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17145

Distr.
LIMITED

ID/WG.478/10(SPEC.)
16 November 1988

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Global Preparatory Meeting for the
First Consultation on the Electronics Industry

Grenoble, France, 28 November - 2 December 1988

THE ELECTRONICS INDUSTRY IN TANZANIA*

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* The views expressed in this document are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

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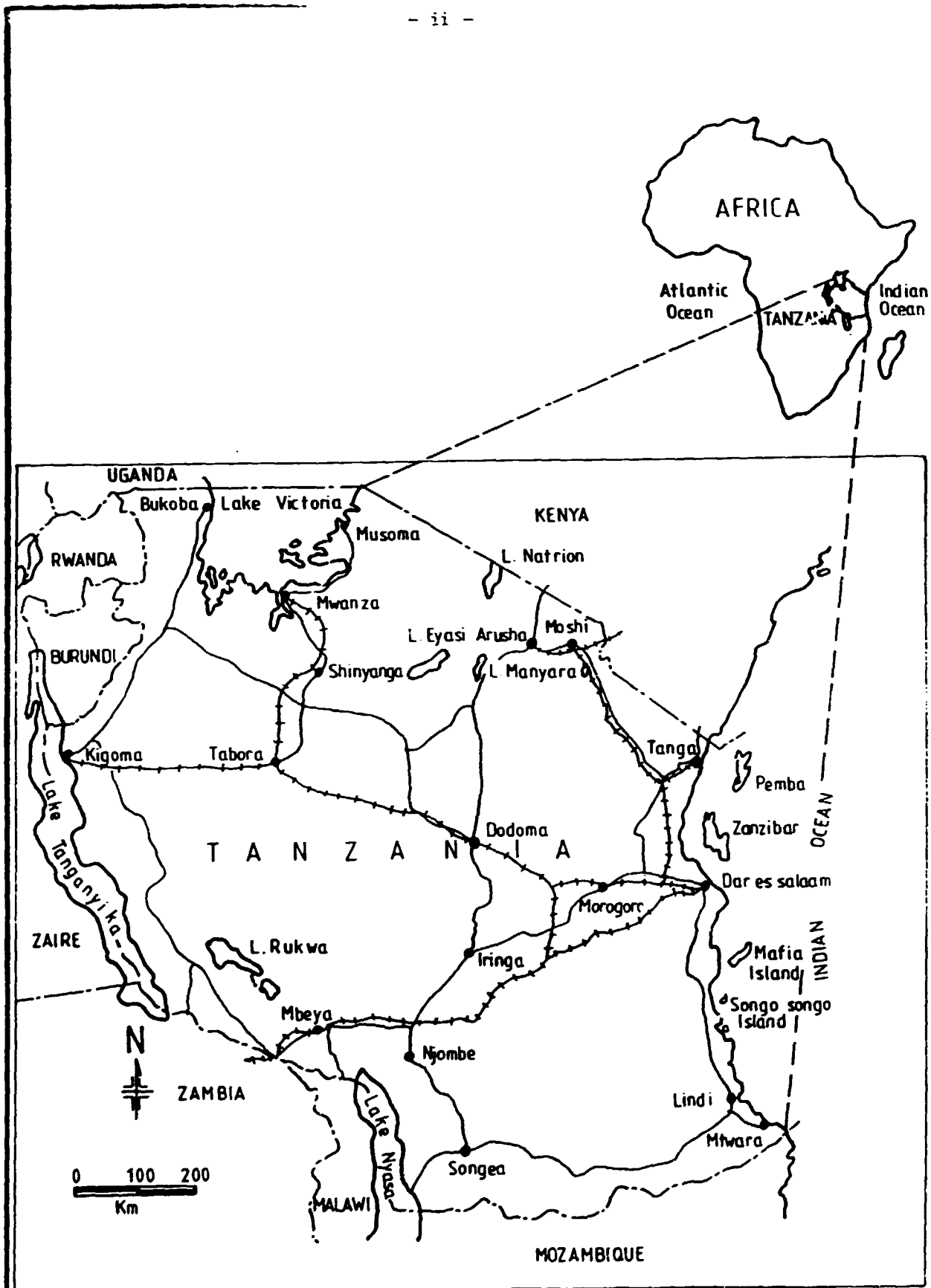

Fig 1 Location of Tanzania

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1. INTRODUCTION AND SUMMARY

1.1 General Background on Tanzania

The United Republic of Tanzania is a littoral state of the Indian Ocean located between longitudes 29°E and 40°E and latitudes 1°S to 11°S (see Fig.1). The United Republic of Tanzania is made up of a union of two formerly independent countries -Tanganyika (on the mainland) and the islands of Zanzibar and Pemba in the Indian Ocean. Tanzania mainland (formerly Tanganyika) has an area of 940,000 square kilometres of which about 20,000 square kilometres is covered by lakes. The islands of Zanzibar and Pemba have a combined area of 2,500 square kilometres.

Tanzania had an estimated population of 23 million in 1987. About 85 percent of the population is rural, living in about 8,700 villages. The overwhelming majority of the rural population consists of smallholder farmers and herders.

The primary economic activity in Tanzania is agriculture which in recent years has annually accounted for about 40 percent of the country's GDP and about 70 percent of the country's export earnings.

Apart from agriculture, Tanzania has a small industrial sector whose contribution has declined from around 10 percent in 1979 to less than 5 percent at present. The contribution of the manufacturing sector to the total GDP has been declining from 1979 to 1985, the latest years for which figures are available[1].

