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Industrial development electricity supply Mbagala, Tanzania, as a case

Daan Kers 1997

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Sociability must be combined with other factors like honesty, a high propensity to save, entrepreneurial energy and talent, and interest in education to lead to economically productive activities.

Francis Fukuyama in Trust

Summary

This research concerns industrial development and factors which affect this development. The quality of electricity supply, as one of these factors, is elaborated upon a project appraisal. The research is applied to Mbagala, a suburb of Dar es Salaam in Tanzania.

As introduction, the performance of industries and characteristics of electricity supply in Tanzania are described.

Factors which possibly influence industrial development are invented and structured. This is done from an institutional approach and serves as thought-supporting preparation for the industrial survey. First, all industries established in Mbagala are invented. A survey amongst these industries is conducted to study their function and the factors affecting it.

Important suppliers of industries are institutes. Their supply of services is mentioned by the industries as the most important factors. Main institutes are selected: land and urban development, electricity, telecommunication, roads, water, industrial support, education and health. A description of the quantity and quality of their services is made, based on interviews held with employees concerned with supply in Mbagala.

The study of industries and institutes leads to the following results:

- Most industries indicate electricity supply as the most restricting factor, followed by water supply. Other factors mentioned include roads, security and bureaucracy.
- Own findings indicate knowledge and skills and cultural behaviour related to entrepreneurship as additional factors of importance. A shortcoming concerning knowledge and skills is a lack of maintenance management.
- Economic infrastructure is very poor in Mbagala, worse than in the rest of Dar es Salaam. But the prospects are promising.
- The factors are grouped and a framework is compiled. This includes government attitude, financial infrastructure, physical infrastructure and human capabilities. Main features are:
 - In line with the liberalization trend in Tanzania, progress has been made in financial infrastructure (taxes, exchange rate). Effects for industries take a relatively short time.
 - Improvements in physical infrastructure have been announced or already started. Financed improvement plans including Mbagala concern roads, telephone and electricity supply. Plans for water supply improvement are in a preliminary phase. Physical infrastructure influences industrial development at the medium-term.
 - To human capabilities no serious attention has been paid. These factors are complex, with long periods of influence and return on investments. The performance of health care and education has been worsened and the prospects are gloomy.

The electricity supply in Mbagala, mentioned by the industries as most affecting factor, is studied in depth. As part of an improvement plan for the electricity grid in Dar es Salaam, the World Bank made a project proposal for Mbagala in 1993. The methodology used by the World Bank is directed to national and Dar es Salaam level and does not consider developments at project level. Therefore, the results of the World Bank study are not accepted and an own methodology for project appraisal is designed and applied.

The designed appraisal methodology is based on area-specific characteristics and covers an assumed project period of ten years. An important area-specific element is the load forecast, which is undertaken after the present situation of supply is defined. From different load forecast methods, time trend extrapolation turns out to be the most useful one for household use in Mbagala. The industrial loads are forecasted individually by means of the survey method. Another area-specific element of the project appraisal is the definition of bottlenecks, which may threat a successful project implementation.

Appliance of the project appraisal methodology to Mbagala results in:

- The quality of electricity supply is that bad that improvement is required as soon as possible.
- To guarantee the quality of supply a substation should be constructed in Mbagala, fed by a transmission feeder from a substation operating at higher voltages. Considering new residential developments, 5 distribution feeders are required. A design is made, in which the existing grid is used.
- On the basis of cost-benefit analyses the grid dimension chosen is 132 kV as transmission voltage and 33 kV as distribution voltage (denoted as 132/33 kV).
- Costs and quantifiable benefits indicate an unfeasible project for Tanesco. For the
 national economy, the project is just feasible. The reason for low benefits is that profit
 from residential electricity sales are nearly zero, due to subsidies. Detailed determination
 of the project feasibility is arbitrary, because the neglection of non-quantifiable benefits
 affects the results.
- The most unreliable element used to come to the grid design is the load forecast for households. This is caused by the character of the load growth of the area, resulting in a low forecast accuracy. This growth is determined by an unplanned urbanization process, combined with uncertain economic prospects. The deviation of required grid capacity, resulting from sensitivity analysis, leads to the choice for a gradual capacity increase of the substation transformer.

Preface

Most people in this world live in so-called developing countries. With the term 'developing' one refers to a desirable process of increasing the welfare of people. Many theories have been developed and practised to describe and realise such a process.

An example which is widely supported amongst researchers is economical development driven by industrialization. Strategies used in Africa to help this process going, have not been successful. In the late 1980s most African governments shifted their strategy to one with less regulation and control in economy. New changes and threats emerged for industries.

In 1992, when this process developed in Tanzania, the idea came into being to undertake a research about industrialization in Mbagala. Industrialization is a main component in my study Technology and Development Studies at the University of Eindhoven. The development methodologies educated here are strongly related to industrial development, in which technology plays a major role.

Mbagala was chosen because it is one of the fast growing suburbs in Tanzania, a country in east Africa with typical characteristics of <u>economical</u> underdevelopment. As such, patterns of complicated development in the economic sphere were expected.

My research had been executed with the support of the Tanzanian Electricity Supply Company. The company enabled me to elaborate electricity aspects. This approach is in accordance with my background as engineer in electrical energy.

The research in Tanzania covered a period from November 1992 to May 1993 and was followed by fieldwork in October and November 1996. During the follow-up research I found some major changes, in particular in Mbagala. These changes are reflected in this report, market out for the economical sphere. To stress that economy is not saving, I will mention the day we walked through the forest I used to train in before, not far from Mbagala. All trees had been cut and burned — probably to make woodfuel for food preparation — and the monkeys disappeared with them.

words of thanks

During my research in Tanzania as well as in the Netherlands many people supported me. To everybody I would like to say: thanks! A list of contributors to this research is enclosed in the chapter 'information sources'. I will thank a few of them especially:

My supervisor dr. Paul Lapperre for his assistance and patience during my research; my other Dutch counsellors dr. Joop Sloot and dr. Lex Lemmens for commending my work.

The people from the Tanzanian Electricity Company for their co-operation. In particular: Sofia from the department Distribution and Commercial Services; Tweve, the late Semela and Chanji from the department Rural Electrification; Kiyeyeu, Munisi, Kyando and Mtega from the Temeke regional office in Kurasini.

The urban and rural development students Magege and Cehpa for their co-operation and supply of data, which included the write of 39 pages with interview results.

I also have to extend a word of thanks to the inventors of the computers, software and information networks which enabled me to construct this report in its present form.

Lousy conditions make training tough, as the whole life is for those who not belong to the privileged part of society. I like to thank my running mates and coach of the Tanzanian team for passing on their spirit of kindness.

With the positive attitude of my parents, they enabled me to study. One of them did not live to see the results. Not being able to express my gratitude, I keep a warm feeling in memory.

Daan Kers, 1997

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Α	Tanzanian industries classified
В	Definitions
С	Exchange rates
D	Electricity tariffs
E	Map of Mbagala
F	Factors related to industrial development; an institutional approach
G	Factors influencing industrialization: a morphological approach
Н	Inventory of productive organizations in Mbagala
1	Questionnaire for industries
\mathcal{Y}	Answers of questionnaire
<u>J</u> /	Mbagala socio-economic survey
Ľ	Esmap methodology
M	Damp and maintenance registration
N	Daily curve measurements
0	Transformer load data, K3 feeder
Р	Factors influencing the electricity demand: a morphological approach
Q	Industrial load forecast
R	Results of total load forecast
S	Research background

abbreviations

Abos	Algemeen Bestuur voor Ontwikkelingssamenwerking, Belgium ministry for foreign aid
Acres	Acres International Ltd., Canadian electricity consultant bureau
ACRS	aluminium conductor reinforced with steel
BCR	benefit cost ratio
Bis	basic industry strategy
Cica	Centre for International Co-operation activities, Dutch NGO from the EUT
CCM	Chama Cha Mapinduzi, ruling socialistic party since 1961
Damp	Dar es Salaam Power Distribution System Maintenance Project
Dimp	Dar es Salaam Road Improvement Master Plan
DRC	domestic resource costs ratio
DSc	Doctor of sciences
EAC	East African Community (economic co-operation between Tanzania, Kenya and Uganda)
ERP	Economic Recovery Programme 1986-1989
Esmap	World Bank Energy Sector Management Asessment Program
EUT	Eindhoven University of Technology (the Netherlands)
GDP	Gross Domestic Product
IMF	International Monetary Fund
IRR	internal rate of return
Isic	International Standard Industrial Classification
ITDS	International Technology and Development Studies in Eindhoven, the Netherlands
Jica	Japanese International Cooperation Agency
LPG	Liquified Petroleum Gas
Lic	Low industrial developed country
LRMC	long run marginal costs
Ltd	Limited
Mit	Ministry of Industries and Trade
min	million
MP	member of parliament
MSc	Master of sciences
MWEM	Ministry of Water, Energy and Minerals
	not available
n.a. NEP	National Energy Policy, 1992
NIA	National Investment Act
NGO	
NPV	non-governmental organization for development aid net present value
Nuwa	National Urban Water Authority
PhD	Doctor of Philosophy
SAP	Structural Adjustment Programme
SDP	Sustainable Dar es Salaam project
Sido	Small Industrial Development Organisation
Tanelec	Tanzania Electrical Equipment Company Ltd.
Tanesco	Tanzania Electrical Equipment Company Ltd.
Tanita	Tanzania Italy cashew nut factory
TDS Tirdo	Technology and Development Sciences, research group at the EUT
Tirdo	Tanzania Industrial Research and Development Organisation Tanzania Sheet Glass factory
TSG	Tanzania Shilling
Tsh	·
TTCL	Tanzania Telecommunications Company Ltd.
Uclas UNDP	University College of Land and Architecture Studies, Dar es Salaam
	United Nations Development Programme
Unido	United Nations Industrial Development Organisation United States dollars
US \$	stichting Wetenschappelijke Studiereizen Ontwikkelingslanden
wso	Stronting Tretensonappenine Studiereizen Ontwikkeningslanden

abbreviations of technical parameters

F, cos 🕏	power factor	CM	corrective maintenance
√, kV	volt, kilo volt	PM	preventive maintenance
W, kW, MW	watt, kilo watt, mega watt	UBM	users based maintenance
kWhr, MWhr	kilo watthour, mega watthour	СВМ	condition controlled maintenance
LF	load factor	MTBF	mean time between failure
LS	loss factor		
'n	hour		

[33] reference to title number 33 in Information sources, literature
[i3] reference to source number i3 in Information sources, oral sources

1 INTRODUCTION

Welcome to this report. It deals with industrialization in a specific suburb of Tanzania's main town Dar es Salaam. The research examines factors influencing industrialization. Electricity supply as one of them is elaborated in depth. This will result in the design of a methodology to undertake medium voltage grid rehabilitation projects. This methodology will be applied for the case of the suburb.

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The context of the research needs explanation for who is not aquainted with it. To start, the main characteristics of Tanzania and Dar es Salaam are described. Special attention is paid to economical aspects.

The general introduction is followed by a description of the industry and energy sector in the country. This presentation serves as background for the research subjects dealt with in chapters 2 and 3.

Finally the starting point for the research is defined. This concerns at first the problem definition and research questions, being presented in paragraph 1.5. Next, the methodology used to come to the answers for the research questions is described in paragraph 1.6.

1.1 Tanzania

1.1.1 General characteristics

Tanzania is located on the east coast of Africa, just below the equator. The country covers an area of about 940,000 square kilometres and has a population of 32 million, which grows fast at an annual rate of 3.4 percent. About 80 percent of the population lives in rural villages. Urbanization continues, specially in the largest city Dar es Salaam.

The map alongside includes the main towns and neighbouring countries. A few roads represented are of good quality. Others are secondary roads, mostly

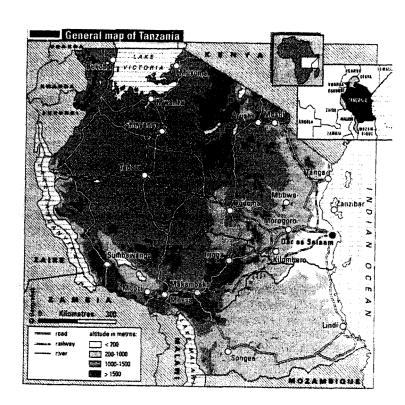


Figure 1.1 Map of Tanzania

sand tracks or tarmac roads in poor condition.

The neighbouring countries Kenya and Uganda have the same national language as Tanzania has, namely Swahili. Tanzania's second language is English, spoken by a minority of the population. The Tanzanians descend from many tribal groups. All of them are part of the total population for less than ten percent. The contrasts between the different groups don't

have a hostile character like in most surrounding countries¹⁾. This is mainly caused by the successful national integration and the common spoken language Swahili. Other ethnic groups are Indians, Arabians and Europeans. Differences between Tanzanians from Arab origin and original inhabitants led to a revolt on the island Zanzibar in 1964. Nowadays ethnic hostilities do rarely occur. But the poor and worsening financial position for most of the Tanzanians is a breeding ground for tensions. One occasion for such tensions is the different welfare of Indian people, caused by their financial success in business and trade.

The climate is warm all over the year, specially at the coast which has a low latitude. A main rainy season occurs in April-May at the coast. Somewhat sooner or later inland.

Tanganyika, the former name of the country, was ruled by Germany from 1890 until 1919 and by Great Britain from 1919 until 1961. In 1961 the country became independent and in 1964 Tanganyika and the island Zanzibar united, forming Tanzania.

The Tanganyika African National Union, the first Tanzanian political party, has formed the government since independence. This socialistic oriented party was renamed into CCM. The first president, Julius Nyerere, resigned in 1985. This was followed by moderate policy reforms, revealed in a decrease of government influence in economy. Most price controls were abolished, imports and exports were liberalized and privatization of public manufacturing enterprises was announced. Elections were held in 1994, in which the participation of all politic parties was free. The CCM won with 59 percent of the votes and obtained 219 of the 274 seats in the parliament^{[14]2)}. But the political competition increased. NCCR's chairman Mrema won the local elections for Temeke's³⁾ member of parliament in October 1996.

1.1.2 Economic trends

Tanzania's economy is dominated by agriculture. Most people are self-sufficient rural farmers. In the colonial time plantations with cash crops were introduced, aimed at export.

In the first years of independence the socialistic policy was directed to industrialization and mechanization in agriculture. A strategy of import substitution was followed and foreign investments were encouraged initially. The economy, especially the industry, developed successfully in the first decade.

But the international market prices for agricultural products decreased, whereby the export earnings did not keep pace with the costs for imported products, mainly capital goods and industrial raw materials. Another financial setback was the collapse of the East African Community (EAC) in 1977, resulting in a hostile relationship with neighbouring country Kenya. Not until 1983 the relation improved. Growing conflicts with the other EAC member Uganda led to a war in 1978. Dictator Amin of Uganda was defeated, but the costs of the war for Tanzania were high.

A severe civil war ended in Mozambique in 1990, as it did in Uganda in 1986. Kenya has been preserved for wars, but political / tribal tensions are growing. Dictator Mobutu created a chaos in east Zaire (now Congo), his forces terrorized for a long period. Long existing tribal tensions, supported by the government, resulted into Africa's largest genocide in Rwanda in 1994. In Burundi a similar situation did not explode. Spheres of influences cross borders. The former francophile regimes of Congo and Rwanda were supported by France; financially, politically and and military. Exiled rebels have been supported by their host country Uganda. In 1997 they formed the main power axis in middle Africa.

²⁾ At Zanzibar the CCM was just defeated by the Civic United Front (CUF) but remained in power and supressed the opposition parties. Especially at the island Pemba where the CUF won all seats, the CCM is unpopular.

³⁾ Temeke is one of Dar es Salaam's major suburbs.

1 Introduction - 3 -

The government influence in the economy grew. The market for agricultural goods became dominated by government controlled co-operatives. The share of the public sector in manufacturing increased as well: from 5 percent of the value added in 1966 to 57 percent in 1982. Most parastatals operated inefficiently. Besides, the government did not pay enough attention to the development in agriculture, which has been the base of the economy.

In 1978 the economic development started to worsen. The national income stagnated and industrial production fell. The whole economic situation deteriorated and in 1981 the National Economic Survival Programme was implemented. In co-operation with the World Bank, a three year Structural Adjustment Programme (SAP) was announced in 1982. This programme was mainly aimed at a stimulation of the crop export, a cut back in government expenditures and a relax of price controls. The SAP met its objectives partially. The main tool used to obtain economic growth was the attraction of foreign investments, which succeeded for 35 percent of the planned amount only.

The SAP was followed by the Economic Recovery Programme (ERP), which has the same objectives as the SAP, but uses more rigorous measures. This concerns the stimulation of agricultural production by a price increase of agricultural goods, improvement of the maintenance of physical infrastructure and increase of capacity utilization by a liberalization of the import of inputs.

The negative balance of payments led to an annual current account deficit of about 400 million US dollars, which has largely been paid by financial aid of donor countries and institutions. The total public external debt in 1990 was estimated at 5,000 million US dollars. The costs of debt serving accounts for 25 percent of the income from export-goods and services (the so called debt ratio).

Since 1983, the per capita GDP declined slightly to a mere 110 American dollars in 1993, which is the third lowest in the world. This situation can not be attributed to internal factors and declining market prices for Tanzania's cash crops only. The economy of most African countries south of the Sahara worsened the last decades. Globalization of production continues, giving most Asian countries promising economical prospects. But foreign investors have shown minor interests in East Africa. Tanzanian main investors have been foreign donors, mainly West European governments, the IMF and the World Bank. Due to the ongoing economic liberalization the World Bank expects a steady growing Tanzanian economy for the coming decennium⁴⁾.

1.1.3 Pattern of income

The present composition of national income is presented in figure 1.2. Agriculture employs 85 percent of the people. Most farmers of the inland are small scale, mainly self-sufficient to feed their own family (not included in the figure) and producing small quantities for the market. The principal food crops are maize, cassava, bananas and rice. Others are beans,

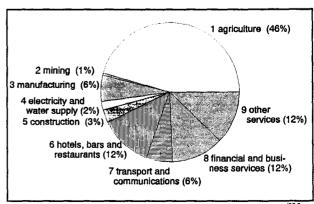


Figure 1.2 Gross domestic product to major divisions, 1990 [204]

This concerns more countries which follow the World Bank reforms, like Uganda. Contrary, loans for Kenya were cut in 1997. The World Bank claims a positive relation between implementation of SAPs and economic growth in the 1990s.

sorghum, sweet potatoes and millet. The cash crops are the main source of export income, chiefly cultivated by larger farmers and co-operatives. These are coffee, cotton, tobacco, tea, sisal, sugar cane and cashew nuts.

Other main contributors to the GDP are financial and business services, commercial services such as bars, restaurants and hotels and other services. The share of manufacturing in GDP is small compared to other developing countries.

The import costs are about threefold the export incomes. Imports concern mainly machinery, industrial raw materials, transport equipment, oil and building and construction materials. The composition of the imports and exports is presented below.

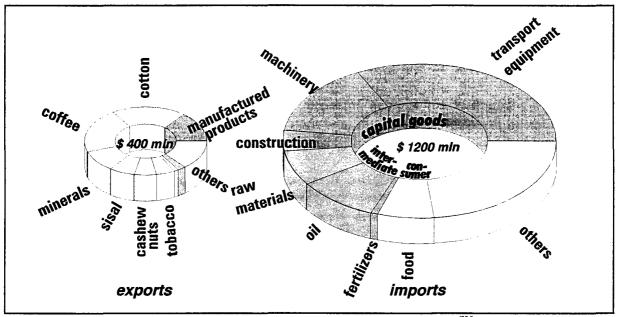


Figure 1.3 Composition of import spendings and export earnings, 1993 [204]

Wages are largely spent on main necessities of life. On average 64 percent of the income is spent on food. According to a study including 51 countries this figure is 71 percent, the highest of the world [Birgit Meade in Food Review, Sep-Dec 1996].

Other expenditures are: ten percent on clothes and footwear and 8 percent on fuel, electricity and water. The composition of income spendings is presented in figure 1.4.

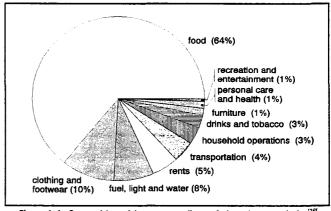


Figure 1.4 Composition of income spendings of the urban population (26)

Prices are increasing continuously. From 1991 to 1996 the food prices raised by 240 percent^[26]. Other prices increased comparable.

The inflation of the Tanzanian shilling has a major impact on these price increases. We can translate such price figures into dollars⁵⁾ and get in this case a 2 percent annually increasing food prices for 1991-1996, with a 25 percent drop in 1992 and 1993.

About the income distribution not much is known, because no official income surveys have been conducted since 1984 ^[B]. The official monthly minimum loan was Tsh. 23,500 (equal to US \$ 39,-) in mid 1996, on which no taxes are levied ^[Change, Oct 1996]. Probably most incomes are below Tsh. 50,000 a month. The official minimum wage increased much faster than the consumer prices. The purchase power of somebody earning this wage doubled from 1991 to 1996. Because of the lack of survey data we do not know whether this improvement concern the majority of the people.

Most households have supplementary income from work by their family members. This concerns, for example, sewing of clothes, production and selling of small foods or a second job of the employed person. Often members of the family work on Saturdays on their 'shambas', which are small pieces of land on which crops and fruits are cultivated.

1.1.4 Education, health and religion

The school system is quantitative not well developed. A minority of the children finish primary education. The literacy rate is around 75 percent. Secondary education is followed by only 4 percent of the children, mainly in the urban areas. The university of Dar es Salaam enrols about 5,000 students. Tanzania belongs to the countries having the smallest percentage of academics in the work force [102b].

The government paid high attention to the health care services. Dispensaries and health centres are spread all over the country, including the villages. The mortality rate of babies decreased in the period 1965-1988 from 128 to 104 per 1000 births. More impressive is the mortality rate decrease from 22 to 13 per thousand people and the increase of life expectancy from 35 to 53 years. While the treatment of diseases is quite well organized, the occurrence and spread of diseases are still a subject of concern. Specially malaria, a disease which can be fatal for young children, is difficult to combat.

The main religion is the Islam, involving about 60 percent of the population. The second religion is Christianity, with Roman Catholicism as largest representative, constituting 22 percent of the population. The different religions do not separate the population into hostile social groups. But religious descent plays a role in the tensions between Zanzibar and the mainland and in the political uncertain future of the new multiparty system.

For this purpose I used the free market exchange rate which presents the real value of the Shilling better than the artificial official exchange rate. The expression in dollars is just illustrative. The food prices, as well as most other prices for basic needs, are determined by the local market rather than by international market prices. However, many indirect relations exist between international and local market prices. For more luxury goods this relation is direct because of importation and foreign competition.

1.2 Dar es Salaam

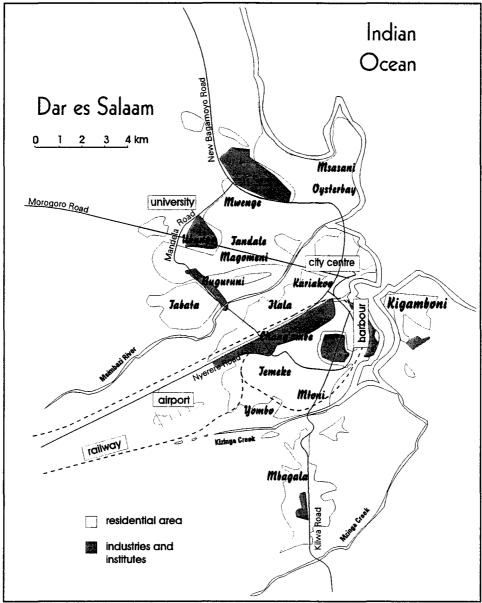


Figure 1.5 Map of Dar es Salaam town, 1995 [85,86,87]

Dar es Salaam⁶⁾ is the former capital and largest city of Tanzania. It is the most important town in many aspects. The government with all its ministries is situated here. Also the head offices of most parastatals and Tanzanian and foreign organizations are established in the town. Furthermore 37 percent of the industries is established in Dar es Salaam, contributing for 45 percent to the total industrial gross output. The main harbour of Tanzania is the harbour of Dar es Salaam, with oil depots nearby.

