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COMPUTERS FOR INDUSTRIAL MANAGEMENT IN AFRICA:
THE CASE OF NIGERIA*

Prepared by the
Regional and Country Studies Branch
Industrial Policy and Perspectives Division

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PREFACE

The Regional and Country Studies Branch of UNIDO is carrying out a study of the use of computers for industrial management in Africa. It focuses on the present levels of computer usage of this kind, and looks at the obstacles to a wider use. The study is intended to contribute to the development of technical assistance programmes and enhanced international co-operation in this field.

The management use of computers encompasses traditional applications such as payroll, accounts, stock keeping, etc. In other countries the computer has proved a useful tool in increasing the efficiency and accuracy of such tasks and contributing to the effectiveness of the management function. Its role in industry in Africa is potentially very important. However, obstacles to a wider use in Africa are many, and include both economic and technical factors. The study attempts to provide an overview of these.

As part of the whole study, several analyses are being made of individual African countries. The present study examines the case of Nigeria.

The study has been prepared by Professor Michael A. Nwachuku, Department of Electronic Engineering, University of Nigeria, Nsukka, as consultant to the Regional and Country Studies Branch of UNIDO.

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EXPLANATORY NOTES

The Naira (N) is the Nigerian currency. In March, 1989, the value of the Naira in relation to the US Dollar (\$) was:

\$1.00 = N 7.58.

Abbreviations

CAD	Computer-aided design
CADD	Computer-aided design and drafting
CAE	Computer-aided engineering
CAM	Computer-aided manufacturing
CAN	Computer Association of Nigeria
CDNUCC	Committee of Directors of Nigerian Universities Computing Centres
PC	Personal computer
SAP	Structural Adjustment Programme
UPS	Uninterruptible power supply

Organizations

FMG	Federal Military Government (of Nigeria)
FOS	Federal Office of Statistics
IBM	International Business Machines
JAMB	Joint Admissions and Matriculation Board
NEPA	National Electric Power Authority
NITEL	Nigeria Telecommunications Co. Ltd.
NNPC	Nigerian National Petroleum Company Ltd.
NPA	Nigerian Ports Authority
P&T	Posts and Telegraphs department (defunct)
UACN	United Africa Company (Nigeria) Ltd.
WAEC	West African Examinations Council

1. INTRODUCTION

The pace of computerization in Nigeria has been affected by the economic situation determined largely by the falling revenue derived from crude oil export. Ironically, the structural adjustment programme (SAP) - a set of austerity measures to deal with the economic depression - may result in more rapid expansion of computerization in industry. This is partly because of the deregulation in trade and foreign exchange, and partly because of the pressure on management to adopt more efficient production techniques.

Section 2 of the paper attempts to deal in brief with this issue, emphasizing the effect of the nation's changing economic fortunes, the weak technological base of Nigerian industry and the general attitude of government.

Section 3 deals with the quantitative aspects of computerization in Nigerian industry, beginning with a brief historical perspective of computers in Nigeria generally. Information is given on the rate of diffusion of computers, the geographical spread, and the types and makes of machines that have been acquired.

The pattern of computer utilization in Nigerian industry is discussed in section 4. The pattern of computerization is shifting from mainframe and mini-computers to systems based on the micro-computer. The growing popularity of the micro leads to an estimate that about 50 per cent of the nation's industries are using computers. The area of application is mainly in the management field with emphasis on payroll and other accounts-based functions. Office-based automation has been slow to take off; CAD/CAM is practiced mainly in the bigger concerns, e.g. those in the the oil and motor vehicle assembly sub-sectors.

Section 5 deals with the problems and prospects of computer usage for industrial management in the country. Issues examined include the performance of the data processing departments; education and training; the service provided by the computer dealers; the infrastructural facilities available in the country; and the crucial question of a national computer policy. Problems that have hindered computerization are those normally associated with a relatively poor, developing country. At present every machinery and every material needed for the computer are imported. Computerization is therefore an expensive business, subject to frequent breakdowns and low productivity.

The paper concludes with Section 6 which offers a set of recommendations intended to deal with some of the obstacles in the way of future developments. Future improvements are assured if attention is paid to such issues as: local manufacture of a standard brand of the micro; the training of more applications-oriented as well as more maintenance personnel; improving the quality of the infrastructural facilities; and changing the attitudes of managers and the general workforce to the computer. Government intervention is seen as a necessary condition for dealing effectively with the problems highlighted in the study.

2. THE CONTEXT OF COMPUTER DIFFUSION

2.1 A profile of Nigerian industry

The most significant economic event in Nigeria in recent years has been the discovery, in 1956, of crude oil in commercial quantity in the area of the Niger delta. Thereafter, exploration and mining operations, carried out initially by international oil companies such as Shell-SP, were intensified, and the first consignment of crude oil was exported in 1958. In 1976 a Nigerian company, the NNPC, was incorporated to engage in exploration, production and processing activities side by side with the multinationals. Soon, oil became the nation's principal dollar earner, contributing, since the 1970's, to more than 80 per cent of the total export revenue (95.1 per cent in 1984).

The prosperity brought about by the oil boom stimulated a high level of demand among the Nigerian populace for modern consumer goods. This in turn led to the setting up of a large number of manufacturing industries operating on an import-substitution basis. By 1980, there were well over 3000 industrial establishments [1] engaged in a wide spectrum of activities ranging from the extraction and refining of minerals, through food-processing and brewing, to the manufacture of a variety of intermediate goods. The list of goods manufactured in Nigeria includes dairy products; canned fruit, fruit juices and preserves; refined vegetable oil; processed foods; beers and stout; sugar and confectionery; tobacco products; drugs and medicines; textiles and leather goods; paper products; industrial chemicals, fertilizers and pesticides; paints and cosmetics; rubber and plastic products including tubes and tyres; cement; structural steels and other metal products; motor vehicle assembly and spare parts; electrical appliances, electrical cables, radio and television sets.

To be sure, the processes used in manufacturing these products covered a broad range of techniques many of which are quite advanced compared with the traditional technology. This, coupled with the fact that Nigerians were being exposed to an industrial culture, means that the country as a whole was undergoing a process of technological change of considerable proportions. But looked at from the perspective of internally generated innovative practices, these industries, with only a few exceptions, left a lot to be desired. Founded as they were on the principle of rented technology [2], and enjoying enormous profits in a largely protected economy devoid of competition, there was little inducement to engage in, or develop, more efficient techno-managerial practices. In this climate, the use of computers for the enhancement of operational efficiency was looked upon as an expensive and unnecessary luxury. The few exceptions to the rule included the oil companies, where the nature of the industry and the international status of the corporations enforced the use of the best available technologies from the very beginning.