1.2 Objectives of the Study

Information technology (the marriage of computers and communication systems to provide enhanced information services to mankind) has already caused major shifts in employment away from "smokestack" industries in most developed countries. The effects of this technology on the international division of labour, on national office and factory productivity and on national employment patterns are of growing interest in the third world to, not only specialists, but policy makers as well.

Information technology is but the current, must advanced stage of electrical engineering. It has been made possible by revolutionary advances in electronics and software science and engineering. Without the advances in electronics, and especially in microprocessor technology the emerging information age could not have been possible.

Since advances in electronics have been the basis for the emergence of the information age, the current and future status of the electronics industry in any country, including Tanzania, will determine, to a large extent, the role and extent of participation of that country in the coming information age.

The above considerations provide a background to the objectives of this study which are to:

(a) Present an appraisal of past, present status and future growth of the electronics industry in Tanzania while paying attention to the impact of past and current policies on the growth of the industry.

(b) Identify domestic constraints retarding development of the industry or the judicious use of the technology.

(c) Recommend appropriate strategies and policies for the continued growth of the industry and/or sustenance of a coordinated programme for the application of the technology, including institutional arrangements for implementing those strategies and policies.

(d) Identify suitable market niches, both domestic and for export.

(e) Assess potential for the development of a national software industry.

1.3 Conclusions and Recommendations

1.3.1 On the Production of Electronic Products

As will be discussed in the sequel, the production of electronic products in Tanzania is confined to the assembly of domestic radio receivers and radio -cassettee recorders. Preliminary information gathered during this study on the demand for electronic products indicates that there is commercial justification for the production of

- custom-tailored printed circuit boards
- telephone instruments
- digital electrical meters
- custom-tailored microprocessor control boards
- personal computers

and for the manufacture, assembly and duplication of printed circuit and microprocessor based boards.

It is therefore recommended that a feasibility study be undertaken on the production of the above electronic products. For reasons detailed later in this report, we do not recommend the production of electronic components in Tanzania even for the medium term.

1.3.2 On the Use of Electronic Products

A major constraint on the use of electronic products in Tanzania is the severe shortage of foreign currency to support imports of any products. This is a long-term problem for Tanzania and prospects for its solution even for the medium term are bleak. This shortage constrains the import of new electronic equipment and also the import of spares and service for equipment already in Tanzania.

Other constraints on the large-scale use of electronic products in Tanzania are amenable to solution within the short and medium term. These other constraints are:

(a) lack of trained and competent manpower for maintenance, repair and sometimes even operation of electronic equipment

(b) lack of a coordinated importation policy leading to imports of a wide variety of different electronic components from both eastern and western countries

(c) lack of specialized workshops and specialized equipment for the trouble-shooting and repair of sophisticated electronic products

(d) inavailability locally of a wide range of electronic components

(e) small size of the market in Tanzania which makes it uneconomic for manufacturers to produce customized equipment for Tanzania

(f) in the telecommunications subsector, the demand so far exceeds the supply that the network is heavily congested resulting in very poor service to customers

(g) lack of coordination in the purchase of software leading to either different departments in one organization or different organizations spending scarce foreign exchange on the purchase of the same software package

(h) lack of software specialists to produce, maintain and update (modify) software packages

These constraints on the use of electronic components and products have to be removed before widespread usage of these products can occur in Tanzania. As for software, a need exists for a central software procurement, production, maintenance and upgrading facility.

1.3.3 Repair and Maitenance

Most repair and maintenance of electronic products in Tanzania takes place largely in the informal sector. In most major towns private entrepreneurs have set up sales and repair workshops with the majority of these workshops being in Dar es Salaam. Workshops have also been established in Dar es Salaam by major computer manufacturers for the service and repair of both personal computers and mainframe computers.

The repair and maintenance of electronic equipment in Tanzania is handicapped by a severe deficit in both the quantity and the quality of Tanzanian electronic artisans, technicians and engineers. This has meant that most repairs of sophisticated electronic equipment is done either by expatriate staff in Tanzania or has to be sent outside Tanzania - mainly to Europe - for repair.

Repair and maintenance is also adverseiy affected by the unavailability locally of electronic components needed in the repair of electronic equipment.

1.3.4 On Policy

Currently there is no national policy on the production and use of electronic products in Tanzania. Policy initiatives are urgently required in the following areas:

(a) electronic manpower training and utilization

(b) local production of electronic products

(c) choice of electronic technology

(d) regional cooperation in the development of an electronics industry

(e) coordination at national level of procurement, updating and production of software.

Currently government policy in electronics is confined to the regulation of importation of computers and computer equipment by the Ministry of Finance, Economic Affairs and Planning, the regulation of telecommunication operations[2] and the transfer, adaptation and development of technology in general including the assessment and choice of imported technology[3]. An urgent need exists,therefore, for a comprehensive national policy on the development of an electronics industry in Tanzania.

2. PRODUCTION OF ELECTRONIC PRODUCTS

2.1 Radio and Radio cassette Recorder Assembly

The only production of electronic products in Tanzania is confined to small scale assembly of radios and radio cassette recorders and the production of dry cell batteries. Radios and radio cassette were produced by two factories - the Phillips Electronic (E.A.) Ltd in Arusha and the Matsushita Electric Co.(E.A.) Ltd in Dar es Salaam. Currently only the factory in Dar es Salaam is in operation. The factory in Arusha was closed down in the early 1980s due to problems in getting access to foreign currency for the purchase of components from the Netherlands.

The Matsushita Electric Co.(E.A.) Ltd has a production capacity of slightly over 200,000 radios and radio cassettee recorders per year. Actual production in a year depends on access to foreign currency for the purchase from Japan of components and other production inputs.

Almost all radios and radio cassette recorders assembled are sold locally with a very small percentage being exported to some of the countries neighbouring Tanzania.