⁶⁾ The town as well as its region are named Dar es Salaam. Unless mentioned else, in this report the name Dar es Salaam refers to the town.

The town grows fast at an annual rate of 7 percent, resulting in a current population of about 2 million people. Suburbs are extending, resulting in a vast town area. The centre of the town is rather small, with a couple of offices-buildings up to fifteen floors high.

The access to the interior is provided by one well constructed tarmac road. It leads to towns as Mbeya and Morogoro in the west of the country and has a fork to the northern cities Arusha and Moshi and to Kenya. Other arterial roads are one sand road to the north and one poorly maintained tarmac road to the south. The road infrastructure in the town was improved by the construction of a four lane road around the city, starting at the harbour. The main roads are asphalted but poorly maintained. Improvement programmes are undertaken by the government and donor countries (Japan). The roads in the city centre and main arterial roads are not designed to accommodate the increasing density of traffic, causing traffic jams as new phenomena in the town.

Because most people are not able to provide their own transport they use public transport. Entrepreneurs own small busses with about 20 seats, the so called 'Dala-dala' busses. In the morning and afternoon these busses are overcrowded. Although the public transport sector functions quite well, the prices are high for the customers due to their extreme low wages.

The water supply system of the town is over thirty years old and constructed for about 600,000 people. Water is cut off often in dry periods. Most households in the suburbs don't have direct access to water. Women carry full buckets of water on their heads from the pumps.

The electricity grid in Dar es Salaam is fairly good but needs extension to meet the rising demand. The losses are high for such a relatively dense grid. Major problems with electricity supply occurring in 1992-1993 were caused by problems at the generation side.

The telephone network is functioning poorly. Often telephone connections don't come about resulting in inefficient communication. To bring a simple message to the other side of the town can require more than two hours of travelling.

1.3 Industry in Tanzania

1.3.1 Industrial policy and development

until 1961: colonial period

In the colonial period Great Britain established an extensive cash crop and mining sector. Labour shifted into towns to work in commerce and administrative sectors. A transport system was developed for the purpose of facilitating the export of raw materials and import of manufactures. A high dependency on external trade developed.

Tanzania was a protectorate under British rule, destined to become independent. The colony Kenya, with its better infrastructure, was preferred over Tanzania for industrial investments. At independence in 1961, the industrial sector in Tanzania was very small. Only 220 industries of more than 10 persons were registered, contributing 4 percent to the GDP. These industries were mainly processing agricultural products for export and producing simple consumer goods for the small urban population. There were sisal decorticating plants and cotton ginneries (30 percent), manufacturing of food products (25 percent), wood and furniture industry (15 percent) and repair of machinery and transport equipment (16 percent). The large companies in manufacturing were owned by transnational corporations, the smaller companies were mainly owned by Asians or Tanzanians from Asian origin.

1961 - 1968: attracting foreign investments

In 1961 the new Tanzanian government started an industrialization policy aimed at import substitution of simple consumer goods and at the stimulation of foreign investments. The plans, as described in the First Three Year Plan, aimed at industrial growth to lay a foundation for economic growth. This strategy was continued till 1969. Many new industries were set up and the share of industry in the GDP increased from 4 to 7.5 percent. Among the industries performing well were textiles, beer, cement, cigarettes and soap.

In general the evolving structure followed a typical pattern of primary processing and light import-substitution manufacturing. In spite of the industrial 'boom', the foreign investments expected stayed away. Furthermore the expected distribution of several industries over the East African Community toke place marginally.

1969 - 1974 : government control in production and the growth centre policy

The Arusha Declaration of 1967 announced major policy changes. The two main principles of this declaration are socialism and self-reliance. The major industries were nationalized. This also concerned the major means of production and exchange, which were land, forests, minerals, water, oil, electricity, media, communications, banks, insurances, export- and import trade and wholesale trade.

During the second National Five Year Plan (1969-1974) the growth centre policy was introduced. By means of investments in industry in nine selected towns the development of the lagging regions would be stimulated. These nine towns are Moshi, Arusha, Mwanza, Tanga, Tabora, Dodoma, Morogoro, Mbeya and Mtwara.

Six of these towns lacked the levels of urban infrastructure to sustain major industries, especially feeder roads to surrounding towns. Large enterprises were established, following a top-down approach. The local processes of growth and development, in which the role and dynamism of local entrepreneurs is essential, were neglected. Forward and backward linkages to regional industries developed marginally. Instead of developing the region, incomes increased just in the selected urban centres, accentuating income differences.

After four years it had become apparent that the government could no longer afford an urban development policy that was draining resources at the expense of the rural areas. In the third National Five Year Plan (1976-1981) more emphasis was placed on rural development.

1975 - 1980 : the basic industry strategy

In 1974 after a two year planning exercise in which several possible long-term strategies were considered, the government chose for the basic industrial strategy (BIS) for the period 1975-1995. The term 'basic industry strategy' focuses attention on the structure of production. This structure comprises of a first set of basic consumer goods industries and a second set of intermediate and capital goods industries to supply the first set of industries. Central issue in this strategy is import substitution. The BIS contains a couple of other promising strengths. The selected industries were expected to be relatively efficient. The capacity to adopt technology to local availabilities was expected to be large. A metal and engineering industry would be created with a key role in the spread of industrial skills.

The basic consumer goods industry comprised of food processing, textiles, clothing, footwear, building materials, supply goods for education and health care, transports and water supply. The supplying capital good industry includes the basic metal industry, engineering, industrial chemicals industry, paper industry, leather industry, construction materials industry and electricity supply. Also the large plantations belong to this group.

The BIS required huge investments. The annual industrial fixed capital formation (at constant prices) doubled in the period 1974-1979 and increased slightly in 1980-1985. Investments occurred in the set up of large scale, capital intensive and import intensive industries.

Little progress had been made with the BIS. The implementation was hampered by economic setbacks as described in paragraph 1.1.2, comprising mainly of foreign exchange problems. Therefore machines, spare parts and production inputs could not be bought. Another negative factor was the extremely poor project planning and co-ordination. Long term planning was lacking. Furthermore the principal infrastructural factors of water and electricity supply and the transport infrastructure were poor.

1981 - 1986 : crisis

In 1978 the industrial performance worsened drastically. After a constant level for six years, the value added declined by more than 10 percent per year. The share of industry in the GDP declined from 12.3 percent in 1979 to a mere 4.6 percent in 1987. This was mainly caused by the declining capacity utilization in industry: from 53 percent in 1976 to 29 percent in 1982 and 25 percent in 1985. The reason is that most industries could not obtain (enough) foreign currency from the government to import intermediate goods necessary to produce.

The scarce foreign currency was spent on investments in production-capacity of industries (according to the BIS) and on a selection of favoured industries. The BIS could not be continued and Tanzania was forced to moderate this policy.

Among the industries, the state owned enterprises performed particularly disappointing. Public sector industries made sizable losses while private industries generated surpluses. Their output per working input of labour and capital was lower than for private enterprises. Main causes contributing to the poor performance of the public sector industries are the protection from foreign competitors for a too long period and the bureaucratic character of the organizations. The protection caused internal prices above world market levels. Protected industries were able to make profit, while having a negative net economic return on capital.

1987 - 1992 : reforms under the ERP

The International Monetary Fund (IMF) indicated two major constraints for industry. These are the overvalued Tanzanian shilling and protection. By means of the artificial high exchange rate and prohibition of free change the only way for industries to obtain foreign currency was to apply to get their share of the limited amount managed by the Bank of Tanzania. As stated before, protection supported inefficient industries and avoided competition.

The ERP installed the basic economical requirements for industrial recovery. It restored the monetary balances by introducing the Open General License-system. This was directly followed by a growth of the capacity utilization in industry. The second measure was the abolishment of protection. Price-distortion disappeared and inefficient producing industries came under pressure.

These fast results are promising, but the measures taken were not sufficient to improve the efficiency of the industries. After an initially rapid increase the capacity utilization stabilized at 55 percent, not meeting the World Banks expectation.

1993 - 2000 : liberalization and rehabilitation of infrastructure

Import had been liberalized. The restrictions on enterprises importing raw materials and spare parts were eliminated. Another impact is a sharp increase of the availability of non-food consumer goods. An increasing import trade is the first result of liberalization.

Three years after the main liberalization measures the Ministry of Industry expects increasing investments in manufacturing, both from foreign and local origin. The procedures new enterprises have to go through were relaxed and will be liberalized further⁷⁾. Privatization became a popular slogan amongst Tanzanians. Certain state owned production companies and market boards and co-operatives have been privatized.

According to the Investment Promotion Centre new investment conditions will be implemented from January 1997, which will be more attractive than the existing ones. At the first International Investment and Technology Forum in Dar es Salaam (November 1996) president Mkapa announced the introduction of a policy of attracting foreign investments. Measures which will be taken soon are a review of the tardy tax regime, ease of immigration formalities and the removal of visa requirements for citizens from countries with investment potential to Tanzania.

Where other economic measures gave satisfying results, the reduction of inflation showed to be difficult. To combat inflation the Bank of Tanzania tightened the money market. This means that loans are given under strict conditions. Interest rates on loans became to be very high. The annual inflation rate which came to 20 - 25 percent in the 1990's, is expected to decrease to 10 - 15 percent for 1997 - 2000.

The past decades the government failed to implement and maintain adequate infrastructure and the contribution of different donors has not been structural and mutually coordinated. However, this situation came to an end. The past five years the World Bank and Japanese International Cooperation Agency (Jica) studied the economical infrastructure and cooperated with the Tanzanian institutes concerned. Per infrastructural discipline the study was followed up by recommendations and an implementation programme. A few studies are still going on. The World Bank and Jica started to subsidize projects according to the implementation schedules and several projects already had been executed. An example which every visitor of Tanzania before 1994 will notice is the improvement of the road quality.

1.3.2 Present pattern of industry

According to the 1989 industrial census^{8/(21)} 1170 industries with more than 9 persons engaged are established in Tanzania.

According to the industrial surveys from 1988 and 1995 [22,25] about 110,000 people are employed in 800 manufacturing enterprises with more than 9 employees.

The industries are concentrated in a few areas. One third of all industries is situated in Dar es Salaam and another third in six of the nineteen other regions, namely Tanga, Mwanza, Arusha, Kilimanjaro, Mbeya, and Morogoro. The distribution of industries in Tanzania is presented in figure 1.6.

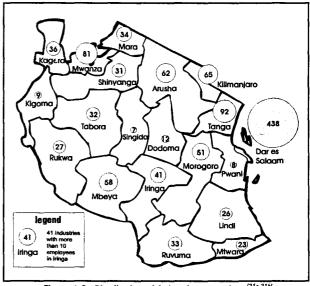


Figure 1.6 Distribution of industries to regions [21a,21b]

The figures of industrial census and surveys have to be used with care. Not all industries are included, specially those of smaller scale. Furthermore the redundancy of industries is high, in the last three years a lot of new industries are established and other ones stopped. However, in broad outlines the data of the census illustrate the pattern of industries.

Another critical note: the surveys published by the Bureau of Statistics are not of use for historical analysis, because the definition of the variables changes. For example, the definitions for scale division (industrial size) changed from 1989 to 1995.

The large industries⁹⁾ have a dominant position, contributing to the industrial employment, value added and turnover for about 50 percent. In these large enterprises the private sector plays a minor role, as presented in figure 1.7.

The geographical spread of public enterprises show a preference for the inland. Only 13 percent of the public small and medium scale industries is located in Dar es Salaam, where this concerns 35 percent of the large scale public industries.

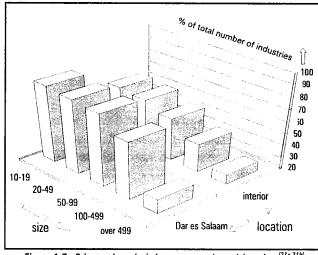


Figure 1.7 Private share in industry, to scale and location [21a,21b]

Thus, the government favoured the

establishment of public industries in the interior and of public industries of large scale.

1.3.3 Industrial sectors

The formal industry is dominated by the production of food, textiles, woodwork and paper. The basic consumer goods production, expressed in the ISIC¹⁰⁾ sectors 31 up to 34, comprises 66 percent of number of industries and 55 percent of total industrial output.

Specially the leather, wood and paper enterprises are of small scale. The technology required for production in ISIC sectors 31 to 34 is not complex. The chemical enterprises are larger and have an important 21 percent share in total industrial output.

Tanzania has an own basic metal and cement industry. These large scale activ-

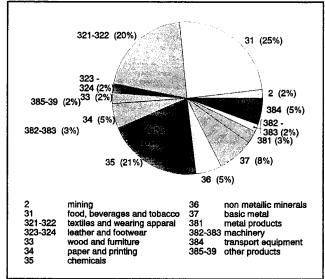


Figure 1.8 Sectors share in manufacturing gross output, 1988 [22]

ities are capital intensive and set up and managed by the government.

A more comprehensive description of all sectors is presented in appendix A.

A common definition for small, medium and large industries does not exist. A method to define this partition is to construct an x-y diagram with horizontal the industrial size (in intervals) and vertical the accumulative amount of employees (or turnover, net profit or another quantity you are interested in). The sizes corresponding with the 33 % and 66 % accumulative values are the borders between small-medium and medium-large. In Tanzania single person activities dominate so strong that this method does not satisfy. Therefore I determined intervals of 1-9, 10-49 and 50 employees and more. The method applied for an industrial developed country will give much larger values.

A common used classification to devide sectors in a structure is the International Standard Industrial Classification (ISIC). Four levels are distinguished. The first three of these are used to obtain an arrangement. The major divisions are presented in figure 1.2.

1.3.4 The informal sector

The description given in the last two paragraphs is based on data of registered industries with 10 or more persons engaged. This means that all industries of smaller scale and all other industries which are not registered are excluded.

Data of these industries are marginally available in Tanzania. A survey of the informal sector in Tanzania was conducted in 1991 ^[75]. The subject of research in this survey is private enterprises with less than 6 employees, without continuous use of high technology and without a fixed building designed for the economic activity. Thus the survey covers only a part of all industries which are missing in most data sources about industries. Although the accuracy of data from the informal sector survey will not be high, these data give an useful impression of the small scale industries.

The informal sector manufacturing products are simple goods, made by hand, tools and small machinery. The main activity is the manufacturing of wooden products, mainly furniture, mats and fibre products. These activities take principally place in rural areas and concern more than 100,000 small enterprises.

The main informal activity in urban areas is the production of clothes. This concerns sewing activities, which mostly take place in the house of the entrepreneur. The number of cloth makers is about 80,000, of which 11,000 in Dar es Salaam.

Other activities are the production of clay products and charcoal, which both take place in rural areas only, food processing, which includes grain milling and the manufacturing of metal products.

The total number of small informal enterprises which belong to manufacturing is 440,000, of which 31,000 in Dar es Salaam. The number of persons employed is respectively 520,000 and 44,000.

Since the liberal reforms the availability of imported consumer goods expanded rapidly. Import trade increased. The number of small shops and other informal selling activities in the towns increased since the beginning of the 1990's.

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1.3.5 The industrial structure explained

If we combine the data from the formal sector and informal sector surveys, concerning the mining and manufacturing activities only, figure 1.9 is obtained¹¹⁾.

Why are the private industries so small and is large scale production dominated by the state and a few multinationals? To be able to answer this question let us first define the main types of industries according to their ownership and management. These types are the family enterprise, modern private management and government ownership. Modern management refers to the appointment of management on the base of rational

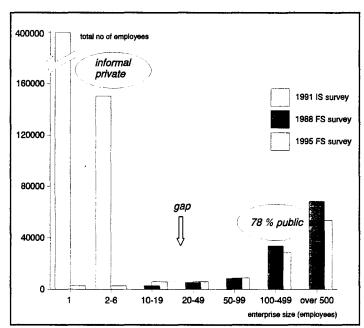


Figure 1.9 Structure of industry

motives (knowledge, skills, costs, etc.) rather than on the base of factors like kinship and friendship.

In Tanzania we find most economic activities, industrial ones as well as others, being family based. These activities are of small scale. Individual enterprises may perform well, but rarely grow large. It seems to be that the family based activities rarely grow into modern structures. For a growing family based enterprise a process of 'management rationalization' is required to survive more than one or two generations. Even the family enterprises which do not expand significantly break up not long after the founding entrepreneur handed the ownership over to his sons.

Modern management does exist in medium scale enterprises, but these are strongly underpresented. Most modern management patterns are found in foreign owned and managed enterprises. The inability to transform from family into modern management is one reason for this phenomenon. Another one is the lack of capacity to organize economic activities together, amongst economists indicated as social capital. Where you will find this capacity within the family and religious institutions, you will miss it in the economic institution.

These findings correspondent with the theory of Francis Fukuyama about the role of culture in industrial development ^[36]. He argues that social capital is related to trust, needed for a sustainable co-operation. Trust and social capital are strongly related to culture.

In the Tanzanian context, the safe job as an office official is preferred by most educated people over the venture of an own enterprise, especially of the manufacturing type. Others prefer trading above manufacturing.

¹¹¹ The informal activities larger than 6 employees are not included in the IS survey. Since the informal character is dissappearing for increasing sizes, mainly the figures in the 7-9 interval are missing. Because of this lack and the overlap of the informal 2-6 and formal 5-9 survey intervals, the 7-9 interval is not presented in figure 1.9. The data of the different surveys are compared for a figurative purpose.

Other explanations for the lack of larger private enterprises are the more classic ones, used by most economists. Applicable to Tanzania are:

- 1 The attitude of the government towards private enterprising is decisive. Except for a few foreign enterprises, the Tanzanian government did not allow large private industries.
- 2 The size of the national market is small. Since purchasing power is very low and the country sparsely populated, large scale production needs huge geographical markets. Import protection by other countries and a difficult accessibility of foreign markets are main restrictions to expand the market.
- 3 Large private industries in other countries developed during a long period, the Tanzanian industrial history started recently.
- 4 Large enterprises need juridical, commercial and financial institutes. All of them are lacked in Tanzania.

Especially the first reason played an important role in Tanzania.

The state has to fill the gap created by the private sector's inability to develop large industries. At least, if the state wants to have these large industries in the country. Certain production technologies require large scale organization. For example the basic metal industry, cement industry and certain higher technology industries which require export quality. The state can choose between the establishment of these industries and the allowance of import of the products concerned. The government had a policy of import substitution and chose to set up the large public sector enterprises (see also § 1.3.1). Also large industries which do not necessarily need large scale production had been established. Many of them with financial support of foreign donors.

This description sheds light on the strange industrial pattern of small scale private and large scale public domination, with a gap in between. It also contains a warning for intended privatization. In the present situation it is not realistic to expect the private sector being able to operate most of the large public enterprises.

One comment about success has to be made. The pattern described tells about the character of organization and structure of industry, but nothing about economic success. Small family managed enterprises may have disadvantages related to scale (high per unit production costs) and will produce mainly low technology products with low technology processes, which are labour intensive. But they can be flexible and can relieve the scale disadvantages by close co-operation in networks. Fast changing, segmented and smaller markets open up possibilities for them. Examples of countries where family based industries grew rapidly and became the key to successful industrialization are South-Korea in the 1960s, the middle of Italy ('Terza Italia') in the 1970s and China since its liberalization in the early 1980s¹²⁾.



Later, part of the small family based Korean industry (especially the export oriented) could grow large due to strong government support. Although this state intervention had been successful, the companies concerned remained family managed and owned.

China's success story has an other side. A considerable part of the exported goods has been produced in labour camps where prisoners are exploited. The camps had not been abolished when Mao's power policy was abandoned.

1.4 The energy sector in Tanzania

The research deals mainly with the electricity supply at distribution level in Mbagala, an urban suburb. To get a good understanding of the functioning and quality parameters of the local grid, the main characteristics of the electricity situation at national level has to be known.

To sketch the relative role of electricity in the whole energy use in the country, this chapter starts to describe the energy pattern. The uses of biomass and petroleum fuels which are the main energy sources are described. Paragraph 1.4.3 deals with electricity in particular. The main features of the electricity system and the electricity use in the country are discussed.

Pattern of energy use

The total annual per capita energy end-use¹³⁾ in Tanzania is about 24.5 gigajoules. This is roughly one-fourth of the per capita end-use in industrialized countries and of the same order as the energy use in surrounding countries. The total energy use increases with almost 4 percent per year.

The energy sources used in Tanzania consist of three main types: biomass fuels, petroleum products and electricity. The main characteristics of each type of energy source are dealt with below.

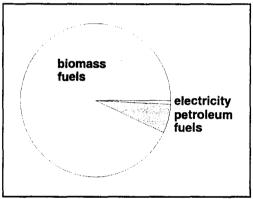


Figure 1.10 Relative end-use of energy sources, 1991 [41]

1.4.1 Biomass fuels

The biomass fuels used are firewood, charcoal, crop residues and dung. Firewood contributes for 88 percent to the biomass end use. In the rural areas wood is the traditional energy source used for cooking. The wood is gathered as brushwood or cut for free, by the consumers themselves. It is burnt in traditional fireplaces with efficiency rates somewhat below 10 percent. A small proportion of the firewood is used for other applications, for example the warming of houses in areas of high altitude, rural commercial use (food preparation) and rural industrial use. The latter concerns tobacco processing industry and heat processes in small industries as bakeries and potteries.

Charcoal is used by the urban population, for the same purposes as firewood for the rural people. It covers 5 percent of the total energy end use of biomass fuels. It is produced from wood, which is heated in simple earthen mounds or pit kilns. This takes place nearby the urban areas from where the charcoal is transported to the towns and sold. Charcoal is the basic urban energy source for all income groups. Except for electricity, it is the cheapest urban energy source. Advantages of charcoal use in urban areas in favour of firewood are the high energy contents (30 megajoules per kilogram for charcoal and 15 megajoules for

¹³⁾ Distinguish end-use from the original energy content of the primary energy source. For example, high energy losses are required for the production of charcoal (Tanzania) and for the steam processed production of electricity (West Europe). In these cases one unit of end-use requires a much higher primary energy amount.

firewood), the ease to handle, transport, distribute and sell and its almost smokeless use. But the efficiency of conversing wood into charcoal ranges between 10 and 20 percent only. Taken into account the efficiency rate of charcoal stoves of 15-25 percent, the total efficiency rate becomes 3 percent.

The use of firewood and charcoal exceeds the regeneration capacity of the forests in Tanzania. Deforestation occurs because afforestation programs are marginally executed. In many countries deforestation led to the disappearance of the majority or even all of the natural woods. This still doesn't apply to Tanzania.

Besides wood, crop residues are used for cooking in rural areas, contributing 7 percent to the biomass energy end use. Dung is almost not used as energy source in Tanzania.

1.4.2 Petroleum fuels

The majority of the raw oil is imported. It is refined, stored and distributed by foreign companies established in Tanzania, in which the Tanzanian Petroleum Development Corporation owns shares.

