviate this problem ranging from direct importation to technology transfer and diffusion. What has been realized in Africa in particular and developing countries in general is that there is still the need to reduce import-dependence of the sector and at the same time contain the escalating cost of the essential building materials. Crucial to this would be the acquisition and strengthening of domestic technological capability to produce indigenous building materials, as most of the countries in sub-Saharan Africa are endowed with raw materials.

The concern in this study is the problem of the inability of the Nigerian government to supply essential building materials, the core of the construction sector. This has resulted in the rising cost of building materials, thus making it impossible to provide especially affordable housing for low-income residents. In general, the building materials sector has found it difficult to cope with the rising demand and the gap between the capacity to produce indigenous materials and the amount needed has widened further in recent times.

This study examines the role local raw materials play in the acquisition of technological capability and the factors militating against performance in the building materials industry in Nigeria. While focusing on two local building materials timber and clay, the study was assesses availability and accessibility of raw materials needed, the technological capability and technical development profile of selected firms in the industry, the nature of the acquisition of technologies in use, and the roles of such other resources as finance and skill, in technological capability accumulation in the industry. This assisted in the examination of how the technologies in use in the established building materials firms have affected the development and accumulation of technological capabilities in Nigeria.

A case study approach was used to cover indigenous building material firms in Nigeria. The four firms chosen are AT&P, Sapele; Woods (Nig) Ltd, Port Harcourt; NBRRI, Lagos; and PRODA, Enugu. The activities in these firms were used to specifically address the following questions:

1. What are the causes of current technological shortcomings of the low cost building materials industry in Nigeria?
2. What are the problems hindering the development of a framework of a general strategy for endogenous capability building in the low-cost building materials sector in Nigeria?

The methodology adopted involved a multi-stage framework starting with desk research and comprehensive interview schedules. Also focused on were government and private agencies responsible for building materials production. The results of the analyses were used to recommend policy changes that are expected to improve the acquisition of technological capabilities in the indigenous building materials firms in Nigeria.

The study highlights the role of technological capabilities and stresses that every part of FLTC and NLTC must be considered for the growth of the building materials industry in Nigeria. Thus, a holistic attitude towards all the capabilities highlighted may be panacea for the sustainable development of the building materials industry in Nigeria.

Chapter One: Introduction

General Background

Human settlement conditions in many parts of the world and particularly in the developing countries are deteriorating mainly as a result of low levels of investment in the construction sector. This is attributable to the overall resource constraints in these countries. In Africa generally, an average of five percent of central government expenditure is going into housing (UNCHS, 2001). Expenditure by international support and finance organizations is equally low. For example, only about two percent of the United Nations system's total grant financed expenditures in 2001 went to human settlements. Also, although in the early 1990s available information indicated that technical co-operation activities (that form the foundation of the enabling approaches in the human settlement sector) generated considerable public and private sector investments, the investments have been found to be no longer sustainable. Most of the investments in human settlements have failed because of one problem or another. However, the overall human settlement objective is to improve the social, economic and environmental quality of human settlements and the first step in achieving this objective is by providing adequate shelter for all, a priority that had been an insurmountable one. A key to realizing this objective is the supply of essential building materials when needed and at affordable prices.

Throughout the world, developing countries are facing severe problems with regard to the supply of building materials. The gravity of the problem is further highlighted by the fact that the supply of building materials is needed for the expansion of housing and upgrading of existing housing in urban and rural areas. It is also the key to realising national development plans in every sector, ranging from agriculture and industry to health and education.

In the provision of shelter especially, the rising cost of building materials has made it impossible to provide affordable housing for the low-income residents. This is very glaring in most countries in Africa. Thus, the building materials sector in general have found it difficult to cope with the rising demand but the gap between the capacity to produce indigenous materialsand the amount needed has widened further in recent times.

A lot of policies and programs have been put in place to alleviate this problem. These have ranged from direct importation to technology transfer and diffusion, and also the controversy of the preference of capital intensive to labour intensive technologies. Of note, the Federal Government of Nigeria in 1988, published the Industrial Policy of Nigeria with a view to improving the industrial sector. A major objective of the industrial policy is to achieve accelerated pace of industrial development. However,

this laudable objective although well articulated, yielded little fruits.

What has been realized in Africa in general and Nigeria in particular is that there is still the need to reduce import-dependence of the sector and at the same time contain the escalating cost of the essential building materials. Crucial to this would be the acquisition and strengthening of domestic technological capability to produce indigenous building materials, since Nigeria is endowed with the required raw materials needed for production.

In Nigeria since independence, the disparity between construction needs and endogenous capacity for production of basic building materials remains wide. While the demand (that has been propelled by ambitious development plans) has increased considerably, there has not been an appreciable increase in the supply of these indigenous materials for the market. This present study focuses on the role that local raw materials play in the acquisition of technological capability and the factors militating against performances in the building materials industry in Nigeria. This is achieved by using indigenous building materials' firms in Nigeria to assess availability and accessibility of raw materials needed the technological capability and technical development profile of selected firms in the industry the nature of the acquisition of technologies in use and the roles other resources e.g. finance, skills etc have played in technological capability accumulation in the industry. This information assisted in examining how the technologies in use have affected the development and accumulation of technological capabilities in Nigeria.

Technological Capability and the Building Materials Sector in Nigeria

Technological capabilities include the skills of persons in various economic sectors who have acquired technical knowledge about production process through formal training and learning by doing (Chambua, 1996). It involves the following activities:

i. The search for available alternative technologies and the selection of the most appropriate.
ii. The mastering of the technology i.e. its successful use in the transformation of inputs into outputs.
iii. The further development of the technology as a result of minor innovations.
iv. The institutionalized search for more important innovations through research and development.

Thus technological capabilities are the capabilities needed to acquire, assimilate, use, adapt, change or create technology. The building of technological capability, therefore, requires considerable indigenous effort, allocation of resources, commitment, in-house tailor-made training in that particular sector, and the creation of an environment, which has a local demand for innovation. Of note is the fact that competitiveness, efficiency and productivity, which are the keys to sustained economic development, are dependent on the possession of technological capabilities (Chambua, 1996). Westphal (1990) cited the case of South Korea, where protection was the dominant incentive in infant industries. This was by means of import controls designed to guarantee them adequate level of non-export sales. In this case, the government of South Korea created a conducive atmosphere for

patronage by granting appropriate incentives.

Since independence in 1960, Nigeria generally pursued an industrialization strategy based on import substitution. With the assistance of foreign exchange earning from petroleum in the early 1970s, government and private enterprises embarked upon ambitious and costly resource-based industrial projects. These took advantage of an array of government incentives. However, problems of the manufacturing sector have often been attributed to inadequate infrastructure, lack and poor utilization of human capacity and available manpower, and absence of a sound technological base. By early 1980s as the country's foreign exchange earnings declined significantly, the high import dependence of the manufacturing sector became a serious liability on the economy.

From 1986 to date, emphasis of the industrial development strategy has shifted towards the promotion of the use of locally available raw materials. This shift was expected to tackle the problem of falling industrial capacity utilization. This was expected to have been aided by the announcement of a set of minimum targets for the local sourcing of raw materials. To ensure compliance and reduce greater support for these targets, incentives were offered. These centered on:

(a) Fiscal measures on taxation and interest rates.
(b) Tax relief for different areas e.g. research and development.

In the case of building materials industry in Nigeria, and considering the two materials being focused on here (timber and clay), the basic raw materials, although available locally are inaccessible to the industries, because of competing uses (e.g. timber is used as fuel for cooking). However, the machines needed to make the materials contemporary fall under those that were expected to source 50 percent of their raw materials from local sources. Moreover, local artisans have always produced the finished products informally. The challenge has been the ability of the industrial firms to produce the materials in terms of quality, quantity and pricing that competitive with the informal production, which presently do not meet the market demands. It is expected that if programs based on the industrial policies were effected, the manufacturing sector would have grown considerably. However, the building materials industrial firms have failed woefully. A detailed examination of the reasons for this failure must await the results of the surveys carried out in the course of this study.

Statement of the Problem

An important goal of international development agencies for the past three decades or so has been "Shelter for all by the year 2000". Unfortunately, what has been apparent in less developed countries is that it has become increasingly difficult for nations to provide shelter for their people even as we are already in the year 2001. An important component of shelter is building materials. In most cases materials cost about 70 percent of total cost of buildings. What has been realised is that meeting the shelter requirements will depend to a great extent on the availability of basic building materials at affordable prices.

Presently, the building materials industry in Africa has had to cope not only with rising demand but that the gap between demand; and domestic capacity for production has widened. The share of Africa in world production of building materials[1] has actually declined in the past two decades. The countries of Africa are therefore facing severe problems with the supply of building materials. The gravity of the problem is better visualized when it is realised that the supply of building materials is key to realising national development.

In Nigeria, inadequate supply of building materials led to increased dependence on imported materials with the attendant pressure on prices as well as scarce foreign exchange. In addition to importing finished products, Nigeria continues to import factor inputs notably raw materials, machinery and energy. Thus, it became a recipient of obsolete technologies at exorbitant costs whose use has been discontinued in developed countries. This situation poses a lot of problems with respect to maintenance and supply of spare parts. The continued dependence on imported building materials has not only imposed additional strains on an already acute balance of payments situation in Nigeria; it has fuelled inflation in the construction sector causing cost over-runs in public projects. It also inhibits private initiatives in shelter production and makes it impossible to provide shelter for the low-income households in the country. Ironically, Nigeria (although it suffers from scarcity and import dependence), is endowed with abundant building materials, comprising largely indigenous building materials that have the lowest gross energy requirements (GERS). They are often traditional building materials e.g. timber, soil, stone, fired bricks etc. Crucial to these facts would be the strengthening of domestic technological capability to produce indigenous building materials.

The study is therefore concerned with the inaccessibility[2] of low-cost building materials in the construction sector in Nigeria and, while focusing on raw materials, looks at how the technologies in use have affected the development and accumulation of technological capabilities in the building materials sector. To bring the study under sharper focus, the following building material were considered: timber and clay. Timber and clay are the two major building materials that are not only produced locally but also form basic components for most indigenous building materials. Timber and clay also constitute a substantial part of the material component in building. Timber can be used as structural material roofing members, door and window panels and frames, and fittings e.g. built-in cupboards, flooring, roofing and shelves. On the other hand, clay can be used for walling, roofing, facing, fittings etc.

While concentrating on four existing firms in Nigeria that supply the low-cost building materials, the study specifically addressed the following questions:

1. What are the causes of current technological shortcomings of the low cost building materials industry in Nigeria?
2. What are the problems hindering the development of a framework of a general strategy for endogenous capability building in the low-cost building materials sector in Nigeria?

Objectives of the Study

The main objective of this study is to examine the development of the endogenous technological capabilities and factors affecting technological change in the production of low-cost building materials in Nigeria while using four selected firms. In light of this overall objective, the study will be concerned with the following:

i. To review the extent to which the building materials industry had access to needed raw materials and the depth of firm-level technological capability required for production, investment and innovation in the selected materials (timber and clay) in Nigeria.
ii. To describe the major mechanisms through which firms in the building materials industry acquire technological capabilities and the process of technological accu mulation by the selected firms in the industry.
iii. To highlight the effects of technological policies and programs on the building materials industry and the construction sector.
iv. To examine policy measures that will assist decision makers in Nigeria (and maybe the rest of sub-Saharan Africa) gain insights into the problems of technological capability in the building material industry and ultimately the construction sector of the economy.

To realise these objectives, the study focused on:

i. The acquisition and application of technology in the production process of building materials.
ii. The key actors and the key issues involved.

Hypotheses

The hypotheses for the study are as follows:

i. Indigenous raw materials are not accessible in the building materials industry in Nigeria. This has led to extremely low level of efficiency in the process of technological acquisition and accumulation in the building materials industry in Nigeria.

ii. Technological capabilities have been diminishing in the building materials industry in Nigeria over time, because the firms and governments have not adopted strategies positive to the changes in the construction sector.

Significance of the Study

Presently in Nigeria, there exists the problem of supplying indigenous low cost building materials at affordable prices. Studies on supply of building materials have been mostly general including those that provide broad overviews of types of material and applications as well as advantages and disadvantages of local materials. Thus, this study is expected to throw some light into the working of the building materials industry. Whereas efforts have been made to propose policies and implement programs that facilitated the setting up of building materials firms, their low levels of performance have little been analyzed in terms of their indigenous technological contents especially the inaccessibility of indigenous raw materials.

This study is more significant as we realized from our case studies that most of the building materials firms that were effective during the 1970s and 1980s are presently in the process of being wound-up or totally abandoned. This further reduces supply in the market and escalates the cost of building materials.

Chapter Two

Literature Review

Generally studies on production of building materials are more on how to encourage use of local materials (Okpala, 1985) and gearing of production towards the unskilled house owner or renter while providing materials, which require little or no skill at all for them. Also, over the past ten to twenty years, research carried out has identified new technologies and materials based entirely on local resources. However, in most developing countries and especially in Africa, little attention has been devoted to the capability of the building materials industry to undertake the work required to provide the necessary materials for both the public and the private markets (Dijkgraaf, 1986). This is significant, as 40 percent to 50 percent of the input in the industry between 1984 and 1985 comprised imports whereas, for the same period in western European countries, this was less than 10 percent (UNIDO, 1985). More recent estimates put the value of gross output accounted for in imports at up to 30 percent and comprising up to 60 percent of all materials used in Africa (Nordberg, 2001). The increasing dependence on foreign inputs increases the strain on scarce financial resources for the African countries.