2.2 Circuit Design and Fabrication

Manpower and facilities for the design and fabrication of printed circuit boards of both analogue and digital circuits are available at a few of the technical education institutions in Tanzania. These are the Faculty of Engineering at the University of Dar es Salaam, the TANESCO Technical Institute and the Dar es Salaam Technical College.

At the Faculty of Engineering. system-level design and printed circuit board fabrication of electronic circuits using discrete components and analogue and digital integrated circuits is possible. Capability and facilities are also available for design and construction of electronic circuits incorporating microprocessors.

SPICE (Simulation Program with Integrated Circuit Emphasis) software has been installed on personal computers at the Faculty of Engineering thus making it possible for researchers at the Faculty to carry out design and computer simulation of sophisticated electronic circuits and systems.

2.3 Software

All major users of mainframes and personal computers in Tanzania have limited in-house capabilities for software development. Most of this capability is confined to the development and modification of financial -and especially billing - programs. The development of engineering software is confined largely to the Faculty of Engineering.

The Faculty of Engineering also possesses a microprocessor development facility giving it capabilities to develop and install programs on micropocessors.To-date, however, the development and installation of microprocessor programs has been confined to about two to three final year B.Sc. (Eng.) student projects.

2.4 Constraints to Production

Perhaps the greatest constraint to the production of electronic component and products in Tanzania is the small size of the local market. With medium size radio cassettee recorder costing anywhere from two

to five times the monthly salary of the highest paid public employees, most electronic products are beyond the financial means of the majority of Tanzanians.

A second major constraints on the production of electronic products in Tanzania is the unavailability of foreign currency for the expansion of the limited production capacity already in place and for the installation of new capacity. Measures introduced in 1984/85 on the liberalization of the economy have helped, however, in encouraging private entrepreneurs with access to foreign currency to import, among other items, electronic products into Tanzania. Liberalization has, however, benefited only the importation of consumer electronic products although one firm in Mwanza used the opportunity to venture into trial production and assembly of domestic telephone instruments although the lack of a type-approval of the equipment for use of the instrument on the telecommunications network in Tanzania has apparently discouraged the venture.

The third constraint on the production of electronic products is the shortage of adequately trained manpower. Currently educational institutions produce only about fifty electronic technicians and about twenty electronic engineers per year and most of these find ready employment in the service sector.

As for the production of software, the major constraints is the lack of adequately trained manpower and the high level of sophistication and afforelability of software package available from vendors. This lack of manpower is now being addressed as the University of Dar es Salaam intends introducing starting in 1989/90 a degree course

in computer science Prior to the take-off of this course there is no training in computer science and computer engineering currently being offered in Tanzania.

The lack of software specialists has also adversely affected the maintenance and upgrading of software packages purchased from reendors. Upgrading of software packages already installed is perhaps the greatest need to meet changing use environments.

The production of electronic components requires special conditions which may not be met by Tanzania even in the medium to long term. Some of these conditions are:

(a) requires large production runs to have economies of scale. Production thus requires an international market where competition is very stiff

(b) requires continuous research and development effort at the frontiers of electronic component science and technology

(c) requires high capital investments most of which has to be in foreign currency

(d) requires highly trained technical manpower

Most of the conditions above have been found difficult to be met by even some developed countries and so the production of electronic components, as opposed to electronic products, in Tanzania must be looked at as a long term prospect.

2.5 Recommendations

The production of electronic products in Tanzania can only take off if the constraints mentioned above are removed. Recommendations on encouraging the production of electronic components in Tanzania are

(a) addressing the issue of market size through collaboratise regional ventures in the production of electronic products

(b) ensuring that foreign currency resources are made available for the production of electronic products. Joint venture enterprise for local and export production may be a promising way out of the problem of a lack of foreign currency.

(c) adequate numbers of trained electronic craftsmen, technicians and engineers should be assured.

(d) training of software specialists should be given emphasis and a feasibility study on a national centre for the production, maintenance and upgrading of software should be carried out.

3. USE OF ELECTRONIC TECHNOLOGY

Electronic components and products are used in Tanzania in the domestic sector, the service sector, in telecommunications, in computing and in control and instrumentation. Important constraints in the use of electronic products and components are maintenance and repair and the issue of technology choice.

3.1 Consumer Electronics

The domestic uses of electronic technology are mainly radios for listening to domestic and foreign radio broadcasts and television sets which are mainly used for looking at video cassette recordings.

Tanzania has radio broadcasting studios in Dar es Salaam. The government policy is to ensure good reception of radio broadcasts all over Tanzania and in that regard has four booster stations in operation and two more nearing completion to improve the reception of radio broadcasts from Dar es Salaam. The booster stations receive short wave broadcasts from Dar es Salaam and re-boradcasts these in medium wave. Plans for introduction of FM broadcasts were shelved in 1978.

Reliable information on the number of domestic radio receivers in use in Tanzania is unavailable. Using the number of radios assembled annually at the only radio assembly factory in Dar es Salaam as a guide, we estimate the number of radio receivers in use at less than 20 per 1000 population - a low number.

Although the government of Zanzibar was the first one in Africa to introduce colour televesion service for domestic broadcasts, it is the policy of the government of Tanzania mainland not to introduce domestic TV broadcasts in the foreseeable future.