One quarter of the petroleum products consist of fuels for transport, which are gasoline, diesel and kerosine. Another quarter is used by the industry. Households contribute to the petroleum use for 11 percent, using kerosine. Because cooking by kerosine is much faster than by charcoal, it is used for quick cooking of small foods and making tea. Kerosine is also used for portable candles.

Kerosine is subsidized by a cross-product subsidy from additional taxes placed on the sale of gasoline. The rationale for this policy is twofold and is similar to that found throughout the developing world. First, kerosine is assumed to provide lighting for the rural and urban poor. As such, it is a basic need and its consumption by the poor should be subsidized by the luxury consumption of the rich who utilize gasoline or petrol in their private automobiles. Second, the subsidization of kerosine makes the purchase of fuels for cooking affordable for households that would otherwise rely on woodfuels. Thus, the case for cross-subsidy of kerosine relies on both equalling and environmental arguments.

Since nearly half of the LPG extracted in Tanzania is flared, it has virtually no opportunity costs. As a result the economic costs of supplying LPG should be very low. However, the uncertain supply of bottles has made LPG an unsatisfactory alternative for most households. Thus, the inability of the supplying organizations to manage a bottle transfer system effectively results in a waste of national resources.

over settilor Sign

1.4.3 Electricity

The electricity use contributes for a mere 0.8 percent to the total energy use and 7 percent to the use of commercial energy. Electricity is mainly used by industry (49 percent) and households (33 percent). About 136,000 households were supplied in 1991, which concerns about 3 percent of the Tanzanians. This low percentage is caused by the scattered distribution of the population in the extensive inland of Tanzania, whereby electrification becomes economically unfeasible. Another reason is the connection fee and meter deposit of Tsh. 15,000¹⁴⁾ to be paid by each new customer. Therefore most households in villages and suburbs supplied with electricity are not connected.

The electricity sector is dominated by the Tanzania Electricity Supply Company Ltd. (Tanesco). For the generation of electricity it mainly uses hydro power, for which three dams were built in the country. In remote areas the electricity is generated decentralized by relatively small diesel aggregates.

Tanzania has large reserves of coal and gas. The construction of a 200 MW turbine using gas from Songo Songo in the south of the country is studied and will probably be executed before 2005. Two proposed coal-fired plants including one of 100 MW were analyzed but need to be studied in more detail. The coal reserves are marginally explored. Because they were found in remote areas their exploration requires large investment costs.

Electricity use by households and light industries is subsidized by the lifeline tariff, as is shown in figure 1.11¹⁵⁾. It entails that the first two blocks of electricity use are cheap for these customers. The objective of the government for this subsidy is to ensure that all consumers, inclu-

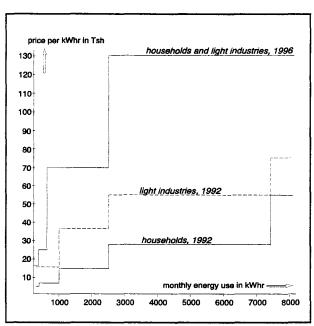


Figure 1.11 Tanzanian electricity tariffs for residentials and light industries in 1993 and 1996 [9]4.9]4, Tanascol

ding the poor, are able to utilize a limited quantity of electricity. The quantity of subsidized energy of 100 kWhr per month is supposed to be the quantity needed for lighting and minor additional use. A critical note to this pricing policy is that only a small part of the population has access to electricity and that electricity consuming households on average have higher incomes. The fact that subsidy is not limited to the small 100 kWhr amount, but concerns the 100-500 kWhr block with the majority of consumers as well, intensified this critism.

Generation, transmission and distribution of electricity

The energy for the national electricity grid is generated by three main hydro power stations, one diesel power station and nine smaller diesel stations. The generation capacity of the grid is 492 megawatt, enough to supply the system peak demand of 337 megawatt in 1996. The

¹⁴⁾ In 1995 the connection fee decreased from Tsh. 35,000,- to Tsh. 15,000,-.

¹⁵⁾ The electricity tariffs for all consumer groups are presented in appendix D.

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last 3 years one hydro power plant had been extended by 40 MW and a 107 MW diesel plant was installed. For the coming ten years the generation capacity is planned to be extended with 509 megawatt by two new hydro power plants.

Rural villages which are too far to supply by the electricity grid are supplied decentralized by diesel generators. Tanesco operates 19 of these diesel generators, contributing to the total electricity supply for 3.5 percent. Large rural industries often own their own diesel generators.

The transmission ¹⁶⁾ of the generated electricity over long distances takes place at 220 kilovolt and 132 kilovolt level. Local transmission grids within towns operate at 33 kilovolts. The transmission lines to rural areas use 33 and 66 kilovolts. The transmission grid is presented in figure 1.12. It shows major future extensions to close the circle connection from Arusha to Singida and international connections. The two major connections to Kenya and Zambia are planned to be executed in the period 1996-2000.

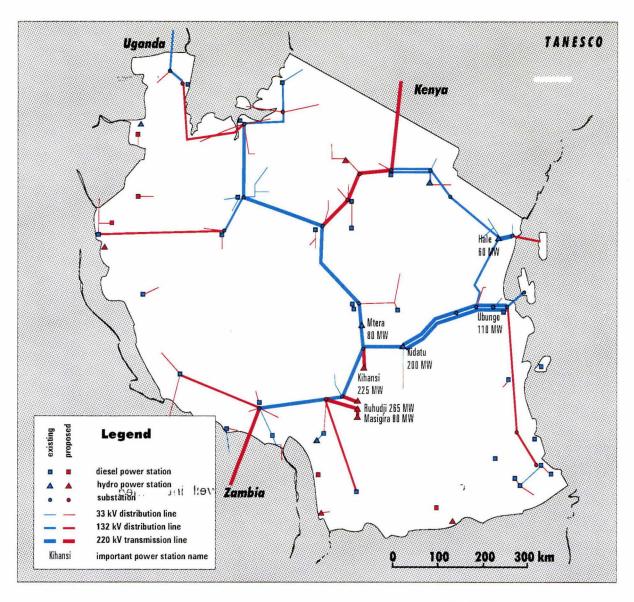


Figure 1.12 Generation and transmission of electricity in Tanzania, 1996 (SOURCE: TANKESCO)

¹⁶⁾ Transmission of electricity is bulk transport from a point to another one, from where the electricity is further transported. Distribution is branched transport from a point to low voltage transformers or consumers connected.

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The distribution of electricity in the towns is performed by 11 kilovolt feeders. By the distribution transformers the voltage is transmitted to 400 volts and supplied to the customers. The large and medium industries are mostly supplied with 11 kilovolts.

power shortages

Problems for the generation of electricity occurred in the second half of 1992. Due to the drought the water level in the two main hydro basins, which are fed by the same river, decreased drastically. Tanesco was forced to cut of customers. Power cut schedules were arranged for the whole country, in which customers were cut off per distribution feeder for periods of 12 hours. From January to March 1993 these cuts occurred usually more than seven times a week. They amounted to over 35 percent of the total electricity generation in these months and around 15 percent for the whole year. In 1993 and 1994 the same situation occurred. The World bank estimated the economic

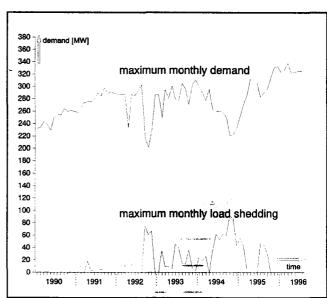


Figure 1.13 Maximum system demand and load shedding 1990-1996 [2]

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value of load shedding at 5 percent of the total country's GDP for the years 1993 and 1994.

losses

Another major problem is the high energy losses. This concerns 4.4 percent of the generated energy at transmission level and 7.1 percent at distribution level. These distribution losses are split up in substation transformer losses (1 percent), medium voltage distribution feeder losses (2.5 percent), distribution transformer losses (0.9 percent) and low voltage grid losses (2.6 percent).

The high losses are partly caused by the low load density of the extensive grid. On a geographically extended system such as Tanesco's losses will be higher than average, so that losses can be expected to be around 13 to 15 percent of the energy production. Another reason is that the grid extensions are lagging behind the increasing demand.

Besides the technical losses also non technical losses occur, coming to 965 percent of the energy production. These non technical losses are caused by meters tampering, illegal connections, meter reading inaccuracy, auditing methods, computer data entry, accuracy of billing and accounting and delay of paying by the customers.

To reduce both technical and non technical losses a loss reduction program is arranged by Tanesco, in co-operation with the World Bank Energy Sector Management Assistance Programme (Esmap) and the United Nations Development Program ^[97]. The Esmap study was followed up by a power supply project study ^[43] and implementation schedules were set up. The first projects had been funded and implementation started. My research as described in chapter 3 is a supplement to both studies.

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As a result of the Esmap non-technical loss study Tanesco introduced in 1996 a new measurement and payment system for small consumers: the Luku system. At one of the Tanesco offices consumers can revalue their magnetic card which is unique for their meter. They put it in their Luku meter to get voltage. The meter counts off the value of the card, taken the tariff levels into account. The principle of the system is comparable to that in the Netherlands before the second world war, which worked with coins. Nowadays modern equivalents are used in South America, South Africa, Britain and the United States. In the latter two the system is mainly used in low income houses, avoiding payment problems.

Consumption of electricity

The electricity customers are divided in ten groups as shown in table 1.2. Each group pays different prices for electricity. The total energy use delivered by the national electricity grid in 1991 was 1.4 million MWhr.

consumer gr up to 1995		consumer group description	number of consumers	share in energy use [%]
1	1	residential	136,109	31.0
2		light commercial	35,426	10.1
3		light industrial	4,873	4.4
4 35	<u>a</u> c 2	low voltage supply	648	10.7
4A		agricultural consumers	386	4.6
5	3	high voltage supply	95	15.4
5A		high voltage supply, energy intensive customers	8	14.3
6	4	public lighting	2,487	0.5
7	-	own Tanesco use	-	-
8		public water supply accounts	43	4.9
9	5	Zanzibar supply	1	4.0
		total	180,076	

Table 1.1 Electricity customer groups and their share in electricity use, 1991

Residential customers concern all households which are single phase connected. Light commercial customers are shops, restaurants, hotels, bars, harbours, schools, churches, airports and other of such public services, if they use less than 7,500 kilowatthour per month.

Light industrial customers are three phase connected customers using less than 7,500 kilowatthour per month. Low voltage supply concerns three phase connections using more than 7,500 kilowatthour per month. Besides a kilowatthour meter, a maximum kilovoltampere meter is used to determine the electricity payments. Farmers belong to the agricultural consumers group if they use more than 5,000 kilowatthour per month.

High voltage supply concerns industries supplied with and metered at 11 kilovolts or more. The tariff for higher energy blocks is lower than for low voltage supply, but the consumers have to own a transformer. The high voltage supply energy intensive customers concern industries with a demand above 5,000 kVA and more than 800,000 kWhr per month. In 1995 the tariff group division was simplified. Tariffs 1,2 and 3 were united.

The electricity demand increased strongly in the past ten years. Between 1985 and 1991 the industrial use increased with 35 percent and the household use with 133 percent. The demand forecast for the coming fifteen years shows an annual growth percentages of about 6 percent.

The daily use of electricity supplied by the national grid is shown in figure 1.14. Striking is the high peak in the evening. Between six and half past six darkness starts and the households put on their bulbs.

Electricity demand is a derived demand. There is no need for electricity itself, but for the electrical apparatus. Once purchased, the number of apparatus determine the electricity demand rather than a rational weigh of the electricity costs and affordable income spendings. This means that income and electricity use are strongly related.

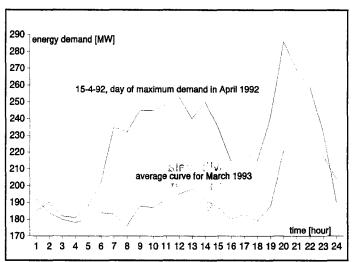


Figure 1.14 National daily electricity demand curve | Source: TANESCO|

This does not mean that consumers can not decrease the intensity of apparatus use if disposable income decreases, the electricity price rises or competing energy sources become cheaper.

Recent researches [2,54] show a high income elasticity for electricity of 0.8. This means that one percent income increase on average results in 0.8 percent increase of electricity use.

But the price elasticity is low: -0.12¹⁷⁾. The survey concerned was conducted just before the recent hugh electricity price increase and introduction of the Luku system. Both may result in a more conscious weigh of costs and benefits by consumers. However, the price elasticity might increase somewhat but will remain relatively low.

Also the elasticity for competing energy is low. For the main energy source charcoal this concerns 0.05 only (one percent charcoal price increase results in 0.05 percent electricity use increase). The reason for this weak relation is that only a few people cook with electrical apparatus. The initial costs of electric appliances are high¹⁸.

¹⁷⁾ The short term elasticity is significant lower: -0.08.

Another reason is that cooking with charcoal became part of the culture. The reliability of electricity supply, which has been much worse than that of charcoal supply, strengthens the choice for charcoal.

1.5 Problem definition and research questions

The first activity undertaken in the research is the description of the problem definition. On the basis of this definition the research questions were derived. The methodology shows how the research questions were tackled. According to these methodologies the research had been executed, as described in chapters 2 and 3 of this report.

1.5.1 Problem definition

Mbagala is one of many suburbs in Dar es Salaam, the capital of Tanzania with about two million inhabitants. It is situated in the south of the town and accessible by the Kilwa Road, one of the three asphalted access roads of the capital. Up to the 1990's it was an area with a mix of rural and urban characteristics.

Mbagala had about 40,000 inhabitants in the late 1980's and this number increased rapidly. It is one of the areas, in the growing capital, able to absorb large numbers of people because most land is still not inhabited. Socio-economic survey data of any kind about the area are not available.

Most families in Mbagala have low incomes and live in low income houses made out of stone and roofed by iron sheets. The average number of persons per household is probably around six. The main religion is the Islam, the second one is Christianity. The native language is Swahili, a minority can speak English.

An industrial area of about two squared kilometres is situated in the south of Mbagala. A number of industries is established in this area where most of the industrial plots are empty. Other industries are given the possibility to become established here. Small scale productive activities are situated in the residential areas in Mbagala.

People have access to health care and education. These are a few small hospitals and primary schools. The condition of the Kilwa Road is poor, which causes long transport times and damage to cars. There is no supply of water by the government because the water grid in the capital is seriously under-dimensioned. People get their water from wells and industries have to bore own wells or buy water from elsewhere.

More than one power cut a week is common. The quality of local electricity is probably not so good, and the increasing demand threatens the quality of supply in the future. These recent power cuts resulted in darkness in evenings and interruption of production for most industries.

Improvements will be required to keep pace with the rapidly growing population and the development of industries. The state of infrastructure, amongst other factors, will affect the industrial development in Mbagala.

1.5.2 Goals of the research

The main goal is to contribute to the improvement of electricity distribution grids by presenting a methodology. Although it is not limited to a certain geographical area, the methodology will be mainly of use for management and planning engineers of Tanesco in Dar es Salaam. A goal which is in line with the methodology aspect is the elaboration of a case. The recommendations for grid improvements to guarantee the distribution grid quality in Mbagala can be used by the engineers of Tanesco's regional office in Temeke, Dar es Salaam.

A second goal is to contribute to planning and policy making purposes for Mbagala. An overall view is presented, including different infrastructural characteristics concerning different institutes. This is directed to industrial development. The research may be interesting especially for organizations co-ordinating these different institutes.

A goal which is interwoven with the former two is to undertake a scientific research to enable myself to graduate in Masters of Science satisfactory. As such, the research agrees with the research program of the department of International Technological Development Studies.

1.5.3 Research questions

As being expressed by the goals, the research concerns two topics: the process of industrial development in Mbagala with its factors of influence and the performance and improvement of the electricity grid in Mbagala.

The second topic is an elaboration of one of the factors dealt with in the first topic, as shown in figure 1.15. This factor is electricity, chosen in advance of the whole research. This early choice is

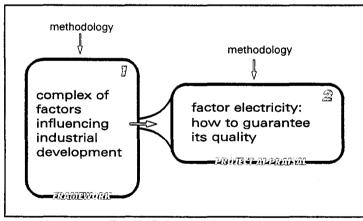


Figure 1.15 Set up of the research

justified by indications beforehand that the quality of electricity supply in Mbagala was poor.

This description leads us to the following research questions¹⁹⁾:

1 Which are the key factors affecting industrial development in Mbagala?

To be able to answer this question two subquestions were formulated:

- 1.1 Which are the industries presently situated in Mbagala?
- 1.2 Which are the complexes of factors affecting industrial development in Mbagala?
- What is the best way to guarantee the quality of electricity supply in Mbagala in the coming ten years, with minimal costs?

¹⁹⁾ The definitions of the expressions used are presented in appendix B.

1.6 Methodology

To be able to answer the research questions different approaches were thought out and discussed. This led to the methodology described in this paragraph. Because these descriptions are aimed to outline the whole research with its steps passed through, not every step is described in detail. Examples of such steps for which an own methodology had been developed are the execution of the electricity load forecast and the maintenance philosophy. Such research details you will find presented later in this report.

1.6.1 Methodology for research question 1.1

Inventory of industries in Mbagala.

Compile a list of all customers in Mbagala registered at Tanesco as industrial.

Construct a map of Mbagala. Visit each industry and determine the geographical place of each industry, the nature of the industry and whether the industry still exists and produces.

Check whether the industries meet my definition of industry. Check the suitability of the definition of industry. Search the industries missing in the list constructed, by visiting the area.

1.6.2 Methodology for research question 1.2

First inventory of factors influencing industrial development in Mbagala

Consult literature concerning economic and industrial development in Tanzania. Identify factors and their complexes, which probably will affect the industrial development in Mbagala. A morphological approach²⁰⁾ is used to support the first brainstorm sessions. This results in a preliminary cross-matrix overview of factors. To facilitate a structure for the search of factors an institutional framework is used. This involves the institutions economy, kinship, education, health, politics, military institution and religion. Selection of factors which appear to be the most important ones for the development of industries in Mbagala.

Survey of the individual industries

Prepare a questionnaire in the Netherlands on the basis of the selected factors.

Discuss the questionnaire with engineers from Tanesco and adjust where necessary.

The scope of the research does not allow for statistical proof but only makes it plausible, by circumstantial evidence, that the factors are important.

t brs :

Selection and visit of industries

A morphological approach is used to ensure that you look at all relevant components of a problem or forecast area. It is a technique for breaking a problem area into its basic variables (factors) and used to explore the relationships between these variables. If we break some area of concern into components, at one instance assuming that they are interrelated, we construct a vertical relevance tree or a horizontal Ishakawa (fishbone) diagram.

Estimate whether all industries of the inventory can be investigated within a reasonable time schedule. Assess on basis of the results of short visits of all industries whether it is necessary to visit all of them or a selection of them is sufficient. In the latter case a random sample should be applied.

Interview the manager of the industry. For technical questions, it can be necessary to interview the chief electrical engineer.

Describe the production process, using the following steps:

- Visit, together with the interviewed person all production steps in sequence of production.
 This includes machinery and other equipment used, labour tasks and organization of the process.
- Make a schedule including inputs and outputs belonging to each production step.

Execute the questionnaire.

Supplier side

Select institutes on the basis of the institutional approach and industrial survey results. Prepare for each institute main questions representing the performance of their services in Mbagala. Include the description of service in the past, present and plans for the future. Find the institutes and visit them. Interview the person which is most involved with the questions. If plans are presented, try to assess the probability of execution of them.

1.6.3 Methodology used for research question 2

Find the criteria to be met by distribution grids. Test the grid in Mbagala for these criteria by calculation, discussion with the engineers involved and results of the visit of industries. Find solutions to improve the criteria which do not meet the quality standards.

Calculate the voltage level, as a main criterion, for a proper project time. Data required for the calculations concern technical data of the components of the grid, recent consumer load data and a forecast for these loads for the project period. Special attention has to be paid to this load forecast, because the accuracy of the calculations will depend largely upon it. This includes the use of trend analysis, macro-economic analysis and field survey.

If the technical pre-requisites are not met for the project time, a grid design is made in order to meet them. Besides the voltage drop important design parameters are the energy losses of the grid and the costs to execute the grid improvement.

For the project (improvement of the grid) a financial and an economical cost-benefit analysis is made. The costs concern all material costs to construct the grid and manpower costs during the whole project period. For economical costs determination, adjustments for shadow prices and taxes should be made. Financial benefits for Tanesco consist of profit from energy sales, decrease of energy losses and reliability improvement. Economical benefits include, besides the elements of the financial benefits, the surplus value of electricity supply for the consumers.

2 INDUSTRIAL DEVELOPMENT IN MBAGALA

In this chapter industrial development in Mbagala is studied and the factors influencing this process are defined. This research corresponds with the first research question (page 25).

In this study industrial development is related to changes in the technology sphere. This concerns facilities, human capabilities, information embodied in documents and the way of organizing the whole process at micro-level ^[93]. These components form an inward directed technology model. To complete the pattern of the transformation process outward elements are added. These are inputs, outputs and the firms environment.

Industrialization and industrial development are closely related, but different expressions. In this study, industrialization refers to efficiency or productivity. Both latter terms are defined as the ratio between outputs and inputs. Industrial development is related to changes in the total industrial pattern. Besides inputs and outputs, this includes the transformation process. The industrial approach used in this study is firm-intern as well as firm-extern directed, because the factors influencing industrial development may be found both in and outside the industrial organizations. To study those inside the organizations may need an understanding of the transformation process. Therefore, the expression industrial development is used instead of industrialization.

Many factors influence the process of industrial development. With common sense one can construct a list of such factors. Literature is available: many authors mention factors to explain a countries industrial or, in a broader perspective, economic development. For research purposes it is desirable to obtain a structure in the overview of factors. Therefore the institutional approach [57] had been used. This approach is dealt with in paragraph 2.1.

Once the framework of factors is designed, it can be used to describe the industrial development process in Mbagala. Therefore a survey amongst the industries had been carried out, described in paragraph 2.3. This is preceded by an inventory of industries in the survey area. The supply side of main factors as being performed by institutions is described in paragraph 2.4. The compilation of the results at industrial and institutional level leads us to the complex of factors which influence industrial development. This concluding description is presented in paragraph 2.5.

2.1 List and structure probable factors

Each variable (factor) with respect to the industrial performance can be classified in one or more of the social institutions. These institutions are: economy, education, health, politics, military system, religion and kinship.

In view of the nature of the research the economic institution contains most of the important factors. To make the search for factors orderly, the economic institution is subdivided in different units which are industry related. These are land, buildings, equipment, labourers, entrepreneur, inputs, outputs and capital infrastructure. A category 'others' is included for economically related factors which cannot be placed in one of the subdivisions. The inventory leads to the overview presented on the next page.

The *economic institution* contains:

-	land	the availability and price of land reserved for industries
-	labour	availability of labour, knowledge level, skill level and labour costs
-	entrepreneur	knowledge and skill level
-	equipment	age of equipment, investment costs, performance, production capacity
-	maintenance	organization of maintenance of equipment, fall out of equipment due to
		failures
-	finance	sources of financing, availability of loans, availability of foreign currency,
		insurances
-	inputs	continuance and quality of supply of raw materials and spare parts
-	outputs	market geographically covered, quality requirements of customers,
		competing industries, economic development of customers
-	economic	public utilities: electricity supply, telecommunications, water supply,
	infrastructure ¹⁾	sanitation and sewerage, solid waste collection and gas supply
		public works: roads and irrigation and drainage works
		transport: railways, ports, waterways, airports and passenger transport
-	others	other service related infrastructure like subcontracting of operation or
		maintenance functions

The *political institution* affects industrial performance by its taxes, licence regulations, support by means of subsidies, import protection and bureaucracy.