In developing countries, technology development in the building materials industry is characterized by four different categories of production (UNCHS, 1991):

i. Large-scale production: Uses advanced technology. They have mechanized and automated plants, which implies that the manufacture is capital intensive and heavily dependent on foreign capital, imported raw materials and factors of production.
ii. Small- scale production and medium-scale production: These consist of 10 to 100 persons, sometimes with automated and partly mechanised technology. Production is usually labour intensive, does not require large capital investments, and is successfully operated by indigenous entrepreneurs employing local manpower exclusively. Most of the materials and equipments are of local origin.
iii. Micro-scale production or artisanal production: Involves few employees, usually family members, applying traditional skills. Capital requirements are minimal and all materials entering into the production process are local in origin. They collectively produce a significant share of the country's total output.
iv. Do-it-yourself activities: Such activities involve the production of construction elements and the use of clay, stone, simple processed wood etc.

The large-scale enterprises are set up through bilateral aid programs and operating under state enterprises. However, these imported large-scale technologies have failed to act as the engine of growth in spearheading the technological development of the building materials industry in Africa. There has not been conscious effort to integrate both the large scale and small-scale units vertically, a situation that is difficult because both are conceived in different socio-economic cultural environments. Thus, there are no opportunities for upstream industrial enterprises to assist downstream small-scale enterprises in the technological improvement of their production facilities. That is why the vast majority of enterprises operating in the small-scale sector and particularly those functioning in the micro-scale sector (i.e. the informal sector) continue to rely on traditional technologies. These are often rudimentary, resulting in poor productivity, quality and consequently poor profitability of wide scale adoption of such materials in construction.

In developing countries, it has been established that the building materials sector is more cost-effective with small-scale technologies than with large-scale technologies (UNCHS, 1998). In more economically developed countries large-scale technologies should lead to a reduction per unit cost of output. In most developing countries, however, production factors are unfavourable to large-scale production technologies. And, with their minimal demands on the transport infrastructure, small-scale technologies have been acclaimed as the key to promoting low-cost building materials in developing countries.

Advantages of small-scale production building materials include low demand for conventional sources of energy, that are scarce and expensive and a low level of dependence on imported machinery and equipment (UNCHS, 1984). Small-scale production units are frequently taken to mean plants with less than a specified number of employees. The number of employees alone, however, is not sufficient as a criterion since it could, for instance, lead to the inclusion of diverse operations. Other indications, for example the volume of output and the size of investments in terms of capital or equipment, should therefore also be considered as a criterion in a division of activities according to scale. It is not the size that differentiates the levels of production units, but rather the nature of the resources required and the capacity to obtain them.

The lack of innovation in the indigenous supply of technologies in the building materials industry has been attributed to many factors (UNCHS, 1991). Since the bulk of the industry operates through small-scale sector, they have little capability in terms of raw materials, capital or skill to invest in innovation. The large-scale industrial firms, in contrast, continue to operate with imported technologies and have little motivation to innovate. Because of the packaged nature of imported technologies, the use of innovation in adapting imported technologies has also met with little success. There is also the general lack of orientations of building research institutions to devote their limited resources to the development of technologies responding to the specific needs of the basic building materials industry operating in the small-scale sector.

In the area of strategies, of note are import reproductions and technology transfer. UNCHS (Habitat), while studying small-scale building materials production in the context of the informal economy in

developing countries in 1988, noted that the policy if import substitution as a development strategy was extended to the building materials sector in developing countries. Thus, they followed the process of import reproduction i.e. establishing local firms to produce materials identical to those previously imported. Even where there are suitable local resources; they are not always developed. It also involves importation of machinery and equipment which are capital intensive, requires a lot of energy that is scarce, prohibitive in cost and are hardly ever available, spare parts, technology for operation and servicing. These have resulted in the tendency of the production plants to operate at considerable less than optimal capacity which ultimately limit the prospects of market expansion.

Most African countries take technological transfer for granted because of the colonial mentality and, as a result, very little indigenous technological capabilities were developed within the building material firms. This led to the failure of the building materials industry to stimulate indigenous innovations that can replace or upgrade traditional technology in the industry. Criticizing technology transfer, many researchers have called for intermediate technology and ultimately appropriate technology. Ken Darrow observes that intermediate technology is:

> Technology that is especially attractive because it seems to solve a number of problems at once. Because it involves self-reliance and local production for local needs, on a national level, this approach can remove from the list of obstacles to development many of the inequalities of an international systems that is dominated by the expensive technology and economic power of the rich countries. At the same time, the lack of well-developed infrastructures and the shortage of highly trained manpower to run large industrial operations become much less important when people are allowed and encouraged to develop themselves wherever they are. A whole array of problems can potentially be solved at once.

If we agree that appropriate technology is important in the development of technological capabilities in Africa, then there is a need to address the gap between technologies developed in construction of buildings and their application. There is also the need to address the problem of access to building materials, technologies and construction delivery systems for affordable housing.

For example, these problems were addressed by the Building Center Movement (BCM) in India (UNCHS, 1996). BCM emerged in 1986 as a grassroots level intervention organization for cost-effective housing. Its objective was to provide institutional intervention for putting into practice at the grassroots level, the new research and development of appropriate technology. This was through transfer of technology, training of artisans, production of elements, construction and guidance. Presently, BCM has 385 building centers in India. The main aim of the movement is to 'enable' and 'empower' people by evolving appropriate housing delivery system with people's participation. The movement utilizes environment-friendly solutions and development of the right level of skills among artisans. The tools and instrumentation used to achieve this aim include:

i. Training and skill upgrading of construction artisans in terms of alternatives, innovative and sustainable building components at the grassroots level.
ii. Utilizing the services of trained artisans along with beneficiary families in the housing construction program.
iii. Construction of affordable shelter with innovative construction techniques.

iv. Providing housing guidance, information and counselling to local people.

This movement has had the following impact:

i. Creating awareness about the available alternative options.
ii. Creating an appreciation of these options not only in terms of cost effectiveness but also in terms of structural, functional and aesthetic sufficiency.
iii. Change in negative perception — low quality non-durable, ugly and only for the low-income families for the first time.
iv. Use of these applications for community buildings like schools, health centers, village offices and community centers.
v. Led to solutions with 15 percent to 40 percent savings over the conventional costs.
vi. Helped in house construction programs with people's participation through upgrading of skill levels of the local construction workers.
vii. Given access to building materials, technologies and construction delivery systems at grassroots level with affordable and cost effective options.

In industrial set-ups in Nigeria, there appears to be a clear choice between large-scale and capital-intensive technology and small-scale and labour-intensive technology. The latter may require less than 40% of the investment of the large-scale technique and provide over six times the total employment. The small-scale technology clearly has more appropriate characteristics for most third world countries, but its technical and economic efficiency had been questioned, mainly because of lower recovery rates (Kaplisky, 1984).

Many developing countries are trying to have and maintain sustainable economic growth. To achieve this, the construction sector has a major role to play as it accounts for a large share of total capital formation that is second only to agriculture as a source of employment. Building materials and construction industries are the basic means for the construction, expansion, improvement and maintenance of all human settlements (Nordberg, 2001). Construction industry is fundamental to achieving sustainable economic growth as it is involved in every human activity. However, the construction industry is not fulfilling its potential role in development in African countries as many of the countries, including Nigeria, are experiencing difficulties in executing their construction projects. This is due to a number of factors. These include difficulties in obtaining materials and other crucial inputs, and in most cases the development projects are too large for the construction industries to meet the demands of inappropriate technology and design. Also, in most of these countries, regulatory frameworks and government policies do not encourage the development of the construction sector (Baker, 2001). Technology import policies by the government and subsidies on certain construction materials inhibit the growth of appropriate technological capabilities in the building construction industry.

In the specific case of Nigeria, it is necessary, therefore, to investigate the technical, economic and social efficiency of the alternative technologies, as small-scale technologies seem to be the only ones feasible presently. Considerable emphasis must be placed on identifying the profitability of the

technologies from the point of view of the private entrepreneur. This is a critical exercise, since appropriate technologies (ATs) will only be widely introduced if they are more profitable from the point of view of the private decision-maker, irrespective of their wider economic and social implications. The economic and social implications, however, should be important in determining government policies towards technology choice. However desirable a technology is, and for whatever reason (for example, creating employment), government should only promote such technologies where the net benefits are greater than those of alternative technologies (taking into account all economic and social effects).

The determinants of private profitability are complex. Private profitability is the outcome of a myriad of government interventions, some explicitly designed to promote certain choices, others with different objectives but with important implications, nonetheless, for choice of technique. For example, each of the policies towards price (processed and raw), towards imports, towards depreciation allowances, credit and interest rates affect profitability of alternative technologies in important ways. Actual choice is then highly dependent on these government interventions, which may promote or hinder appropriate choice. In some cases, it appears that the various interventions are so many and so complex that only detailed investigation will reveal the net effects. It is highly likely that the government itself does not know what these interventions are. A major requirement for promoting AT is that the implications of government policies towards choice of technique be systematically investigated so that a policy package may be designed which does not, deliberately or by mistake, hinder AT.

In examining relevant government interventions, it is necessary to underline the importance of political economy to choice of technique. Policies that led to particular choices are formed as a result of pressures from interest groups, for example, from timber magnates, machinery importers and manufacturers. Policies which conflict with dominating interests will not be introduced however appropriate the resulting choices may be.

What is known is that endogenous technological capability can be achieved either by the stimulation of indigenous supplies of technology or by producing foreign inputs or by a combination of both (UNCHS, 1991). In this context, however, it is important to make a distinction between technology imports and endogenous technological capability building. Past experiences showed that importation of production technology especially when transferred under turnkey arrangements that are most likely in packaged forms did not lead to autonomous capability building. On the other hand, when intermediate approaches involving both import and local supply of technology were applied[4], better results were achieved initially, but later they still ran into problems.

What have been lacking from the literature are studies of existing small-scale building materials firms in Africa that showed the situation on the ground. Why is it that the firms did not grow or at least be able to meet the demands of their environment even when raw materials are available locally? What are the problems encountered that made it impossible for them to develop and improve their technological capabilities that will consequently make them sustainable? This is the area that this study wants to make its humble contribution.

Chapter Three

Conceptual Framework

In a broad sense, technological capacity or capability in the building materials industry has been defined in two ways. First, it is essentially the capacity to exploit technology as a means of improving one or more of the production characteristics and at the same time producing new and innovative materials. Second, it is concerned with the substitution of one or more traditional factor inputs in existing processes by new ones (UNCHS, 1991). The point of focus is how the government should intervene through public policy so as to optimize the growth of these capabilities.

This is essential because national technological capabilities are crucial to increasing a country's economic independence over its natural, human and environmental resources. What has been shown from experiences in the newly developing countries is their inability to control their developmental processes. Although there are several approaches to the analysis of technological capabilities in developing countries, four of them have been reviewed. These are approaches by Sanjaya Lall (1992), Bell and Pavitt (1993), Weiss Jr. (1993) and Ernst, Mytelka and Ganiatsos (1994). Simply, Lall (1992) distinguished two forms of technological capability i.e. firm level technological capabilities (FLTC) and national level technological capabilities (NLTC). The framework of Bell and Pavitt (1993) describes the process of international technology transfer and technological accumulation in developing countries. Charles Weiss Jr. (1993) framework of two main stages consists of development of human and institutional resources and the eventual development of a modern integrated system that can compete effectively across a broad range of world markets. Ernst, Mytelka and Ganiatsos (1994) in their approach categorize capability in terms of production, investment, minor change, strategic marketing, linkage and major change[5].

5. See Adeboye, T. O., Bagachawa, M.S.D., and O.A. Bamiro (1995) and Adeboye, Titus and Norman Clark (1995).

Adeboye *et al* (1995), in reviewing the four approaches, concluded that they reveal the complexities of the concept of technological capability and that they also show the absence of uniformity both in specifying its components and in describing the process of acquisition. Also, it will be difficult to end up with a framework containing all of the elements of all the approaches. The framework to be adopted here, however, is that the technological capability needed for the production of indigenous building materials in Nigeria is made up of FLTC and NLTC (using Lall's categorization). It is also concerned with how these capabilities are acquired (by focusing on raw materials), used and can be improved on over time. Ernst *et al* (1994) also presented the first category as those required at the early stages of industrialization, which is what happens in Nigeria, while the second category of capabilities is what is required by firms in the later stages of industrialization, when the need to retain competitiveness becomes critical. On the other hand, FLTC interact and are complemented by NLTC (these are based on the institutional context within which FLTC take place). Thus, the components of the capabilities that will be investigated include the following:

I. FLTC
a) Production capabilities
b) Investment capabilities
c) Minor change capabilities

II. NLTC
a) Physical and social infrastructure
b) Human capital
c) Science, engineering and technology
d) Institutional infrastructure
e) Financial infrastructure

Firm Level Technological Capabilities (FLTC)

The firms require these capabilities at the early stages of industrialization. They are compulsory and necessary for the long run existence of any manufacturing activity.

- Production capability: this relates to the knowledge and skills used in plant operation. Activities included within this category are production management, production engineering, repair and maintenance of physical capital.
- Investment capability: This refers to the knowledge and skills utilized in the identification, preparation, design, procurement, installing and commissioning of new industrial projects or the expansion and modernization of existing ones.
- Minor change capability: It is the firm's ability to improve and adapt continuously its products and processes in response to input and output markets.

National Level Technological Capabilities (NLTC)

To put the firms in the national context, NLTC are required. They are necessary for the existence of the firm in relation to the national economy.