The government of Tanzania looks on TV receivers and VCRs as luxury goods and discourages their importation by tacking onto them very high customs duties and sales tax (above 100 percent of purchase value). The Tanzania Posts and Telecommunications Corporation, which manages frequency usage in Tanzania on behalf of the government, has also apparently decided to discourage the importation of television receive only earth stations (TVROs) for direct reception of satellite TV signals. Prior to 1988 there was no licensing fee required for TVROs but starting in 1988 the licensing fee was set at about 1500 U.S. dolars with an annual fee of about U.S. dollars 500 - substantial amounts for individuals in Tanzania. By mid 1988 there were three operational TVROs in Tanzania - one belonging to the U.S. embassy, one to a paper and pulp factory and one to TV Zanzibar.

Individuals living near the islands of Zanzibar and those living near the borders with Kenya and Uganda can enjoy reception of TV signals broadcast by these countries.

Tanzania has two television channels in her standard B eath satellite station used for international telephone, telex and facsimile services and her backbone microwave radio telecommunication network linking all the major towns in Tanzania can support distribution of television signalsfrom the earth satellite station.

The Department of Electrical Engineering of the University of Dar es Salaam is involved in a research project aimed at using satellite technology to disseminate information to rural areas. One achievement of the project so far is Ph.D. research which defined and demonstrated new audio-visual services and a new communication system for the distribution of information to rural areas of third world countries. Since the satellites of immediate interest to Tanzania and most other third world countries are Intelsat IV satellites and since these satellites use the single channel per carrier, frequency division multiple access (SCPC/FDMA) mode of communication, the research investigated in detail how a dominant carrier, which enables the use of low cost receive - only earth stations, can be implemented on an SCPC/FDMA system[4]. Practical implementation of the system is underway and the system is expected to be operational in 1989.

A final item of consumer electronics in Tanzania is the use of toys embodying electronics. With trade liberalization, toys embodying electronics have become available in some shops in Dar es Salaam and some of these toys have found their way into homes of mostly the wealthier members of society.

3.2 The Social Sector

Here we confine ourselves to a discussion on the use of electronic technology mainly in the health and education sectors in Tanzania. The use of electronics in other areas of the social sector is minimal except for its use domestically - a topic already covered above.

Tanzania has four large referral hospitals and all four have sophisticated electronic diagnostic machines. The equipment is concentrated in the pathology laboratories and intensive therapy units. In the pathology laboratories, the equipment is used for the automatic analysis of blood and other samples. In the intensive therapy units the equipment is used for patient monitoring. All four hospitals also have EEG and EKG machines.

The level of sophistication of electronic equipment being used in hospitals has been increasing rapidly as Tanzanian medical staff trained abroad order the same equipment they used while training overseas. This sphisticated equipment, usually incorporating microprocessors, is usually beyond the maintenance and repair skills of local technicians.

In the education sector, the technical colleges at Dar es Salaam and Arusha and the Faculty of Engineering and the Faculty of Science of the University of Dar es Salaam have sophisticated electronic test equipment which is used in training and research. The equipment is also used to provide consultancy and repair services to local industry.

Repair workshops belonging to some local firms such as Aeradio (E.A.) Ltd, the Directorate of Civil Aviation, the Tanzania Harbours Authority and other public corporations also possess sophisticated best equipment for the troubleshooting and repair of electronic equipment. We shall return to this point later when we discuss repair and maintenance of electronic equipment.

The Tanzania Harbours Authority and the Directorate of Civil Aviation also operate electronic navigation systems for marine and air operations, respectively. Minor servicing and repair of this equipment and also of equipment aboard ships and aircrafts is done inhouse whereas major troubleshooting and repair jobs are done by specialized firms like Aeradio (E.A.) Ltd in Dar es Salaam or sent overseas. The Air Tanzania cooperation avionics workshop to be established at Kilimanjaro airport is also intended to cater for all major repairs of air navigational, and avionic systems.

In avionics, airport, aircraft and traffic control electronic systems, the equipment is becoming increasingly digitized and computerized and its repair and calibration has had to be done mostly in Europe and where it has been done in Tanzania it has usually required the use of expatriate personnell.

The government owned radio broadcasting service operates radio transmitters whose technology ranges from that using thermionic valves (vintage 1950s) to that using the latest technology (vintage 1980s). The equipment has been purchased from the United Kingdom, Japan, the United States of America and the People's Republic of China. The supply of spare parts for the very old equipment is a major problem whereas its replacement by new equipment is not immediately possible due to foreign currency constraints.

3.3 Control and Measurements

In Tanzania, the use of electronic measurement and control equipment is confined to the industrial sector. There is a very great diversity of this equipment both in terms of the technology and in terms of the suppliers of the equipment. In terms of the technology, equipment ranges from that using discrete semiconductor components to that using the latest in microprocessor technology. As far as the origins of the equipment is concerned, equipment has been purchased from a variety of suppliers in both developing and developed countries and from both the east and the west.

The great diversity in electronic control and measurement equipment in use in Tanzania has raised new problems in:

- training of engineering manpower
- procurement of spare parts
- troubleshooting, repair and maintenance
- portability of control software for microprocessor controlled equipment
- interchangeability of parts and components

The use of electronic equipment in industry is also handicapped by the following observations made after obtaining information from some of the large industries in Dar es Salaam:

- very few industries have specialized sections in their electrical workshops for the repair of electronic equipment
- there is a general lack of skilled electronic craftsmen and technicians
- there is a general lack of test and fault-finding equipment, especially oscilloscopes

. there is little professional development of engineering personnel to enable them to cope with either existing electronic equipment or newer, more sophisticated equipment.

The use of power electronics and thyristor motor speed controls is also becoming increasingly common starting with industrial electrica drive systems which were installed in Tanzania in the 1970s. This trend has implications on the training of electrical engineering manpower as regards their ability to troubleshoot and repair such systems.