Kinship concern the family. Family business is a common phenomenon in many countries. You will find this especially in cultures in which the family ties are strong. The characteristics of industries managed by families may differ from other industries². This can influence the development of industry.

The *education* provided can be judged by the knowledge level of the employees and entrepreneurs. The knowledge formed in primary and eventually secondary and tertiary education is a base for the development of skills by work experience and training. Knowledge and skill level are included in the economic institution.

The *health care* service is important to prevent and cure diseases of employees. An employee suffering from malaria can not work until he or she is cured.

A factor belonging to the *religious institution* is the absence of employees due to professions of faith. Stopping production at weekends is, for example, a tradition which is related the Christian free Sunday. It is expected that the religious institution play a minor role in the industrial development.

The *military system* can hamper industrial performance by requisitioning of materials. The governments of western and former communist countries invested heavily in their military industrial complexes. This resulted in learning effects from military research and development to civil institutions and industries. Since Tanzania does not have a military industrial complex and does not undertake research and development in this area, such learning effects are not expected.

¹⁾ This definition of economic infrastructure is formulated by the World Bank [102a].

²⁾ The dominant role of the family in business and industrial activities is described in § 1.3.5.

To be able to measure these factors they have to be made operational. For this purpose the variables were translated into indicators. An overview of variables and indicators for each institution is presented in appendix F. The importance of these factors for the individual industries in Mbagala were found through a questionnaire and conversation (paragraph 2.3).

relations between factors

Many of the factors describes above will relate to each other. Some of these relations are described in researches undertaken before. On the basis of these sources a preliminary model had been set out. This inventory was thought out according to a morphological approach. This meant brainstorming about relations and note them in a fish-bone diagram³⁾. Once the factors are marked out, their relations can be expressed in a cross-impact matrix. In this matrix all factors are presented, the prime variables as well as moving variables. In appendix G both the fish-bone model and the cross impact matrix are presented. The intention of both is just to support the inventory process.

2.2 The industries, an inventory

To be able to invest the industries in Mbagala, all of them have to be known. This means that an inventory of all productive organizations in Mbagala, meeting the definition of industry formulated, is required.

To what extent the completeness of this inventory can be reached depends on the methodology followed and information available. The methodology and definition of industry used are described in the next paragraph. The construction of the inventory is treated in the following four paragraphs.

2.2.1 Methodology

All industries supplied of electricity are registered by Tanesco. The definition of industry used by Tanesco is the connection of three phases electricity. Three phase supply is necessary for alternating current motors and equipment using much power. In practise most industries are three phase supplied and most three phase supplied consumers meet the definition of industry.

The three phase supplied electricity consumers form the point of departure to construct the inventory. All these consumers found in the Tanesco files were located and drawn on a map of the area. They were visited to check whether they meet the definition of industry in order to be included in the inventory.

³¹ This schedule looks like a tree. You start with the final variable (in this case industrial development), find variables which you think are related. These variables will each relate to others, etcetera. Of course you have to stop once and mark the model out for those variables which you find the most interesting: these with the strongest relations. A disadvantage of the use of this model is that interlinkages between variables in different branches of the tree may be overlooked. The model is also denoted as ishikawa diagram, the Japanese word for fish-bone.

An industry we defined as an organization meeting the following criteria:

- 1. using machinery to make or process products
- 2. selling products for a market
- intention to produce a certain number of products constantly
- 4. producing products with a certain degree of standardization, thus not at customer specification only

Then the list was completed for industries not supplied of electricity and for other industries not meeting Tanesco's definition of industry. This was done by visiting the area where industries were detected. This method satisfies because the area is of a limited size.

2.2.2 Collection of data

The data required to construct the list of industries supplied of electricity by Tanesco are given below.

- A list of industries in Mbagala supplied of electricity.
- A recent geographical map of the area of Mbagala. All main roads have to be included in the map and a reproduction of buildings is desirable.

Electricity consumers

Tanesco registers all its electricity consumers in its billing system⁴⁾. The sequence of registration is according to the account number. The account number starts with a two digit number representing the district. The district Mbagala is numbered 06. All consumers are classified in eight tariff groups, as presented in table 1.1.

I went through all printed records beginning with 06 and selected those with tariff numbers 3,4 and 5. This resulted in a list of 38 organizations. Until their industrial nature is concluded by means of a visit, they are named 'productive organizations'.

Maps

In 1992 / 1993 hardly any maps of Mbagala existed. Tanesco mapped a few parts of Mbagala. At the Survey and Mapping Division, the Ministry of Lands, Housing and Urban Development and the City Council no maps were available. Finally, I drawn a map by myself, on the basis of visits of the area and an outdated map with a scale of 1:50,000.

In 1994/1995 the Survey and Mapping Division released detailed survey maps of Dar es Salaam, scaled at 1:2,500. The information is based on 1992 air photos. Every single land plot and building is included. The area of Mbagala includes eight of these maps. In 1996 I bought all and used copies of it for adding notes.

1:

⁴⁾ The billing system consists of an old computer system. The bills are printed and sent to the customers by post. Besides, hugh records are printed monthly with all billing information. The information enclosed is, amongst others: name of consumer, account number, tariff group, date of connection, last 6 measurement dates, last 6 measurement values, costs and customer debit saido. Technically it is possible to export a selection of data from this system, for example in spreadsheet or text-editor format. But Tanesco's computer department has problems with doing this.

2.2.3 Short visits of productive organizations

The location and type of the 38 productive organizations are not described in the Tanesco files. The larger industries situated in the industrial area are easy to find, but others like remote grainmills are not.

All productive organizations on the list were looked for in 1992. For this purpose the Tanesco district manager of Temeke, of which Mbagala is part of, was approached. His meter readers are well known in their area of duty. They visit all electricity consumers in their area monthly to note the electricity consumption.

Together with meter reader mr. Saïd Ally the productive organizations on the list were visited. Each visit started with an introduction to the manager of the organization. Then the place was noted on the self made map and the organization was ticked on the list.

At each meter cupboard Tanesco keeps a list containing the name of the customer, his account number and the meter reading which is be filled in by a meter reader once a month. This list was looked at in order to check whether the organization visited is the same as ticked on the list and to see whether the organization still used electricity. This because some organizations are out of production and eventually disconnected.

Then the production process was examined roughly. The type of products was asked for, to be able to apply the Isic classification. The production units were described. In case of small production processes, the nominal power and power factor of each motor, registered at the motor plate, was noted.

Furthermore, questions were asked depending on the circumstances. For example, if the organization was out of production, it was asked for which reason, since when and whether it was temporary or not.

If the organization could not be found on the list because it was established recently, it was asked for the date of starting production and whether the installation of equipment had been completed.

Results of short visits

Most of the organizations situated in the industrial area meet the definition of industry. The type of their activities is diverse. It includes a rooftile factory, leather processing factory, furniture factory, car assembly company and fish processing company. The industrial area contains two large industries which both were not in production: a cashewnut factory and a glass sheet factory. Furthermore there are a couple of activities at the industrial area which industrial nature is uncertains two construction companies and two car repair companies.

Remarkable is the large number of grainmills found. These mills are mostly small scale organizations with two to four labourers, accommodated in a building in the residential areas. The customers come with their own maize and pay per kilogram ground. The grinding mechanism is driven by an three phase electrical motor with an electrical capacity of about fifteen kilowatts. Sieves are used for cleaning the maize and the flour.

Besides mainly medium and large scale industries at the industrial area and grain mills in the residential areas, quite a few productive organizations were found. This concerns six car maintenance companies, one of them additionally making steel products, one brick factory and one saw mill.

Of the thirty-nine organizations on the list derived of the Tanesco files thirty-four were found. Three of the remaining four are probably grainmills which exist no more. Eight of the organizations visited and occurring on the list were out of production, two of these already closed down.

During the search for industries with mr. Ally, four of the industries found did not occur on the list prepared. These were added.

The lists of organizations derived from the Tanesco files and the other four industries found are presented in appendix H. The map of Mbagala including these organizations is presented in appendix E.

2.2.4 Search for other industries

The list is completed as far as industries supplied with electricity concerns. Productive organizations in Mbagala not supplied with three phase electricity are carpentries and sewing activities.

carpentries

In 1992 about ten carpentries were situated in Mbagala. Almost all of them are situated along the main Kilwa road. They are small scale, mostly with less than five labourers. The production is custom-made. This mainly concerns furniture and products like window frames. The raw materials purchased are rough wooden planks and pieces. For the manufacturing of the products hand tools are used. These carpentries do not meet the definition of industry formulated, because they don't use any kind of machinery. Also the products are not standardized and the production is not planned to be in continuous quantities.

sewing

The sewing workshops are situated in the owner's home. Mostly this concerns one sewing machine, driven by foot. This machine can be situated in front of the house, covered by a lean-to. Clothes produced and textiles are exposed. Mostly the customers bring their own textiles and give order which product they want. Others sew at home and bring the clothes produced to shops, where they are sold.

These sewing activities are spread all over Mbagala in the residential areas. A reliable estimate of the number of these activities is difficult to give, because some of the workshops are situated inside the house and difficult to recognize. Probably the number is in the order of a few hundred.

The distinction between the small scale activities for commercial purposes and sewing machines for household use is not clear. The sewing activities are not considered as industrial because the production is at customer order and there is not a certain quantity of production intended.

others

Furthermore only one productive organization not supplied with three phase electricity was found. This is a ceramics workshop, using a kiln fed by firewood. The products are manufactured with self made moulds. Also this organization does not meet the definition of industry, because the production is on customer order. No serial production exists.

2.2.5 Changes found in 1996

In October and November 1996 the survey was followed up. For this purpose the inventory was checked first. All productive organizations at the industrial area were visited, whether they are included in the 1992/1993 inventory or not. The area was walked through and all productive activities were looked for.

At the industrial area a few changes toke place. The ceramic industry expanded and shifted to this area. The sheet glass factory started production partly. The fish processing industry closed down.

In the residential areas a small soda iodization plant had been established. A few small grain mills closed down, no new ones started. Many small wood workshops arose, most of them processing manually, using simple tools. A few metal workshops started as well. Most of both type are not industrial⁵⁾. Their rise is in line with a significant increase in informal business activities in Mbagala. Most of them are concentrated in three areas along the Kilwa Road, as is shown in the map of appendix E.

2.2.6 Definition of industry reconsidered

Using the industrial criteria defined, almost no organizations important for the industrial development in Mbagala are excluded. Therefore the definition formulated is appropriate for Mbagala.

The excluded organizations are mainly garages and informal sector enterprises like carpentries and sewing workshops. According to Tanesco sources, these carpentries and sewing workshops rarely grow to industrial organizations and play no role in the electricity demand forecast⁶⁾.

⁵⁾ Their production is without machinery, irregular, not standardized and on customer order. This means that the definition of industry is not met.

⁶⁾ I will not underestimate the importance of those informal activities in Mbagala. They employ much more people than the formal industries do. They show a large flexibility and with the low technology and local character their independence on infrastructural factors is relatively low.

Furthermore, two construction companies do not meet the definition of industry, because they do not produce standardized products. A large construction company as Jensen, however, is an important part of the industry in Mbagala. It has its own carpentry and will build a plant producing bricks for own use. It is not the intention of the definition to exclude such an organization. Thus for these two construction companies an exception is made. They are included in the research without being named industrial.

The grain mills meet the definition of industry, but can be considered borderline cases. The role of grain mills in the industrial development in Mbagala is marginal, because the production processes are very simple and not flexible. For all organizations the same technology is used. But this group of grain mills dominate the small industrial activities in Mbagala. For this reason this group of industries is included in the research.

2.3 The industries, a survey

The survey is meant to determine the following things:

- 1 classify the industry according to basic characteristics
- 2 measure the relative importance of factors the 'constraining strength'7) of the factors is measured
- 3 determine the actual electricity load and project it for the coming 10 years

2.3.1 Methodology used

Interviews preferably were arranged with a person of the industry which is concerned with the topics dealt with. Mostly this is the manager (director) of the organization. Parts of the interviews were held with engineers.

To be able to describe the industrial performance it is necessary to get an understanding of the production process. Together with the interviewed person all production steps were gone through.

After the process description a questionnaire was executed. The questionnaire is aimed to obtain structural information. By measuring standardized values, results from different industries can be compared.

Questions with prepared multiple choice answers which apply to all industries can't deal with specific industrial characteristics: the information obtained will be not in depth.

Therefore a conversation was held following the execution of the questionnaire. Open questions were asked with relation to the backgrounds of the factors mentioned as important ones by the interviewed person. The form of this discussion is non structural. A list of topics to be treated was used as a reminder.

The importance of factors depends on the quality of supply of them. An ideal situation with perfect supply will to other relative importancies of the factors. For example, if electricity would be supplied with excellent quality, ost enterprises would not mention it as an imprtant factor. The ain of research is, however, not to measure hese heoretical importances. Factors which form bottlenecks have most impact on development. These are also hich keep the entrepreneurs busy and easy to measure.

2.3.2 the questionnaire

The questionnaire concerns the importance of factors playing a role in the industrial performance. It contains four parts:

1 Basic characteristics

With the basic characteristics the industry can be classified.

These characteristics are:

- nature of industry according to Isic classification
- year of establishment
- type of ownership
- number of employees under contract and temporary employment
- 2 Criteria to meet the definition of industry

This part is included to check whether the classification as industry is correct.

The four criteria are described in paragraph 2.2.1

3 Factors affecting the industrial performance.

The following main factors are presented:

labour skills, labour knowledge, electricity supply, water supply, telecommunication, roads, sewage system, licences, foreign currency, loans, spare parts and tools, repair and maintenance facilities and security. For each factor the importance is divided into four categories, ranking from unimportant to important. Added is a row 'others', which represents eventually factors not included in the list of eleven factors.

4 The electricity demand and expected load in the future. Asked is for the actual electricity use and expected use for the coming ten years. The load forecast is dealt with in chapter 3.

The complete questionnaire and checklist used are presented in appendix I.

Reliability and validity of questions

The *validity* of questions concerns differences between the measured results and the contents of the variable, caused by unforeseen errors. Making the variables operational did not cause validity problems because the measured concepts were not abstract and mostly unambiguous to make operational.

Language problems occurred in some cases when visiting the grainmills. In these cases an interpreter was used for translation in and from Swahili. The interviewer was not familiar with all English technical terms concerning specific machinery. Because these terms mainly were limited to the machinery, it did not cause problems.

The social desirability did not play an important role because no opinions and cultural components were measured. The questions concerned facts as much as possible.

The external validity concerns the generalization of the population of research to other populations. For this research this concerns generalization of the industrial performance in Mbagala to the other areas in Dar es Salaam and eventually elswhere. The specific

characteristics of Mbagala as a fast growing suburb - from rural to urban - with an light industrial area and one road-connection to the town are unique in Tanzania. Beforehand it is not intended to draw conclusions for a larger area than Mbagala.

The *reliability* of questions concerns distortion of answers by the interviewed person, caused by coincidental circumstances. For example, the interviewed person may be influenced by the interviewers social status. He or she may be not familiar with European researchers or treat them as influential persons as most Europeans in Tanzania have executive jobs and influential relations.

I presented myself as a student, carrying out a research for Tanesco. Together with the foreign nationality this makes the interviewer (me) an independent and non threatening person for the interviewee. The presented relation with Tanesco may influence the overall interview because the interviewed persons will be inclined to highlight the electricity component within the interview. In such case the interviewer made use of it and emphasized his interest in other aspects as afterwards.

2.3.3 Description of production processes

As discussed at the beginning of this chapter, the transformation process with its four technology components is used as model for the production pro-cess. This model is visualized in figure 2.1.

All steps of production are passed in sequence of the process, from raw materials to the final products. For every production step the function was asked and described. The machinery was inspected,

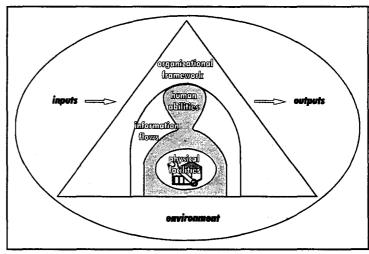


Figure 2.1 Model of the transformation process

including its labour tasks and electrical capacity. The type and quantity of inputs and outputs of materials were asked, as well as their origin and destination. This information leads to a schedule of all steps of the production process including inputs and outputs.

The production parts can be of different age. Machines are replaced; parts of the technology used are changed. Therefore was asked for recent changes in the production process and the advantages of them. The plans and possibilities for coming investments in technology were discussed.

2.3.4 Selection of industries

Initially, seven of the fifteen other industries were randomly selected. The reason for this restriction was to refuse to commit myself, in case not all industries could be investigated within the time available. This was not the case, thus the remaining eight industries were included as well.

The short visits of all fifteen grainmills brought a large similarity to light. All mills have the same type of production process. This similarity is also expected for the results of the survey. Therefore a sample size of five mills was considered to be sufficient. All mills were numbered, from one to fifteen. By means of a computer-program five numbers were randomly selected.

A reservation was made: when the results of the survey of the five mills contradicts the similar characteristics of the mills found, the selection would be extended. This extension of the selection made proved to be not necessary.

In the follow up research in 1996 all industries at the industrial area were included. Confined was with five grainmills and three wood workshops. These were not randomly selected.

The industries selected are marked by an asterisk in appendix E.

2.3.5 Results of the survey per industry

The results of the investigations are treated per industry in this paragraph. At first the enterprise is described in general. The layout of the production steps is presented in a flowchart and the important factors for industrial performance are described. The production activities are shown in rectangles and the trans- portation between them are presented by arrows. For simplification only the main storages are presented, for which triangles are used.

Started is with the two large industries TSG and Tanita, then the medium scale industries at the industrial area and at last the grainmills and others found in the residential areas. The detailed results of the questionnaire survey are presented in appendix J.

On the base of the results from the questionnaire and open discussions common factors can be described. Together with the investigation at supplier side (institutions, § 2.4) this results in a complex of factors which affects the industrial development in Mbagala (§ 2.5).

Tanzania Sheet Glass

general description

Tanzania Sheet Glass (TSG) is part of Saruji, the parastatal organization for non-ceramic mineral products including the large cement factories. TSG was set up to produce sheet glass for buildings and is the only one of its kind in East Africa. Other glass sheet production plants are situated in South Africa, Nigeria, Libya and Zimbabwe. The production process is not suitable to make car windows and bottles.

The intention of the Tanzanian government was to build a large plant to substitute the import of glass for windows used in construction of offices and public buildings in Tanzania. The local demand was estimated at 5,000 tonnes of glass sheets annually. The export of glass to the neighbouring countries Uganda, Kenya and Zambia was projected to supply the full market demand of 11,000 tonnes per year (1990 figures). The project was initiated and financed by the Belgium government, by means of a US \$ 13 million government loan and \$ 21 million commercial loans⁸⁾. The main contractor was a Belgian engineering company with expertise in glass technology. Training of employees would be provided by them.

The plant is designed to employ 500 persons. The production capacity is 15,000 tons of glass per annum. The furnace is supposed to produce non-stop for periods of four years. Maintenance would be provided by a team of mechanical and electrical engineers. Their supervisors had been trained in Tanzania and Belgium.

history

The construction of the factory was completed in 1983. The total investment costs amounted to 37 million US dollars. When the plant was to start production, the electricity was not supplied. The 11 kilovolt line from the Kurasini substation was finished in 1985, the other line planned was never constructed⁹. The plant includes a diesel generator with a capacity of 800 kilowatt. This is a stand by unit to feed the main production units which may not be stopped. Its capacity is not sufficient to supply the whole plant. Consequently the plant could not start production in 1983.

By close down the furnace became obsolete and useless. The delicate magnesia bricks of the recuperation furnace expanded and the walls cracked, caused by the high humidity. Repair of the furnace required high costs and did not take place since 1985, the year in which electricity was provided. The technicians and operators trained in Belgium lost their

The so called Delcredere-guarantee was founded as an insurance for exporting companies, for cases as coups and civil wars. Since Delcredere was partly nationalized in 1964, the guarantee has been used to finance many unfeasible projects in developing countries. This did not apply to the loan for TSG. The debt could be paid back if the Tanzanian government or private companies would place orders with Belgium companies. The Abos financed the delivering Belgium firm, the goods were supplied, after which the Tanzanian client could pay in local currency. A part of the original loan would be forgiven. This system, applied by some west European governments in the late 1980s - early 1990s, appeared to be very sensitive for fraud. In 1991 the Tanzanian Daily News published a list of 171 fraudulent local entrepreneurs. The system was abolished afterwards. The commercial loan for TSG remained.

⁹⁾The electricity installation of the plant is designed to be supplied by 11 kilovolt from two sides, from the Kurasini substation and the Pugu road.

job. But a team of seven technicians and managers of different disciplines remained in function, plus ten security guards. The whole plant had been maintained all the time, including greasement of the machinery.

Neither the Tanzanian nor the Belgium government would finance a 5 million US dollars recovery plan. Donors were looked for. Companies from China and India were interested and studied the possibilities to investment, but eventually they withdrew.

Douglas de Coninck describes in his research [27] the reasons for the project failure, using Belgium sources. The large project was invented to save the Belgium contractor Sodemeca from bankruptcy. This attempt delayed the bankrupty of this Belgium basic metal parastatal till 1990. The overtaking bureau Basse-Sambre ERI was confronted with serious failures made in the preparation phase. Major ones are:

- too large scale, production was five to eleven times expensive as importation of glass
- no electricity supply, low water supply and a too bad road (or: a wrong location choice)
- poor performing first Belgium contractor: poor manpower training, poor supervision over subcontractors, poor aftercare (or: low commitment of the contractor)

Nearly all do Coninck's findings concerning TSG agree with the answers the interviewees gave. His research contains a very critical treatment of 25 projects under the Belgium Ministry of foreign aid (Abos), including political abuse of development aid and corruption.

technology choice

The two main principles of glass technology are the float principle and the drawing principle. With the float process the molten glass floats horizontally on a layer of tin and hardens. Thicknesses vary between 4 and 20 millimetres. The minimum economic capacity is about 150,000 tonnes a year. That is why the process is mainly used where large markets for sheet glass exist.

With the drawing principle a metallic comb is dipped into molten glass and pulled slowly up. Three processes exists: the Forcault¹⁰⁾ process, the Pittsburgh process and the Colburn process. The design capacity of all three vary between 10,000 and 20,000 tonnes of glass annually. The Pittsburgh process differs from the Forcault process by the method used in conditioning of the ribbon being formed in the kiln. The Pittsburgh process is the more delicate and complex one. In the Colburn process the vertical drawn glass is bent into a horizontal position while the glass is still in a plastic state. This process permits larger widths and speeds than the other two drawing processes.

The Float glass is of the highest quality, followed by the Pittsburgh, Forcault and Colburn processes respectively. All types of sheet glass may be used for building and furniture purposes. The glass defects associated with the Forcault and Colburn process do not apply to the louvre glass parts, used for windows in East Africa. Float and Pittsburgh are suitable for producing car windscreens and mirrors, the latter also concerns the Forcault 'A' quality process. Fourcault and Pittsburgh glasses are capable to be produced to less than 2 millimetre thicknesses. For producing container glass (oa. bottles) other processes are

¹⁰⁾ In 1915 mr. Forcault, a Belgian, invented a machine to produce a sheet glass ribbon of uniform thickness with polished surface being shaped in a continious mechanical process. The invention has survived until the present day without major changes. The later introduced Colburn and Pittsburgh processes are based on the Forcault drawing principle. The float process was introduced most recently.

required. For quantity and quality reasons only the Pittsburgh and Forcault process are suitable for the Tanzanian market. The Pittsburgh process allows higher glass drawing speeds. This requires more attention and skills in the operation and a higher output than a Forcault plant. Tanzania's limited market and availability of skilled labour led to the choice for the Forcault process.

production process

Three phases can be distinguished in the production process. At first the treatment of raw materials. This concerns the sand benefication process where the sand particles are selected and the crushing and milling process of dolomite, lime stone and kaolin. This is followed by the batch weighing of the raw materials. At last the glass is made in the furnace and formed by drawing machines. The whole production process is shown in figure 2.2. The transportation between the production steps is done by conveyors. All materials have own stores.