- Physical and social infrastructure: T hese are the essential infrastructures that are generated by the nation. They include access roads, telephones, electricity and water supplies.
- Human capital: It includes the level of education of the workers and how their relevant education is improved over time.
- Science, engineering and technology: It is concerned with research and development expenditure in relation to GDP, to total scientists, the number of relevant research institutions, the number of research and development personnel as a percentage of work force.
- Institutional Infrastructure: It is concerned with the ability of industrial and training institutions to promote linkages, service support etc.
- Financial infrastructure: It concerns the number of financial institutions, depth of the financial market and availability of different classes of credit to promote technological development.

It is assumed that firms and governments have active roles to play in the future developments of these capabilities. Also, improvement in the building materials industry is dependent on improvement in the technological capability in the industry.

Chapter Four

Research Method

The research method used consisted of integrated research methodology, which involved a combination of systematic observations and comprehensive interview schedules. The interview schedules and observations were in the southern part of Nigeria where most of the operators of the micro scale enterprises and research institutes involved in timber and clay products are located.

The Study Area

Nigeria has three distinct vegetation regions: Rainforest in the southern part, guinea savannah in the middle and Sahel savannah in the northern part. The natural forest resources of Nigeria occupy about two thirds of the entire country and hold more than 500 indigenous hardwood species. During the colonial era, the country was noted for its exploitation of timber. At the same time, clay deposits are available in almost all states in Nigeria. The study locations are Sapele, Port Harcourt, Lagos and Enugu. Two timber processing companies were studied and interviews carried out at Sapele and Port Harcourt, while two clay producing set-ups were studied at Enugu and Lagos.

Data Description and Sources

The primary focus in the study areas consisted of timber and clay products, workers, the technology in use, the output and managerial capabilities in the industries chosen. The interview generally centered on timber and clay products that have been developed and produced, the problems encountered with the procurement of raw materials, production processes and technical problems over the years, government policy changes over the years that have affected the accessibility, affordability and sustainability of their products. The field study conducted during the months of October 1999 and April 2000, yielded the data for the empirical analysis of existing factors affecting production of timber and clay products, acquisition of technological capabilities and factors hindering the performance in the building materials industry in Nigeria. Information sources consisted of both primary and secondary data. Primary data consisted of:

1) In-depth interviews through questionnaires to:
   - Responsible officers of the selected firms: (Woods (Nig.) Ltd Port Harcourt[6]; AT and P (Ltd), Sapele; PRODA, Enugu: ETERNIT, Enugu; NBRRI, Lagos).
   - Interview of selected workers in these organizations.
2) Interview of micro-scale enterprises supplying local needs.

3) Interview of responsible officers at research institutes (NBRRI and FIIRO, Lagos).
4) Interview of building professionals (NIA and NIQS).
5) Interview of artisans working with these products.
6) Interview of responsible officers at the Raw Materials Research and Developing Council (RMRDC).

Secondary data sources included academic journals and a variety of books well referenced in the text. The sources and description of data are as summarized in *Table 1.*

Sample Selection

At the conception of the study, two timber companies located at Sapele (AT&P) and Calabar (Serom Woods) were selected for the study. However, at the commencement of the study, the research team was shocked on getting to Calabar to find out that the factory had closed down and the site completely deserted with millions of investments abandoned. In the case of Sapele, production had stopped and only a skeletal staff was left on the site, but the environment was well maintained. We were informed that UAC (Nig Ltd) had put the factory up for sale. We were able to carry out the survey there and the members of staff interviewed were eager to give useful information as they saw so many years of service going down the drain. In place of Serom Woods, another timber company woods (Nig) Ltd in Port Harcourt was studied.

In the case of clay products, Enugu (PRODA) and Lagos (NBRRI) were studied. At PRODA, the responsible officer was very co-operative, interacted with the research team but diplomatically refused to respond to the questionnaire directed at the company.

After repeated futile efforts, the research team decided to carry out the survey at Emenite (Nig) Ltd that supplies asbestos-cement products. This was with the aim of comparing activities at the company (that has a very prominent foreign presence) with managed completely by Nigerians. At NBRRI, Lagos, we were given all the support needed.

In all the companies, in-depth interviews of 20 workers selected randomly from all cadres were carried out. Also carried out were in-depth interviews of 20 micro-scale enterprises supplying building materials locally. Twenty artisans using timber and clay in building locally were also interviewed.

Table 1: Sources and Description of Data

Description and data required	Sources and means of collection
(A) • Development of timber and clay production. • Problems of procurement of raw materials. • Production process. • Technical problems and solutions over the years. • Effects of government policies and their relationship with the professionals.	In depth interview by the research team of individual firms through questionnaire, discussions and observations
(B) • Information on workers selected randomly from the selected firms. • Information on exsting micro-scale team. enterprises supplying local needs. • Information on artisans using the materials. • Socio-economic information on educational circumstances and training, work history, advancement and satisfaction on the job of selected artisans.	Structured questionnaire, interview of the owners of the enterprises by the research Interview of the workers selected randomly and interviewed separately to ensure privacy and truthfulness.
(C) • Information on the research institutes to investigate indigenous building materials accessibility development and production for the market.	Research institutes were visited by the research team and questionnaires administered.
(D) • Information on building professionals. • Information on policy makers and implementers of programs.	Questionnaires were administered to NIA and NIQS officials. Comprehensive interview schedule by the researchers to RMRDC officials.

Source: Compiled by the authors, 2000.

Data Analysis

Data analysis utilized various methods of summarization. As most of the establishments were reluctant in giving quantitative information, a lot of importance was given to qualitative data. Simple statistical methods (means, percentages etc.) were utilized where necessary to analyse the quantitative aspect of data and at the same time test the hypotheses. Also used in testing of the hypotheses, were capacity utilization and the profile of the efficiency of the technology. The interest here is in the rate of growth of the resources over time.

Thus:

1. Efficiency == $\frac{\text{Amount Produced}}{\text{Total expected to be produced [Efficient production is put at 50\% of plant capacity]}}$

2. Capacity Utilization == $\frac{\text{Output}}{\text{Amount of Output that can actually be produced}}$

3. Mean Capacity Utilization == $\frac{\text{Total Capacity Utilization}}{\text{No. of Years Considered}}$

4. Mean Efficiency == $\frac{\text{Total Efficiency}}{\text{No. of Years Considered}}$

Inferences from the simple statistical tables of firms' circumstances and inferences from especially qualitative data were also utilized.

Dissemination Workshop

A workshop was conducted where relevant policy makers, researchers, building professionals, builders, artisans and manufacturers of building materials were invited to discuss the findings and their implications for policy.

Chapter Five

Research Results

State of Technological Capabilities

The technological capabilities in the selected firms were investigated using the two categories identified in the literature i.e. FLTC and NLTC.

i) The Firm Level Technological Capabilities (FLTC)

These sets of capabilities including production, investment and minor change capabilities were found to be at the rudimentary stages in the firms studied. Focused on are the raw materials (timber and clay), machines, production capabilities and financial infrastructure.

Raw Materials

The raw materials are shown to be a very important factor in the production process. They face a lot of problems in all the industries studied. The two raw materials focused on in this study (i.e. timber and clay) are reported on.

Timber

The natural forest resources of Nigeria occupy about two-thirds of the entire country and hold more than 500 indigenous hardwood species. During the colonial era, the country was noted for its exportation of timber.

Timber is a plant material of great biomass. Besides being used as fuel and medicine, it is also an important structural material. It is the oldest of all building materials and continues to stand pre-eminent in many fields of the building industry. It is easy to work and does not require sophisticated tools or expensive equipment at the building site. It is a low-cost building material with diverse usage in buildings especially in housing. Uses include chipboards, fibreboard, plywood, frames, planks, posts, beams, trusses etc.

The greatest drawback of timber is not only that it is prone to termite damage and fire hazards, it also absorbs moisture, swells, causes problems in facades, joints and boards and degenerates rapidly.

However, efforts can be made to prevent these problems by producing environmental resource efficient and moisture resistant timber and recognizing all these problems during the design of buildings and neighbourhoods. In African Timber and Plywood (AT&P) Company, timber is not only the major raw material; it is sourced 100 percent locally from Edo and Ondo States. Other raw materials like resins, glues gums etc. that form about 10 percent of the raw materials needed, are imported. Because of illegal felling and poaching of immature trees by some unpatriotic private saw-millers a lot of wastage occurs.

Woods (Nig) Ltd, Port Harcourt, sources its timber from Akwa Ibom and Cross Rivers States. These are then transported to Port Harcourt. The company purchases from timber in the local market. About 5% of its raw materials are imported. Presently, it is not involved in any replenishing program for the forest and one expects that with time, it may become difficult to access timber as the forests are rapidly being depleted due to over harvesting of existing natural wood from the rain forests of Akwa Ibom and Cross Rivers States.

Clay

Clay deposits abound in the country and its use in building includes making of bricks, walling or partition blocks, roofing tiles, wall tiles and such diverse products as drainpipes and sanitary fittings.

The manufacture of clay bricks is energy-intensive and the fairly common classification is: *by use* common bricks, facing bricks and engineering bricks; *by quality* internal, ordinary and special; *by finish* sand-faced, rustic and multi-colored; *by manufacture* hand made and machine made; *by perforation* solid, perforated, hollow and cellular. Clay bricks are usually extremely durable. Although they may change in appearance after considerable exposure, they usually do so in a manner that is pleasant. They are incombustible and provide good fire resistance. In terms of exposure, the position of the bricks in the structure is important and this determines the treatment needed. The overall appearance is determined by the pattern of jointing. The cost is determined by the cost of the bricks, the cost of laying and transportation costs.

At the two organizations studied i.e. PRODA (Project Development Institute) and NBRRI (Nigerian Building and Road Research Institute), we were informed that (although it is only in two states in northern Nigeria where clay deposits are not suitable as building materials), it is difficult to collect enough clay to sustain the building industry in the country. Apart from this, there is the problem of transportation from its to industrial firms that escalates the cost of the clay. There is also the problem of acquiring the land for quarrying of clay, as those already quarried have constituted an eyesore, environmentally degraded open pits, and serious erosion. This has led to formation of gullies, landslides and eventually slumping of the neighboring region.

Of importance also to non-availability of clay for the industrial firms is competition from subsistence local users of clay for pot making, adobe walling etc. There is also cultural attachment to clay usage (forbids removal of clay from the particular region), competitive usage of clay (in form of laterite) as

filling in building and road construction. All of these increase the price of clay generally. Also, clay is not used extensively as it has a poverty image throughout the world. However, as a building material, it is ecologically sound (recycles itself), does not spend limited natural resources and is labor intensive, thus providing employment.

Machines

A major problem in respect of the machinery was that there was no well worked out plan about the maintenance, replacement or making it contemporary in accordance with changing trends of such firms in the country. Thus, in no time they lost their leading role as major supplier of the materials they produce and with time they could not cope with the stress of the market.

AT&P

AT&P imported its first mill comprising of machines, spare parts and technical support from Britain in 1935. In 1951, these were modernized. Also, in 1981, modernization took place again and the technology used although imported was intermediate to suit the Nigerian market. Since 1981, there had not been any major overhauling of the mill. With the economic trend of the late 1980s and 1990s and the structural adjustment programs, the investment needed for improvement and maintenance was no longer available as all the machines used were imported. No room had been made over the years to develop local improvisation and sourcing of spare parts. This was also the period of exorbitant pricing of imported items in the country. Thus, there was scarcity of essential spare parts and due to the track records of the company minor change capabilities were not possible. All of these factors constitute a major factor in the ensuing collapse of the firm.

Woods (Nig.) Ltd.

In 1993, production started with imported intermediate technology. The machines were imported from Britain but the manpower is 100% local. The cost of the machine including Cander (that is the most expensive single item) was about 25 million naira ($500,000). In terms of manpower, training was on the job with the assistance of information manuals supplied by the manufacturers and other references. The machines are simple to maintain and spare parts are sourced locally and amenable to improvisation. Minor changes are carried out as the firm grows.

This is a young and upcoming building materials industrial firm in Nigeria that has been able to carry out minor changes and maintenance of the imported machines to suit its requirements especially with the rising cost of foreign exchange needed to purchase imported spare parts. On the other hand, presently, maintenance is carried out when necessary. No program is put in place in respect of manpower training, major maintenance (like overhauling and turn-around), replacement and modernization when the life-span of the present machines is exhausted i.e. all the ingredients that ensure sustainability of the existing enterprise.

PRODA

PRODA started in 1968 with a local kiln that produced fired bricks (15x7x15mm^3). Since then, the kiln has not been modernized and presently, the capacity of the kiln is about 500 bricks per day. Builders are not patronizing these bricks as they have not been made contemporary and in the long run they are more expensive to use than sandcrete blocks.

NBRRI

In 1980, the institute started production of clay blocks stabilized with cement (50x25x20mm^3). The blocks are bigger than bricks and easier to lay by craftsmen as they are about the same size as the common sandcrete blocks that they are used to. To demonstrate their viability, the blocks were used to construct NBRRI's office buildings.

The machine for making the blocks was designed and manufactured at NBRRI with 100 percent local raw materials. Artisans were trained on how to use them. However, it has been difficult to popularise the blocks as the price of the machine is exorbitant (and regularly increased), compared to the mould for sandcrete blocks. Also, as the labor is specialized, initially it is more expensive than that for sandcrete blocks, although in the long run, it is cheaper. As the finished product is fair-faced, people are sceptical about having walls that are not rendered.

Production Capabilities

In the case of production capabilities, the knowledge and skills used by the firms in plant operation were focused on. Thus considered were production management, the engineering of production and the repair and maintenance culture of the physical capital in the firms. Efforts were made to study how these capabilities have improved with time.

AT&P

The range of products by the company is shown in *Table 2.* Shown in *Table 3* is the level of capacity utilization and efficiency of the plants over a 12 year period. The mean capacity utilization for the period was 7.1 percent and the mean efficiency of production was 14 percent.