Since Tanzania is only now starting on building a capital goods industry with emphasis on the development of metal manufacturing, machine building and, later, iron and steel industries, she will continue for a long time to come continue to be a net importer of electronic measurement and control equipment. Since the trend in the development of such equipment worldwide is towards increasing automation of manufacturing processes, Tanzania will have to prepare itself for this change in technology as it is most likely that in future this may be the only technology available in the international marketplace.

3.4 Telecommunications

The telecommunications sector is the single largest user of electronic equipment in Tanzania. Electronic systems are used here in the public switched telephone network (PSTN), private telecommunications networks operated by the railways, the harbours authority, the military and security establishment, the electricity utility and in private and public mobile and non-mobile radio communication systems.

3.4.1 Existing Facilities

The public switched telephone network has switching, transmission and subscriber loop facilities. In switching there is a diversity of equipment ranging from step by step exchanges still in use on the network through crossbar exchanges to digital exchanges.

Tanzania had a total of 173 exchanges in 1986 out of which only two exchanges at Morogoro and Zanzibar are digital exchanges. The projected number of exchanges and other data on exchanges is shown in Annex 1. The total installed capacity of the exchanges by the end of 1986 was only 73,000 lines. The average exchange fill was 74 percent and 54,000 direct exchange lines (DELs) were connected. Of the direct exchange lines, 77 percent were served by 21 analog and 2 digital automatic exchanges and the remainder by 138 small manual exchanges. Seventy seven percent of the exchanges, serving over 50 percent of the subscribers are over 20 years old and in poor condition.

The telephone density in Tanzania at 0.2 DELs/100 population is among the lowest in the world. Service is concentrated in Dar es Salaam and in the 25 regional capitals with 80 percent of the DELs but only 10 percent of the population. Furthermore, 40 percent of exchange lines serve PBXs with only a few telephones being used solely for residential purposes.

The transmission facilities consist of a backbone microwave radio network linking Dar es Salaam with all other major towns in Tanzania and with the neighbouring countries of Malawi, Zambia, Kenya, Rwanda and Uganda. International voice traffic is transmitted via a Standard B earth satellite station at Dar es Salaam in use since 1983 and via a terrestrial link, through leased circuits on a standard A earth satellite station in Nairobi.

There is an automatic international digital telex exchange in Dar es Salaam. Telex service is also available to 15 other major towns in Tanzania.

3.4.2 Operations and Service

Although the only problem with telex service is inadequancy, telephone service is not only inadequate but is also congested and unreliable.[5] The inadequacy of the telephone service is so severe that the number of customers waiting to be provided with telephone service countrywide was about 60,000 by end of 1986 whereas the number of DELs was 54,000.

Congestion on the network is mainly caused by poor maintenance and inadequate capacity (both switching and transmission capacity), on the trunk network. The poor maintenance and high fault rates in the network are evident from the figures in Table 1 below.

Table 1: Faults on Tanzania's PSTN

Catagory	Total Faults per Exchange Connection per annum	
	Actual	Acceptable
Underground	0.34	0.15
Overhead	0.78	0.30
Subscriber apparatus	0.72	0.30
Exchange	0.25	0.05
Found no Fault	0.11	*
Right when Tested	0.50	*

Source: Tanzania, Posts and Telecommunication Corporation.

* Although 0.61 for FNF and RWT is high, it is 22.6% of the total which is acceptable.

The occurence of faults on various parts of Tanzania's PSTN is seen to be much higher than the acceptable standards for a well maintained network of a similar type and characteristics to the one in Tanzania.

The traffic on the network of the Tanzania Posts and Telecommuncations Corporation (TPTC) is 82 percent local and 15 percent trunk with the balance being international traffic as is shown in Table 2 below.

Table 2: Distribution of Telephone Traffic (%)

Outgoing calls	Distribution			
	Dar es Salaam	Large Towns	Small Towns	Total
Local	82	79	85	82
Trunk	16	20	15	17
International	2	1	0	2

Source: TPTC (1986)

The service offered by TPTC on its network is "plain old telephone service" (POTS) although two subscribers have leased voice grade circuits which they are using for data transmission. TPTC has no plans at present to offer data transport services to its customers.

3.4.3 Private Telecommunication Networks

Although the military and other security services operate private radio and telecommunication networks, no data or these is available in the public domain and so we shall not cover these networks in this report. Of the remaining private networks, the large ones are those belonging to the Tanzania Electric Supply Company (TANESCO), SITA - the airline reservation system and the railway signalling and telecommunication systems of the Tanzania Railways Corporation (TRC) and the Tanzania Zambia Railwa Authority (TAZARA).

The TAZARA telecommunication system links all stations along the railway line. The system has automatic exchanges in all towns which are electrified and magneto exchanges in all towns without electricity. The system is currently being upgraded by providing photovoltaic electric power systems and automatic exchanges on all non-electrified towns. The system also operates a UHF radio link between some of the large stations.

The TRC telecommunication system also links all stations along the railways network. This system, like the TAZARA system, is also being upgraded by electrifying some of the stations with photovoltaic power system. The TRC telecommunication system is maintained by TPTC.

The SITA airline reservation system links major airline offices in Dar es Salaam with other offices worlwide via leased voice grade circuits from Dar es Salaam through Nairobi in Kenya too London. Although the SITA network is a packet-switched network, it is operated in a circuit - switched mode from Tanzania to London thus denying users in Tanzania the benefits of sharing the telecommunication resources possible with packet - switching. Within Tanzania, the Air Tanzania Corporation (ATC) operates terminals in major up-country towns it serves and in Zanzibar. These terminals access the SITA network through a gateway in Dar es Salaam. The ATC network uses a star topology with messages between any two terminals in the network having to pass through a node in Dar es Salaam.