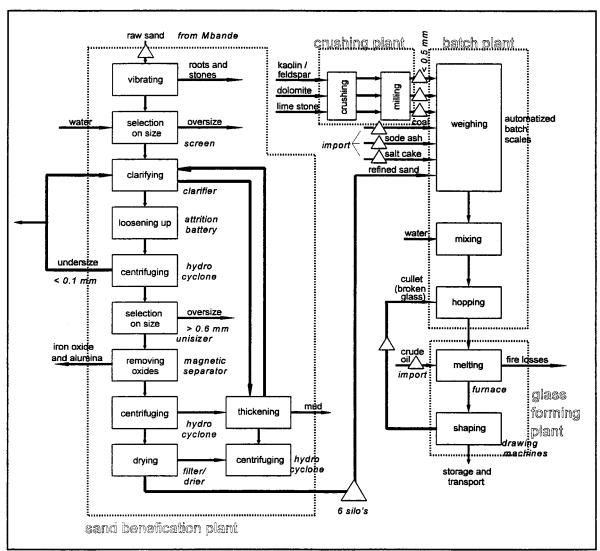


Figure 2.2 Production process of TSG

The raw sand is transported upstairs in the hall. There the sand is vibrated in a first screen and passes through a second screen which is finer. Oversized particles are removed. In the

clarifier the heavy sand is removed. To remove the undersized particles two hydrocyclones are used. In the magnetic separator metal particles are removed. Namely, iron oxide makes glass yellow / green and alumina introduces glass defects. Before being transported to the batch weighing process, the sand is dried. The sand benefication process is centrally operated with the help of relays operated control panels. In the process three loops guarantee a continuous process.In the batch weighing process seven raw materials are weighed. This process is computerized and of a high accuracy. The seven materials are mixed and water is added.

In the furnace the mix is melted and added to the mass of molten glass of 1500°C at the bottom of the furnace. This amounts 500 tonnes of glass. Before entering the burners, the inlet gas is warmed at 750°C through recovering of the outgoing gas heat. In the cooling zone of the furnace, the liquid glass is transported upstairs at constant speed at the right thickness, by drawing machines. In the hall above the furnace the glass sheets are cut and placed in racks.

basics			
silicium sand	SiQ2	73 %	network former (vitrifier)
soda ash	Na2O	14 %	modifier (lower the melting temperature)
ime stone	CaO	9 %	stabilizer (reduce solubility in water)
auxiliaries			
water	H2O		melting accelerator
salt	NaCl		refiner
dolomite	MgO	4 %	preventor (preventing devitrification)
kaolin		1 %	preventor

Figure 2.3 raw materials for TSG glass (52)

factors with relation to the performance

The delay of electricity connection was the reason the plant did not start. Nyabuta mentioned in [52] that, if production would start, other factors would be important as well. These are the availability of foreign exchange for the purchase of inputs and spare parts¹¹⁾, management and labour skills and distribution bottlenecks, mainly related to the road quality.

But another fact makes the whole plant loss-making. The capacity is designed to meet the whole initial demand in the surrounding countries. However, the African market is rather small and the international market is compatitive. Strong effort would be required to reach the whole market in the east Africanl countries. The real total demand would more likely be around 5,000 tonnes a year than 15,000. This means that the plant should have to operate at low capacity.

This has dramatic costs effects. Namely, the process may not be interrupted and the quantity of molten glass in the oven heated by burner fuel has to remain constant. Since the fuel costs are the main variable production costs, producing at low capacity becomes very expensive. In such case TSG would not be competitive: the price per cubic metre of glass would become tenfold the price of imported glass.

Irregularities in the supply of inputs were overcome by keeping large stocks. For the main public supplies water and electricity (partly) was taken care self. A pump installation and diesel generator was installed.

¹¹¹ The problem of availability of foreign exchange is outdated since the introduction of the Open License System and further liberalization measures.

a new start

In 1996, after a long disappointing period, a new investor came with serious plans to take over TSG. This concerns Kioo Ltd, a bottle factory in Chang'ombe (in town). The capacity of the raw material treatment processes of TSG is about the same as of Kioo, but its quality is much better. Because high investment costs were required to improve Kioo's quality, the Mbagala plant was taken over, including its main engineers. Three of four production parts are interesting for Kioo: the sand benefication, the crushing and milling plant and the weighing process. Not the oven and glass production plant, which is the heart of TSG.

Rehabilitation of the benefication and crushing plants toke a mere two months. This period could be so short because the production process of TSG had been maintained during the 13 years of non-production and because the engineers are well experienced with TSG. Most work to be done concerned the components for electricity supply. Furthermore some relays of control systems had to be replaced and a few start problems arose. The sand benefication and crushing plants were operational at the beginning of November 1996. The batch weighing process would take a few months longer, because probably the whole computer controlled system has to be replaced.

The capacity of the plants will be used almost fully. Only about 35 people will be employed, including management and maintenance department. Maintenance will be carried out by three engineers: one electrical and two mechanical. Preventive maintenance schedules are used. Data are filled in on cards and in logbooks. The stock of spare parts is still available in a sufficient amount. But in the future imports will be needed. Least costs solutions will be considered, which can lead to the replacement by locally produced motors.

Tanita

general description

Tanita consists of two of the nine cashew nut factories in Tanzania, all operating under the Tanzanian Cashewnut Marketing Board (TCMB). Both Tanita factories date from 1983¹²⁾. Tanita stands for Tanzania-Italy. Around 1980 the Italian government participated financially and techologically in the build of two cashew nut factories in Dar es Salaam. One is at the main industrial area at the Pugu Road and one in Mbagala. The end product is packed roasted cashew kernels, exported mainly to Japan. Infrastructure was provided for the factory. The electricity grid was extended as well as the water supply.

The factory produced in two shifts. From eight a.m. to nine p.m. production toke place at maximum capacity, at night the production was lower. The production amounted 12,000 tons of cashew nuts per year, the total number of employees was 1,200.

After two years of production the Mbagala factory stopped. Since then it did not restart and the production process deteriorated. In 1992 a recovery plan started, supported by Italian technicians. The whole production process had been rehabilitated. The date of resumption of production was planned for October 1993. However, production did never start. The Tanita factory at the Pugu Road performed better, but stopped production at the end of 1992.

production process

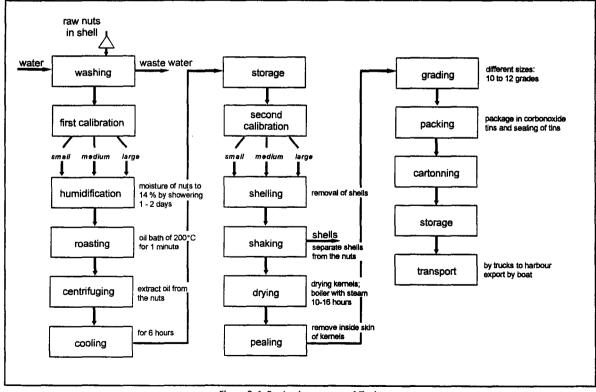


Figure 2.4 Production process of Tanita

¹²⁾ The Pugu Road factory was established in 1965, being the first one in the country. The Mbagala factory started in another part of Mbagala and moved to its recent and much larger establishment in 1983.

factors with relation to the performance

The cashewnut parastatals operate such inefficiently that they lost the international competition. Till 1990 the TCMB was the sole buyer of cashewnuts from the farms. In 1990 the government allowed other co-operatives to buy as well. From 1992 private traders and industries were allowed. Soon this led to international competition. Private traders started to buy directly from the farms and export the nuts raw. These are processed in factories abroad. The poorly functioning TCMB has not been able to purchase cashewnuts since 1992. The farmers had often been paid too late. Furthermore the management concerning foreign marketing probably has been bad.

Other constraining factors are a shortage of water and power cuts. The water requirement is ten tons a day. Because no water has been supplied by the NUWA, it had to be obtained from the Mzinga Creek. The capacity of this river is irregular and often insufficient. Therefore a water well would be constructed, which never happened. The frequent power interruptions would hamper the production. But this problem concerns the factory at the Pugu Road only, because the Mbagala factory did not produce anyway.

One of the technicians told that the rehabilitation of the factory in 1993 was complicated because military confiscated fuses and many other small components during the seven years of standstill. This might be a reason why the Mbagala factory did not start up production before 1992.

no restart expected

The market situation and poor functioning of the TCMB described above seems to be structural. This means that despite the plant rehabilitation production will not take place any more. This concerns the Mbagala plant as well as the other eight plants, of which most are situated in the inland. Except of a waste of huge investment costs which never had been recovered, about 11,000 people became jobless. This amounts to ten percent of the total formal industrial employment in the country.

Furniture World

general description

Furniture World produces furniture such as cupboards and beds, for household use. The company was established in 1992. Before a soap factory was planned. Furniture World is managed and owned by the same entrepreneur as Afro Leather has.

In the first years of operation the company started up. The number of employees increased from six employees to 15. Due to a poor market situation production decreased and five people are employed now. The selling shop and office belonging to the company had to move to a less attractive place in town¹³⁾. The machine to fix strips at the sides of the planks had been replaced by one with a larger production capacity.

production process

Cheap wooden boards imported from the United Kingdom are used to construct the furniture. These boards are laminated at both sides.

In the plant five machines are used in series. The boards are transported by hand in between. Large boards follow the whole production process, small pieces are treated by hand as well.

At first the boards are sawn on size, according to the type of furniture to make. The sides of the boards are sawn parallel. The boards are clamped and with a drilling machine the holes for connection are made. With the edge bend machine roundings are eventually sawn. Next a machine fixes strips at the sides of the boards with glue and pressing. The different boards produced are assembled by hand. The finished furniture is transported to town by truck. The furniture is sold in the shop in the city centre in Dar es Salaam. Prices vary around Tsh. 100,000 for a small wardrobe to Tsh. 200,000 for a larger model to use in bedrooms.

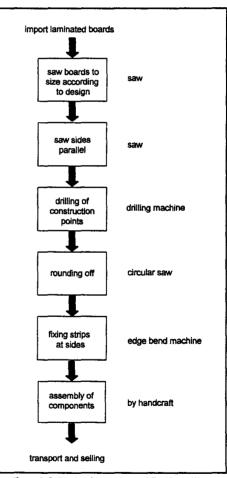


Figure 2.6 Production process of Furniture World

factors with relation to industrial performance

High sales tax, electricity supply, bureaucracy and roads were indicated as being important both for Furniture World and Afro Leather. Furthermore the skills of the personnel were mentioned as being a restricting factor. It was found difficult to familiarize the employees to operate the machines. Because of this learning process the plant started with relatively simple machines.

¹³⁾ The shop, named Tyffanies, was housed at the Samora Avenue, the main shopping street in town. Because the build of new offices there it moved to a temporary accommodation in the India street in 1995. Another place is looked for.

Afro Leather

general description

Afro Leather is a tannery, established in 1989. In contrast to most tanneries this one is private. Skins are processed into wet blue leather of specified thickness. Depending on the kind of chemical treatment the leather becomes stiff or supple, for the production of respectively shoes and bags (ao.). The skins are exported to Europe and the far east.

The machinery is imported from Italy and purchased through the Unido. Since the company started, the production process changed once. A new fleshing machine was installed in 1992, able to process whole skins. The two old machines could process skins with a maximum width of two metres, for which the skins had to be cut in two parts.

In the first years the factory increased production and operates at 80 percent of capacity now. A production of 300 skins a day is planned, which is the production capacity at normal complement. 25 employees work in one shift of eight hours a day. In 1992 twenty people were employed, of which five under contract. All maintenance activities are undertaken by one engineer for both Afro Leather and Furniture World. Regular inspections are made, but preventive maintenance is not scheduled structural.

The entrepreneur maintains international business relations and is of Indian origin. Besides Afro Leather he manages a furniture plant, situated at the same plot (see Furniture World). Investment in other productions in Dar es Salaam like a caustic soda plant has been examined. Till so far these projects turned out to be unfeasible or were shelved.

production process

The raw cattle skins are supplied from abattoirs in the Dar es Salaam region. The skins are washed in slowly rotating drums with a height of about three metres, each of them driven by an electric motor. Then the skins are treated with lime, salt, sodium sulphide and chrome dual (CS 26-33) to remove the hair from the skin. This takes place in a drum in a separate room. This production step is the most laborious one and forms the restriction in production capacity. Therefore a store of rinsed skins is kept.

Next, the flesh of the skin is removed by a fleshing machine. In the end the skins are cut in the right thickness. The skins are stored, transported to the harbour and shipped to Europe, where they are delivered to leather processing companies.

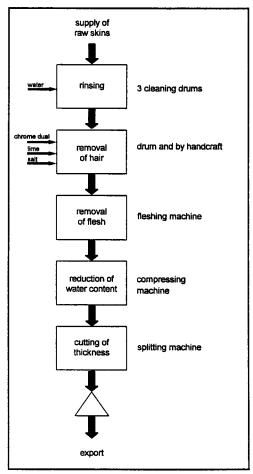


Figure 2.5 Production process of Afro Leather

factors with relation to industrial performance

Factors indicated as being important are high sale taxes, the quality of roads, water supply, electricity supply and a reduction of bureaucracy.

The power schedule hampered the production utilization as soon as the production capacity was utilized. This problem became serious as soon as the load scheduling started in 1993. Therefore a 100 kVA diesel generator was purchased. Remaining problems are voltage fluctuations and imbalances between the phases.

At full production, the rinsing of the skins requires 20,000 to 25,000 litres of water daily. The NUWA supplies no water. Therefore an own borehole and pump had been installed, with a capacity of 2000 litres an hour.

The telephone connection never functioned and the telephones had been given back to the telecommunication company TTCL. Communication between the factory and office in town is only possible by travelling.

Foreign exchange is easy to obtain the last couple of years. The obtainability of loans is not relevant for the entrepreneur, because imports and investments are paid from own capital stock. Loans are unfavourable because interest rates are enormous high.

Leyland DAF

Leyland DAF Tanzania Ltd. is an assembly, repair and maintenance industry for DAF and Leyland trucks and busses. The company was established in 1964 and build the Mbagala assembly branch in 1983. The main branch with office and repair facilities is situated in the industrial area at the Pugu Road. In Mbagala is the assembly branch situated. Leyland DAF Tanzania employs 175 persons, of which 27 in Mbagala.

From 1967 Leyland DAF was restricted to produce medium weight trucks (7 to 15 tonnes) and busses of one seize. During the liberalizations in 1986 these restrictions were abolished. In 1993 the parent company in the Netherlands restructured the organization and decided to hive off the branches outside Europe. A family owned private company bought the Tanzanian company.

The Mbagala branch has an assembly line and stores. No maintenance and repair takes place here. The chassis and components have been imported from DAF in the Netherlands. Bus bodies are made and connected by contracted body builders. The trucks and busses are sold to private and civil transport and bus companies in Tanzania. The imported chassis and components are paid in American dollars and the trucks are sold in Tanzanian shillings. The selling price for the main standard type truck (Leyland Comet 14.16) amounts 38 million Tsh. (1993). The production capacity is 16 trucks per month. For both busses and trucks standard models are assembled, the Leyland Comet and the DAF FTT 3300 / FAT 3300 and TB 2100. Modifications are made on customer order.

At the time of my visit at the Mbagala branch low activity was going on. Due to purchase problems time gaps occurs between finishing the assembly and the delivery of new batches of components. Therefore only 64 trucks and buses were assembled in 1992. Since 1994 DAF is assembling no more trucks and busses at all: the last truck assembled was a DAF TB 2100 in December 1994. In 1996 the company started to sell Chinese trucks. These trucks are already assembled in China. Plans are made to import DAF minibuses (type LDV 200 and 400), also assembled, and sell them. This means the end of all assembling activities.

The machinery used for assembly is one small and one large drill machine, one autogeen (gas) and one electrical welding machines, electric hand drills and two compressors. Several tools are used. For lifting two jacks and a fork-lift truck are used. A transport bridge for lifting and transporting is under construction.

factors with relation to industrial performance

In the years before 1992 the capacity utilization was high. The main problem in 1992 was to obtain foreign currency, required to order the truck parts. But this was solved by the liberalizations in 1994. Another uncertain factor has been an eventually bankruptcy of the supplier DAF in the Netherlands.

Security was mentioned as a factor of less importance. The electricity supply did not hamper production, because the enterprise has been connected to the non interrupted line for TSG.

The obtainability of credits is the main obstacle nowadays. The government recently started to keep the amount of Tanzanian shillings low in order to combat inflation. Therefore it became hard to obtain credits from the national bank for both DAF as for the customers. Before is was use that the customer obtained loans from the bank, paid DAF who bought the imported parts from it and the customer paid back the loan and rent over a period. The customers stayed away. Since December 1994 no single bus or truck has been assembled¹⁴⁾. The companies future is uncertain. Therefore it started to sell small Chinese trucks. In the near future probably small DAF busses will be imported ready made. If this development will continue, it means the end of assembly activities. DAF Tanzania will become an importer and seller, with an additional maintaining and spare parts function.

Additional hampering factors are long delivery times of spare parts (over 6 months) and government bureaucracy.

¹⁴⁾ Obtaining loans was mentioned by Maarten Gnoth [39] in 1994 as one of the problems for DAF's customers. But he overlooked the importancy of it for DAF. Instead, the main arising problems for DAF he mentioned are financial difficulties of the transport operators, operating in an overstressed competing market and suffering from devaluation of the Tanzanian Shilling. In fact both this situation and the customer problems to obtain loans are interwoven.

Leyland-Landrover / LRT Motors

general description

Leyland Landrover rehabilitated Landrover terrain cars. At first the cars are dismantled. The parts are cleaned and repaired when necessary. Detoriated components are replaced. Finally the cars are assembled again. In 1992 the company employed sixty people, rehabilitating about ten cars a week. For the repair of components small machinery is used. In 1996 still 25 people were employed. The major source of income shifted from rehabilitation of cars to the sell of spare parts, for Landrovers and Beijing jeeps. Beijing jeeps are also sold, as well as tractors and generators.

Thus, the machinery is not used any more. The company will start production again in the first half of 1997¹⁵⁾. The company name Leyland-Landrover changed into LRT, by which it is not a nameholder of Leyland any more. At the Pugu Road is another branch established, called Burns and Bland Ltd. There they still recondition Landrovers as well as Beijing jeeps.

production process

The different components pass through different processes. So we can not speak of one production process with a specific sequence. The machines used are:

circular saw electric welding machine turning lathe small gas welding machine

drilling machine electroplate- and spraying machine

machine to align wheels drier

engine-block cleaning machine electric water pump

LRT owns a borehole, which is also used by DAF-Leyland. The quality of water satisfies for its cleaning purpose. A diesel generator guarantees a continuous electricity supply. Its capacity meets half of the total machinery capacity, which is sufficient because a few machines produce simultaneously (low load factor).

factors with relation to the performance

The factors mentioned as being important are the electricity supply and, to a lesser degree, the roads, water supply and the possibility to obtain loans.

¹⁵⁾ The interviewed officer could not tell which kind of process or for which type of cars this would be.

Global Sea Products

general description

Global Sea Products is a private owned company which processed and packed prawns since 1987. The prawns were delivered frozen by ship. They were cleaned and packed, after which they were exported. The package was done by hand by about twenty employees. Motors were used in the compressors for the cooling of the storage- and work rooms. The production quantity was about 15 tonnes per month, with a turnover of US \$ 150,000,-.

The entrepreneur comes from Yemen and gained his Master of Science degree in maritime sciences in Saudi Arabia. He started the company in Dar es Salaam, where family of him lives, in 1987. Because the enterprise had been out of production in 1992 and 1993 due to the power rationing, he started business in transports. In 1996 I found the factory abandoned, with broken machinery and parts spread over the plot. A restart of this factory became unlikely.

production process

The production process which is simple, passes through the following steps. The prawns are delivered in a container twice a week, transported from the harbour by truck. The new container from the truck is changed for the old one at the company. The container cooling uses electricity. The cooler has a small standby diesel generator able to operate for forty minutes. To cool the prawns continuously during the processing they are mixed with ice. For this purpose an ice machine is used.

In the working room, cooled at 12 to 14 degrees Celsius, the prawns are put together with ice in a washbasin. At the first table they are cleaned and salted. On the next one the sizes are graded. The prawns are weighed in quantities of two kilograms on the third table. Next, they are sealed and packed. All is done by hand and simple appliances. No machinery is used in the production process itself.

The packed prawns are stored in a freezer, cooled at minus 50 degrees Celsius. For transport they are transferred to the cooled container.

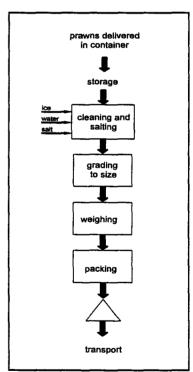


Figure 2.7 Production process of Global Sea Products

factors with relation to the performance

The cooling of the prawns requires nonstop electricity supply. During the power load scheduling the supply was cut for long periods (over twelve hours), which caused a thaw and decay of the prawns. The destruction of one load is disastrous because of its high value: about US \$ 25,000. The production had to be stopped because of these long power cuts.

A solution to this problem would be the purchase of a stand-by diesel generator of enough capacity. This required too high investment costs. Besides, the diesel consumption is expensive. For cooling about 50 litres diesel a day are required.

Another problem for this company was the quality of the electricity supply. The voltage level was too low, burning the windings of the motor of the main cooler several times.

In addition to electricity supply, security hampers the performance of the enterprise. Although four security guards were in service, several burglaries took place. The night foregoing the first visit and interview, the air conditioning and parts from the truck were stolen. According to the entrepreneur, the police is corrupt and asked payment to hunt down the criminals.

Skanska Jensen

general description

Skanska Jensen is a large international building company, originating from Denmark. It established a branch in Mbagala in 1987. This one employs 200 people of which most are working at the building sites. The management and executive engineers are foreign, mostly Danish. The Mbagala branch executes building projects in Dar es Salaam. These range from small jobs taking two days to the build of large hospitals and hotels. The largest project has been executed recently: the build of the Sheraton Hotel, the most pretentious hotel in the country. The irregular supply of relatively large projects means that the activity varies strongly. Besides Mbagala, branches are situated in Morogoro, Tanga and Iringa. The African branches changed their name from C.G.Jensen into Skanska Jensen in 1994, which is the one used world wide.

The plot in Mbagala includes an office and warehouses for stock and spare parts. The cranes and trucks have a parking place. Workshops for preliminary work concerns a carpentry for the production of construction materials and a metal workshop for repair and the production of components. Both the carpentry and metal workshop make use of several machines.

A brick factory was build at the Mbagala location in 1994. In production times (when a project is starting) it produces 25,000 concrete bricks per day. These bricks are used for own building projects.

factors with relation to the performance

Factors mentioned as being important are the condition of the roads, the water supply, the electricity supply and the creative skills of the local engineers. Also important is the maintenance of machinery.

The water supply is provided by an own pump. The new brick plants' request exceeds the pump capacity. The possibility to put the water-pumping installation of TSG into operation was examined. Because TSG is nearby it may be feasible to construct a pipeline and eventually an electricity line from Jensen to TSG. If this doesn't succeed, a new water pump has to be constructed.