Since 1990, capacity utilization had been less than the mean and from 1995 it had been 2 percent. Efficiency had been less than the mean since 1990 and had dwindled to 3 percent from 1997. After renovation in 1981, capacity utilization increased to 35 percent and efficiency became 70 percent (as expected output was supposed to be 50 percent of the plant capacity). However, output was still far short of what was expected to give a healthy profit. Due to the fact that maintenance of the machines was not being carried out regularly, output was declining. This led to the eventual closing of the mills.

Table 2: Range of Products by AT&P

S/No	Products	Percentage of Total Production
1.	Plywood	25
2.	Particle boards	25
3.	Flush doors	10
4.	Machine products	35
5.	Others	5
	Total	100

Source: Fieldwork, 2000.

Of note is the fact that the mill that was modernized in 1981 was the 1951 one (that was too old and most of the spare parts were no longer in production even in Britain as they are using more sophisticated machines). This posed a lot of problems for improvement of skills and knowledge used in plant operations. Also, there was the problem of inability to improvise required parts with locally produced ones.

Table 3: Capacity Production (in tonnes) at AT&P

	1980	1981	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
PC	100000	125000	125000	125000	125000	125000	125000	125000	125000	125000	125000	125000
AP	10000	43750	13500	8000	7000	5000	3000	4200	3000	2500	2100	1950
CU%	10	35	11	6	6	4	2	3	2	2	2	2
E%	20	70	22	13	11	8	5	7	5	4	3	3

(PC - Plant Capacity; AP - Actual Production; CU- Capacity Utilization; E - Efficiency)

Source: Fieldwork, 2000.

Woods (Nig) Ltd.

The range of products by the company is shown in *Table 4*. Shown in Table 5 is the level of capacity utilization and efficiency of the plant over a four-year period. The mean capacity utilization was 16.2 percent and the mean efficiency was 33 percent. These figures are lower than those for 1998 and 1999.

Table 4: Range of Products by Woods (Nig) Ltd

	Products	Percentage of Total Production
1.	Panel doors	50
2.	Wooden fixtures	20
3.	Others	30
	Total	100

Source: Fieldwork, 2000

At the start of production in 1994, capacity utilization was only 5 percent. This was because of lack of technical know-how of goods to be produced. In 1996, capacity utilization rose to 10 percent, while doubling the 1994 production. This continued on the increase to 30 percent in 1999 due to acquisition of better technical know-how*(Table 5).* However, if efforts are not made to have appropriate repair and maintenance process, improved knowledge and skills used in plant operations among others, it is expected that with time, production will decline as happened to the older firms studied.

Table 5: Capacity Production (in Tonnes) at Woods (Nig) Ltd

	1994	1996	1998	1999
Plant Capacity	80,000	80,000	80,000	80,000
Actual Production	3,800	8,300	16,100	23,700
Capacity Utilization (%)	4.8	10	20	30
Efficiency (%)	10	21	40	59

Source: Fieldwork, 2000.

PRODA

The company produces a lot of items, but our major concern for this study is with clay products as a building material. In this case, it is brick that is used either as walling material or as facing bricks. The efficiency has always been low (about 3 percent) since the firm was not able to upgrade its kiln from its rudimentary state since the late 1970s.

NBRRI

In this case, it was expected that since the machine is 100% locally produced and the raw materials are sourced locally, the clay blocks should have been well received and adapted. This has never been the case. A lot of practitioners do not know about it and those that do find it difficult to replicate. Other problems include inability to reduce initial cost of machine inaccessibility to raw material (clay may not be available at the building site) and non-availability of trained masons.

Financial Infrastructure

Generally, Nigerians are very suspicious of investigations in respect of the financial state of their establishments. Thus, we were unable to gather adequate information of this aspect of the work directly. However, the following aspects were observed.

In respect of financial infrastructure, it is not easy to access funds from the commercial banks. They are interested in short-term loans at relatively high interests rather than industrial developments that need long-term loans at low interests to allow for profits and development of technological capabilities.

Foreign exchange is generally needed for machines and spare parts. As resources are highly limited, the choice of technology is affected. Most times, since foreign input is substantial, the overseas partners dictate the type of machines. to be supplied. The foreign exchange needed is purchased through commercial banks from the central bank. This is through the daily bidding. The amount sold is highly controlled by the Federal Government. This causes delays in remitting money. The gravity of this problem is better appreciated when the issues of high inflationary rate and under pricing of the naira in the foreign exchange market are considered.

Incentives in the form of preferential access to foreign exchange, protection, grants and tax relief are generally on short-term basis and are often removed abruptly at the whims and caprices of policy makers. The complaint is that most Nigerian investors are insincere and quickly abuse incentives when given. However, this cannot be an excuse for not making finance accessible. What we need are effective monitoring and evaluation systems that must be put in place on a long run basis.

ii) The National Level Technological Capabilities (NLTC)

These sets of capabilities including physical and social infrastructure human capital science engineering and technological efforts financial infrastructure and intermediate input supply base were at a very low level or absent in the firms studied.

Physical and Social Infrastructure

Observations were made of the available infrastructure in the establishments and the level of their interaction with the immediate environment.

AT&P

The factory, administration unit and the supporting infrastructure are housed within a landmass of about 150 hectares. The establishment generates its own electricity and water. Workers are employed directly and indirectly through its distribution and transportation networks. The company also provides means of livelihood for a large proportion of Sapele Local Government Area and its neighbors. Most of its suppliers and distributors are from the immediate environment. The AT&P Technical Training

School also trains technicians from the environment, who then set up small-scale shops. This facility has made the area, especially Benin and Warri regions, noted for the production of sophisticated and good quality wood furniture and craft in the country.

The company built a neighborhood road to connect its factory to the town of Sapele and also to allow easy delivery of its raw materials and evacuation of its finished products. A staff club is provided for use of staff members and guests.

Woods (Nig) Ltd

The factory is located on one hectare of land in a high-density area of Port Harcourt. At the time of the study, the company was hooked to a neighbourhood transformer for its electricity supply. This transformer was not functioning and therefore the company had to use a private generator. This is very expensive, thus limiting its daily use. Workers are employed from Port Harcourt through interviews conducted regularly. There are no facilities for staff training. When it needs labor of a particular skill, advertisements are placed in the local newspaper and interviews conducted to select the best available candidate.

PRODA

The factory is located on 10 hectares of land on the outskirts of Enugu while the administrative section is housed in the city of Enugu some six kilometres from the factory. Of note is the fact that there is no easy communication between the two sections of the establishment and communication is person to person. The factory has no relationship with the town and residents are not aware of its existence and products. The staff strength has not grown for about 15 years. The environment looks dilapidated and unkempt, and not much activity is going on. Access to the main connector road is through circuitous route that is not maintained.

NBRRI

Physical infrastructure of about 20 hectares of land exists. The premise is easily identified from the Idiroko Express Way, although it is located out of town and it is not easily accessible from Lagos. It relocated to this site about five years ago from a more accessible site in the heart of Lagos that became congested over time. Some of the buildings are still under construction. However, those already completed are unique as they are built with their product of stabilized earth with fair-faced finish.

The establishment has no relationship with the locality, as it is too far from the closest village. Most residents of the nearest Satellite Town of Otta are not aware of its existence. Even its products are not available in the local building material markets at Otta.

Human Capital

The depth of skills and knowledge of human resources constitutes a very important aspect in the process of acquisition of technological capabilities. It is also important in the development of indigenous capabilities. It is only at AT&P that there were well worked-out training programs especially by the parent body UAC (Nig) Ltd. The effect was apparent in the performance of the firm. However, the training was not sustained. In all the firms, what is apparent is that staff members perform better when there are programs put in place for both formal and on the job regular training. Immediately this ceases, performance dwindles and it becomes a major factor in the eventual collapse of the industry.

AT&P

By 1991, there was a general manager, six heads of departments and about 2000 workers working for the company. The six departments are forest, production, engineering, commercial, personnel and marketing.

In respect of training, various programs were organized by UAC. (Lagos). Also, some training programs and conferences were organized in-house when needed. For example, the Annual Management Conference took place from 1991 to 1993 with the proceedings well reported in the quarterly journal of the company i.e. *Timber News*, that was regular when started but with time production became irregular and finally stopped when the firm went into depression.

For a company that has been in existence for such a long time, the welfare package has been very poor. Housing allowance is very small compared to other firms in the country. In the case of health, there is an industrial clinic that deals with emergency cases, management staff and their families while the junior staff members are given a health allowance that is paltry. In case of serious industrial accidents, the company pays for referrals to specialist hospitals. Because of this occupational hazard, the staff members are compensated with up to 80% of their monthly salaries and given lighter jobs. Up to the time of the interview, negotiations are still going on about compensation for affected staff members who have lost limbs from industrial accidents and since the company is distressed, they do not have nothing to do. Transport allowance is given to the staff. There is a gratuity and pension scheme in force but the pension, though regularly paid, is not adjusted in relation to inflation and thus, over time, the amount has become insignificant and ridiculous. There are good safety gadgets provided and replacements are imported regularly. The management-staff relationship was very cordial until 1993. After this period, it became poor. This led to a strained relationship even when the incumbent managing director was removed. Since then there had been a lot of mistrust between the management and the junior staff.

Woods (Nig) Ltd.

From 1994 to September 2000, there has been no expatriate labor at both managerial and technical levels. There has also been no supervisor specifically for the production unit. Supervision had always been carried out by the Managing Director (who got his knowledge from reading brochures etc.). Between 1994 and 1997 there were three staff members at managerial level. This increased in1998 by one and has been constant to date. *Table 6* portrays staff changes from 1994 to date.

The firm finds it difficult to recruit skilled labor in the woodcraft industry. The unskilled labor employed has to be trained in-house as craftsmen. There have been 25 such craftsmen trained so far by the company since its inception. Having trained them, in the past five years, four technicians and 20 craftsmen have left the firm. This is despite the incentives of periodic salary increment and cash rewards.

Welfare package is fair in relation to general welfare systems in the country. Members of staff live in company houses. The company has a staff clinic for members of staff and their immediate family. A handsome allowance is given for transport. There is a pension and gratuity scheme in force and the management-staff relationship is cordial. However, there is no safety scheme in place, thus exposing the staff to industrial accidents.

PRODA

To date, the staff strength consists of a supervisor that oversees the whole set-up, five foremen and thirty-five craftsmen. They have been working with the company from 15 years and above. The company sparingly organized training programs with the result that majority of staff members are in the low and intermediate cadre despite the fact that they have been working for the company for between 15-30 years. However, a few enterprising members of staff are attending the evening degree programs at the Enugu State University, Enugu, with the plan of changing their career when they complete their degree programs.

About 50 percent of senior staff members are accommodated in company houses. A rent subsidy, although given to other members of staff, is small. The amount given is smaller than that given by the federal government to civil servants at the state level. In respect of health, staff members are expected to use the general hospital and when receipts are tendered from the general hospital, they are paid. In practice, staff members patronize private clinics at their own expense, as the services at the general hospital are sub-standard.

Transport allowance given to staff members is small. Buses are provided especially for the junior staff but the service is not consistent. This is despite the fact that the firm is located out of town and it is not easily accessible by public transport. There is a well worked-out gratuity and pension scheme. Although the amount is small, it is paid regularly.

Table 6: Labor Profile at Woods Nig. Ltd.

Cadre	Local							Expatriate
	1994	1995	1996	1997	1998	1999	2000	
Management	3	3	3	3	4	4	4	Not applicable
Technical	3	3	3	3	3	3	3	Not applicable
Skilled labor	15	15	20	20	28	29	19	Not applicable
Unskilled	4	4	4	4	4	4	4	Not applicable
Total	25	25	30	30	39	39	30	

Source: Fieldwork, 2000.

NBRRI

The present staff strength that deals with both production and research consists of four engineers, five scientists, six technicians, two artisans, four architects, two quantity surveyors and one land surveyor. There are also 23 workers in research and development and all of them are working in the Building Department. The institute has six departments: Building Research, Road Research, Engineering Research, Special Projects, Production, information and Planning, and Finance and Administration. For staff development, each member of staff was given the opportunity to attend one workshop or training program in a year. This was subject to availability of funds in the organization. Welfare package is below average compared to the university that has the same salary structure. All members of staff are entitled to a housing allowance. Retainership clinics are used to supply medical services for senior members of staff and their immediate family members. Junior staff members are encouraged to use the general hospitals and expenses paid back on production of receipts. For transport, buses are provided for junior and senior staff as the organization is located in a remote area on the outskirts of Lagos and car loans are not given to staff. A gratuity and pension scheme is in force. A pension board was set up in 1998 that makes payments regularly. Nothing is put in place in respect of safety but a case is currently being made about safety conditions in the organization. The management and staff relationship is cordial. However, we observed that the workers are idle. They lack equipment to work with and the bureaucracy is too cumbersome for the effective utilization of their potential. Thus, staff members are not able to utilise the incentive of the 10 percent commission entitlement for any job sourced by a staff.

Physical Investment

In all the firms studied, a major problem is that of regular maintenance and overhauling of machinery. In all of them, there is no clear-cut program put in place for refurbishing and replacement when any equipment reaches its lifespan. Thus with time, the equipment became inefficient and consequently obsolete. In AT&P, because it is a subsidiary of UAC (Nig) Ltd, there was an initial maintenance program. The firm started backsliding seriously in 1981 when the program was not followed

conscientiously again. Also, the present apparent success of Woods (Nig) Ltd is because the machines are relatively new. If no conscious effort is made to effect a maintenance program, the factory too will gradually grind to a halt like its predecessors.

The Case of Emenite (Nig) Ltd.