The SITA network enables any ATC terminal too access, store and/or retrieve data from host computers belonging to SITA and situated in Georgia, U.S.A.

The TANESCO telecommunication system is the largest of all private telecommunication networks whose information is available in the public domain. The network consists of power line carrier (PLC) equipment for telecommunication over existing 220 kV and 132 kV transmission lines, a radio link system between substations and mobile radios.

At present the TANESCO telecommunication system provides voice communication services needed to control the operation of its interconnected electricity generation, transmission and distribution system. In order to improve the reliability in operation of the

interconnected network, TANESCO is installing a system for supervision, control and data acquisition (SCADA) built up as follows:

- a control centre in Dar es Salaam
- a SCADA system connected to existing power plants and substations with possibilities of up to 50 connections
- extension of the existing PLC system to cover the transmission network built up in the 1980s and also to cater for increased demand of communication.

The SCADA system will transmit data over voice grade circuits using several voice frequency telegraph (VFT) channels using frequency modulation (FM) in accordance with CCITT recommendations R.35 (50 baud), R.37 (100 Baud) and R.38A (200 Baud). Seperate VFT channels will also be provided for telephony and telex systems.

The TANESCO telephone system currently has 10 automatic exchanges with a maximum capacity of 246 connections out of which 75 connections are used as trunk lines. The system is to be expanded so that by 1989 there will be 6 additional exchanges with 42 connections.

TANESCO's telephone system has more sophisticated traffic handling facilities than those available on the TPTC network. TANESCO's system, for example, offers a conference facility, multiaddress signalling and prioritized customer categories.

The telex system operated by TANESCO links 10 substations and offers full duplex communication between the substations.

The maintenance and repair of telecommunication systems belonging to TANESCO is the responsibility of a light current workshop operated by the corporation.

3.4.4 Maintenance and Repair

The maintenance of telecommunication equipment is severely handicapped by the following constraints:

- lack of foreign exchange to purchase spares
- the great diversity of equipment
- the lack of troubleshooting and test equipment
- the lack of trained staff

Since we shall address the issue of repair and maintenance of equipment in detail later, here we confine ourselves to a discussion on the diversity of telecommunication equipment in use in Tanzania. The diversity in terms of the vintage of the technology was discussed above. The diversity due to source of origin of the equipment is what will concern us here.

Investment in the telecommunication sector in Tanzania is highly dependent on bilateral and multilateral aid. Since most bilateral aid is tied to the purchase of equipment and services from the country providing the aid, it is to be expected that the diversity of equipment will be a reflection of the diversity of the source of bilateral aid. Annex 3 gives a sample of the diversity of test equipment owned by TPTC. The great diversity of the equipment puts severe strains on the skills of maintenance and repair personnel and complicates the purchase and stocking of spare parts.

3.4.5 Underutilization of Network Resources

Although the telecommunication network is inadequate to cater for new demand for service, the network already in place is also underutilized due to:

- poor maintenance of the network causing frequent failures
- inadequate fault clearance
- high volume users do not get exchange line priority
- inadequate operational transport fleet

The telecommunication resource is inadequate to meet the present demand and, therefore, the underutilization of this resource should not be tolerated. Ways and means of enhancing the utilization of the present telecommunication network should be found and implemented.

3.4.6 The Future

Up to about the mid 1950s, the pace of change of telecommunications equipment was relatively slow. Since then, the pace has considerably accelerated with the first electronic exchanges appearing in the 1960s and these have been superceded by systems that reflected the convergence of computing and telecommunications technology.

The future of telecommunications technology will involve computer control of exchanges, time-division switching, the transmission of information in digital form and the provision of integrated information services including voice, data and image communication services.

Tanzania has already embarked on this road into the future with the installation of digital exchanges with time-division switching and digital transmission systems. Tanzania, however, needs to chart carefully her move into the future of telecommunications. The rapid pace of technological change in this sector has widened the range of technological options available to countries like Tanzania thus complicating the issue of the choice of technology. A need, therefore, wxists in Tanzania for the formulation of a long-term strategic plan on the move into the integrated services digital networks which will be ubiquitous in the twenty first century. The formation in 1985 of a centre for telecommunications development by the International Telecommunications Union (ITU) will help countries like Tanzania in the development of telecommunication policies and systems.

3.5 Computer Hardware and Software

Computers were first used in Tanzania in the early 1960s. These early machines were not user friendly and could only be used by people possessing special skills. Since skilled programmers were and are still very scarce in Tanzania. the usage of computers was confined to only a few establishments possessing the needed skilled manpower.

The importation of minicomputers and personal computers which started in the late 1970s and early 1980s and the wide availability of applications software has revolutionized computer usage in Tanzania.

Computers now find usage in business, in health, in education, in offices, in factories and in homes. Major computer manufacturers such as IBM, Wang and ICL have entered into contracts with local firms to market and service their products.

3.5.1 Hardware

Computer hardware in use in Tanzania includes mainframes, minicomputers and personal computers. Most mainframes in use were purchased or imported into Tanzania no earlier than the 1970s. However, mainframes from the latest vintages of the technology are also available.

ICL was the largest supplier of mainframes in Tanzania in the 1970s. In the 1980s, Wang entered the market for mainframes aggressively and managed to capture orders from many parastatal organizations.

Although Apple computers were apparently the first personal computers (PCs) to be imported into Tanzania, the IBM personal computer and IBM-compatibles now far outnumber Apple personal computers in use in Tanzania.

Only one office machine and equipment vendor, Business Machines Limited, offers an IBM-compatible PC for sale in local currency thus removing the foreign currency constraint to the purchase of the hardware.