2.2 The structural adjustment programme (SAP)

The halcyon days of Nigerian industry came to an end with the slump in the international crude oil market which began in 1982. The government was forced to embark on a series of austerity measures which included severe foreign exchange restrictions and a system of import licensing. In this regime of austerity, computers and computing equipment were accorded a very

low priority, being classed with general goods. The Buhari-Idiagbon military administration did not issue any import licences for these items in the whole of 1984 and 1985. In 1986, after considerable agitation from all sections of the computer community, import licences for a total of N2,000,000.00 were granted to 13 companies [3].

In a period of economic recession, marked by a scarcity of foreign exchange and a rapidly depreciating value of the national currency (the Naira), many industries have had to either close down, or operate well below capacity, for want of raw materials or spare parts. A recent survey carried out by the Manufacturer's Association of Nigeria [4] showed that the average capacity utilization in the second half of 1988 was 40 per cent, compared with 35 per cent in the first half of the same year.

The present military government under the presidency of General Babangida came to power in August 1985, and immediately set in motion an economic "recovery" programme that has come to be known as the Structural Adjustment Programme, or SAP for short. Some of the principal policy instruments of SAP are: a deregulation of foreign exchange; lifting of import and export restrictions; and the privatization of erstwhile government-owned companies and parastatals. These changes have been accompanied by a more than ten-fold devaluation in the value of the naira since 1981. A new industrial policy, enunciated early in 1989, has toned down some aspects of the 1977 indigenization decree that excluded foreign capital from some sectors of the economy.

SAP is then a new factor that is helping to reorient Nigerian industry towards the adoption of more efficient technological and managerial practices, as well as stimulating the search for local sourcing of raw materials. As one commentator put it [5]:

"any serious attempt in the (manufacturing) sector to come to terms with the future, must first of all accept the inevitability of a declining rate of returns in the medium term; this is a function of the basic fact that production alignments will have to be accompanied by considerable investment either in personnel (training), and/or in equipment; where such investment is in equipment, it goes without saying that such equipment would best be simple and affordable, if not fabricated locally".

The management of Nigerian industry is increasingly turning to the computer as a means to achieve the desired "realignment" of the factors of production.

Still the high naira cost of computing equipment is an effective deterrent to all but the most well-established companies. Today only the oil companies, banks, and possibly the government, can afford a mainframe or a mini-computer. The micro-computer with its relatively low cost and increasing computing power has become exceedingly popular and is set to play a key role in the computerization of Nigerian industry in the next four or five years.

2.3 Infrastructures

The constraints imposed by the infrastructural factors on computerization are discussed in section 5 of this report. It is however important to note here that the oil boom stimulated increased societal demands in other sectors

as well. In the field of education, the nation witnessed a rapid expansion in the number of tertiary institutions and in the range of courses available at the institutions. Computer science departments started to appear in universities and polytechnics from 1977, offering degree-level education in computers and related subjects.

SAP, and the earlier austerity measures, brought about by the oil glut, also affected the institutions; many of them are now too ill-equipped to fulfill their educational goals.

The story is the same in the provision of electrical power and telecommunications infrastructures: rapid expansion in the number of customers, but not enough investments to ensure the maintenance of a sound service.

It is perhaps not surprising that the government has not responded to the frequent calls for a computer policy (although it has itself been one of the major purchasers of computing machinery), as to do so would undoubtedly lead to increased expenditure in an area hitherto accorded a low priority.

The conclusion is that computerization in Nigeria has been taking place in the face of severe limitations. Without the benefit of a guiding policy, matters have been mediated by vendors and consumers in an uncontrolled market environment.

3. COMPUTERS IN INDUSTRY

3.1 A historical perspective

There is no definitive account of the diffusion of computers in Nigerian industry. While it is on record that the electronic digital computer made its first appearance in Nigeria in 1963, in connection with the analysis of the 1962/63 national census data [6], its earliest use in industry probably dates from the early 1970's.

Among the early adopters in industry were such companies as the Nigerian Textile Mills (1970), BEWAC (1971), Nigerian Agip Oil Co. (1971), Shell Petroleum Development Co. (1972), Leventis Technical (1972), UACN (1973), Volkswagen of Nigeria (1976), Nigerite (1976), Lever Brothers (1978), and Peugeot Automobile Nigeria (1978) [7]. The UACN and Lever Brothers are conglomerates with considerable industrial interests in addition to their trading activities; their installations were used for batch processing of data for their industrial divisions/subsidiaries.