Emenite (Nig) Ltd was established in 1961 at Emene, Enugu, on a joint ownership basis with foreign partners from Belgium and with equity participation. It first commenced production in 1963. The technical support lines from foreign partners are ranked in order of importance.

1. Research and development for new processes
2. Procurement of raw materials
3. Procurement of spare parts and components
4. Plant refurbishment
5. Major annual maintenance

Raw Materials

Conscious efforts are made to source for raw materials and spare parts locally *(Table 7).* The three major raw materials are cement (85 percent and sourced locally from WAPCO), fibre (10 percent and imported) and cellulose (five percent and sourced locally). The imported component cannot be sourced locally because it is part of the contractual arrangement with the foreign partners. The company operates the stocking of six months for raw materials and at least two months for finished products.

Choice of Technology

The technology used is superior to that of local competitors with knowledge-intensive core technology. Initial purchase and installation of machinery was 100 million naira (about one million US$) and a replacement cost of 150 million naira (fifteen million US$). The production line (that was purchased from Europe) was the single most costly item. Information core technology was from the foreign partners. Alternative technology was not considered because local technology of such standard was not available. The search for the core technology was carried out in Germany and Belgium. Qualified staff members (but not necessarily experienced) were sent to make assessment of available technology. Options were not considered, as the local investors did not have the resources to dictate terms. Also, local consultants were not hired to evaluate options, as there were no sufficient consultants in the field especially in plant fabrication at the time.

From the performance of the plant, it was felt that the right choice of technology was made considering the prevailing circumstances. The following reasons were given.

- The government had no facility in place to provide consultants at conceptualization of

projects
- Advice was sought from PRODA in respect of selecting and bargaining for core technology. The result was inadequate.
- There is no government grant or fiscal subsidy to aid choice of technology.
- The Nigerian Standard Organization (NSO) is concerned with product quality standards. It does not assist in making the product of high quality.
- The unfavorable and high inflationary rate of foreign exchange dictates that projects have to be conceived and executed fast.
- Government agencies have not been of any assistance in overcoming performance problems.

Over the years, the machines have been upgraded locally, some spare parts have also been fabricated locally, the storage of materials have been improved thus minimizing waste and raw materials alternatives are regularly sourced locally. However, the foreign partners still enjoy the monopoly of the essential important components of both the materials and machines without which the whole establishment cannot operate. This has been a major criticism of technology transfer from the developed.

Table 7: Project Input at Emenite (Nig) Ltd in Percentages

Year	Local Raw Materials	Imported Raw Materials	Local Parts	Imported Parts
1994	75	25	90	10
1995	75	25	90	10
1996	80	20	90	10
1997	80	20	95	5
1998	85	15	95	5
1999 Jan-Sept.	85	15	95	5

Source: Fieldwork 2000.

Production Capabilities

The production capability follows the process designed by the foreign partners. This is highly sophisticated with little local innovations. Although during our reconnaissance, the machines appeared to be well run and maintained, on closer inspection, the essential part of production management is imported. Thus, in the event of the establishment being deprived of these facilities, the local equivalent had not been developed.

The range of products by the company is shown in *Table 8.* The average efficiency of production is about 50 percent and the capacity utilization is about 48 percent *(Table 9)* for the past five years. Most times because of failure of The National Electricity Power Authority (NEPA), the company has been

spending a lot of money to keep its private generator working. This ensures increased production that has doubled over the years.

Table 8: Range of Products by Emenite (Nig) Ltd

S/No	Product	Percentage of Total Production
1.	Emcal Flat sheets	70
2.	Standard corrugated sheets	15
3.	Ultimate sheets	5
4.	Corrugated roof-up sheets	5
5.	Emulux/Qualitile/Duracal/Garden Items	5
	Total	100

Source: Fieldwork, 2000.

Physical and Social Infrastructure

The factory, administrative unit and the supporting infrastructure are housed within an area of about three hectares at a satellite village of Emene near Enugu. The company generates its own electricity and water. The physical infrastructure is well planned with the buildings in conducive surroundings. Apart from recruiting part of its unskilled labor primarily from the locality, the company has no relationship with the environment.

Human Capital

As part of its contractual agreement with the foreign partners, the company employs two technically skilled expatriates. In fact, they hold the key to the workings of the factory that they guard jealously. As it is difficult to find relevant technical labor in the country, engineers, scientists, technicians, craftsmen and artisans who have obtained B.Sc. Higher National Diploma, and trade tests in their respective areas of professional competence are employed regularly. Thus put in place is a well-worked out in-house training program where these professionals are retrained specifically for the company. Incentives to staff include sponsorship to attend part-time courses in higher institutions and satellite campuses in Enugu. Also included, is the retirement benefit plan for every member of staff. Thus, in the past five years, only three engineers, a scientist, a building professional, two technicians, five craftsmen and six artisans have resigned from the company.

Table 9: Capacity Production (Metric Tons) at Emenite (Nig) Ltd

	1994	1995	1996	1997	1998	1999
Plant Capacity	40,000	40,000	40,000	40,000	40,000	40,000
Actual Production	12,000	14,000	16,000	18,900	25,000	32,000
Capacity Utilization(%)	30	35	40	47	63	80
Efficiency (%)	50	50	50	c50	50	50

Source: Fieldwork, 2000.

Welfare package is good as testified by the staff, although there is room for improvement. Housing allowances are given. However, members of staff are agitating for revolving housing loans so as to have the opportunity to build their own houses. The company has an industrial clinic within the premises. Coupled with this, individuals are given medical allowances. Transport allowance is given and, although gratuity is paid when due, staff members feel that the pension allowance should be improved. In respect of safety in the work environment, the staff members agree that safety training on prevention methods is arranged regularly for staff. The company provides state of the art safety methods and gadgets for staff.

Finance and Incentives

Local participation in financing of the establishment is through commercial banks. The financial constraints of high interest rate and difficulty in the procurement of foreign exchange affected the choice of technology. Foreign exchange is needed for raw materials and spare parts, machines etc. This situation is better appreciated when we put into focus the point that foreign exchange is obtained through bidding and no preference whatsoever is given to manufacturers.
However, along the line, government inducements resulted in sourcing of local raw materials. Lip service by government agencies in using the products resulted in patronage of less than five percent for government projects. The problem is that the policies are not sustained. They are mostly one-time shots.

Research and Development

About 10 percent of annual budget were used for research and development and about five percent of staff members are engaged in research and development. However, there are no government subsidies or data bank where information can be assessed. The company through its research has been able to produce a brand of roofing sheets that competes favorably with corrugated iron sheets (the cheapest roofing material in the market). This brand of asbestos is more durable, accessible and is easier to fix by artisans. This is a major achievement by Eternit.

On the other hand, the company exhibits all the problems of technology transfer especially that of being saddled with an expensive process line that does not adapt easily to local spares. Thus, there are periods when the products are scarce on the market. This may be because of inability to procure essential spares from foreign partners. Most times, the problem leads to hiking of the prices of the materials in the market.

Research Institutes

The Raw Materials Research and Development Council (RMRDC) and two research institutes, the Nigerian Building and Road Research Institute (NBRRI) and Federal Institute for Industrial Research (FIIRO) were studied in-depth. This was aimed at finding out the reasons for their inability to develop products that were expected to affect the supply of indigenous building materials in the country. In-depth interviews were carried out with responsible officers at the selected firms. The interviews centered on building materials developed and produced for the market. Major problems include the inability of government to make adequate resources accessible to the organizations regularly: This would enable them to carry out meaningful research and to disseminate findings adequately to the users of the products. Stifling the organization of funds will disorganize research programs in the institutes and dampen the enthusiasm of researchers and ultimately affect their contribution in a negative way. Other important problems highlighted include procurement of materials and factors affecting capacity utilization along with obstacles affecting their efforts to make the products accessible to the users.

The Raw Materials Research and Development Council (RMRDC)

RMRDC was established in 1988 at Abuja with the main aim of expediting development and self-reliance through maximum utilization of local raw materials for industrial usage. This is achieved by the Council's participation in all the organized private sector operations and programs they are invited to, examples being quarterly meetings of the Manufacturers Association of Nigeria (MAN) and NASSI. Its relationship with research institutes in the country is through commissioning of specific research projects. A monitoring system is put in place to get feedback from the end users of the products emanating from the research projects. The main users of its services are the organized private sectors, manufacturing industries, government and prospective foreign investors. To promote its work, techno-economic surveys of industries are done twice a year. However, the council does not have any link with design and construction users. Also, it is through these surveys that the council has been able to identify some alternative raw materials for industries involved in wood and clay products.

Timber

Presently, there are ten types of wood–based industries in Nigeria. These industries use wood materials for sawmills, plymills, particleboards, logs, poles, matches and toothpicks and medicare. Most of them are located in the wood producing states of Lagos, Cross Rivers, Ondo, Oyo, Imo, Edo, Delta and Ogun states. All of them account for about 90 percent of the saw milling business in the country.

Saw Mill Process Technology In Nigeria

The process technology used is labor-intensive. Manual labor is used throughout in the rolling, sawing and loading of planks. The technology is obsolete, leading to wood waste of up to 50 percent. The spare parts for the machines used in slicing are imported. This has led to a lot of sawmills folding up in the recent past. Even the special vehicles used in transporting the logs on land are obsolete and they break down regularly along the motorways in the areas of operation.

Installed Capacity and Utilization of wood and wood products

In 1988, Nigeria had 14.9 million hectares of forestland capable of producing roughly 305 million cubic metres of wood. Of this, 70 percent (214 million cubic metres) was utilizable. About 80 percent of this came from the rain forest and the rest came from plantations.
According to RMRDC (1999), the estimated requirement of the wood industry in 1988 was about 7 million m^3 while the installed capacity was put at about 8.8 million m^3. In 1992, the total number required was estimated at 6 million m^3, while the national installed capacity was 16.4 million m^3. In 1996, total log requirement stood at 7.1 million m^3 while the installed capacity was 16.6 million m^3. The shortfall over time was 1.84 million m^3 in 1988, 10.45 million m^3 in 1992 and 9.56 million m^3 in1996 *(See Table 10).*

Sawmills Production

According to RMRDC (1999), of the 6,994,660m^3 of round logs produced in 1988, about 6,256,500m^3 (89.4 percent) went into sawmills. In 1992, about 5,759,765m^3 (95.5 percent) of the logs were consumed by the sawmills. In 1996, the amount dropped to 4,200,000m^3 (54.4 percent). Over the years, the sawmills industry consumed over 80 percent of logs produced, thus making it the dominant wood-based industry in the country. The fall in 1992 arose because of the poor economy, while the rise in 1996 was due to a partial recovery from the recession and the accompanying new demand for tropical hard wood in the international market. However, the national capacity for utilization dropped due to poor and inefficient wood conversion methods and inadequate log supply.

Plywood Production

Ply-mill requires wood of specific quality, the absence of which has led to a fall in the production of plywood and veneer. At the same time most of the good quality plywood are smuggled out of the country. The capacity utilization in the industry in 1992 was only 35 percent and in1996 there was a shortfall 40.8 percent.

Research and Development Programs

In fulfilling its mandate, the council has continued to strengthen and pursue more vigorously its research and development programs on the development of raw materials the industries. This mandate

is very broad and a lot of activities fall under it. To date, the council has not carried out any major activity in respect of clay. As it relates to timber, a tree plantation project that was concerned with development of tree plantations of indigenous economic species was initiated in 1999. This was concerned with sponsoring institutions to produce improved materials for distribution to private sector investors, communities and local government areas (LGAs) for plantation establishments. The characteristics of the seedlings showed that they are all geared towards boosting the supply of agricultural raw materials. We expect that this is not a one-time shot and that with time; the facility will be extended to not only replenish our timber forest but carry out research to improve and increase supply of contemporary timber. Also, we expect that clay will be focused on in due course.

Awareness of RMRDC Existence

RMRDC carries out seminars and workshops at national, state and local levels to promote public awareness of its work. It has 33 liaison offices in as many states. However, interaction between its offices and interested people is only by correspondence. Also, meaningful information can only be accessed at Abuja. This makes the liaison offices virtually redundant. A very important observation is that the register of industries available at the council is not up to date. Most of the industries are out of production. This does not augur well for the development and sustenance of industries in Nigeria.

The Nigerian Building and Road Research Institute (NBRRI)

The institute has existed for about 22 years with six departments. It has moved to its permanent site on the outskirts of Lagos. It operates a closed budget with a percentage of actual disbursement by government given to each department. Generally, and as shown in the example, an average of about 48 percent of actual budget was disbursed yearly from 1996-1999 *(Table 11).*

Majority of the financial allocations to the institute have been used for infrastructure development (as the institute has just moved to the new site) and in running the institute. Little has been put into research. Most times, funds were diverted to take care of special projects e.g. purchase of furniture for staff offices etc. The building department operated a zero-budget in 1998. Thus, N300, 000.00 was diverted into the department from other sources. This amount was too little to have any appreciable impact on research in the department.

Members of staff observed that the government has not encouraged research into building materials and components in the country. The United Nations recommends that countries should spend at least about 3 percent of its GDP on research in order to develop meaningfully. Ghana with less than 10 percent of Nigeria's population, spends about 0.01 percent of its GDP while Nigeria spends about 0.001 percent of its GDP. This shows that Nigeria, is not serious about research generally and pays only lip service to it. The attitudes of policy makers show that they do not know or appreciate the actual import of research. The attitudes of officials of the Ministry of National Planning portray ignorance on the part of policy-makers respect to research. Even private organizations are not encouraging local research institutes. Most of them are multi-nationals that prefer importation of materials, as they

receive research result packages from their home countries.