The importation of computer hardware into Tanzania is controlled by a committee chaired by the Director of Computing in the ministry of Finance, Economic Affairs and Planning. Any person or organization wishing to import computer hardware into Tanzania must apply for and receive permission from this ministry.

Maintenance and minor repairs of computer hardware is done either using experts available locally or by local firms representing the major computer manufacturers. Boards and other sub-assemblies which cannot be repaired locally are sent to manufacturers representatives, usually in Europe, for repair.

Experience in Tanzania shows that most computer manufacturers invest very little in the training of local sales and service staff. The local service establishments suffer from shortages of supplies and of skills.

3.5.2 Software

System software and utilities are purchased from either computer manufacturers or software vendors in Europe on U.S.A. Applications software is also purchased from software vendors although some of the large computer users have limited in-house software development capabilities.

Most of the applications software available in Tanzania is for the analysis of financial data, billing, payroll processing, word processing and materials management. The only engineering applications software package in use are in engineering planning and in structural analysis.

There is a local computer users network for the sharing of experiences and the exchange of software. This network started with the users of Apple Computers in 1983/84 but now involves users of other PCs as well.

The development of large applications software packages for institutional mainframes is still in its infancy in Tanzania. The major constraint on software development is the severe shortage of skilled software developers in most institutions. The lack of software development capabilities forces Tanzania to spend her scarce foreign currency resources on the importation of applications packages.

Although there are many computer data bases available worldwide, some of them of immence potential value to Africa, few of these data bases are accessible and usable in Tanzania. There are three main reasons for this:

- lack of a policy on access to foreign data bases
- cost of accessing the data base and the fact that this cost has to be met in scarce foreign currency
- the telecommunication system may make actual access very difficult.

In Tanzania, users of telecommunication facilities for data base access are the U.S. embassy and the Air Tanzania Corporation with the latter accessing the SITA network data bases in Georgia, U.S.A. This limited usage of data bases denies Tanzania access to information that is vital to her development efforts. Information on topics such as appropriate technologies, specialized personnel and new techniques in health,agriculture, education, sanitation, industry etc.,is available in computer data bases and it would be of immense value to policy makers and others involved in development activities.

Wide access to computer data bases in the developed world has raised concern in some parts of Africa on the "new information dependency" which Africa might fall into. This issue is also closely linked with the issue of transborder data flow (TDF). The issue of transborder data flows is a complex one and needs careful study by developing countries before they can articulate coherent policies on it.

3.5.3 Networking

Although no computer network presently exists in Tanzania, several large corporation such as TPTC and TANESCO have already seen a need to link some of their personal computers in some of the major upcountry towns to their mainframes in Dar es Salaam. This link, using a star topology, can be effected using leased voice-grade circuits.

The linking of computers and peripheral equipment on a local area network has also so far not been attempted by anybody in Tanzania. The Ministry of Energy and Minerals has, however, ordered a local area network which it will use to network PCs and peripherals at its headquarters.

The TPTC can offer data transport only through leased voice-grade circuits. There are no plans at present to offer data communication services on the telecommunication system using other schemes where data is allocated a bandwidth outside the voice bandwidth and can, therefore, be given a different tariff. The evolution of a true data transport service using a packet-switched network can, at present, only be seen as a very long term prospect.

3.6 Maintenance and Repair

The repair and maintenance of electronic equipment is very important to Tanzania because she is a user, rather than a producer, of electronic products. The repair of most consumer electronic equipment takes place in the informal sector with many small workshops in towns carrying out the repairs. Most large industries and corporations also have electrical, and a few electronic, workshops where they carry out repairs of their electronic equipment.

The repair and maintenance of electronic equipment is handicapped by the following:

(a) lack of planned and programmed maintenance policies for electronic equipment

(b) lack of trained technical personnel (artisans, technicians and engineers)

(c) lack of troubleshooting, test and calibration equipment

(d) lack of specialized skills required to maintain and repair the latest, sophisticated electronic equipment.

(e) lack of spares, especially electronic components and integrated circuits

The constraints mentioned above have resulted in inadequate repair and maintenance of electronic products and equipment. One way of overcoming this inadequacy, given the manpower and other resources currently available, is the grouping of these resources into one

or more centres which could provide electronic repair and maintenance services to all sectors of the economy. The development plan of the centre(s) would also ensure that skills in the repair and maintenance of electronic products are acquired so that the number of electronic products having to be sent overseas for repairs is considerably reduced.

3.7 Manpower Requirements

It has not been possible to establish the demand for electronic technical personnell in Tanzania but, all available evidence indicates that the number of electronic personnel available falls for short of the requirements.

Electronic technical personnel are produced at the following educational institutions:

(a) National Vocational Training Centre and the Technology Precision Centre (for artisan(s)

(b) The Dar es Salaam Technical College (for technicians and technician engineers)

(c) The Faculty of Engineering (for engineers)

(d) The TPTC Staff College

(e) The TANESCO Technical Institute

(f) Institutions outside Tanzania

Students from the above institutions receive theoretical and practical training in electronics but to be useful in the repair and maintenance of electronic products they need to undergo on-the-job training.

Training in the troubleshooting and repair of sophisticated electronic equipment is currently unavailable in Tanzania and must be obtained abroad.

Training in computer science and computer engineering is also currently unavailable in Tanzania and must be obtained overseas. Plans are, however, underway too offer an undergraduate program in computer science at the Faculty of Science of the University of Dar es Salaam starting in 1989/90. Specialized training on digital exchange software is available at the TPTC Staff College in Dar es Salaam. Both theoretical training and practical training using a small digital exchangee at the college are provided.