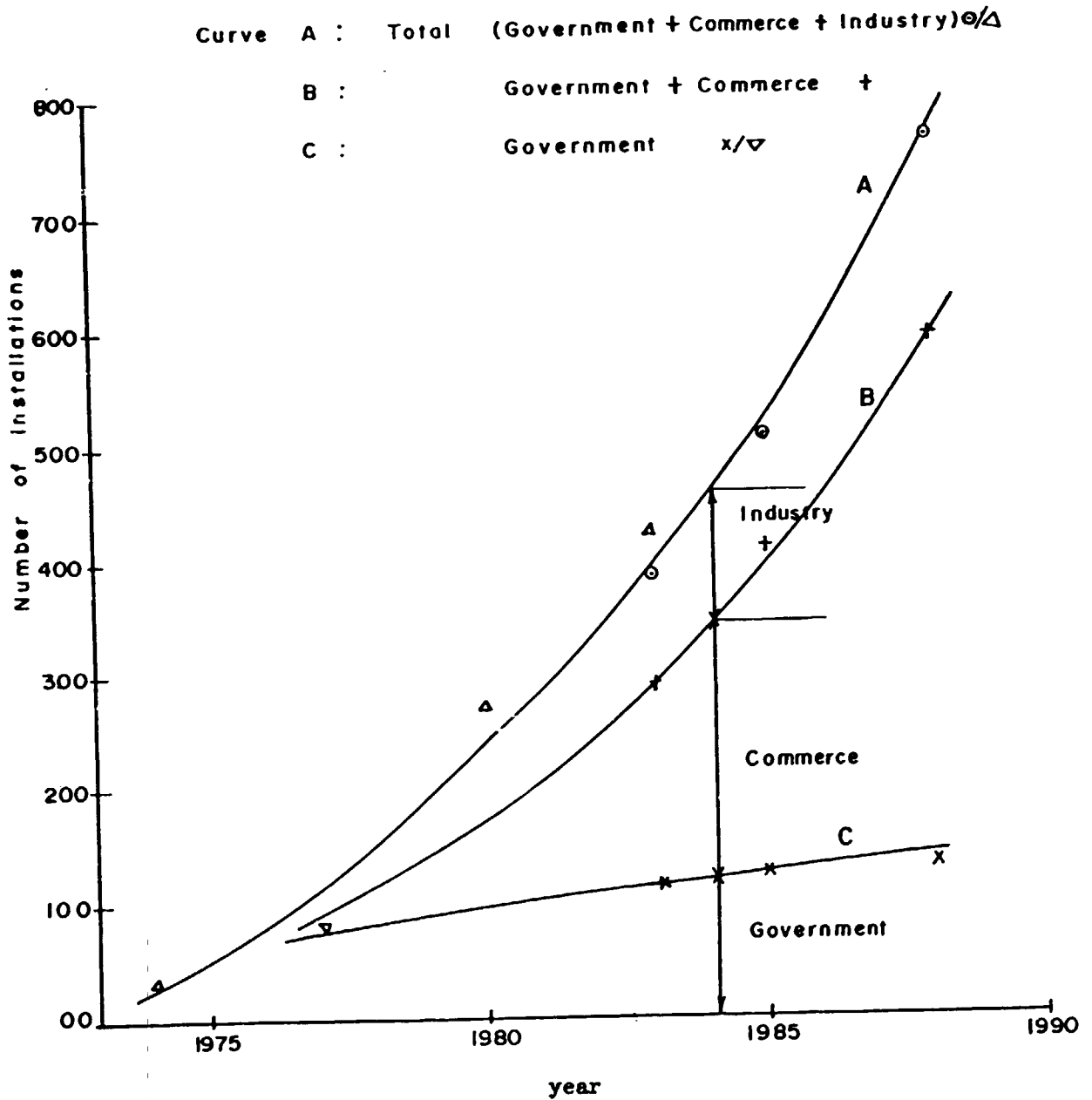
In the ten years between 1963 and 1973, the total computer population in the country stood at between 20 and 25 with perhaps no more than 6 or so of these being associated with industry, mostly in the multinational companies. By 1977 the total number of installations had grown to around 70. This was at a time when many Universities, government departments and parastatal organizations, including the WAEC, JAMB, NEPA, NPA, and the FOS, as well as many banks and commercial firms, had begun to show interest in computers. There could not have been many more than 10 installations in the industrial sector.

Upto 1977 there were only three computer vendors in Nigeria, and all three were the local subsidiaries of overseas computer manufacturers dealing almost entirely with mainframes and minis. In 1977, the government promulgated the indigenization decree which set apart some categories of industrial activity exclusively for participation by Nigerian nationals, while stipulating a minimum of Nigerian interest in others. This had a dual effect on the computer industry in the country. First, there was an influx of indigenous vendors in the computer business. Second, the keener competition in the industry led to more aggressive marketing policies. As a result, the number of computer installations in the country rose sharply. Whereas 39 computers were installed in 1975-1977, 1978-1980 witnessed the addition of 197 new installations. There were 149 new installations in 1981-1983, and a further 99 in 1984-86 [8]. Already by the end of 1982, the price of crude oil was beginning to drop sharply in the spot market; and this marked the beginning of severe foreign exchange shortages and the attendant import restrictions.

3.2 Computer diffusion in industry

The Federal Office of Statistics (FOS) has conducted periodic but unpublished censuses of computer installations in Nigeria; the latest of these [7] gives the position at the end of 1984. Published computer statistics began to appear in 1983 when the first edition of the Nigerian Computer User's Directory [9] was published. The second edition of the publication appeared in 1985 and the third edition in 1988. The availability of this directory permits more accurate statements to be made regarding computer diffusion in the various sectors of the economy. The data contained in the Directory must, however, be treated with caution.

Figure 1. Growth of computer installations in Nigeria



Source: $\odot, +, x$ [ref. 9]
 Δ, ∇ [ref. 8]

Figure 1 shows the growth of computer installations from 1974 to 1988, broken down into three categories, namely:

- (a) government installations including parastatals and educational institutions;
- (b) the service sector, including commerce and banking;
- (c) industry (manufacturing and production).

As can be seen in Table 1, the fraction of the total installations going to the industrial sector has risen steadily from about 17 per cent in 1977 to 23.5 per cent in 1988. It seems that this increase has been won at the expense of government installations which from figure 1 appear to be levelling out. (Government share of the installations is probably set to rise with the present computer sales drive targetted at the Local Government administrations which are now beginning to function effectively as the third tier of government [10].)

Table 1. Growth of industrial computer installations since 1977

Year	Total number of installations	Industrial Installations	
		Number	Percentage of total
1977	115	20	17.4
1980	235	45	19.1
1983	390	80	20.5
1985	496	110	22.2
1899	754	177	23.5

3.3 Number of installations

In absolute terms, the number of industrial installations (estimated at about 180 in 1988) is still small compared with the total number of industrial establishments (more than 3000 listed in the Industrial Directory [1] in 1980, and possibly up to 4000 by 1988). The figure however needs to be adjusted to take account of undeclared micros.

The journal "Computers in Africa" estimates that there were 350000 microcomputers in Nigeria in 1988 [11]. Although this figure includes home computers as well as microcomputers used in institutions and commerce, it is probably an overestimate. If we accept a total figure of 200000 of which say 5 per cent are for industrial use, and allowing an average of 4 microcomputers per industrial user [12], we arrive at a figure of about 2500 for the number of industrial establishments using microcomputers in 1988. This number may be compared with an estimate of 60 microcomputers in industry found by a 1983 survey [13].

If the figure of 2500 is accepted, it means that more than 50 per cent of industrial establishments in Nigeria are using computers in one form or another. A survey conducted in 1987 [14] among 60 establishments spread

throughout the country which were thought by the investigator as "most likely to be using computers", showed that 54 of these, or 90 per cent, were indeed using computers. Although no firm conclusion can be drawn from this finding, it probably shows that the more well-established Nigerian industrial concerns are turning to computers in a big way.

3.4 Geographical spread

The state-by-state distribution of computer installations in Nigeria, using data from the Computer User's Directory 1988, is shown in Table 2. Lagos state leads the field with 72 per cent of all installations, followed by Oyo State (5.0 per cent), Kaduna (including Katsina State)(3.9 per cent), Bendel State 3.1 per cent, Anambra 2.9 per cent and Kano State 2.2 per cent. The other 14 States share less than 11 per cent.