Table 10: Installed Capacity and Utilization in the Wood and Wood Products Sector (1988-1996)

Raw materials (Wood Resource)	1988		1992		1996	
	Installed	Utilized	Installed	Utilized	Installed	Utilized
Wood (M^3)	8831750	6994660	16482318	6031922	16625653	7069145
Saw mill (M^3)	8050000	6256500	15793188	5759765	10900000	8200000
Ply mill (M^3)	565000	345000	512510	180857	5306000	216397
Particle board(M^3)	117000	55000	62140	34290	7500	54600
Furniture (M^3)	394300	212700	-	-	-	-
Poles and Co	99450	55100	-	37750	-	-

Source: RMRDC Annual Report, 1999.

Research and Development

A total of 24 staff members are engaged in research and development in the Building Department of the institute.

These are four engineers, five scientists, six technicians, two artisans, four architects, two quantity surveyors and one land surveyor, Although the researchers are placed on the University Salary Scale, the salaries and allowances are not paid on time. Most of the equipment for research has broken down. For minor researches, grants of N50, 000.00 are given. In 1997, (23) staff members got the grant from the institute; those for 1998 and 1999 were still pending when this interview was conducted in November 1999. As the research grants are not given regularly, it is difficult for research staff to plan their work and come out with meaningful results. Thus, the researchers are disillusioned and in total, not much research work is carried out. In spite of these constraints, NBRRI has done a lot of work on clay as a building material. They have developed and utilized clay bricks and blocks and presently they are improving on them. They developed burnt bricks, cement stabilized bricks, and manufactured a brick-making machine. With respect of this machine, the question is why the adoption of this technology a problem. Identified is lack of equipment for research, and that currently in use is outdated. Others include lack of funds to purchase new equipment and local materials input and lack of incentives for staff members. There is the issue of poor remuneration and welfare packages for researchers. For example, the last training session for professionals in the building industry using NBRRI research products was that on clay held in 1985.

Table 11: Profile of Budgetary allocation at NBRRI from 1996-1999.

Year	Budgeted Amount (Million Naira)	Actual Disbursement (Million Naira)	Percentage Disbursed
1996	100	60	62
1997	72	30	42
1998	60	30	50
1999	50	20	40
		Average disbursement	48.5

Source: Fieldwork, 2000.

Research is not fully developed in the area of meeting the specifications of the users. Also, research is not market driven. Even when innovative products e.g. clay blocks are developed, they are not given enough publicity that will make prospective users aware of them. Artisans are not trained regularly in the art of laying the blocks and most importantly, there has not been appreciable improvement in the product (clay bricks) for the past 15 years.

Federal Institute for Industrial Research, Oshodi (FIIRO)

FIIRO is located in Oshodi in Lagos and was established in 1956, (44 years ago). There are presently six departments: Engineering; Biotechnology; Policy and Monitoring; Food; Chemical and Fibre; and Analytical Services.

Research and Development

The staff strength includes a total of 25 engineers, scientists, e.g chemists, microbiologists etc. and over 50 technologists with a Higher National Diploma. Other members in the department include plumbers, carpenters, secretarial staff etc. These are expected to take part in demonstration projects of developed projects.

A separate allocation for research is included in the budget. This amount (although the actual figures were not given) from our observation could not have been adequate as there was no sign of appreciable research activities taking place. For a particular research to be embarked on, the mandate has to be given by the Federal Government through the Ministry of Science and Technology. Not much research is carried out on timber, as there has never been the mandate for it. However, there is on-going research (that started in 1994) on wood waste as a major component in the production of fibre pulp and fibreboard for the building industry. The focus is on developing a simple recycling process of the wood waste. The local raw material for this project is got from the nearby forest regions of Ogun and Edo states. Also, in the early 1990s, some research was carried out on clay with the building industry

in mind. This has since been aborted.

Presently, activities in respect of research is concerned with assisting interested entrepreneurs that approached the institute for advice on machines and sources of raw materials. An example is that of floor and wall tiles. A major problem is the issue of who should provide the resources for research. Building firms that consult the institute for research activities lose interest when the cost of research is brought into discussion. This is because, generally, Nigerians expect basic research and design results from government agencies as part of its contribution to industrial growth in the country.

Advertisement

The process of getting research findings to the market that will eventually reach the end users is through the technological marketing section. This section informs the public about the new materials available. It is responsible for representing the institute at trade fairs, conduction of seminars and writing of reports. The National Agency for Technological Acquisition (NATA) also helps in creating awareness. According to our interviewees, clients have not been responding due to the general apathy towards new products. Most entrepreneurs have a low capital base. Coupled with this, the products are not patented. However, no clay or wood products have been designed by the institute, even though research has been carried out on them for production purposes and there is a great need for products. These products are presently being imported into the country.

Staff Welfare

The welfare package for staff is very poor, thus staff members are not motivated. With respect to training, staff members claimed that nothing had happened in the past 16 years as there is no well worked out programs. Before then, a few senior and junior staff members were for relevant training in China, France and in local institutions like ASCON at Badagry. However, the work environment made it impossible for them to use their training to research activities in the institute. The low staff turnover can be attributed to the general poor economy in the country. Incentives are given to staff who bring business to the institute in the form of percentage rewards. End of year award for best research and technology ideas etc. is also given. However, all these incentives are negated by the inability of the institute to put in place facilities and programs that will enhance staff performances.

In respect of housing, different packages are provided for junior and senior staff. Senior staff are housed at the institute's quarters, while junior staff are given housing allowances. Nobody has been provided with housing loans for private housing provision. There is a medical clinic that is operated from staff resources with free medication but this cannot cater for serious ailments. In such situations, staff are expected to makel private arrangements.

Buses are provided to transport staff to and from work. These are inadequate. Senior staff were given car-refurbishing loans a few months before the interview so that they could repair their very old cars. A staff member is entitled to gratuity after working for five years. After working for ten years, he is entitled

to gratuity and pension. However, it is an uphill task to collect these entitlements especially for the junior staff.

There is no well worked out package for safety. Safety gadgets are not provided on the job. Non-provision of the facilities is caused by red tape from the supervising ministry. Generally, there is a lack of resources for purchasing essential materials necessary for research and production. Most times, staff improvise and, with time, get disillusioned and consequently redundant.

Professional Bodies

The Nigerian Institute of Architects (NIA) and The Nigerian Institute of Quantity Surveying (NIQS)

NIA and NIQS were selected for the in-depth study in respect of their activities because of their promotion of the improvement of the use of indigenous building materials. The institutes do not have regular organized fora for disseminating information on new and available building materials manufactured locally or the selection of available building materials. There are no regular awareness programs directed at members and the general public on design and construction possibilities of indigenous materials available in the country. There are also no regular programs for sustaining the link between optimizing the design and construction of buildings and use of indigenous building materials.

However, there is some link between NIA and manufacturers of building materials. These are with organized import-oriented groups like aluminium products companies and mechanical and electrical companies that sponsor some of their products. There is also minimal creation of awareness among members on cost and availability of indigenous building materials, especially timber and clay. The two institutes have no link between them and research institutes in the country. All the professional institutes have their annual conferences on particular themes that are directed primarily at their members.

NIA, because of all these problems, instituted the Architect's Forum and the annual Archibuilt Event in 1990. Although the program has been in operation for ten years, it is still working towards achieving the desired results. Archibuilt cannot be the only event to achieve the desired goal of improving the manufacture and use of local building materials. There must be a lot of programs of interaction, awareness, incentives and research put in place by the professional bodies in partnership with the manufacturers, financiers, users, government agencies and the general public. This in the long run will assist in achieving the desired goal.

The NIA and Archibuilt

In 1985, NIA realised that for successful implementation of the National Housing Policy, there was need for concerted and sustained efforts at developing local building materials and promotion their utilization. Determined therefore to put in place an effective machinery to bring this to fruition, and

conscious of the general paucity of information and awareness on the availability, sourcing, exploitation and utilization of the locally available building materials, the institute embarked on the Archibuilt Forum in 1990, to fill this vacuum (Famuyibo, 2000). Archibuilt is, therefore, an annual specialized national forum of building materials and construction technology. It is aimed at providing a forum for the exchange of ideas between manufacturers of building materials and the relevant professionals who specify their products on the one hand, and with the end users who are the ultimate focus of the exhibition.

Week–long planned activities are held annually. The activities comprise interaction of architects, quantity surveyors, engineers, estate surveyors with each professional body using a day to plan activities for awareness, exhibition, interaction etc. with manufacturers, end-users and the general public. Although, the program has been in operation for ten years, it is still working towards achieving the desired results. The publicity is still very weak and the most people are not aware of it.

Micro-scale Enterprises

The micro-scale enterprises interviewed are involved with stocking and selling of materials in the markets. They get their supplies from the manufacturers. They patronise the manufacturer who can supply according to requirements and on time. Most times they are expected to pay a large sum of money to become distributor of the specific product. Thus, it is the market forces that determine the actual cost of the materials to the consumers. Generally, because of the inefficient volume of production, the manufacturing firms supply less than the requirements and there is the problem of high transportation costs and high possibilities of accidents as the roads are not well maintained. These problems are responsible for the high cost of the materials at the selling points. The manufacturers do not interact with the artisans using their products. The only interaction that the enterprises have with the manufacturers is when the quality of the products is poor. They use the opportunity to appeal to the companies to improve the quality of their products.

Artisans

Majority of those interviewed had used the materials for a long time. Most of them trained as apprentices and became to experienced workmen. A profile of six of the artisans interviewed is presented in *Table 12*. Compared to other building materials, they agree that timber products are relatively cheap as they are sourced locally. They know about improvement in the use of the materials from the marketers, who invariably are artisans; architects, who specify and encourage the use of these materials; and contractors, who use these materials on their building sites. They agree that there are not a lot of clay products on the market. Thus, an artisan that specialises in clay products must specialise in other trades so as to be able to earn an appreciable living wage. However, the cost of labor for clay products is higher than that to sandcrete blocks as there are less artisans involved in brick laying. This allows them to enjoy a monopoly.

Testing of Hypotheses

i) Hypothesis One: Indigenous raw materials are not accessible in the building materials industry in Nigeria. This has led to extremely low level of efficiency in the process of technological acquisition and accumulation in the building materials industry in Nigeria.

Raw Materials

In all the firms studied, the states of supply of raw materials are as follows:

- AT&P: Timber, that contributes about 90 percent of the materials needed, is sourced locally. However, there are the problems of illegal felling, poaching of immature trees, wastage from wrong harvesting, no appropriate program to replenish the forests, and competitive usage of timber by cabinet makers and other users. This has led to the dwindling of the supply over time and eventual shutdown of most of the mills.
- Woods (Nig) Ltd: Timber is sourced in the local market. Only about five percent makers of raw materials needed are imported. Apart from the fact that its products are expensive in the market, there is the problem of being able to access timber in time as the forests are rapidly being depleted, as there is no national well-worked out policy or program for replenishing the forests.
- PRODA and NBRRI: Both organizations faced similar problems. These include the difficulty of collecting enough clay to sustain the building industry, expensive transportation to the required site, acquisition of land for quarrying of clay, and competition from subsistence users. These factors increase inaccessibility and the dwindling of supply.

Profile of Efficiency

- AT&P: Efficiency dwindled from 50 percent in 1930 to 20 percent in 1980 and three percent in 1998. Meanwhile the whole factory has collapsed and has presently been put up for sale.
- Woods (Nig) Ltd: Efficiency increased from 10 percent in 1994 to 59 percent in 1999. Presently, the efficiency in the firm is still rising as better technical know-how has just been acquired.
- PRODA: Efficiency has always been low i.e. three percent, as the kiln has never been upgraded from its rudimentary state.
- NBRRI: As the machine is 100 percent produced in Nigeria, the major problem lies with sourcing of raw materials. It was difficult to calculate the efficiency of the machine because it has never been measured, as the machine is still not known in the building market.

Technical Learning

In all the firms, the state of technology did not allow for technical learning as the technology for production was imported. Over the years, all that the technicians and the professionals did was to maintain the machines using imported spare parts. Even when some of the machines are fabricated in the country, there are no government incentives to encourage their development. Thus, in the long run, the establishments acquired little or no capabilities and with time, efficiency dwindled. Coupled with inaccessibility to essential local raw materials, the firms collapsed.

Table 12: Profile of Selected Artisans

	1	2	3	4	5	6
Vocation	Carpentry	Carpentry	Carpentry	Technician	Technician	Technician
Length of use of mat (years)	7	10	8	3	6	5
Length of training (years)	7	5	4	5	4	6
Where did you train ?	Lagos--apprentice	P.H.--apprentice	Benin apprentice	Technical school (trade test)	Manufacturer (artisan)	P.H.--apprentice
Structures built Timber Clay	 20 5	 7 5	 6 4	 - 10	 - 15	 3 -
Profitability of these mat Is it profitable?	Yes	Yes	Yes	Yes	Yes	Yes
Will you Recommend their use?	Yes	Yes	Yes	No choice	Yes	Yes

Source: Fieldwork, 2000.

In comparison, in the case of Emenite (Nig) Ltd, where the technology is imported and there is an arrangement with the overseas associates, efficiency is better. However, for 39 years that the firm has been in existence in Nigeria, no effort has been made to improve technical learning. Thus, the process of technological acquisition and accumulation has been very slow.

All the firms studied showed that although indigenous raw materials are abundant (or have the potential of being abundant) in the country, they are inaccessible to the building materials' industry. This problem contributed greatly to low efficiency in respect of performance and the process of technological acquisition and accumulation. Therefore inaccessibility of indigenous raw materials and the shallow depth of technical learning in the firms have contributed considerably to low productivity

and extremely low level of efficiency in the process of technological acquisition and accumulation in the building materials industry in Nigeria.

ii.) Hypothesis Two: Technological capabilities have been diminishing in the building materials industry in Nigeria over time, because the firms and governments have not adopted strategies positive to the changes in the construction sector.