The electricity cuts by Tanesco do not hamper the production in the workshops and offices because one of the two diesel generators installed has enough capacity to meet the demand. When the new brick factory is operational, the demand will be met by starting the second generator. In this case the peak load will be about 140 kVA, while the capacity of the generators is 130 and 125 kVA.

Long power cuts however result in about three times higher costs for electricity, because own generation fed by diesel is expensive. Due to the power cuts, the generator was operating thirty hours a week (January 1993) using about 600 litres diesel.

C

The quality of power delivery is poor. Frequency and voltage level are not constant. Worse are high voltage peaks, mainly occurring when the power is switched off and on. Protection devices do not react properly on the extreme situations which occur. In 1995 all computers crashed because of such a high voltage swing.

The term creative skills means the productive skills of technicians. Where re-productive skills can be trained and are executed well, own creativity was mentioned as a main problem. In many cases checks have to be made during the work by the foreign foremen. In spite of the relatively well experienced technicians Skanska Jensen has.

The workshop machinery and construction equipment is preventive maintained according to monthly schedules. The maintenance history is recorded in logbooks. These records are not much used for evaluation purposes. Although the maintenance method used is not explicit advanced, it is much better than that of other building companies. That is why Jensen has its equipment ready to use as a project is arranged, where others have not. It gave Jensen a good name and is its major strength. Or, probably better formulated, it is a weakness in the competition of building industries.

Tamelt

general information

Tamelt started as a carpentry in a residential area and moved to the industrial area. The company extended with a roof tile plant, which became operational in 1992. It is much larger than the carpentry, producing concrete roof tiles with a maximum output of 5,000 a day. The selling price per tile was Tsh. 240 in 1992 and Tsh. 280 in 1996. Total sales varied strongly. The capacity utilization in the years 1993 to 1996 was respectively 40%, 70%, 20% and around 25%. 26 persons are employed. Most of the customers are individuals and a few are contractors, mainly from Dar es Salaam.

The imported machinery is advanced. It was delivered and installed by a Swedish company. Because the employees had to become familiar with the machinery, the start up of production was laborious and was still going on in 1993. During the start up period a foreign technician was contracted.

The production process is mechanized, except of the palletizing and depallatizing of the moulds. The plant is financed by the Tanzania Development Bank and a Dutch development organization providing a concessional loan.

production process

The raw materials are sand of specified grainsize, water, cement and colouring agent. The sand comes from Mbande, the cement from the cement factory at Wazo Hill, the water from Chang'Ombe in town (the quality in Mbagala in not sufficient) and the pigment is imported. For one mix is used: 400 kg of sand, 3 cement bags of 50 kg each, 60 litres water and 7 kg pigment. The sand, cement and agent are transported from storage basins to the mixer by conveyor.

In the mixer the raw materials are mixed, including water. The mixed concrete is transported to the moulding machine by a conveyor. There the tiles are made at a rate of 32 per minute and transported to the drying racks. The tiles are taken from the conveyor to the drying racks by hand. The racks are placed in curing rooms where the tiles are kept in the moulds for 24 hours. After this time the tiles have to harden for three weeks before they can be sold. The total stock kept is between 40,000 and 75,000 tiles.

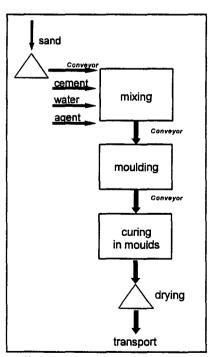


Figure 2.8 Production process of Tamelt

Small series of top-tiles for the ridge are produced in a separate machine. Transport of materials is mainly done manually.

A forklift truck is used for the transport of pallets and a bulldozer for the transport of sand and other materials on the side. For the transport of materials and tiles to and from the factory two trucks were available, of which one has been broken since a couple of years.

The production quality is tested at different stages. The particle size of the sand is tested for each batch delivery by means of an automatic sieve shaker with seven sieves: the right particles remain in the sieves of grade 1, 0.5 and 0.25 mm. Per batch one tile is tested on strength, water penetration and weight. The strength tester presses a bar on length side of the tile with a power range from 0 to 5000 Newton. An electronic balance controls for the right weight of 4.5 kg. A cistern is glued on top of the tile and water remains in it for 24 hours. The bottom of the tile may not become wet.

Initially Tamelt planned to set up activities as maize milling to produce flour and sunflower seeds and groundnuts grinding to make cooking oil. The oil machine has never been used, the milling machine had been removed to Songea.

Regular checks of the machines are made. This concerns mainly oil level checks and the fixing of loose vibrated nuts. Preventive maintenance is not scheduled and no records are kept of checks and failures.

the carpentry and other activities

The main product of the carpentry is furniture, mainly produced in small series for companies and public utilities. Seven persons are employed here. For the production several machines are used, namely a circular saw, a rounding saw and a drilling machine.

factors with relation to the performance

The electricity cuts hampered the start up of the plant. An electricity cut at production time causes problems. The mixer should be emptied and cleaned, to prevent hardening of the concrete. Directly the mix is put out manually and bricks are made of it. Tamelt became experienced in it.

Too large voltage drops occurred, resulting in the burning of the motor windings of the moulding machine. This problem was solved by Tanesco in 1993.

At the moment of start up the capital stock was insufficient to finance the stock of tiles in the production process.

The stock keeping of spare parts can not be called visionary. Production decisive components are not kept on stock. For example, the end pieces for the slipper were detoriated one day I visited the factory. The tile edges became unacceptable crumby. Once two pieces were kept in stock, but had been used the last time. This time the pieces had to be ordered from Sweden. The production was interrupted for two weeks.

Marshalls Ceramics

general information

Since 1990 the Marhalls Ceramics¹⁶⁾ had been a small scale family enterprise established at home in a residential area. A simple wooden fired kiln, manual labour process and small production series on customer order made that it was not included in the research in 1993.

In 1995, however, the company made a large jump. After five years of producing at small scale it moved to the industrial area and the whole enterprise, including production process, changed significantly. The entrepreneur, trained in glass technology in West Europe, got funded by a western donor¹⁷. A production process with machinery was set up. This includes crushing and mixing machines and an electrical kiln. The total investment costs amounted to \$ 200,000.

Two type of products are made: insulators and household clay products as pottery and cups. About 250 insulators a day are produced for Tanesco. They are used to connect low voltage cables at the small wooden poles. The pottery and cups are mostly not produced on order.

The production capacity is 150 tonnes of clay products per year. The expected production is nearly half of this. Ten employees were meant to work at the factory. However, at the time of my visit there were three people employed.

production process

Different raw materials are delivered in the form of stones: silica, dolomite, feldspar and silicate. A crushing machine crushes these stones into boregrain. Next, the boregrain is ground. This takes place in a large 500 kg batch or a small 20 kg batch, depending which production quantity is required. The result is mixed together with kaolin, water and small amounts of soda, barium and silicate. This is sieved and mixed a second time.

The resulting clay is put in moulds. Pots are made manually on an electric potter's wheel. The clay products are dried, taken out of the moulds and dipped in a glass mix to glaze. The glass mix is fabricated self, eventually coloured with an agent.

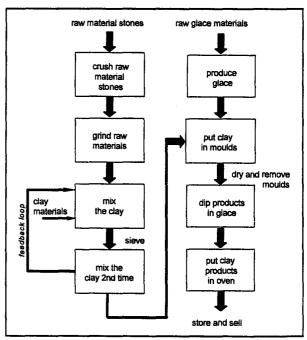


Figure 2.9 Production process of Marshalls

¹⁶⁾ The Marshalls Ceramics Company Ltd is the ceramic workshop described in paragraph 2.2.5.

¹⁷⁾ This donor is the CICA, which co-operates with the ITDS research group of the TUE.

The products are put in the three phase electric oven. For very small batches or single products two small single phase electric ovens are used. The temperature goes up in two ramps to the second constant interval of 1250 degrees Celsius, followed by a cooling phase. The oven follows this program automatically. The total duration of the baking process is 11 hours.

factors with relation to the performance

The main problem mentioned forms frequent power cuts. It is annoying to interrupt the process and restart it: the process has to be controlled precise then. But the clay products are not destroyed, they only have to undergo the remaining part of the heating process.

Water comes both from the well of TSG and an own water collection system. The quality of both waters is said to be sufficient.

Pole Italy

general information

This foreign enterprise was established in 1994. It includes a chicken farm and sawmill. The enterprise is situated about eight kilometres south of Mbagala, near the rural village Mwandege¹⁸⁾, on a huge plot of more than one square kilometre.

The chickens are bred and fatten in barns. To serve the chicken with food and living conditions as light and climate, different installations and machinery is used. The grown chicken are transported to the abattoir at the Nyerere Road, which is another branch of the enterprise. The chicken farm is not industrial.

The sawmill is the major activity of Pole Italy. The number of employees vary, at high production times it amounts to 100. Daily 20 to 50 large trunks are processed into planks for furniture and floors. These are exported, mainly to Italy.

production process

The trees are selected and sawn in the forests not far from the factory. Six main types of hardwood are used¹⁹⁾. The trees are large, diameters of two metres are common. Depending on the purpose of use, the trees are cut in lengths of 3 to 6 metres. With the help of bulldozers, tackles and trucks they are transported to the factory.

Two main production phases exist: the coarse sawing and the treatment processes. Support and additional activities are carried out by the technical workshop.

After bringing the cut trees, they are brought to the <u>sawing line</u>. Each trunk is taken by a grab arm, which is moved by a <transport bridge>. The trunk is fixed with pneumatic arms. It is transported by conveyor through a bandsaw several times, every time shifted a certain distance. This part is automatized, controlled by one operator. The resulting tree slices are transported by conveyor rollers to a circular saw, which saws the plank length. Next the remaining slices are sawn on width. Eventually special lengths are sawn, only on customer order. The resulting planks are stored.

So it does not belong to the area of research. The large enterprise required the extent of the medium voltage grid inMbagala and has to be included in the research for quality and planning reasons concerning electricity supply (chapter 3). Besides, to exclude this enterprise might be permitted on the base of the area marking out, it is wise to control for linkages with Mbagala. This is why the industry is presented here.

These are Mkongo, Panga panga, Mninga, Mhuhu and Mninga Maji. The cut of these trees probably exceeds the generation capacity of the natural forests. This means that when the concerning trees in the surrounding areas are cut, the factory can close down and large forest areas will be affected or dissapeared. A serious treatment of this topic requires more attention than I paid: I do not know the forest reserves and regeneration capacities, as well as the selectivity of cutting and forest-destroying side effects. Although the natural forest reserves with their typical flora and fauna will not only have emotional value but economical value as well, this topic is beyond the area of this research.

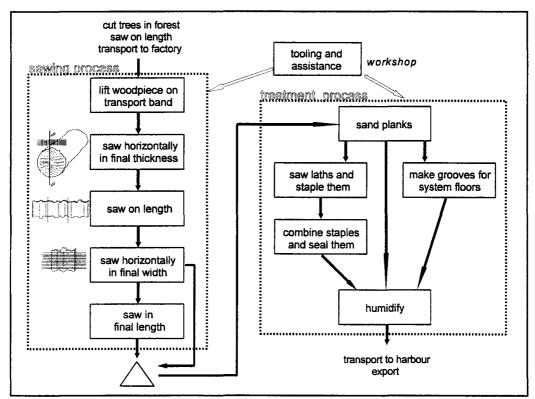


Figure 2.10 Production process of Pole Italy

The treatment process starts with sanding of whole planks. Next, grooves are sawn in planks meant for system floors. Planks meant for laths are sawn into short pieces, combined, stapled and sealed with plastic, by means of heating. All treatment processes are largely automatized, needing a few controllers. The planks are stapled on pallets and when enough stock is produced, the pallets are transported in the boiler. An isolated room of approximately 150 m³ is fed by steam of 80 degrees Celsius. For this purpose a water boiler outside is heated in an oven. Scrap is used as fuel wood, which is abundantly available. The steam is circulated by a pump and cold water is added in the return pipeline to precipitate the steam. Small holes are made in the wood. The humification takes 6 days for laths to one month for large planks. An humidity of 70 percent is optimal to obtain a high durability for transport.

Additionally, local sold furniture is constructed here. Used are 6 electric saws with banks, one large sanding machine and one TNG machine. A compressor and large ventilator support the process.

The workshop gives technical assistance. Maintenance and other technical support are major tasks. Three electricians and two mechanicals are employed here. The workshop contains six saw stretches and two CNC sawmachines to produce the large bandsaws. One lath, two welding machines, two sawmachines, a second type of saw stretches and a drilling machine are used.

The processes are operated by Tanzanian labourers. Frequent supervision is executed by Italians, to keep the process going and control the performance to guarantee the quality. Regular machinery checks are made. Machinery maintenance records are not kept.

In 1994 an 33 kV electricity line had been constructed especially for Pole Italy. One 500 kVA transformer is used, besides one of the same size for the chicken farm. For stand-by purpose two diesel generators are used, one of 255 kW and one of 80 kW capacity. Two generators rated at 200 and 250 kW are not in use.

factors with relation to the performance 20)

Electricity supply forms the major factor. In fact the factory was lucky to be provided of electricity, because the construction of the power line, financed by Tanesco, was financially not feasible.

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These factors were not discussed specifically with the people concerned, but with an maintenance engineer.

Grainmills

introduction: types of technology

The main staple foods used in Tanzania are maize, rice, cassava and sorghum. From those maize is most popular, contributing to the calorie intake for sixty percent. Most of the common dishes and small foods are baked or cooked from maize mill. There are ugali, chapati and small types of cake.

Because the milling enterprises found in Mbagala milled maize only, I will confine to maize milling²¹⁾. Before discussing the maize milling technologies and their characteristics, it is worth to mention the composition of a maize kernel. A kernel has three distinctive parts. The bran is the outer casing, that makes up about 10 percent of the weight. Beneath it is the starchy endosperm, with about 80 percent of the kernel weight. The inner part is the germ. It contributes for just 10 percent to the kernel weight, but contains the maize oil.

Grinding mills can be classified by several methods. Bachagwa ^[8] classified according to the kind of market and technology used. He distinguishes three types of milling technology: household milling, custom milling and merchant milling.

In <u>household milling</u> traditional methods of hand grinding are practised. It is predominantly a rural-homestead activity on a family subsistence basis. Hand grinding involves manual decobbing of maize, placing the grain in a wooden mortar and pounding it with a pestle. A flat basket 'ungo' is used then and grains are separated from their peels. Coarser grains are again put in the mortar and the process is repeated several times. The total process is very labour intensive: in one hour about one kg of flour can be produced. The losses, mostly existing of removed peals, are about 35 percent. If hand and foot mills are used, the productivity increases to 3 to 10 kg an hour.

In <u>custom milling</u>, grains are supplied by subsistence consumers in turn for a milling fee. Occasionally, custom mills also serve petty traders. Custom mills are privately owned and small scale. On average three to four people are employed. These are unskilled and for 25 percent family member of the entrepreneur. The technology used is a single stage hammer mill, driven by an diesel or electric motor. Grains are fed into the mill through a hopper at the top. They are crushed by being squeezed between the hammer bars. A hammer mill consist of a horizontal rotary shift carrying rotating high-speed disks to which a number of hammer bars are fixed. The outer casing has a screen designed to regulate particles of the appropriate size in the lower part of the mill. The flour is eventually sucked through a cyclone and leaves the mill through a spout, right into a bag.

The hourly capacity ranges from 250 kg to 1000 kg of meal. The mill body is produced locally and the engines are imported or assembled in Tanzania. The electrical capacity ranges between 6 and 45 kW.

The flour is called 'dona'. The extraction rate is about 98 percent. Because the germ of the maize in ground as well, the flour contains oil. This makes that it can not be stored for

²¹⁾ Because most mill grinding concerns maize mill, often both words are used interchangable.

longer than one month before becoming rancid. Custom milling toke it over from household hand milling in the second half of the 1970s. The tedious work and association with an old fashioned custom made hand milling unpopular.

Merchant milling involves purchasing, milling, packaging and distributing millet products. Grains are purchased straight from the villages or via parastatal marketing institutes. Till the early 1990s merchant milling was strictly reserved to the state owned National Milling Co-operation (NMC). The maize is milled by roller mills. They produce sifted flour, known as 'sembe'. A roller mill consists of a series of machines that clean, condition, degerm, grind, sift and classify the output. The milling is done by rollers that rotate at different speed in opposite direction. A special device separates the bran and germ fractions from the endosperm. This is why the extraction rate is somewhat lower than 80 percent. It also results in a low oil content, by which the flour is perishable for six months at least if it is well stored.

All technology for roller mills is imported. The hourly capacity ranges from 1 to 5 tonnes per hour. All rollers can be operated at a three shift basis. On average 40 people are employed, of which 10 are skilled. Characteristics of product quality enter directly and indirectly into the technology choice decision matrix:

	custom milling		merchant milling
-	restricted to small scale with local markets due to short perishable time of flour	-	larger scale required due to high capital costs of roller technology
+	Customers can bring their own maize. They select the quality themselves and see what they get	-	monopoly of the NMC till about 1990 ²²⁾
-	The unsifted whole-meal flour has to be cooked longer than sembe: on average about 3 minutes compared to 2 minutes	+	The white sifted flour is more popular amongst Tanzanians, especially in urban areas ²³⁾
0	The nutrient composition is slightly better than for roller milling. However, it is no criteria of preference for the consumers	-	Merchant milling requires 20 percent more maize input, because of the high waste

Table 2.1 Characteristics of custom and merchant milling

These characteristics made custom milling technologies to serve neighbourhood markets in rural areas, small towns and low income urban areas. Merchant milling cater mainly to urban consumers.

²²⁾ Till the 1990s privates were not allowed to distribute milled products. Moreover, the NMC could obtain scarce credits to invest and up to 1983 NMC's flour (sembe) was subsidized by 55 percent of its selling prize. These protections and subsidizes resulted in an inefficient operating parastatal sector.

²³⁾ According to Bagachwe [8] this is a result of distorted preferences. Sifted flour is finely milled, looks whiter, tastes sweeter and lasts longer. This lead 80 percent of the consumers of unsifted meal to sift it themselves. Traditionally, sembe was as twice as expensive as unsifted mill was. It was a luxury commodity consumed by high income groups in urban areas.

general information

In 1992 18 grainmills were found in Mbagala. All of them are custom mills, using the hammer mill technology. All are located in the residential areas, of which 12 along the main Kilwa road. They are private enterprises. The milling enterprises are small scale. Most have one or two mills and on average employ 4 labourers. Mbagala has one relatively large custom milling enterprise, with 6 operational mills.

The enterprises exist of one or more mills, situated inside a building. The mills consist of a milling mechanism, driven by an electric motor using a card. The nominal power of the motors is between six an forty kilowatts.

For large quantities of maize bags of fifty or one hundred kilograms are used.

In addition to maize, some grainmill enterprises mill grain which is used for making beer, a traditional activity in the rural areas and suburbs. For this purpose a special mill is used.

production process

Grinding of maize and other grains is part of the so called post harvest system, the entire process from harvesting to consumption. Figure 2.11 shows the sequence of this process.

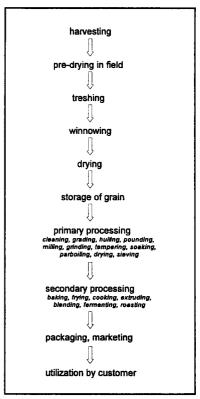


Figure 2.11 The post harvesting system

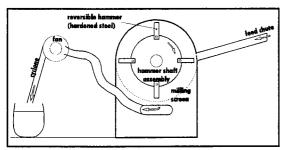


Figure 2.12 representation of a hammer mill

The milling machines all have similar compositions. The mill is driven by a three phase electric motor, connected by a cord. The kernels of maize are put in a funnel connected to the mill and are ground. The flour falls down through a trunk in a bag.

The input of the maize, replacement of the bags and control of the machine requires one labourer. The washing of maize and sieving of

maize and wheat to remove stones and other particles is mostly executed by the customers themselves.

factors with relation to the performance

Due to the electricity cuts the production decreased by one third in 1993. In enterprises situated far from the transformers low voltages occurs, sometimes resulting in the burning of motor windings. Thirdly the water supply is mentioned as an important factor. Water is supplied by water selling people who take the water from wells by barrow. The daily use is about thirty litre a day, which costs 50 Tanzanian shilling. The quantity of water available is sufficient, but the supply is not continuously.

The environment of the grainmills is mainly locally. Inputs, outputs and labour are geographically limited to Mbagala. The mills are not dependent upon physical infrastructure as roads and the telephone system.

In 1996 I expected the total output of the grainmilling enterprises to be grown proportional to the population. However, I surprisingly found an opposite development. The production of the grainmills decreased. The owners were complaining about competition from ready sold flour in the retail shops, milled at large scale elsewhere. It became difficult to make profit and a couple of grainmills closed down. Additional to the strained market situation, the input costs raised because of the electricity price increased significant.

Besides the growth in private merchant milling activities, the change from custom milling to merchant milling can be seen in the light of the urbanization process of Mbagala. Where the area was rural in the 1960s, it got more urban influences afterwards. Till the 1990s it was a area with mixed rural/urban characteristics. Since the town expansion went southwards in the 1990s, not only the population grew but (socio-)economic factors changed as well. Purchasing behaviour is a part of this. Such development was gone through by other suburbs of Dar es Salaam before. Custom milling disappeared there.

2.4 The institutes

Most institutions and their subdivisions as included in the institutional approach are presented by government institutes. There are ministries, city council departments, parastatals as electricity and telephone companies, financial institutes as banks, the army, hospitals, schools etcetera. Non governmental institutional contributors are for example church institutes and private services.

The supplying institutes are described in this chapter to obtain an insight in the quality of services. Only the key - institutes were selected. These followed from the first industrial survey in 1992/1993, and are mainly institutes belonging to the economic infrastructure. The object of research is the quality and quantity of their services, concerning Mbagala. The approach is directed to describe the (socio-)economic situation, and emphasizes the interest of the industries²⁴⁾.

Institutes operate at different levels. A sort of hierarchic structure exists for each institution. Ministries operate at policy defining level. Government parastatals at policy supporting level. They manage local branches which execute the policy. Private services and other subcontractors operate at policy executive level as well.

The individual performance of all levels and their mutual organization determines the final quality of services. This quality can be measured at best at the policy executive level. A planning engineer, for example, can very well inform about quality indicators related to the field he is involved in. A broader view with vision of performance and future plans at regional scale can be best obtained at policy supporting level. The policy defining level is less interesting for this research, because it has a too general character²⁵⁾.

The institutions and their subdivisions selected are presented in the table below. The institutes representing them are given in the last column.

institution	subdivision	institute	
economic	land	- Ministry of Lands - City Council on town planning	
economic;	electricity	- Tanesco	
nfrastructure	telecommunication	- TTCL	
	roads	- Ministry of Works, Com. and Transport - City Council on Works	
	water	- Ministry of Water, Energy and Minerals - National Urban Water Authority	
politics	industrial support	- Ministry of Industry and Trade	
education -		- City Council on education	
health	-	- City Council on health	

Table 2.2 Selected institutes

Education, land & housing and health are basic human rights and development goals in their own rights. In this research, however, they are considered as means to contribute to economic development.

This does not mean, however, that ministries were excluded. Specialized advisors are well acquainted with certain developments which toke and will take place. Furthermore, policy making and executive level are often mixed in Tanzania due to the centralized character of most institutes.

Because of time limitation financial institutes as the National Bank of Commerce and the Ministry of Finance were not included. Serious attention to finance would require much time, which would be at the expense of other institutes. Excluding finance implicates the choice to emphasize physical economic infrastructure in the institutional framework.