The position of Lagos metropolis as the political, commercial, and industrial capital of Nigeria, as well as being the base of practically all computer vendors in Nigeria, easily explains its dominance in computer usage. Oyo, Kano, Kaduna and Bendel States, each with more than 2 per cent of the installed computer capacity, are also known to have a significant concentration of industries.

Table 2. Distribution of computer installations by state

S/NO.	State	Number of installations	Percentage of total
1	Anambra	22	2.9
2	Bauchi	5	0.7
3	Bendel	24	3.1
4	Benue	3	0.4
5	Borno	2	0.3
6	Cross River ^{a/}	7	0.9
7	Gongola	4	0.5
8	Imo	13	1.7
9	Kaduna ^{b/}	30	3.9
10	Kano	17	2.2
11	Kwara	8	1.0
12	Lagos	550	71.7
13	Niger	1	0.1
14	Ogun	10	1.3
15	Ondo	12	1.6
16	Oyo	38	5.0
17	Plateau	5	0.7
18	Rivers	13	1.7
19	Sokoto	3	0.4

a/ Includes Akwa Ibom State.

b/ Includes Katsina State.

Source: [9] (3rd edition)

3.5 Computer types

Table 3 shows the percentage distribution of types of computers used in Nigeria (all sectors) from 1979 to 1988. The growing population of microcomputers is hard to estimate as has already been noted. It is however certain that the trend is towards the increasing use of microcomputers: "the trend in computer sales in Nigeria indicates that older computerized companies and institutions with mainframes, as well as those newly computerising (with or without mainframes or minis) are all investing substantially in desktop micros" [16].

Table 3. Types of computer installations 1979 - 1988

Year	Micros Percentage of total	Minis Percentage of total	Mainframe Percentage of total
1979 ^{a/}	-	50	50
1983 ^{b/}	10	57	33
1985 ^{c/}	4	58	18
1986 ^{d/}	24	41	35
1988 ^{e/}	41.5	44.6	13.9

Sources: a/ [15]
 b/ [7]
 c/ [9] (2nd edition)
 d/ [8]
 e/ [9] (3rd edition)

3.6 Computer brands

Using figures compiled by the Computer User's Directory, the distribution of installed computers among the leading brands (1988) is shown in Tables 4 to 6. Among those described as mainframes, the most popular computers are NCR (22 per cent), IBM and ICL each with 21 per cent of the total. Others are Wang (18 per cent) and Cyber CDC (13 per cent).

With minicomputers, the leading brand is NCR (24 per cent), closely followed by ICL (23 per cent). Monroe LC 60 (15 per cent) and Digital (PDP and VAX) (12 per cent) are also well represented.

In the area of microcomputers the IBM-PC and its stable mates are the clear leader (43 per cent); Apple (20 per cent) and Tiger (16 per cent) are also well-represented.

3.7 Sources of imports

Table 7 shows the importation of digital computers by country of origin in the first six months of 1988; Table 8 gives the importation of off-line data processing equipment for the same period.

The total value of computer-related imports for the first six months of 1988 is N90,616,000.00, made up as follows:

Digital computer	71,357,400
Analog and hybrid computers	15,393,300
Off-line data processing equipment	2,064,000
Peripheral units	1,393,400
Central storage units	407,900
Total	N 90,616,000

Table 4. Brands of mainframe computers in use (1988)

Make	Number installed	Percentage share
NCR	32	21.6
IBM	31	20.9
ICL	31	20.9
Wang	26	17.6
Cyber CDC	20	13.5
Eclipse	6	4.1
Prime	2	1.4
Total	148	

Source: [9] (3rd edition)

Table 5. Brands of mini-computers in use (1988)

Make	Number installed	Percentage share
NCR	99	24
ICL	96	23.2
Monroe	60	14.5
Digital	49	11.9
Microdata	31	7.5
Hewlett-Packard	24	5.8
IBC Super Cadet	14	3.4
Nova/Olivetti	12	2.9
Wang	12	2.9
IBM	11	2.7
Texas Instruments	5	1.2
Total	413	

Source: [9] (3rd edition)

Table 6. Brands of microcomputers in use (1988)

Make	Percentage share
IBM	43.3
Apple	19.7
Tiger AT	16.0
Tandy	7.6
ICL PC	4.4
Wang	3.4
Olivetti	2.9
Commodore	1.9
Amstrad	0.4
Atari	0.2
Sanyo PC	0.2
Total	100.0

Source: [9] (3rd edition)

Table 7. Import of Digital Computers complete by country; 1988, January to June

Country	Quantity		Value N'000
	kg	Number	
Japan	310,337	46,381	46,525.3
USA	35,895	699	15,057.6
United Kingdom	18,444	468	4,395.2
Federal Republic of Germany			2,022.8
Netherlands			1,052.0
France	2,089	202	891.6
Switzerland			636.3
Republic of Korea	2,134	210	461.0
Ireland	1,772		191.9
Italy	302	19	85.6
Australia	268	12	22.8
Hong Kong	106	2	11.4
Free Zone	38	1	3.8
Total			71,357.4

Source: Federal Office of Statistics

Table 8. Import of off-line data processing equipment by country; 1988, January to June

Country	Quantity		Value N'000
	kg	Number	
United Kingdom	3,635	43	786.3
USA	9,383	202	609.2
Israel	2,000	70	158.7
Federal Republic of Germany	455	13	132.6
Belgium	2,953	48	103.4
France	33	6	85.8
Hong Kong	3,320	6	66.4
Italy			61.3
Japan	1,165		40.8
Switzerland	33	1	11.7
Austria			8.0
Total			2,064.0

Source: Federal Office of Statistics

4. INDUSTRIAL APPLICATIONS

4.1 Overview

Computerized tasks in the manufacturing industry may be conveniently classified into three functional categories, namely: design, manufacture, and coordination. The design function includes the conceptualization of the product; the science-based activity of analysis and design (aimed at specifying and possibly optimising the parameters of the product); and the graphics output which serves as the input to the manufacturing function. Manufacturing on the other hand entails all the activities taking place on the shop floor which are necessary to transform the design into a physical product as efficiently as possible, and to acceptable standards of quality and cost. Under co-ordination we place those tasks of an administrative or managerial nature which are necessary for the smooth running of a company's business. Whereas design and manufacture are unique to industry, the co-ordination function applies to other types of businesses as well.

Internationally, the computer has been successfully applied to all spheres of industrial activity, starting initially with the computerization of individual tasks - the so-called "islands of automation" - and progressing in various stages of integration to what is now termed "computer integrated manufacturing".

4.2 Pattern of applications

The findings of a limited survey of the use of computers in Nigerian industry carried out by Tulien in 1985 [17] are summarized in Table 9.