This study has shown that technological capabilities have been diminishing over time at AT&P, PRODA and NBRRI. Presently, little improvements are taking place in terms of capabilities development. Even at Woods (Nig) Ltd, the history of woes will continue unless the problems are solved. The major strategies adopted include importation of machines, sourcing of raw materials locally which most times are not accessible, inconsistent government policies that are mostly short term and whose performances are not evaluated and monitored. Also, all the research institutes studied are not well financed and the performances of government agencies did not show commitment on the part of the policymakers and implementation agencies of government programs. This made it impossible for the institutes to focus and take research into building materials as seriously as they deserved. Priority and publicity are not given to these areas of research.

The government has not put in place policies, directives and incentives that will motivate the firms to take the risks in developing indigenous capabilities. Monitoring and evaluation have not been considered in respect of involvement of government agencies in the development of the sector. Government agencies do not patronize the building materials produced locally in its projects. This could have been a major publicity for these products in the face of stiff competition from imported materials that are cheaper, better in appearance and finish, and whose lobbying for favorable government policies is well known.

None of the following three stages are in place presently: technological capability as a means of improving production characteristics, technological capability as a means of supplying to take care of demand, and technological capability as a means of production of new and innovative materials. Unfortunately, there are no strategies for long-run basis at government level to assist in the production of raw materials and development of appropriate technology.

Report of the Dissemination Workshop

In an effort to enrich the findings, discussions, and create awareness of the project, a two-day workshop was organized for policy makers and managers, industrialists, financial experts, academicians, relevant professionals and builders. The workshop took place in Port Harcourt on the 14th and 15th of November, 2000 at Rivers State University of Science and Technology. The idea was to inform them about the study and with their assistance improve on the recommendations proposed by the research team. This was carried out on the first day. On the second day, a press briefing was held. The participants and representatives of the major mass media in the country attended the briefing.

Chapter Six

Major Findings and Discussions

State of Technological Capabilities

Machines

These are imported and are mostly of intermediate technology. There are no plans in place for the local professionals and technicians to understand the technology of machines manufacturing especially using local materials. Thus, when the machines break down, the local technicians were unable to revamp them. In the case of spare parts, most of them are still imported and not much effort is made to produce them locally.

In all the firms studied, the following was found:

- Timber is sourced locally (between 80 percent – 90 percent). However, it is not accessible to the firms as:
  i. There are well worked-out strategies for replenishing depleted forests
  ii. There is competition from other commercial users
  iii. There is poaching by unpatriotic timber merchants
  iv. Domestic use has increased recently due to high cost and non-availability of kerosene and cooking gas
  v. There is wastage of wood due to the rudimentary nature of felling and logging.

- Clay is sourced 100 percent locally, but like wood, it is not accessible.
- Public provision of infrastructure was either erratic or absent. All firms spend a lot of resources providing constant and regular supply of water and electricity.

Human Capital

All the firms studied are run with local labor (both skilled and unskilled). A very important aspect highlighted is on-the-job training to improve the performance and output of workers. Workers attached a lot of importance to the training as they see it an avenue for improving their skills and consequently their performance on the job and their future marketability. However, the programs were not carried out on a long-run basis. This led to dissatisfaction and apathy on the part of the staff.

Welfare packages were generally below average compared to general welfare systems in the country. A common dissatisfaction was lack of well worked-out home ownership system.
The capacity to exploit technology was not in place in any of the firms studied, as production characteristics were not up to the standard expected to allow this. In addition, there was nothing to encourage production of new and innovative materials and the substitution of traditional factor inputs to replace imported ones.

The Research Institutes

Government involvement in research into building materials (especially timber and clay) in Nigeria is plagued with the following problems:

i. Policy makers do not appreciate the importance of research.
ii. Policy makers are not aware of the requirements by the building industry to produce indigenous materials.
iii. Government agencies responsible for research in the country have not mandated their research institutes to focus on local building materials.
iv. When finance in form of subvention is allocated to research institutes by government, the disbursements are irregular and grossly cut. Thus they are inadequate and insufficient to be relevant. They are often used for infrastructure development and day-to-day running of the institutes rather than for research. There is no monitoring system to check the performances of these institutes.
v. Incentives given to staff are poor and not paid regularly to researchers.
vi. Who should fund research? Is it the government or the organization needing the information for its industrial firm?

Government Agencies

The Ministry of Science and Technology does not focus specifically on building materials, research or availability and accessibility. The Ministry of Finance has not been able to develop consistent policies on macro-economic incentives.

The Professional Bodies

There is not much relationship between the professional bodies, the building industrial firms and the government. Although NIA has started with Archibuilt, this is not enough. There is need for other professional bodies to improve on what they have presently. Publicity of these activities must be given a lot of importance.

Entrepreneurs

All the entrepreneurs work in isolation. There is no association to learn from. They hardly invest in research and when they do, the investment is too little to have any meaningful effect. They prefer import substitution, as it makes their work easier and ensures profitability in the short run. Thus, independent activities are carried but and there is no collaboration. This in most cases leads to duplication of efforts that is not only costly but disallows improvement of development capabilities.

Specific Relevant Policies

Generally, trade liberalization measures imply stiff competition. These are expected to stimulate innovation in the firms. However, in Nigeria, they led to poor performance and eventual closures of the firms. This was because a conducive environment was not created for the successful performance of the firms before liberalization was effected. Also, the economic crises during the SAP period led to severe capacity under-utilization amidst scarcity, high labor turnover due to low wages, limited flow of financial and human resources to the technology-generating institutions and most importantly, majority of the firms, in an effort to reduce overhead expenditures, forgot control. Thus, they were unable to compete with imported materials.

What is needed are small-scale building materials industries that are supported through stable and consistent policies, legal and fiscal incentives, access to credit on a regular basis, research and information. Also, policies should be put in place to promote information exchange on appropriate building technologies. Only when these policies and programs are truly part of the industrial environment that liberalization measures may be considered.

Chapter Seven

Suggestions and Recommendations

Machines

Imported machinery should be of intermediate technology with spare parts conforming to a prototype that can easily be manufactured in Nigeria. There must be a well worked-out maintenance program right from the onset of purchase and installation.

Appropriate Technology

The appropriate technology for industrial set-ups in Nigeria has to be labor-intensive. This reduces the degree of automation, as there is a large supply of labor, weak technological infrastructure and balance of payment problems.

Indigenous Technical Change (ITC)

Technical change cannot be imported. It has to evolve from the local industries themselves. However, for this to happen, the environment must be conducive. There is the need for protective policies and directives by the arm of government responsible. Indirect subsidies are essential and relevant for any industrial strategy in Nigeria. However, experience shows that ITC takes a long time to mature.

Using Technological Shelf

ITC can progress by improving on inventions from other industries. These can be from developed countries. Thus, in pursuing technological improvements, there is much to draw from the experience of the rest of the world. The challenge lies in being able to locate it, draw the relevant lessons, adapt, and integrate it into suitable designs for local use. For this to occur, commitment and sincerity of purpose by all concerned must be exhibited.
International Assistance

International assistance must change its form from to that of an enabler. For example, international agencies can play a crucial role in identifying relevant technologies thus saving the industry from reinventing the wheel. They have an important role to play in disseminating information on technological advances, as Nigerian firms do not possess institutional infrastructure required to generate market

and transfer technology. A word of caution, however: most of the aid agencies in the developed countries are interested in pushing technology that includes machinery supply (sometimes obsolete) with inadequate relevant spare parts at exorbitant costs. All they are interested in is to assist their country's machinery suppliers.

Materials: Timber and Clay

The two materials studied here are available locally. What we need to put in place are programs for making them accessible to the industrial firms not only regularly but also in the quantity required. To enable this, good transportation and evacuation systems must be put in place. These systems must not only be environment-friendly but must be socially, economically and culturally friendly.

Timber

To avoid depletion or over-exploitation of timber, there is need to have the required plantations for a longer period, may be 25 years or more, so as to ensure sustainable supply of the required raw material for the industries and other users. This dictates a long-term plan that has to be well monitored and maintained. Sustenance of such plantation will not only lead to a better supply of raw material, but will also ensure future job creation for youths. This will reduce unemployment, idleness and conflict with the authorities.

Clay

When pits are burrowed to supply clay, there is a need for a well worked-out rehabilitation program of the pits to avoid landslides and environmental degradation.

Financial Infrastructure

There is need for policies affecting lending by commercial banks. This must be viewed as an aspect of social lending. Programs must be put in place to monitor compliance by commercial banks. Defaulting banks must be penalised. This must be made public so as to discourage other prospective defaulters. It has to be a permanent system, not the one-shot program that is common.

As foreign exchange is needed mostly for machines and spare parts, there is need on the part of policy makers and the people generally to improve technical know-how. This is possible if a scholarship system is appreciated, mediocrity and sychophancy are discouraged, and funds are used properly.

Also, there is need for government to put in place a system of banking that allows for long-term financing. Presently, there is a search for an effective system. The problem is that the country is in a hurry to find a solution. It is forgotten that the act of getting the solution to such a problem is a process that cannot be achieved in a hurry. The solution cannot be transferred from the developed countries. It has to evolve from the economic environment of the country while learning the solution from

developed countries. The availability of loans cannot be left entirely to market forces as all the factors that make such a solution possible are absent in the economic environment of Nigeria. When entrepreneurs use personal financing for industrial development the right technology is compromised.

Research and Development

The government has not been forthcoming in terms of commitment and funding of research. In the case of building materials, there is the need to put in place effective monitoring and evaluation of materials.
Recognition must be given to institutes that have carried out outstanding and innovative research. This may be through national annual awards that must be well publicized to encourage others.

Nature of Research and Development

Research programs must meet local needs. Technological improvements must be directly linked to particular plants. This allows the researchers not only to identify technological problems but also to provide fertile ground in which improvements can be tested.

Re-orientation of the Research Institutes

There is a need for government to have independent and profit-oriented research and production technology organizations that are solely responsible for producing proto-type simple spare parts from local raw materials for industrial use. Government directives will then be made so that individual industrial firms sourcing for imported machinery must use these the prototypes. Initially the directives will include a certain level of compliance by the industrial firms. With time, this percentage can be increased. This is what should lead to sustainable production of spare parts for industrial firms in the country. The existing research organization can be upgraded to perform these tasks.

Who Should Fund Research in the Country?

The present luke-warm attitude to research by both policy makers and the general public must change. To achieve this change, incentives can be given to companies that encourage research. Firms can be mandated to use a certain percentage of their earnings for research. Monitoring compliance must be put in place. Most importantly, government agencies must be seen as encouraging research in their institutes through regular, adequate and prompt release of research grants. And, the results of the research must be submitted, evaluated and publicized. Where necessary, government must patronise of the research results. When the organizations are aware of the benefits of research, they will be willing to fund it.

Welfare systems

Welfare systems are generally very poor. Staff especially the junior staff, are not adequately catered for and they cannot complain for fear of being sacked. There is need for government to insist in provision of services that encourage staff members to perform on the job. Most times what is needed is an enabling environment such as home ownership.

Home ownership: This is a service that is always an incentive to staff. As part of the government policy to increase housing stock in the early 1970s, the federal government mandated employers to institute home-ownership programs. These programs were to assist staff in securing loans from the Federal Mortgage Bank (FMB), local banks and building societies to purchase or build personal houses. Incentives in form of tax rebates were given by the government. Compliance by the firms was monitored for a few years. However, the FMB was unable to perform effectively and, with time, the firms discontinued the program due to lack of a system. It is necessary to resuscitate this program. But, this time around, all the bottlenecks should be ironed out. Home ownership is a panacea for better job performance in Nigeria.

End Notes

1. United Nations Industrial Development Organization (UNIDO) “The building materials industry: the sector in figures” Sectorial Studies Series No. 16, Vol. 11 (1985) as cited in UNCHS(Habitat) (1991) *Development of National Technological Capacity for Production of Indigenous Building Materials* Nairobi: UNCHS(Habitat).
2. Accessibility in respect to low cost building materials means material that is available in the location at all times, affordable, of appropriate technology, contemporary and taking the short and long run costs into consideration.
3. As cited in Congdon, R.J. (ed) (1977) *Introduction to Appropriate Technology (Towards a Simpler Lifestyle)*. London: Rodale Press.
4. This is referring to the experience of Egypt in introducing new technology to modernise the brick industry, as cited in UNCHS (1991) *Development of National Technological Capability for Production of Indigenous Building Materials* Nairobi: UNCHS (Habitat).

6. This is not the real name of the company. The company demanded anonymity before agreeing to interact with us. We gave it our word.

References

Adeboye, T. O., Bagachwa, M. S. D. and O. A. Bamiro (1995) *Effects of Reforms on Technological Capability in Sub-Saharan Africa: A Conceptual Framework* ATPS Working Paper No. 1.

Adeboye, Titus and Norman Clark (1995) *Methodological Issues in Science and Technology Policy Research: Technological Capability* ATPS Working Paper No. 2.

Akin-Aina, Tade and Ademola Salau (Eds.) (1992) *The Challenge of Sustainable Development in Nigeria* Ibadan: Nigerian Environmental Study Action Team (NEST)

Atman, Rudolf (1986) "Intermediate Building Technology" Course Unit: Housing Production Technology, 48th ICHPB, IHS-BIE, Rotterdam.

Baker, Laurie (2001) 'Rehabilitating Indigenous Technologies for Mud Construction" in *Innovative Experiences Series* Nairobi: UNCHS (Habitat).