Training in computer programming using standard languages such as BASIC, FORTRAN, PASCAL, COBOL and training in using applications packages for wordprocessing, spreadsheets and data base management is offered by several public and private educational institutions, mostly based in Dar es Salaam.

Training in machine language and assembly language programming of microprocessors is offered by both the Dar es Salaam Technical College and the Faculty of Engineering. The Faculty of Engineering also possesses a microprocessor development system enabling users to develop software and install it on EPROMs.

4. NATIONAL POLICY ON THE ELECTRONICS INDUSTRY

Tanzania has had no national policy on the production and usage of electronic products. The Tanzania Posts and Telecommunications Act of 1977[2] and The Tanzania Commission for Science and Technology Act of 1986[3] do, however have policy implications for some sectors and some aspects of the electronic industry in Tanzania.

The Tanzania Posts and Telecommunications Corporation (TPTC) is empowered by law to, among other things:

(a) regulate and control radio communication

(b) provide telephone and telegraph services

(c) provide type approval of telephone instruments and other equipment for connection to PSTN.

(d) licence private telecommunication networks.

In carrying the four duties above, the corporation's board of directors has issued from time to time policies on the installation, operation and licencing of radio communication equipment and on the type of equipment private suppliers are allowed to use either on the PSTN or in radio communication and in mobile radio communication.

The Tanzania Commission on Science and Technology Act of 1986 provides for the establishment of a Centre for the Development and Transfer of Technology, Powers of the centre with policy implications for the electronics industry are the powers to:

(a) identify appropriate technologies for utilization in different sectors of the economy

(b) evaluate and select technologies

(c) perform unpackaging of imported technology

(d) act as a catalyst for the development of indigenous technology

The Commission for Science and Technology (CST) started functioning in 1988 and the powers stated above are general enough to cover the electronics industry sector. Although the powers are stated in very general terms, the problem is that the TPTC Act of 1977 and the control of computer imports by the Ministry of Finance, Economic Affairs and Planning are not superceded by the CST Act of 1986. A need therefore exists to bring together all organizations active in the electronic industry to articulate a ppolicy for the industry as part of the national policy on science and technology[7] The main objectives of the policy should be:

(a) regulating and controlling the education, training and utilization of electronic artisans, technicians and engineers

(b) enhancing the efficiency and effectiveness of repair and maintenance of electronic equipment and reducing the necessity of sending this equipment abroad for repair

(c) building up national capacity for the development and modification of sophisticated applications software packages

(d) guiding the development of the production of electronic products including the assembly of microprocessor-based control modules and even personal computers

(e) ensuring the ready availability of components needed for electronic repairs

(f) rationalizing the importation of electronic products with a view to lessening the diversity of the equipment.

Once a national policy on the electronics industry has been articulated, it is essential that a detailed implementation strategy for the policy is evolved. The implementation strategy should include time targets for the attainment of objectives and the role each public and private entity active in electronics is exported to play to achieve the desired objectives.

5. CONCLUSIONS

Tanzania is an insignificant producer of electronic products having only one small factory for the assembly of radios and radio cassette recorders.

Tanzania is a larger use of electronic products than she is a producer. Electronic products are used by individuals, in the health, education and other service sub-sectors, in control and measurements, in telecommunication and in computing. Although the usage of electronic products is extensive it is handicapped by several problems which hinder its even wider usage:

(a) lack of skilled electronic personnell for the operation, maintenance and repair of electronic systems

(b) lack of troubleshooting and test equipment

(c) lack of spares and components

(d) lack of foreign currency for purchasing equipment and components

(e) a wide variety of equipment from a variety of countries

The use of electronic products in Tanzania can expand when the problems mentioned above are solved. To aid in the solution of these problems and to regulate the development of an electronics industry in Tanzania requires the articulation of a policy on the electronics industry.

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ANNEX 1

Telephone and Telex Facilities over the Project Period (1986-1990)

As of December 31.	1986	1987	1988	1989	1990
			Forecast		
I. Local Telephone Network					
(a) Number of exchanges	173	190	205	220	230
(b) Equipped capacity					
i) Dar es Salaam	28,880	30,880	30,800	34,800	36,800
ii) Main Provincial rowns	29,700	30,400	30,800	32,800	34,800
iii) Rest of Tanzania	15,442	16,200	17,200	18,200	19,200
T o t a l	73,942	77,400	78,800	85,800	90,800
(c) Direct exchange lines(DEL)					
i) Dar es Salaam	21,198	23,500	26,500	30,500	33,000
ii) Main Provincial towns	24,015	26,000	27,500	30,500	37,000
iii) Rest of Tanzania	9,247	12,000	15,000	17,000	18,000
T o t a l	54,460	56,000	60,000	66,000	72,000
(d) Rest of Tanzania	0.05	0.06	0.07	0.08	0.08
Average	2.5	2.3	2.8	3.1	3.4
(e) Demand satisfaction (%) 1/	46.4	46.4	46.4	46.5	46.6
(f) Average exchange fill (%) 2/	74.0	74.0	77.0	77.0	79.0

1/ Demand Satisfaction = $\frac{\text{working lines}}{\text{working lines + waiters}}$

2/ Exchange Fill = $\frac{\text{working lines}}{\text{equipped capacity}}$

ANNEX 2

Test Equipment Owned by TPTC

Category	Quantity	Number of Suppliers
Level measuring instruments	179	11
Multimeters	498	15
Signal Analyzers	45	6
Level Calibrators	13	5
Noise Meters	59	7
Voltmeters	95	11
Frequency Meters	22	9
Frequency Counters	57	9
Power Meters	84	8
Oscilloscopes	71	11
Signal Generators	220	24