These findings are partially corroborated by the findings of [8] which showed that nearly 84 per cent of all computer installations in Nigeria use the system for financial accounting including payroll. Nevertheless, they also show that in the Nigerian environment, examples of computerization in all three spheres may be found. The same conclusion may be drawn from Table 10, which was obtained from a rather biased sample of 60 firms [14].

CAD and CADD are the least developed, no doubt on account of industry's heavy dependence on imported technology and product licensing. Use of computers in manufacturing (CAM), with the exception of certain high technology process industries in which the process computer is essentially a part of the process machinery (e.g. petroleum refining and the steel mill), is only a recent phenomenon. It is in the area of co-ordination, or management, that the greatest advance has been made.

4.3 CAD/CAM

It is estimated [8] that 3.3 per cent of all computer installations in Nigeria are used for the manufacturing function. If we allow that only 20 per cent of all installations are for industrial use, we may infer that only about 16 per cent of industrial organizations are using computers in manufacturing. This application area includes stock-control, works order processing, production monitoring and control, and process scheduling.

Table 9. Results of an industrial applications survey ^{a/}

Computer application	No. of firms using	Percentage
1. Financial operations	8	67
2. Inventory & stock control	4	33
3. Production planning & control	5	42
4. Design engineering	3	25
5. Manufacturing engineering	2	17
6. NC machine tools	-	-

^{a/} Number of companies in survey is 12.

Source: [17]

Table 10. Use of computers for management in a survey of 60 firms

Computerized function	Percentage
1. Accounting	100
2. Administration	57
3. Production management	49
4. Word-processing	26
5. Process control	15
6. CAD/CAM	6

Source: [14]

Table 11. Use of programming languages in a survey of 60 firms

Language	Percentage
1. COBOL	68
2. BASIC	63
3. FORTRAN	17
4. RPG II	11

Source: [14]

A number of firms which have taken a lead in this area are already working on the computerization of their maintenance setup. One factory at which the programme is very advanced is placing emphasis on maintenance cost control, and the integrated scheduling of preventive maintenance with regular machine operation.

NC machines and industrial robots are for the most part unknown. Quality control, which has been neglected in Nigeria, is not computerized, although in the case of a steel mill, computers are used off-line for product monitoring and quality control.

4.4 Management

The management function includes the following tasks:

- financial administration
- office automation
- personnel management

4.4.1 Financial administration

Computerization has been most widespread in the area of financial management including payroll, accounts, general ledger, sales and invoicing. In fact the accounting task is frequently the motivation for installing the computer in the first place. More than 80 per cent of computer installations are used in this way. There are also many instances of companies that have not installed computers but have their accounts and payroll batch-processed on a bureau computer owned by a vendor or an agency. A reasonable estimate is that more than 50 per cent of all Nigerian industry is using computers for accounting, either in-house with their own data processing staff, or with the help of external computer agencies. The software used for this purpose is usually a commercial software product. The companies often do not have experienced system analysts; there may be one or two programmers to maintain the software.

Some firms are reluctant to use a computerized invoicing and billing system. The usual reason given for this is the fear of fraud. In addition, the public perception of the NEPA and NITEL computerized billing systems as being very inaccurate, has not helped to establish confidence in such systems.

4.4.2 Office automation

Office automation is not widespread. Micro-computer-based facilities have word-processing software. Table 10 shows that only 26 per cent are using word-processors, but this usage has not displaced the familiar secretary behind a typewriter. Companies with only mainframes and/or minis are, not surprisingly, still relying on the manual typewriter. Fax machines are found only in the most advanced offices, but the telex is more widespread. Electronic mail and teleconferencing are virtually unknown.

4.4.3 Personnel management

Once a company has computerized its payroll, it quickly goes in for computerized personnel administration making use of the same data base employed for payroll.

4.4.4 Database and spreadsheet

Databases and spreadsheets are used on micros by technical and general managers who may have a microcomputer installed in their private offices as stand-alone systems. One company plans to integrate these micros with a mini which holds the company's parts data base.

4.5 Programming languages

COBOL is the most popular language used, closely followed by BASIC. FORTRAN and RPG II are also used. Table 11 shows the reported usage of these

languages among the 60 firms polled by [14]. The percentages are assumed to be applicable nation-wide.

4.6 Summary

In summary it may be observed that the rate of diffusion is fastest in payroll and other accounts-based functions, slower in office-based co-ordination applications, while manufacturing and design applications come out a poor third.

A similar pattern has been observed in Ireland [18], and seems to conform to wider international experience. It has been explained in terms of the need for rationality (defined as "the existence of unambiguous and documented procedures by which work is performed") as a pre-condition for effective computerization [19]. In this view, payroll, accounts receivable, general ledger and other accounting type tasks are among the most rational processes for all organizations, and are consequently the earliest to be computerized. As a corollary, it may be observed that a general weakness of small- and medium-scale industries in Nigeria is that they cannot boast of having the degree of rationality conducive to effective computerization. The diffusion of computers to these areas could be impeded as a result.

5. PROBLEMS AND PROSPECTS

5.1 Introduction

We have seen from the discussion in the preceding sections of this paper that computerization in Nigerian industry has advanced considerably beyond the stage when it was a monopoly of a few rich, multinational, oil companies and business conglomerates. Computers are now being used by middle-sized companies under indigenous management. Establishments in the latter category are turning to the computer in ever increasing numbers as an answer to the challenges posed by the economic recession in a new, largely de-regulated and more competitive, business environment.

The trend will most likely to continue, with the computer diffusing in greater numbers to the medium-sized, and, perhaps to the smaller scale industries. It is also possible to foresee the computer being put to more complex uses. But the rate of progress will be determined by actions taken to remove the constraints to development present in a number of crucial areas. In this section, we look at these issues in turn, and attempt to predict the prospects for the future of informatics development in the country.

5.2 Problems of the data processing departments

All companies with mainframes or minis, and those with a sizeable number of microcomputers (whether stand-alone or connected in networks), have data processing departments under the control of a data processing manager who reports either to the technical manager or to the general manager. In general the staffing levels in these departments are far from satisfactory. One finds a handful of supporting staff - a systems analyst, one or two programmers, and some data entry personnel (who have generally been converted from a lower staff cadre), and an operator. This staffing level is often adequate to handle only routine data processing tasks using accounting packages which may have been modified and are maintained in-house. In these circumstances, there is little time or encouragement to engage in original software development aimed at extending or intensifying the degree of computerization.