Excluded because they are of lesser importance for Mbagala industries are ports (the National Harbour Authority) and solid waste collection (the Tanzania Environmental Cleanliness Association). This also concerns passenger transport, gas supply (not existing yet), railways and the airport. Religious institutes, the military institution and the police were excluded because they shift too far away from the scope of the research.

The results of the interviews concerning the selected institutes are presented in this paragraph. Interviewed persons attended me to the Sustainable Dar es Salaam Project (SDP), which appeared to be so interesting for the research that it is included as well.

The method used to find the right interviewee is simple. I explained what I wanted to know at the main desk and at the department they referred to. There the name and function of the person who was best known with my questions could be given. Mostly the first interview delivered the satisfactory answers²⁶⁾. The interviews were ended with the question whether other oral or literature sources were known related to the topics dealt with.

Ministry of Lands, Housing and Urban Development

- land -

The first question I would like to have answered is: what is the availability of land in Mbagala for investors? As included in the overview obtained by the institutional approach, the availability of land is one of the factors influencing industrial development. Availability can be expressed (operationalized) by the price of available land and the quantity of land which is or will come available for new industrial investments.

An additional topic which was paid attention to is population and development trends and urban development plans concerning Mbagala. This interested me because urbanization influences industrial development and, more in particular, is an important variable for the electricity consumption forecast (chapter 3).

development trends and plans

In the late 1970s the Dar es Salaam Master Plan ^[61] had been developed. It describes the urban planning for the period 1979-2000, including infrastructure as electricity supply, water supply, telephone networks and roads. This major plan still is the most recent plan available. However, most of it has not been implemented. Mbagala was not included in this plan, because it was considered a semi-rural area outside Dar es Salaam.

The only exception concerns the institution land. All interviewees could give some information of importance, but none of these results could answer my questions satisfactory. Finally I interviewed 8 persons of different discipline, enough to assembly the desired information.

Urban development plans for Mbagala have been made at the Ministry and the City Council. The different projects I saw included areas of about one squared kilometre. For example, lower and medium income houses, housing estates, market places, playing fields, a church and mosque, a post office, a dispensary and a social club are included. However, these plans have never been executed because they could not be financed.

Therefore the activity of the ministry related to residential planning is mainly restricted to the legalization of squatter areas. Because all the land in Tanzania is owned by the government, people need official allowance to build their house on a plot. However, many people do not apply for a time consuming allowance and start to build illegally. If a whole area is constructed in this way it is called a squatter area. Mbagala largely exist of squatter areas. One of them was legalized: an area in the mtaa²⁷⁾ Rangi Tatu.

availability of land

In the late 1970s and early 1980s the land at the present industrial area had been released for industrial activities. The procedure is as follows:

- 1 an investor requests for a land plot for industrial purpose at the Ministry
- 2 the allocation committee of the Ministry decides to offer the land or not
- 3 if the committee agreed, the investor receives a letter of offer and pays administrative fees. In 1996 these fees amounted Tsh. 3000,- (US \$ 5,-).
- 4 the investor is supposed to start up the industrial activity he applied for. if he does not, the Ministry has to re-allocate the land to another investor

The first three procedures have worked well. But the fourth one has never been executed in Mbagala. Land speculators obtained most of the industrial plots, almost for free. Officially they are not allowed to sell the land. But if land becomes scarce, new investors take risk and buy. This course became common use in Tanzania. It is sensitive for corruption: for the land speculator it is worth to pay officials for not being strictly controlled.

In Mbagala about 60 percent of all industrial plots are not occupied and most of the empty plots are owned by land speculators. One may discuss the justice of it, but it is unlikely that new investors are put off. The illegal prices are of the same level as normal market price would be²⁸⁾. An disadvantage is that the market is not open and transparent, but exists of networks in the informal sphere. Therefore it is hard to obtain reliable land prices. Besides, the prices will vary. To obtain an impression I informed for industrial land prices. These are around Tsh.10 million (US \$ 15,000,-) for half an acre of prepared land, surrounded by a wall.

Plots are hard to obtain any more in the main industrial areas in Dar es Salaam. Entrepreneurs invest in formerly unfavoured locations. The main examples of these locations are the north of the town and Mbagala.

^{.27)} A mtaa is a local area. Local matters are discussed in a committee, chaired by the mtaa leader. Mbagala contains ten mtaas.

²⁸⁾ In fact this sentence is wrong: in Tanzania no real market prices for land exist. The Ministry of Lands is aware of its contradictory policy and discusses about the introduction of market conform prices and privatization of land.

District Land Development Office (City Council on town planning) - land -

To get an impression of the industrial development in Mbagala it is not enough to know that Mbagala becomes more attractive because in other areas land is hardly available and expensive. To know more about the availability, it is important to get informed about the owners of the industrial land in Mbagala and the purposes of use.

As point of departure I used the detailed town maps at the Survey and Mapping Division and visited all plots on the industrial area. Industrial plots are allocated by the Ministry of Lands, residential plots by the regional land officer concerned, which operates under the City Council. Records of industrial plots are kept at both the Ministry and regional officer. However, the Ministry referred me to the regional officer who is concerned with local matters.

At the District Land Development Office for Temeke a list of all land owners²⁹, addresses and date of land allocation could be obtained. All 24 plots are owned and registered for industrial activities. Three of 17 occupiers manage the industrial activity as it is recorded. A few others stopped their activity. 11 industrial activities are registered where no activity was ever started at the plot-side. Seven industrial plots are registered to be vacant. The year of obtaining the land vary between 1979 and 1995, but mostly concerns the first half of the 1980s.

शाप

Nearly all land at the industrial area is registered to be owned for industrial purposes, but that only a few of the owners are active as industrial entrepreneurs. As long as the Ministry does not privatize land, the market for obtaining land will largely remain non-transparent and illegally. The impact of this constraint on industrial development will be limited.

Ministry of Industry and Trade

- industrial support -

The factors related to this institute can be found in the political institution. As presented in appendix F, tax regulation, industrial licensing and government support are main groups of factors. For the research it satisfies to get notion how the different regulations work. Study of all possibilities and assignments of subsidizes, for example, was omitted. In the light of the liberalization and changing government policies, these changes and their impact on industrial development are more interesting. Thus, the question became: which significant changes have been made in industrial policy making?

²⁹¹ To obtain the list I had to visit the Land Officer for Temeke 8 times. After different delays ('much work to construct a list'), followed by bureaucratic regulations ('you need an official request from your client') and different times of not observing appointments I started to suspect that I was not expected to get insight in the data of land owners. However, after my last request, supported by the Tanesco regional manager for Temeke, I got the list send to the Netherlands. I was not able to contact the registrated land owners any more. I would not have done this anyway, because it strays too far from my research subject.

The ministry is so well known and involved with industrial development in Tanzania, that it would be a lost opportunity not to ask: What do you expect of the industrial development in Tanzania in the coming ten years? Of course, the validity of this question is doubtful because of the ministries involvement. The desirability to answer positive is high and the history has shown fairly positive quantitative government projections followed by opposite results. Anyway, qualitative information can be useful.

The ministry is involved with local procedures as well. The last question can be repeated for Mbagala specifically. Related to this, it is interesting which investors applied for industrial licenses concerning Mbagala.

changes in industrial policy making

Before discussing the changes in policy making, the procedures to go through to start an industrial activity are described:

- 1 the investor applies for land at the Ministry of Lands (described before)
- the investor applies for an industrial license at the Ministry of Industry and Trade (MIT)
- 3 the investor makes a feasibility study, both financially and economically. This study has to be approved by the MIT
- the investor contact the Labour department of the Ministry of Labour to comply with labour laws and confirm with industrial safety. If this is approved, investments and production can start.
- 5 the investor applies for a business license at the MIT. It allows the product being sold at the market.
- 6 if meeting certain criteria, the investor can obtain an investment approval at the Investment Promotion Centre (IPC) [46].

Formerly, these procedures formed an instrument for the government to control the compilation of the industrial sectors. Private investors had no free choice in industrial activities. Around 1990 the economy started to liberalize. Private investments were no longer discouraged, investment possibilities improved.

In 1990 the government passed the National Investment Act (NIA). It initiates a shift away from the support of the public sector, in favour of the private sector. A package of investment incentives was offered, including the remission of taxes on profits for the first five years and custom duty exemptions. The NIA is embodied by the IPC.

In 1995/1996 the conditions for investors further improved: import tariffs on capital goods were decreased and foreign exchanges might be transferred outside the country. Further improvement of these conditions had been prepared in 1996 and the IPC announced to implement them in January 1997. Amongst others, the number of priority sectors for investments were increased in 1997. Tax holidays during the first fifteen years for industrial investments below \$ 300,000, established in the NIA, got the critisized by the IMF as going too far [African Business, April '97].

In a research at the MIT, Donné van Engelen [34] describes the changes in government policy making related to the manufacturing sector. Table 2.3 shows the strategy and policy instruments used in the period 1990-1994. However, van Engelen did not find any positive development in the manufacturing sector resulting from these policy changes³⁰.

aspect of industrial strategy	orientation	policy instruments:
industrial trade strategy	import substitution	import licences, import tariffs
	export promotion	real exchange rate depreciation, general retention scheme, seed capital revolving scheme, commodity exchange programmes, duty drawback scheme, export credit guarantee scheme, tax exemptions and evasions
low degree of direct regulatory	international trade	import licenses, partial foreign exchange allocation
control in the areas of:	ownership	industrial licensing
relative roles attributed to the private and public sector	private sector public sector	guarantees against nationalization, investment incentives, parastatal reform
		industrial licensing, reservation of certain areas for public sector
level of dependency on foreign finance (both private investors and government aid)	increased dependence (but decrease of aid)	foreign investment incentives

Table 2.3 Orientations and policy instruments used during the fifth policy period (1990-1994) [34]

expectations for Tanzania

The liberalization measures did already have its results. It started with a rapid growth in trade, especially the import of consumer goods. The MIT expects that this first trend soon will be followed by a second one: a rise in private investments in manufacturing. From 1997 the MIT aims at the enhancement of both local and foreign investments in manufacturing. One of the first attempts was the foundation of the International Investment and Technology Forum, to be held every two years. The first one was organized in Dar es Salaam in November 1996. 200 local and 190 foreign companies were present. The new government policies were presented, aimed at motivating the entrepreneurs to invest. The Forum was followed by a substantial inflow of direct foreign investments of \$ 790 million [African Business, Jan '97].

Although the move in government policy is promising, a fast growth in manufacturing investments and production requires more than that. The MIT indicated the obtainability of loans as a rising problem. Since the banking system started to liberalize, interest rates became as high as 40 percent, which gave enterprises equity problems.

³⁰⁾ Van Engelen gives overal growth data for 1991-1994. The author describes that the gross fixed capital formation in manufacturing remained high in this period, while the annual growth in manufacturing value added dropped to a mere 0.8 percent. Unfortunately no qualitative research had been undertaken for this period of significant policy chance, such as the reasons beyond these dissappointing results and structural changes (ao. size, ownership and sectoral developments).

Liberalization forms a threat for industries which formerly were protected, as the parastatals were. Also local private companies face more direct foreign competition. At the long term the government can not permit to preserve their inefficient industries. On the other hand, by the abolishment of several restrictions as on investments, imports of capital goods and foreign exchange, other enterprises will profit. Thus, on the long term a shift in industrial structure can be expected.

expectations for Mbagala 31)

At the MIT Mbagala is expected to be one of the main areas for new industrial investments . Both foreign investors and investors from Dar es Salaam will move to Mbagala. This will take place already in the coming three years.

New investors who recently applied for industrial licences successfully could not be given. In 1992 an investor would start a metal factory producing nails, but did not pass the application procedure because the MIT doubt the feasibility of the enterprise.

industrial support The prospects for private industrial investments as well as for many existing private enterprises are positive. However, the impact of liberalization on the whole industrial performance is uncertain and will turn out on the longer term. The structure of industry on national level, which is still an artificial one³²¹, will probably change significantly.

³¹⁾ The MIT is not involved with local developments as Mbagala concerns. However, I was lucky that the specialist in trade and investments I interviewed lives in Mbagala and is - by virtue of his profession - interested in its industrial performance.

³²¹ As described in paragraph 1.3.1, the government built the structure of industry according to her policy. As one of these policies the Basic Industry Strategy shaped a structure which still largely exists.

Tanzanian Telecommunications Company Ltd

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- telecommunications -

The important questions related to TTCL are: what is the present quality of the telephone service in Mbagala and which related developments in telephone service are planned?

For recent data and development plans (strategic level) about Dar es Salaam the head office of TTCL is the obvious party. The Southern Zonal office is involved with local matters and 'experience from the field' concerned Mbagala. The data presented below were obtained at these two branches.

As Puttenstein describes [78], the parameters for the quality of telephone service are:

- a the ability to use the telephone service
- b the connection establishment, retention and quality
- c the billing quality

The most hampering parameters of these are the connection establishment, expressed in the successful call rate, and billing quality.³³⁾

These quality parameters do not cover the waiting time between applying and obtaining a telephone connection. In 1996 Dar es Salaam had 40,565 telephone connections, while 78,791 appliers still waited for connection [L1]. The waiting time depends on the local network situation. 16 days is said to be an usual waiting time if the local network and telephone exchange situation is optimal, but in reality one year is a more common waiting time.

The connection price is high for lower and medium income groups, but do not form an obstacle for business and industrial customers. In 1996 urban households paid a connection fee of Tsh. 34,000, deposit charge of Tsh. 30,000 and monthly rent of Tsh. 2,580. For business purposes the deposit charge is Tsh. 50,000 [L1].

The quality parameters are much worse in Mbagala than in the rest of Dar es Salaam³⁴⁾. There is a telephone cable in Mbagala, connected to the Kurasini exchange office in the south of Dar es Salaam. This exchange office is overloaded and does not accommodate for new connections. Therefore Mbagala counts only around 100 connected lines, while the number of waiters is somewhat more than 1,000 [L2].

Under the Telecommunications Restructuring Program 1992-1996 (TRP)³⁵⁾, the centre of Dar es Salaam was rehabilitated in 1994-1995. The second phase of the program covers the areas around the town: at first the north including the beaches and second the southern suburbs Tabata, Temeke, Mtoni and Mbagala. The implemention is planned for the period 1996-1998.

³³⁾ a On average 5 % of the customer lines are out of order at any time (southern zone of Dar es Salaam: 7 %).

b The successful calls vary according to the telephone exchange connected to and the momental busyness. The central exchanges function with success rates of about 25, 50 and 60 percent. Toll calls have the half of this rate. The retentions are relatively low: about 1 percent of all calls.

The quality of calls is poor, with low volume, hum and cross-talk. Especially at long distance calls.

c All bills are incorrect and delivered late. Result: frustrated customers - refusals of payment - unjustly disconnections.

Source: Puttenstein [78]

³⁴⁾ Reliable data as successful call rates were not available. Industrial customers mentioned that often connections could not be achieved at all.

³⁵⁾ The TRP has been financed by the World Bank in co-operation with the Swedish Industrial Development Association.

Concerning Mbagala the TRP includes a new exchange office, to be constructed at the industrial area. The capacity of it is sufficient to connect a couple of thousand customers. At the end of 1996 the first construction preparations were ongoing.

Expected is that after the implementation of the Mbagala telephone exchange all waiting customers can be connected and the quality of connection will improve. At that time the quality of calls between Mbagala and elsewhere will mainly rely on the main telephone exchanges and transmission lines. This means that at least the quality will be the same as for the rest of Dar es Salaam.

ielapinna

The quality of telephone services is extremely poor in Mbagala. It will improve significantly in 1998, by the construction of a telephone exchange in Mbagala. By that time applications can be provided and the quality of phone calls will be comparable to that of Dar es Salaam after implementing the TRP³⁶⁾.

Tanzania Electricity Supply Company Ltd

- electricity -

Related to the electricity supply, the important variables are the quality, reliability and price of electricity for Mbagala industries. Both the current and coming situations are relevant.

The reliability and price characteristics are comprehensively described in chapter 3 of this report, for Tanzania as well as specifically for Mbagala. Therefore I'll confine to the conclusions.

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The quality of electricity in Mbagala is fairly bad. This concerns low voltage levels, extreme transition voltages as well as frequent power cuts. The formerly subsidized electricity price rose significant in 1995, but did not become excessive high. The national generation capacity rose, whereby the change on heavy load scheduling as occured in 1992-1994 decreased. The local performance, which became the bottleneck, will improve significant in 1998. An already funded rehabilitation project for Mbagala will be implemented then.

To give an impression: under the TRP the rate of successful phone calls within Dar es Salaam improved from about 3 - 4 to about 6 successful calls per 10 (L1).

The Ministry of Works, Communication and Transport and City Council on Works

- roads -

Two main questions are: what is the quality of the roads concerning Mbagala ³⁷¹? and is the capacity of these roads sufficient to serve the traffic load?

Also interesting is the question which are the plans for rehabilitation and extension of the roads concerning Mbagala?

present quality and capacity

The quality of the three asphalted roads in Mbagala is obvious³⁸⁾. The heavy used access road (Kilwa Road) deteriorates fast. Before its rehabilitation in 1994/1995 many holes and crumbled sides made traffic slow and affected vehicles. Afterwards, the quality of the road became acceptable. The frequency and quality of maintenance will determine whether the road will return in its old state or not³⁹⁾. The other two roads are secondary branches. They are of good quality, because they are new and lightly loaded. The quality of connected roads near town vary from quite bad (Mandela Road) to reasonably good (improved roads). Compared to 1992 the road quality in 1996 was better. Many main roads were improved.

In 1996 a second filling station was under construction at the industrial area. This points to increasing traffic at the Kilwa Road. However, it does not belong to the highest loaded trunk roads in Dar es Salaam. In 1994 between 5,000 and 10,000 vehicles passed daily. About half of the traffic on the Kilwa Road exist of heavy vehicles, the highest ratio in Dar es Salaam. Congestion does not apply to the Kilwa Road, but the traffic density in town increased from 1992 to 1996 and will further increase. For the year 2010 the Kilwa road load is estimated at more than 40,000 vehicles daily [x].

expectations

The Ministry of Works, Communication and Transport sets the policy for road development concerning Tanzania. The City Council is informed at the executive level and would probably know about the plans for the roads in and surrounding Mbagala.

The policy of the ministry is to rehabilitate existing roads rather than constructing new ones. The trunk road passing Mbagala (Kilwa Road) had been recovered up to the end of Mbagala in 1994/1995 under the Dar es Salaam Road Improvement Master Plan (Dimp). Rehabilitation of the second part from Mbagala to Lindi in the south is forthcoming. A couple of rural villages south of Dar es Salaam which formerly were reachable by bumpy

³⁷⁾ 'Concerning Mbagala' includes, besides roads in Mbagala, the road connections with the town, harbour and industrial areas in Dar es Salaam as well as the inland.

I travelled daily by car and bycicle over the main trunk road over its whole length and could determine the road quality. Since I liked travelling in Dar es Salaam by bike, I got to know the quality of all major and many secondary roads in 1992 and most of these again in 1996.

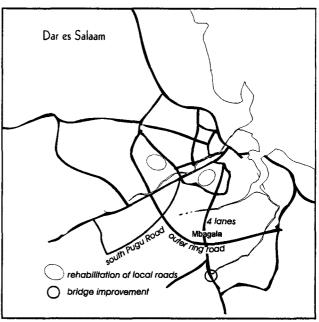
A construction engineer of Skanska Jensen [13], involved in road projects, was very negative about both the quality road construction and rehabilitation and the frequency of maintenance. The 1994 rehabilitation belongs to a cycle: after five years without maintenance the road will be broken so far, that expensive rehabilitation will be required again. Fleischeuer [35] describes the major problems of the road construction sector: bureaucracy, corruption and a lack of skilled manpower, which result in inappropriate choices of technology.

sand-roads were interconnected by a tarmac road in 1994, which forms a large loupe from the south of Mbagala to the Nyerere Road.

The City Council is involved with a study on new plans for road development in Dar es Salaam [45]. This study distinguishes short term plans, for the period till 2000, and long term plans, for 2000-2010. It starts with a traffic survey and analysis, including the measurement and forecast of traffic flows for all main roads. Development plans are presented for the roads and public transport. The plans are structured in implementation schedules. Project costs and a feasibility study are included. The plans concern road construction, rehabilitation and maintenance. They are meant to be followed by financing and implementation.

Included in the plans is the construction of the outer ring road. This 23 kilometre long four lane road will start at the junction Mandela road-Morogoro Road. It will make a loupe surrounding the town in the south: Crossing the Nyerere road near the airport, passing still uninhabited and remote land south of Temeke it will reach the Kilwa road next to Mbagala's industrial area. It will continue seven kilometres eastward, ending near the swamps of the Mzinga estuary. The beach, which is planned to be developed for tourism, is nearby. The outer ring road is included in the short term plans.

Other important plans for Mbagala are the widening of the Kilwa Road to four



Figur 2.13 Road plans for Dar es Salaam [45]

lanes up to the outer ring road and the improvement of the road network in whole Dar es Salaam. The Kilwa Road project is partly a short term plan (the part town-Mandela Road) and is a high priority project. The road network concerns road and bridge improvements and rehabilitations, the widening of trunk roads to four lanes and the construction of intersections.

The impact of the implementation of these plans will reach beyond improved traffic opportunities for Mbagala's industries. Transport and travelling time to Mbagala will shorten significant, obviously followed by urbanization of the are. This will be stimulated by the construction of a main road through non-developed land: new urbanization patterns mostly develop along access roads.

The Jica intended and executed the study and is the most likely financier for the plans. It became the largest foreign financier of infrastructural projects in Dar es Salaam. However, prudence is called for assuming implementation of all plans, because they are still in an early phase.

The quality of Mbagala's only trunk road had been very bad, but improved in 1994/1995. Traffic congestion increasingly occurs on important roads, but not on Mbagala's access road. The 'study on Dar es Salaam road development' presents a promising scenario for the whole town. The construction of a second access road for Mbagala will not only improve the environment for industries, but might accelerate urbanization in and around Mbagala as well.

National Urban Water Authority

- water -

The accessibility to water supply in Mbagala and expected water supply situation for the coming 10 years are the topics to deal with.

The National Urban Water Authority (Nuwa) is the responsible institute to supply water. The water network in Dar es Salaam has been heavily underdeveloped. The capacity is insufficient to supply water all the day. The daily demand for 1995 is estimated at 314,000 m³, while the installation capacity is 273,000 m³ per day with a lower supply due to heavy losses. Pressure is low. A small part of the population has own connection to the network, most people carry their water from pumps.

In Mbagala only TSG was supplied, by one pipeline along the Kilwa Road. This pipeline has been useless because the pressure is so low that water does not reach Mbagala (it does not climb the first hill). So it has no sense to make connections to this pipeline.

The water supply in Mbagala exists of industrial boreholes and a few public water pumps, owned by the Nuwa. The water quality from three boreholes in Mbagala is good. Their hourly capacity is 28, 5.6 and 1.6 m³. People can fill their cans here and carry them home. Boys with handcarts deliver watercans for a fee. The boreholes capacity does not meet the residential demand. Water is mentioned by the people in Mbagala as the main problem in the area [x].

Concerning industries in Mbagala, the policy is that Nuwa does not provide water connections at all. They eventually will advise if an enterprise will drill its own borehole. The water capacity of them is limited and the water quality quite good, but without water treatment the water is sandy.