CASSAD (1992) "Improving the Fortunes of Small-scale Industries in Nigeria: Policy Guidelines" Monograph Series 3, Centre for African Settlement Studies and Development (CASSAD).

Chambua, S.E. (1996) "Endogenous Technology Capacity and Capabilities Under Conditions of Economic Policies of Stabilization and Structural Adjustment (The Case of Technology Generation in Tanzania)" ATPS Working Paper No. 10, April.

Chatterji, M. (Ed.) (1990) *Technology Transfer in the Developing Countries* London: Macmillan Press Ltd.

Congdon, R. J. (Ed.) (1977) *Introduction To Appropriate Technology (Towards A Simpler Life Style)* London: Rodale Press.

Cooper, C. (1994) "Science and technology in Africa Under Conditions of Economic Crises and Structural Adjustment" UNU/INTECH Working Paper No. 4.

Corrrea, Charles (2000) *Housing and Urbanisation* London: Thames and Hudson

Daghestani, S. (1988) *Science and Technology Policy for Self-reliance in the Muslim World* Amman: The Islamic Academy of Science, Jordan.

Dahlman, C. J. (1985) *Managing Technological Development: Lessons from the Newly Industrializing Countries* Washington D.C.: World Bank Staff Working Paper No.717.

Dahlman, C. J. and L. Westphal, (1983) "The Transfer of Technology: Issues in the Acquisition of Technological Capability in Developing Countries." *Finance and Development* Vol.20 No.4 (6-8).

Dijkgraaf, Cor (1986) "The Private Sector in Housing Development" A Summary of Introduction at 48th ICHPB Core Program, IHS-BIE Rotterdam.

Drucker, Peter F. (1985) *Innovation and Entrepreneurship* New York: Harper and Row.

Famuyibo, A. (2000) "Archibuilt Forum: The Rational (Introduction)" in Archibuilt 2000, Program

and Souvenir brochure. Theme: *The Nigerian Building Industry: Challenges of the New Era* Held at International Conference Center, Abuja, Nigeria 15th-22nd November.
Federal Republic of Nigeria, (1988) *Industrial Policy of Nigeria* Abuja: Federal Ministry of Industries.
Fransman, M. (1985) "Technological Capability in the Third World: An overview and introduction" Fransman, M. and K. King (eds.) *Technological Capability in the Third World* London: The Macmillan Press.
Fransman, M. and K. King (eds.) (1984) *Technological Capability in the Third World* London: the Macmillan Press.
Freeman, C. (1982) *The Economics of Industrial Innovation (2nd edition)* London: France Printers.
Handisyde, Cecil C. (1967) *Building Materials (Science and Practice)* London: The Architectural Press.
Hodder, B.W. (1980). *Economic Development in the Tropics.* New York: Methuen and Co.
Kaplinsky, R. (1990). *The Economies of Small: Appropriate Technology in a Changing World* Washington D.C.: I.T. Publications in association with Appropriate Technology International.
Kaplinsky, Raphael (1984). *Sugar Processing (The Development of a Third World Technology)* London: Intermediate Technology Publications.
Macdonald, E. (1983). *The Trouble with Technology* London: Frances Pinter
Nigerian Environmental Study Action Team (NEST) (1991) *Nigeria's Threatened Environment (A National Profile)* Ibadan: NEST
Ngahu, Catherine W. (1997) "Technology Innovations used to Overcome the Problem of Resource Scarcity in Small-scale Enterprises: Implications for Policies" ATPS Policy Brief, July.
Nordberg, Rainer (2001) "Building Sustainable Cities" in *Habitat Debate* Vol.5 No.2.
Okpala, Don C. I. (1985). "Promoting the Use of Local Building Materials in Nigerian Housing Construction: The Problems and Prospects" in Onibokun, Poju (Ed.) *Housing in Nigeria (A Book of Readings)* Ibadan: NISER
Omara-Ojungu, Peter H. (1992) *Resource Management in Developing Countries* Essex: Longman Scientific and Technical
Raw Materials Research and Development Council (RMRDC) (1999) *Annual Report* Abuja: RMRDC.
Stewart, F. (ed) (1987) *Macro-policies for Appropriate Technology in Developing Countries* Boulard: Westview Press, Inc.
Stoneman, P. (1987) *The Economic Analysis of Technology Policy* Oxford: Clarendon Press.
The Earth Building Foundation Inc. (2001) *Adobe Mini-FAQ* Arizona: The Earth Building Foundation Inc.
UNCHS (Habitat) (2001) "Appropriate Grassroots Level Intervention for Cost-effective Housing, India" *Best Practices for Human Settlements* Nairobi: UNCHS (Habitat)
UNCHS (Habitat) (2001) *Sustainable Cities* Nairobi: UNCHS (Habitat)
UNCHS (Habitat) (1998) *Environmental Friendly Construction Practices* Nairobi: UNCHS (Habitat)
UNCHS (Habitat) (1998) *Shelter 7* Nairobi: UNCHS (Habitat)
UNCHS (Habitat) (1998) *Woman's Participation in Shelter and Housing: A Case Study of Women Block Makers in Kenya* Nairobi: UNCHS (Habitat)

UNCHS (Habitat) (1996) *Appropriate Grassroot Level Intervention for Cost-effective Housing in India* Nairobi: UNCHS (Habitat)
UNCHS (Habitat) (1991) *Development of National Technological Capacity for Production of Indigenous Building Materials* Nairobi: UNCHS (Habitat).
UNCHS (Habitat) (1990) *Co-operation with Least Developed Countries* Nairobi: UNCHS (Habitat)
UNCHS (Habitat) (1988) *A Compendium of Information on Selected Low-cost Building Materials* Nairobi: UNCHS (Habitat).
UNCHS (Habitat) (1988) *Development of the Construction Industry for Low-income Shelter and Infrastructure* Nairobi: UNCHS(Habitat).
UNCHS (Habitat) (1984) *Government Policy Guidelines to Improve the Efficiency of the Construction Industry* Nairobi: UNCHS(Habitat)
UNCHS (Habita t) (1984) *Small-scale Building Materials Production in the Context of the Informal Economy* Nairobi: UNCHS (Habitat).
UNCHS (Habitat) (1982) *Development of the Indigenous Construction Sectors* Nairobi: UNCHS (Habitat).
United Nations Industrial Development Organization (UNIDO) (1985) "The Building Materials Industry: The Sector in Figures*." Sectorial Studies Series* No. 16 Vol.11.
Wangwe, S. M. (1995) "Rehabilitation in the Manufacturing Sector in Tanzania: Approaches and Technical Implications" ATPS Working Paper No.4.

Published by the African Technology Policy Studies Network, P.O. Box 10081, 00100 General Post Office, Nairobi, Kenya.

ISBN 9966-916-88-1

ABOUT THE AFRICAN TECHNOLOGY POLICY STUDIES NETWORK

The African Technology Policy Studies Network (ATPS) is a multi-disciplinary network of researchers, policymakers, actors in the private sector and other end users interested in generating, promoting and strengthening innovative science and technology policies in Africa. With a regional secretariate in Nairobi, the network operates through national chapters in 17 countries, with an expansion plan to cover the entire sub-Saharan Africa.

One of the objectives of the network is to disseminate research results to policy makers, legislators, the organized private sector, civil society, mass media and farmers' groups through ppublications, dialogue and advocacy. Among its range of publications are the Working Paper Series (WPS), Research Paper Series (RPS), Special Paper Series (SPS) and the Technopolicy Briefs.

Papers published under the Working Paper Series (WPS) shall be those produced from the ATPS small grants process or from regional projects but do not meet the strict requirements set out under RPS. Failure for these papers to meet the standards of RPS will not suggest that they do not have significant policy or methodological contribution to make to the work of ATPS. The Board supports all efforts aimed at improving the WPS, such as building skills that will make most of the ATPS research outputs to be published under the RPS. Researchers will be encouraged to produce their final drafts in a publishable manuscript form that is shorter and easier to read. The format will be established by the Secretariat.

ATPS is supported by a growing number of donors including the International Development Research Centre (IDRC), the Carnegie Corporation of New York, the Rockefeller Foundation, the World Bank, the OPEC Fund, Ford Foundation, Coca-Cola Eastern Africa, the African Development Bank, and the Royal Dutch Government.

Yomi Oruwari, Margret Jev and Opuene Owei work at the Faculty of Environmental Sciences, Rivers State University of Science and Technology, at Port Harcourt, Nigeria

For more information on this series and ATPS, contact:

The Executive Director
The African Technology Policy Studies Network
3rd, Floor, The Chancery,
Valley Road

P.O. Box 10081
00100 General Post Office
Nairobi, Kenya
Tel: 254-2-2714168/092/498
Fax: 254-2714028
Email: info@atpsnet.org

Abbreviations & Acronyms

ASCON	Administrative Staff College, Badagry, Nigeria
AT	Appropriate Technology
AT&P	African Timber and Plywood Company, Sapele, Nigeria.
BCM	Building Center Movement
FIIRO	Federal Institute for Industrial Research, Oshodi, Lagos.
FLTC	Firm Level Technological Capability
GERS	Gross Energy Requirements
MAN	Manufacturers Association of Nigeria
NATA	National Agency for Technical Acquisition
NBRRI	Nigerian Building and Road Research Institute, Lagos.
NIA	Nigerian Institute of Architect
NIQS	Nigerian Institute of Quantity Surveying
NLTC	National Level Technological Capability
NSO	Nigerian Standard Organization
PRODA	Project Development Institute, Enugu
RMRDC	The Raw Materials Research and Development Council, Abuja.
SAP	Structural Adjustment Programs (or Policies).
UAC	United African Company (Nig.) Ltd.
UNCHS	United Nations Center for Human Settlements (Habitat), Nairobi, Kenya
UNIDO	United Nations Industrial Development Organization
USD	United States Dollar
WAPCO	West African Portland Cement Company Ltd

ATPS Working Paper Series

No.	Title Publication	Authors
1	The Effect of Economic Reform on Technological Capability	T. Adeboye M. S. D. Bafachwa O. A. Bamiro
2	Methodological Issues in Science and Technology Policy Research	T. Adeboye N. Clark
4	Rehabiliation in the Manufacturing Sector in Tanzania	S. M. Wangwe
5	Agricultural Policy and Technology in Sierra Leone	C. Squire
6	Effectiveness of Agricultural Research Extension in Sierra Leone	A. K. Lakoh
8	Generation and Utilization of Industrial Innovation in Nigeria	O. Oyeyinka G. O. A. Laditan A. O. Esubiyi
9	Irrigation in the Tuli Block, Botswana Water Conservation Techniqes or Optimal Strategies	I. N. Masonde
10	Endogenous Technology Capacity and Capability Under Conditions of Economic Policies of Stabilization and Structural Adjustment	S. E. Chambua
11	Technology and Female-Owned Business in the Urban Informal Sector of South-West Nigeria	Dr. R. O. Soetan
12	Technology Innovations Used to Overcome the Problem of Resource Scarcity in Small Scale Enterprises	C. W. Ngahu
13	Financing of Science and Technology Institutions in Kenya During Periods of Structural Adjustment	M. Mwamadzingo
14	Impact of Economic Liberization on Technologies in Enterprises Processing Agricultural Produce	P. Madaya
15	Technology and Institutions for Private Small and Medium Firms	B. Oyeyinka
16	Institutiona Reform, Price Deregulation and Technological Change in Smallholder Agriculture	E. C. Eboh
17	Adoption of Agricultural Technologies by Rural Women under the Women-in-Agriculture Program in Nigeria	D. S. Ugwu
18	Electrical Power Utilities and Technological Capacity Building in Sub-Saharan Africa	Brew-Hammond
19	Investigation into Factors that Influence the Diffusion and Adoption of Intentions and Innovations from Research Institutes and Universities in Kenya	Bwisa, H. M. and Gachui
20	The effects of Economic Reforms on the Quality on the Quality of Technological Manpower Development in Nigeria	H. E. Nnebe
21	Issues in Yam Minisett Technology Tranfer to Farmer in Southern Nigeria	Michael C. Madukwe Damain Ayichi Ernest C. Okoli

22	Technological Respone to Telecommunication Development: A Study of Firms and Instituions in Nigeria	Adeyinka F. Modupe
23	Gender Differences in Small Scale Rice Farmers' Access to Technological Inputs in Enugu State of Nigeria	David Nwoye Ezeh
24	Adoption of Sustainable Palm Oil Mini-Processing Technology in Nigeria	Nkechi Mbanefoh
25	Domestic Energy Situation in Nigeria: Technological Implications and Policy Alternatives	Olabisi I. Aina
26	Technological Capability in the Nigerian Leather Industry: A Firm-Level Case Study	Uka Enenwe, Enwere dike, Anthony Ihuoma, Mike Duru.
27	Agricultural Research and Delivery in the South-Eastern Highlands of Ethiopia: A Case Study of the SG-2000 Approach in Hitosa District	G. Yiemene
28	Impact of Computer Technology Adoption on Banking Operations in Nigeria	A. I. Odebiyi
29	Agricultural Technology Adoption on Small-Holder Farmers: Policy Policy Options for Nigeria	J. O. Olusi
30	Donor Funding and Sustainability of Rural Water Supply and Sanitation Technologies in Swaziland	Aja Okorie, M. Mabuza, U. Aja-Okorie.
31	Promotion of Production and Utilization of Ceramic Roofing Materials in the Informal Housing Industry in Sierra Leone	Tamba Jamiru
32	Technology Transfer and Acquisition in the Oil Sector and Government Policy in Nigeria	R.I. Chima E.A. Owioduoki R.I. Ogoh
33	Acquisition of Technological Capability in Africa: A Case Study of Indigenous Building Materials Firms in Nigeria	Yomi Oruwari Margaret Jev Opuene Owei