The problem of inadequate staffing is not primarily due to a lack of qualified personnel in the country. Indeed unemployment among qualified and trained computer practitioners has become a fact of life in Nigeria today; there is however a dearth of experienced high-calibre personnel. The poor staffing levels seem to have been necessitated by management policies which do not accord a high priority to the data processing department in a period of economic recession and job insecurity. As one data processing manager put it: "how can you ask for more staff when you are lucky to keep yours?".

The issue is compounded by a lack of co-operation from personnel in departments slated for computerization. There is the fear that computerization will, at worst, lead to mass retrenchment, or, at best, to a loss of earnings from institutionalized overtime perquisites.

Management, on its part, sometimes appears only tolerant of the data processing departments, and can only justify their existence by saddling them with other responsibilities outside the strictly data processing function (one data processing manager is also in charge of the procurement and maintenance of office equipment and supplies).

The problems faced by the data processing departments are thus: low status; lack of management support; poor staffing levels; and lack of co-operation bordering on outright hostility from departments "in danger" of computerization. As a result, there exists a severe under-utilization of computing equipment, as well as low productivity among the staff. As one data processing manager observed: "it makes you and the computer seem dull".

An improvement in the situation discussed above can only come about with the development of a better attitude to computers among decision makers, managers, and the general workforce. There is no indication at present that the representatives of the labour unions are being taken into confidence by management, when computerization is being planned, to get their support. Efforts by individual industry in this regard must however be accompanied by a national informatics education campaign.

5.3 The cost of computers

Without doubt, the single most important factor contributing positively to the growing popularity of computerization in Nigerian industry is the availability of the microcomputer which has greatly reduced the cost of owning and operating a computing facility. At prevailing prices, any one wishing to install a mini-computer in Nigeria will have to be looking for a sum of about N 1,000,000.00, with perhaps a similar outlay in the cost of supporting facilities including software. On the other hand, a network of micros which can handle the data processing needs of most medium-sized companies will be available at about one-tenth of this amount. Sources in the trade suggest that the total mainframe and mini sales in Nigeria are running at about 30 units per annum or less. Perhaps, less than 30 per cent of this is for industrial use.

Unfortunately, micros are still highly priced in Nigeria relative to their international prices. Although one frequently reads about falling prices in the international press, the prices of the same goods in Nigeria seem to be always on the increase. This discouraging situation is explained partly by the low and ever-falling dollar parity of the naira, and partly by the high mark-ups which have always been a feature of the Nigerian hardware market.

To ease the problems of acquiring much-needed industrial equipment, including computers, Nigerian banks have devised leasing loan arrangements. A possible side effect of this approach is that it may lead to better feasibility studies, by competent consultants, of proposed computer installations, and therefore, to better utilization of such facilities.

Another approach to finding a solution to the problem of high cost of the micro is the development of computer manufacturing in Nigeria. On this, see section 5.5 below.

5.4 Computer services

There are over 200 registered companies in Nigeria offering a broad range of computer-related services [20]. Most of them were set up between 1977 and 1982 to take advantage of the Indigenization Decree and the then prevailing economic boom.

A partial survey [8], conducted in 1986 and involving 47 computer companies, showed that 88 per cent of these are vendors; 79 per cent are consultants; 70 per cent offer training services; 68 per cent have maintenance facilities; while 45 per cent offer bureau services. There is a lot of overlapping as many firms offer three or more services.

As is to be expected, the companies vary widely with respect to available capital, experience and technical expertise, and the quality of maintenance and after-sales service provided. The weakest link in the chain is in the area of a reliable maintenance service to reduce the incidence of down-time in installations. Even where service facilities exist, replacement parts may not be readily available. The quantity and range of spares carried are not enough, and waiting times for imported spare parts are usually very long. The problem is aggravated by a proliferation in the different makes of imported computers - especially micros - available in the market. User complaints about vendors are more often than not associated with the great difference between claimed and actual maintenance capability. But as one speaker at a recent symposium and workshop said [21] "the area of operation of fraudulent vendors are becoming narrower than before"; and he predicted that in time these vendors would disappear.

On the whole the companies are doing a creditable job, in spite of their numerous handicaps, to supply the growing need for computer equipment and services in Nigeria. The next few years will see a vast improvement, as suppliers take advantage of the liberalization of foreign exchange and the increased volume of business expected from growing industrial usage. Already a new development has started with the setting up of a Rework Centre at Lagos by NCR for the refurbishing of aging equipment.

5.5 A local computer industry

Many reasons have been adduced in support of Nigeria developing a local computer manufacturing capability. These include the high cost of imported equipment, the need to standardize on hardware (and software), and the question of maintenance [22]. Assessing these arguments, Pryce [22] expressed the view that "the evidence points overwhelmingly to the local production of a clone of the IBM PC - a machine-type (rather than an individual machine) with a vast store of cheap software, with ample power for 95 per cent of Nigerian computing applications for the next 5 to 10 years, and capable of being periodically up-graded in memory and speed by exploiting US and Japanese advances in chip technology".

One computer firm is already assembling the Modellor version of the IBM PC, and there is a Kenyan experience [23] to learn from. But experience of the motor car assembly industry in Nigeria suggests that the nation should, from the start, look beyond mere assembly of computing equipment. The Nigerian Government seems to have taken a stand on the issue. Dr. Chu Okongwu, the Minister of Finance, was quoted [16] as telling a Computer Workshop at Owerri in Imo State that "the Government is looking forward to the day when a 100 per cent indigenous (computer manufacturing) company will be built and maintained in Nigeria".

A development that can be expected in the near future is the appearance of software houses producing application software for local needs. Many of the experts at the symposium reported in [22] believe that all requirements

for indigenous production of quality software are already met. A commercial software venture can only be viable in Nigeria if it is preceded by a degree of standardization of microcomputer types, and, possibly, local manufacture. It may also be useful to consider the Iraqi model [24] where an information processing centre under the ministry of industry undertakes the development of software relevant to the needs of Iraq and distributes them at low cost to government-owned industries all of which use standardized equipment.

5.6 Infrastructural deficiencies

The problems associated with the inadequacies of the infrastructural factors as they affect computer development in the developing countries are very well known. A leading member of the computer community in Nigeria has observed [25]: "...the environmental situation in Nigeria has remained, resulting in considerable additional cost to computer installations. It is true that computers have become more tolerant to adverse conditions as they have become smaller, but non-the-less, any installation still has to be supported by a generator, or an uninterruptible power supply system, high quality air-conditioning and, above all, a dust-free atmosphere. I fear that this expense will continue to be with us for some years to come". These issues can bear further elaboration.

5.6.1 Electric power supply

The most acute problem arises from an erratic power supply. PC users are the greatest sufferers as very often they cannot justify spending large sums of money, perhaps greater than the cost of the PC installations, on stabilizers and UPS. The cost in frustration, when, in a session of about two hours, the power supply fails three or four times, or remains down for an hour or more, has to be experienced to be appreciated.

Apart from a general qualitative appreciation of the power supply problem, there has been no attempt to quantify its severity in terms of extra cost to the user, loss of data, personal frustration and equipment malfunction. NEPA ceased long ago to publish statistical data of faults on the power system; but the sources of its problems are only too well known [26]:

- power supply to the "grid" from only one main source
- single transmission lines to the load centres
- single transformers at the substations
- system overloading due to uncontrolled and uncontrollable expansion of consumer connections
- gross mismatch between the rate of acquisition of new consumers and the rate of capital investments to reinforce the system.

The attitude that these things will always be with us pervades the whole strata of society from the user to the supply authorities. And this is probably justified if one thinks merely in terms of the enormous capital investments that will be needed to bring about a change. This is where a national body supervising the problems and progress of computerization can come in. Such an authoritative body will be in a position to quantify the cost to the nation of an erratic power supply as it affects both the computing community and industry generally. It may well be that the annual cost of enduring an erratic power supply is far greater than the annual cost of the capital investment required to bring about an improvement in the reliability

of the supply. The issue of reinforcing the national grid to achieve greater reliability must be seen as a national priority.

5.6.2 Telecommunications

An efficient telecommunication service is an important requirement in the development of computer-based technologies in any country. The more sophisticated state-of-the-art computer technologies depend on the telecommunication network. This need is mutual, as modern telecommunication technology has itself become more dependent on the use of the computer. This inter-dependence of computers and telecommunications has given rise to new telecommunication services based on digital technology.

To date, the Nigerian telephone network uses electro-mechanical equipment. Current estimates are that there are 205,000 connected telephone sets in the country, giving a density of 2 telephones per 1000 persons, which is among the lowest in the world. (The comparative figure for the USA is 500 per 1000 persons, and Ghana has 7 telephones per 1000 persons).

The Nigerian corporate computer user is beginning to demand facilities for wide area computer networks as well as data communications. At present, the demand is judged insufficient to warrant the establishment by NITEL of a data communication service using the existing voice facilities [27]. Dial-up facilities and leased data lines are in use in the Lagos area, but, as pointed out by Denloye [27], an operator of a leased line "is left pretty much on his own to attach whatever equipment he chooses to the line. He can expect no help from NITEL in determining the quality of the line he leases, and has to ensure correct operation himself".

The oil industry has taken a lead in establishing their own data network with or without the involvement of NITEL. Shell has installed an X.25 packet switching data network between Lagos, Port Harcourt and Warri using trunk lines leased from NITEL. On the other hand, the NNPC has recently completed a private telecommunication network said to be the largest in Africa [28]. The all-digital network incorporates 875 km of optical fibre cables, and will come under the Integrated Data Services Company, one of the 12 new subsidiary limited liability companies established by the NNPC in 1988 as part of its new commercialization programme.

The NNPC installation is an interesting development since it is a chink in the armour of monopoly invested in NITEL (a new limited liability company created in 1986, in succession to the now defunct P&T, to run the telecommunication service on a commercial basis). NITEL is aware of the need to improve the quality and range of its services. As President Babangida himself has said: "today, the telecommunication network is unreliable and inadequate to meet the demands in the country. In order to improve this situation, a programme of expansion and modernization of the network is being planned" [29].

In an effort to evolve a coherent Telecommunications Policy, two national symposia have been held [30, 31]. Despite much debate, a decision has yet to be made on the introduction of digital switching and transmission systems although a Minister of Communications once said [32]: "the conclusion of the various submissions overwhelmingly pointed to the fact that Nigeria has to go digital".

5.6.3 Environmental conditions

Nigeria has a tropical climate. There are really only two seasons: a hot and very humid rainy season; and a hot and dust-laden dry season. These are trying conditions for electronic equipment designed for more temperate regions. Room air-conditioning is required for all installations, including microcomputers, as a solution to the temperature and humidity problems; but again this is subject to the vagaries of the power supply. It is almost impossible to keep out the harmattan dust although the use of room air-conditioning permits one to keep all windows shut and use heavy blinds.

International computer manufacturers perhaps ought to pay more attention to the needs of tropical countries in their designs.

5.7 Computer education

Computer education in Nigeria has come a long way since the foundation of the IBM African Education Training Centre at the University of Ibadan in 1963 for the training of computer personnel able to operate, program and, to a limited extent, service IBM 1461/1620 machines. Today there are full-fledged computer science departments in Nigerian universities and other tertiary institutions teaching a range of subjects including computer organization; software engineering; programming and programming languages; numerical computations; and systems analysis. Studies at these institutions lead to degrees or diplomas in computer science (see Table 12).

In addition, electrical and electronic engineering departments of Nigerian universities are teaching courses in microprocessors, digital design, and computer interfacing [33].

Computer education and training are also offered by a number of private academies (some with government recognition), vendors and consultants (see Table 13). These are usually profit-oriented, and are limited in scope. In many of the major towns, there are now computer bureaux, equipped with one or two micros and which offer short term courses on operationg systems (mainly MS-DOS), and commercially available application software, e.g. database, spreadsheet and wordprocessors, in addition to other services.

There is a general consensus that the quality of training especially in software is good [22, 25]. Nevertheless the broadbased educational programmes offered at the Universities and polytechnics concentrate on hardware and software issues . There is only a limited exposure to industrial problems-solving. Despite the difficulties in providing training courses in application areas relevant to the needs of a developing country [34], there is a need for greater efforts in this direction. Without doubt, the products of the existing programmes are adequately trained to man routine data processing departments and computer centres; and they will always be needed in limited numbers as the base of computerization in the country widens. However, it is emphasized that the country needs a crop of application-oriented computer experts with a firm background in applied science or engineering, and good training in computing and computer-interfacing, to harness the higher capability of the computer to transform a nation's industrial economy.

Table 12. Computer education in tertiary institutions

S/No.	Name of institution	State	Course Title	Award
1	Ahmadu Bello Univ.	Kaduna	Math with Comp.Sc.	degree
2	Anambra State Univ. of Technology	Anambra	Electronics/ Computer Sc.	degree
3	Bayero Univ.	Kano	Computer studies	certificate
4	Federal Uni. of Tech. Abeokuta.	Ogun	Comp. Sc.	degree
5	Federal Uni. of Tech. Bauchi	Bauchi	Comp. Sc. & Comp. Tech.	degree
6	Federal Uni. of Tech. Owerri	Imo	Communication Comp. Eng. Tech.	degree
7	Obafemi Awolowo University	Oyo	Comp. Sc.	degree
8	Rivers State Univ. of Tech.	Rivers	Comp. Studies	degree
9	University of Benin	Bendel	Computer Sc./ Data process.	degree/ diploma
10	University of Ibadan	Oyo	Computer Sc.	degree
11	University of Lagos	Lagos	Computer Sc./EDP	degree/certif.
12	University of Nigeria, Nsukka	Anambra	Computer Sc.	degree
13	University of Port Harcourt	Rivers	Computer Sc.	degree
14	University of Sokoto	Sokoto	Computer studies	certificate
15	College of Sc.&Tech.,PH	Rivers	Computer Sc.	certificate
16	College of Tech.Calabar	Cross River	Computer Sc.	diploma
17	Ibadan Poly	Oyo	Computer Sc.	diploma
18	Inst.of Man.&Tech.	Anmbra	Computer Studies	diploma
19	Kaduna Poly.	Kaduna	Computer Studies	certificate

Source: ref. [9]

Table 13. Computer training provided by computer vendors and consultants

S/No.	Course title	No. offering	Percentage
1	Commercial programming	21	100
2	General programming	21	100
3	Scientific programming	21	100
4	Systems analysis	19	90
5	Real Time programming	16	76
6	Computer operations	15	71
7	Data processing	13	62
8	Systems programming	13	62
9	Audit of computer systems	11	52
10	Key punch operation	11	52
11	Data base	6	29
12	Languages for micros	6	29
13	Software project	6	29

Source: ref. [9]

5.8 Professional activities

The principal professional body on computers in Nigeria is the Computer Association of Nigeria (CAN), established in 1980. CAN holds widely publicized annual conferences on computers and computer applications at which papers on relevant topics are presented. Adeniran [35] found that of the 165 papers presented at conferences from 1965 to 1985, no fewer than 89 were presented at CAN conferences. Conference proceedings are not generally available in published form.

In 1975, the Committee of Directors of Nigerian Universities Computing Centres (CDNUCC) was formed as a "forum for the sharing of experiences, exchange of ideas and general co-operation" [36] among Nigerian University Computing Centres. A biennial series of conferences was initiated in 1985 and the proceedings were published; there has been no further publication since.

Other bodies including the universities and computer consultants also organize conferences, workshops and seminars on computing themes. Ogis and Ododo, a computer consultancy has pioneered computer publishing in Nigeria with the Nigerian Computer User's Directory. Ogis and Ododo also publish a monthly trade journal called "Computing and Computers". Another computer directory, "The Nigeria Computer and Telecommunication Buyer's Guide", is also available. A new trade journal, "The PC Digest", was launched in March 1989 by a computer vendor.

That avenues for disseminating technical and semi-technical information are still limited is a sign of the immaturity of computing in Nigeria. With books, and international journals and periodicals, out of reach of even university libraries, the need for more local publishing in computers as well as other areas has become urgent.

5.9 Policy issues

At almost every gathering of computer people in Nigeria, there is a call for a national computer policy, and also for a high-powered executive authority to give effect to the policy.

In the late 1970's the Federal Government set up a committee known as the Central Computer Committee, charged with the task of assembling available national data on computing. The Committee was expected to develop standards for users, vendors and consultants on computer projects as well as develop inputs for a national policy on computing. In addition, the Committee had the practical function of reviewing all applications for the importation of computers and making recommendations to the Ministry of Finance. In a period of import licensing, the last function tended to dominate the activities of the Committee. With the advent of deregulation, the Committee can now be fairly said to be moribund. If, as Onunaku [37] states, the Committee succeeded in making recommendations for a computer policy, there is no indication what the outcome was, apart from the considerable interest shown thereafter by Governments of the Federation in computerising aspects of their administrations.

Lately the Government has been showing considerable interest in the need for greater computer awareness and literacy in the country. For example the Federal Ministry of Education in October 1988 announced a programme to spend a

sum of N 20.0 million to equip 45 Federal Unity secondary schools with microcomputers. 40 micros will be installed at the National Teachers Institute, Kaduna, to turn out teachers for the programme.

It is important however to place the Government's latest initiative in perspective. Assuming that the programme will purchase upto 500 micros, this works out at slightly more than 10 micros per school. The Federal Unity schools have no more than 2 per cent of a total secondary school enrolment of about 2 million (on a population base of some 100 million). This effort may be compared in relative scale to a similar programme in Singapore (total population 2.5 million) which as far back as 1981 flooded all secondary schools in that country with 200 mini and micro computers [38].

But there are other signs to show that the FMG and State Governments are taking the computer question very seriously. For example, the Anambra State Government has been at the forefront of giving moral and financial support to the initiatives at the State's University of Science and Technology to develop a computer manufacturing capability. Computer literacy camps have been organized for secondary schools in Lagos State. As far back as 1984, the FMG invited a United Nations Mission to Lagos "to advise on the preparation of data bank projects with a view to defining basic policy issues and establishing successful computerization within the government" [39]. Five data bank projects in the areas of agriculture, industry, and science and technology were considered.

However encouraging these government initiatives may be, they are not a substitute for a co-ordinated national strategy for computer development in the country. The case for government intervention is all the stronger in a developing nation, where government, by tradition and sheer resource base, plays a pre-eminent role in all aspects of national development.

6. CONCLUSION

Computerization in Nigerian industry is undergoing a healthy development. With the removal of import restrictions and foreign exchange controls, and given the pressure on management for more efficient methods of production, the use of computers is likely to expand rapidly both quantitatively and qualitatively.

The study identified a number of factors which, if effectively tackled, will accelerate the pace of computerization. Priority should be given to ensuring adequate and reliable supply of electrical power and telecommunications facilities. Of equal importance is the need to adopt policies that will ease the cost of owning and maintaining a microcomputer. In this regard, due consideration should now be given to the local manufacture of a standard brand of micro, and the establishment of software houses, possibly with the backing of the Federal Government.

In the educational field, accent should now be placed on the production of graduates with experience in applications-oriented areas.

Progress in dealing with these matters will be faster, better coordinated, and will extend the use of computers to more fundamental areas of application, if developments are mediated by a national informatics policy. A national informatics authority should be set up to plan and regulate the process of informatics development. As suggested by Foster et al. [40], the national informatics authority should, among other functions, promote informatics applications in all sectors of the economy; monitor the progress and trends in informatics development in the nation generally; and set national targets for all sectors.

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