The capacity of the groundwater in most parts of Mbagala is limited. Studies were undertaken to construct a small grid in Mbagala, fed by one or two boreholes and pumps. Because the capacity is insufficient to supply individuals, the water will be sold in kiosks. The seller at the kiosks will be paid by the Nuwa or will get a small ratio of the turnover. These plans have not been worked out yet. In fact they mean a replacement of the informal activities by controlled ones, including income generation for the Nuwa.

A couple of new small boreholes and realization of the study for a small local network are not very impressive compared to the huge demand. To find a solution for the shortage the Ministry of Water, Energy and Minerals recently conducted a study to the build of a large water reservoir in the south of Dar es Salaam.

Ministry of Water, Energy and Minerals

- water -

In 1996 the Ministry conducted a study to solve the problem of increasing shortage of water capacity in Dar es Salaam [82]. The study concluded that the only feasible solution is the construction of a water dam in the Mzinga River. The daily capacity of it is estimated at 66,000 m³ per day. This quantity is about the same as the current difference between demand and generation capacity in Dar es Salaam and almost as large as the total demand estimated for 1996 for all southern suburbs of Dar es Salaam.

The study is pre-luminary. It is executed by Serviceplan, a private consultants bureau in Dar es Salaam. If the Ministry judges positive, it will be continued by a feasibility study on the Mzinga Dam project. Earlier studies advised the build of the Kidunda dam in the Ruvu river (Jica, 1994) and expansion of existing Ruvu treatment capacities, rehabilitation of the Mtoni water treatment plant, increased storage reservoirs, limited groundwater development in the valleys of Mbagala and Yombo (south of Dar es Salaam) and a feasibility study on the utilization of the Mzinga and Kizinga rivers (Howard Humphreys, 1995). All the measures recommended in the latter study can fill the gap of about 10 years necessary to build the Kidunda dam.



The accessibility to water is excessively poor for Mbagala's residents. Industries are not supplied, they can construct their own boreholes.

The prospects are uncertain. The construction of a water dam in the Mzinga river will be a solution, but realization is doubtful. The build of the Kidunda dam will take ten years at least. Other smaller measures will help Mbagala marginally.

City Council on Health

- health -

The access to health facilities in Mbagala is the topic of interest. An attempt can be made to describe the quality of health service, but serious judgements will require investigations which drift too far away from the scope of the research.

Before describing the health situation and facilities in Mbagala, a short theoretical explanation is presented what health and health care means to society and economy. As Szirmai describes [88], main indicators for the state of health are demographic indicators (life expec-tancy and mortality), disease statistics and health service indicators (number of doctors, hospital beds, etc). Disease statistics usually are unreliable, service indicators concern quantitative figures only. Demographic figures remain. In Tanzania, Infant mortality in the first year of age decreased drastically from 16 percent in 1950-1955 to 9.2 percent in 1990-1995. Life expectancy at birth increased from 37 years in 1950 to 51 in 1992. Thus, these demographic figures improved significant, but Tanzania still belongs to the group of worst performing countries in the world. The epidemiological transition is still going on: while the death rate decreased, the fertility rate still did not.

The main diseases can be devided into six categories. The major one concerns infectious diseases. Infections concern diarrhoea and bacterial and viral diseases as cholera, polio, hepatitis and typhus. Contaminated water and food and pollution by faeces are main transmitters. The other caegories are airborne diseases, diseases transmitted by direct physical contact (ao. Aids) and diseases transmitted by animal vectors (ao. malaria).

Six main factors influence the spread of these diseases. Health technology; water supply, hygiene and sanitary facilities; combat of animal carriers of disease; nutrition; education; dealth care policy.

Many of these are economy related. There is a clear relationship between prosperity and life expectancy, especially for the poorest countries. Undernourishment interacts with infectious diseases. Also, health technology (ao. vaccination, inoculation) has been of major influence on the state of health.

Probably also health influences the economy. Illness will decrease individual productivity. Undernourishment make people passive and malnutrition can lead to impairment of mental functions. Although this relation is hard to prove due to quantifying problems, investments in health in its broad sense (the six factors) will enhance economic growth.

For so far this background information. Related to Mbagala, no official health indication data are avaliable at all. According to a survey in 1996 [M1,M2] the main diseases in Mbagala are malaria, diarhoea and aids. The latter one will cause mortality amongst the economic productive age group. Although these data are interesting, they are superficial and not usable as quantitative data.

We saw that the causing factor water supply is very poor performed in Mbagala. It is open to contamination. Facilities for the hygienc treatment of excrements do not exist. Education is poor. Because of a low standard of living, nutrition is probably low.

The supply of health care in Mbagala is poor. Hospitals have never been established. They are located in town, about fifteen kilometre away. Standard services for most common

diseases as malaria is fairly good there. But structural budget shortages and a lack of adequate equipment and maintenance of it⁴⁰⁾ harmed the service. Both the quality and quantity of service can in no way be compared to that of west European countries.⁴¹⁾ But quantitave parameters are worse than for most other low income countries also. For example, in the period 1970-1990 the population per physician had been around 25,000 in Tanzania, while the average for low-income countries decreased from 22,000 to 11,000 in that period [101A].

Transport time to town is around forty minutes by car, but is longer for most families who do not have adequate transport. For first aid, diagnosis, outpatient' treatment, clinical treatment and nursing most patients rely on local care. So most of these services do not exist for them.

The government did not provide health care in Mbagala. A couple of small private dispensaries has been started, some of them with a few beds. In the north of Mbagala inhabitants organized the set up of a small clinic in 1995, without government support or other donors. Probably this one will expand in the coming years.



Hospitals are not well accessible and the quality of them became worrisome. Private local health service is provided in Mbagala, but in a very small quantity. The prospects are negative.

City Council on Education 42)

Concerning education the interesting questions are: what is the quantity and kind of education services in Mbagala? Again, as with health, it needs much effort to measure the quality. So we have to satisfy with literature concerning the quality related to the whole of Tanzania.

The school system is derived from England. The enrolment of youth in primary education had been virtually full,

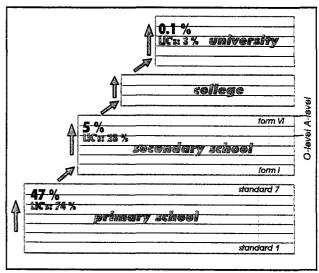


Figure 2.14 The Tanzanian school system and nett enrollments

W.Schulte⁽⁸¹⁾ concludes that the quality of care in the Muhumbili hospital in Dar es Salaam is declining and in danger. Bottlenecks mentioned are a lack of maintenance, equipment and funds; motivation and attitude of personnel and second economy activities. Muhumbili is Tanzania's only academic hospital. The research was limited to the use of medical equipment for diagnosis purposes. Unfortunately Schulte did not describe the maintenance methods used and did not measure the resulting performance of equipment.

⁴¹¹ Common quantitative indicators are the population per physician and hospitals beds per 1000 inhabitants. For Tanzania these figures are 50 resp. 6 times smaller than for the Netherlands. Data for Dar es Salaam were not available, I estimate the difference at about 10 resp. 5 times.

The Ministry on Education could not give information about developments related to Mbagala.

but was negatively affected by the reforms since the 1980s, which stressed quality over quantity of education and growth over equality.

Secondary schools are less common, especially in rural areas. Relatively, vocational training is nearly non-existing. The only university en-rols about 5,000 students.

A schematic layout of the system with percentages of the youth participating, is presented in figure 2.14. For all education levels, the quantitative figure is worse than for other low-income countries (LIC's) and significant worse than for lower-middle income countries. Also, countries which developed rapidly, as South Korea and Taiwan, showed much higher enrolment figures at the time they still were LIC's.

A main problem forms the extreme low incomes of the Tanzanians. Parents can hardly afford all their children following primary school. Further education applies to higher incomes or a few selected students with good school results. Another main problem is low government budgets for all education levels. Payment of teachers for primary schools is poor and often delayed. The ratio teachers / scholars is very small for primary education. Also university facilities are poor, compared to universities as Nairobi and Kampala⁴³⁾.

Related to vocational training, the common used expression that the need for educated people is high in Tanzania, may be doubted. For many people just finishing university it is hard to find a job which agrees with the field and level of education. This is caused by a lack of formal sector opportunities and capital inputs [88].

Duijsens concludes in [31] that shortcomings on knowledge and skills are mainly caused by the use of the English language as medium of instruction and too limited financial means⁴⁴⁾. Since most employees of Mbagala industries have lived in Mbagala, local education services will be most relevant. However, migration patterns, mobility of scholars and attraction of educated and skilled employees from elsewhere makes that the quality and quantity of education in Dar es Salaam plays a role as well.

school	scholars	teachers	data from	remarks
Mbagala primary school	5,555	83	1996	largest school in Temeke district
Mtoni Kijchi primary school	1,338	22	1995	
Rangi Tatu primary school	2,657	35	1995	
Nzasa primary school	1,192	9	1995	
St Anthonys secondary school	1,039	75	1994	private school

Table 2.4 Schools in Mbagala

All primary schools in Mbagala are heavily overcrowded with scholars. The ratio of scholars per teacher is the highest of Dar es Salaam. Classes with more than 100 children became

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However, the quality of academic education is relatively good. Most teachers have international experience. An additional advantage is that a university is popular for foreign aid and co-operation projects. It is striking that some foreign East African students prefer Dar es Salaam over other universities in East Africa.

The research includes a survey amongst 30 metal working companies and a total of 8 educational institutes at secondary, college and vocational training level.

common. Many lectures have been taught outside, because of a shortage of classrooms. The situation became so urgent that the City Council made Mbagala a high priority area for coming extension plans. However, concrete plans could not be presented. The abilities of the ministry and City Council are limited due to decreased budgets.

Secondary education is served by one private school. Its facilities are much better arranged than for the primary schools. The school may meet the local (financial) demand for secondary education, because most parents are not able to pay the school fees. The enrolment is relatively small. Any type of vocational training is absent in Mbagala.

The quantity and quality level of education provided in Tanzania are not impressive. In Mbagala the situation is extremely bad, with overcrowded classes. Probably some extension will take place, but the prospects for education in Mbagala are negative.

Sustainable Dar es Salaam Project

- intermediary -

The Sustainable Dar es Salaam Project (SDP) was established in 1993 with funds of the United Nations. Its task is to co-ordinate the policies and strategies of governmental institutes, non-governmental organizations and private organizations.

The Planning Office has been the official institute co-ordinate different the government institutes according the governments' policy. The results show that Planning Office neglected its task, restricting to budget and approvals attributions. In contrary to the Planning Office, SDP has no decisive power, it can only advice. Figure 2.15 gives an impression of the need for an institute as SDP. The chaos of dotted lines institutes presents the mutual communication, which are not organized and occurred exceptionally.

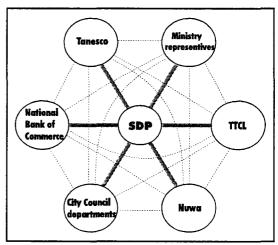


Figure 2.15 Communication between some institutes

In the first years of existence the SDP formulated its aims and goals, became known in the world of different institutes, prepared studies and made plans. The following two phases are planned as follows:

- The policies, strategies and plans of the different institutes have to be co-ordinated.
 This is the actual phase in 1996. An example of one of the first serious attempts is a meeting in November 1996 with 200 representatives of all institutes involved.
- 2. Per geographical area selected the co-ordinated policies, strategies and plans are elaborated in detail. Per area (for example a suburb) a framework of infrastructural projects is set up. The present situation and the plans are described. It also includes data from own studies as socio-economic data and population estimations.

Although the second phase in not reached yet, the SDP collected data from different institutes. Existing and projected infrastructural provisions were drawn on maps, in which Mbagala is included. The design was still quite rough, but some results I did not collect yet could be used. These are:

- An up-country busstation in the very south of Mbagala
- Kongowe⁴⁵⁾ is appointed to be a new growing peri-urban township. It will include a modern market

Concerning Mbagala, the SDP conducted a study on the socio-economic situation. This includes the measurement of the variables: population size, origin, household compilation, education, employment, income and expenditures, opinion of problems in Mbagala, main diseases, health facilities used, energy sources used, transport provision and the handling of solid waste.

The viability of the results was controlled by interviewing the interviewers of the survey. The methodology used as well as several details were discussed. The whole original data matrix (vertical 200 households, horizontal 23 variables) could be obtained. The attention paid to this survey is aimed at broadening the view of Mbagala. With concentrating on the industrial development, the characteristics and development of the residents were neglected. Although this marking-out had been well-considered, socio-economic influences on the local industrial performance will likely exist. So an understanding of the main socio-economic features is desirable. More specifically, certain indicators could be well used for the electricity demand forecast, as described in chapter 3. Such data for Mbagala⁴⁶⁾ were not available by other means. The results of the study are described in appendix K.

Kongowe is a small rural village 5 kilometres south of Mbagala along the Kilwa Road.

Amongst the main parameters for load forecast are the income, income distribution, net income growth and consumer price developments. One can foresee that these data have never been measured for Mbagala, thus assumptions have to be made taking Dar es Salaam or even national data. But since 1982 the Bureau of Statistics did not measure any data related to income at all, because this is labour intensive and relatively expensive. Only consumer price indices have been available. [B]

2.5 Common complexes of factors

2.5.1 The industries

The survey amongst the industries of Mbagala shows low capacity utilizations and moderate developments. The interviews gave an insight in the role of different factors.

Main factors related to low capacity utilization concern physical infrastructure. Electricity and water supply are the major ones. Others are roads, sewage and telephone. Significant shortcomings in infrastructural services are tangible and their impact is directly felt.

A few major factors were not indicated directly by the interviewees as being very important, but came up in the qualitative interview part. The availability of credits is one of these, and is part of the economic infrastructure. Of high importance are human skills, both at employee and employer level. Major skills concern management and maintenance.

The industrial pattern remained the same in the period 1992-1996. Industries hardly developed, despite the ongoing government liberalization. The impact of the investigated factors will be a main cause, especially the severe electricity cuts in 1993 and 1994. However, due to an improving climate for new investments and the switch of new investment locations to areas surrounding the town, new investments are expected to come in Mbagala. In contrast to the formal industry, the informal sector activities changed significantly. This concerns trade as well as productive activities.

questionnaire results

In the 1992/1993 survey the industries of Mbagala indicated electricity and water supply as the main factors, as shown in the table below.

factor	i	ii
electricity, cuts	13	
water supply	9	1
roads	4	1
security	4	1
electricity, voltage	3	
bureaucracy	2	
loans	1	1

factor	i	ii
foreign currency	1	
raw materials	1	
labour skills	1	
maintenance facilities		2
licenses		2
sewage		2

Table 2.5 Hampering factors mentioned in the Industrial questionnaire, Mbagala 1992/1993 i : number of answers 'important' ii: number of answers 'some important'

The urgent character of electricity supply had been decreased in 1996, but it remained the major hindering factor. The availability of loans increased in importance, while foreign currency was no longer an impeding factor.

factors related to scale

The fifteen small industries situated in residential areas are less dependent upon these factors than the medium and larger industries are. Small firms decreased the impact of electricity cuts on production by using flexible production times.

The small enterprises are mostly financed by own capital, so do not depend on government conditions for obtaining loans. The environment of these industries, including inputs and outputs, are restricted to Mbagala. Therefore roads and communication with the city are of little influence, and foreign currency are not used.

2.5.2 The institutes

The quality of services performed by the institutes has been poor. Generally, this has been worse in Mbagala than in the rest of Dar es Salaam. A reason is that Mbagala had been a semi-rural area with a low level of services. It started to urbanize in the early 1980's. This was a period of economic crisis, resulting in a setback of government investments, embodied by the institutes. Mbagala was the victim: the construction of basic infrastructure was poorly or not performed. Most obvious setbacks concern the water supply and telephone services. Improvements in the period 1992-1996 were minor: only the quality of roads improved ⁴⁷⁾.

In 1996 most institutes showed serious improvement plans concerning Dar es Salaam. Execution of a few of them started already (roads, telephone). Others are in an earlier phase, from first studies (water) to being financed already (electricity). All institutes include Mbagala in their improvement plans, mostly as priority area. Great leaps forwards are announced for roads, telephone and electricity, all of them within three years. New industrial investments are expected in Mbagala in the coming five years. Negative prospects concern education and health services. Water is uncertain: studies were ongoing in 1996. However, a satisfactory improvement of water supply (supply meeting the demand) will not be realized within ten years.

The compilation of factor improvements will improve the industrial climate significantly. Most radical impact on Mbagala will have the new southern ring road.

the party behind the scenes

The investments in infrastructure in Dar es Salaam in the period 1994-2000 are striking, because these occur so abruptly after a long period of poor performance. Although the government policy changed toward a more liberal one, its financial abilities did not improve significantly: it can not afford huge investments, whatever the preferences are. The explanation comes from outside the country: the Japanese government, represented by the Jica. Nearly all studies and projects described are undertaken or financed by the Jica. The World Bank and the IMF play an advising role as well, but as far as the discussed institutes concern, real impact of them is rather small.

⁴⁷⁾ As part of policy liberalizations the availabilty of foreign exchange improved as well, but this was not included in the survey concerning the institutes.

Why is the Japanese government investing so seriously in infrastructure? Direct private Japanese investments in East Asia and West Europe might be feasible, but can these indirect investments be feasible for the Japanese government? Are these projects part of a policy which includes following steps, as direct industrial investments? Such questions are interesting, but would need an additional research. Even if I had the time for such a research, it probably would not lead to satisfactory answers.

So I will confine with the conclusion that structural investments take place and probably will be extended the coming ten years. If the Japanese government will profit from these investments, it will seriously attempt to make the results successful and will keep involved, in contrast with most projects funded by aid from West European governments.

2.5.3 A framework

The investments by institutes were discussed individually. Approaching with a view from higher perspective, we can concentrate on the connections between the different investments and measures, and their impact on industrial development. In structuring the complex of relations, the recent liberalization trend of the Tanzanian government policies and, relating, Tanzanian economy can be placed. A consideration of the research results, combined with information about development trends from recent literature, leads to the framework shown in figure 2.16 ⁴⁸⁾. An arrow stands for influence: investments and regulations from outside the frame, indirect influences within the frame.

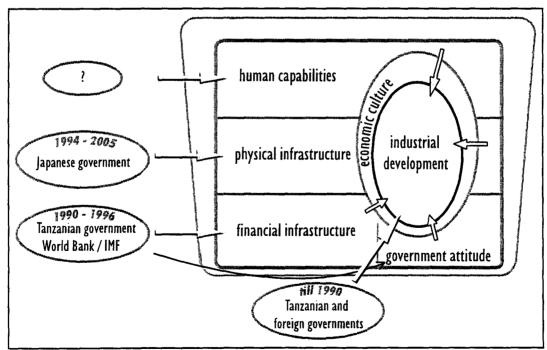


Figure 2.16 Complexes of factors : a framework

⁴⁸⁾ Since the findings from research concern Dar es Salaam, prudence is called for generalization to a broader area as the whole of Tanzania. Industry, preented central in the figure, is just one of all contributors to the economy; the one this research concentrates on.

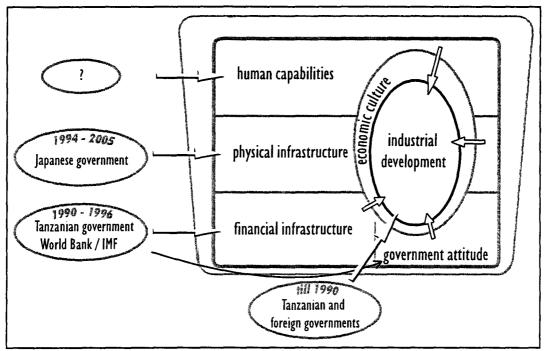


Figure 2.16 Complexes of factors : a framework

The important factors dealt with are grouped. The groups used are government attitude, financial infrastructure, physical infrastructure and human capabilities. They make up a large part of the enterprise environment⁴⁹.

These factor groups can be ranked in a sequence, according to both the time needed to improve these factors and thes time of impact of the factors on industrial development. From short to long time this is: government attitude⁵⁰⁾ and financial infrastructure; physical infrastructure; human capabilities; economic culture.

Liberalization of the availability of foreign exchange (financial infrastructure), for example, did increase the industrial capacity utilization within one year, a relative short term. Education and training (human capabilities) need a long term to have impact. As drawn in the figure, the shield of economic culture has different thicknesses. Improvements in financial infrastructure will be followed by increasing industrial profits and capacity utilization, in which cultural behaviour does not play a dominant role⁵¹. Education and professional training can change the attitude in a more enterprising one. This is part of continious process which results will hardly be visuable within a decade.

⁴⁹⁾ Again, the research did not aim at describing all possible (groups of) factors. For example, it may be possible that political peace influences cultural behaviour and industrial development. Extreme situations like wartime will undermine the trust in the durability of industrial activities.

Government attitude refers to the enhancement of industrial entrepreneurship. This rather concerns an attitude, embodied in procedures, bureaucracy and other discouraging behaviour, than direct financial support. Because the financial infrastructure and government attitude are mutually related and both changed due to the liberalization trend in the early 1990s, they are presented together in figure 2.16.

But also here examples of the cultural component exist, of which I will give one. Small entrepreneurs have their own local networks, in which government and financial institutes are not included. If government institutes start promotion activities, the economic culture of small entrepreneurs make them unaware of these possibilities and the related procedures to pass through. Both government attitude and entrepreneur behaviour cause such misunderstandigs: the entrepreneur might be unknown with business plans and simple feasibility studies required for certain applications, the government has deterred entrepreneurs by introducing cumbersome procedures.

excluded factors

Most of the discussed factors are mentioned in the main literature sources on Tanzanian economy. These sources describe the mutual relations ad hoc, without 'total views' expressed in conceptual frameworks or models. In general the research results agree with the descriptions in literature.

But the role of a few factors seems to be underestimated in this research. One of them is corruption. Although mentioned in this report a few times, the research results did not show a structural and clear role of this factor. Because of a lack of viable information rather than finding it unimportant, corruption is not included in the framework.

Also technology choice is not included as a separate factor. Technology is considered as part of the industrial development. It showed to be a moving variable instead of a prime one. Certain technology choices were made by the government and donors. Entrepreneurs did not find the availibility of technology a restricting factor⁵²⁾. This availibility may differ internationally, giving Tanzania comparative disadvantages related to certain technologies, but this issue is outside the scope of the research.

^{52l} Formerly the government restricted the import of most capital goods. It determined which technology was appropriate. Since the liberalization technology imports are free.

3 ELECTRICITY SUPPLY IN MBAGALA

As we have seen in the last chapter, electricity supply is an important constraint for industrializa-tion in Mbagala. Regular power interruptions and low voltages are the main symptoms. This chapter treats the reasons beyond the poor electricity performance in Mbagala and what to do about it.

The aim of this treatment is to define the present quality of electricity supply in Mbagala and to recommend a financial and economical optimal solution to guarantee this quality in the coming ten years. This aim corresponds with the second research question (page 25).

In 1992, the World Bank conducted a prepatory study for grid improvement in Dar es Salaam ^[Esmap, 97], followed by an appraisal study by the Jica ^[43]. Not satisfied with the methodology used in these studies, an own methodology was made and applied for Mbagala.

The approach used for project management is described in paragraph 3.1. Some theoretical aspects concerned the project are discussed afterwards. After this introduction, the project appraisal is elaborated. For this purpose a methodology was designed, followed by the application for Mbagala. The results are compered with those of the World Bank and the Jica. This appraisal results in recommendations to come to a satisfactory electricity supply in Mbagala.

3.1 Project approach

The project appraisal, what this chapter is about, is one step in the project process. The project cycle is a proper and common used structure to describe this process. A diagram form of it is presented in figure 3.1 and explained below, with references to projects in the electricity sector. The last step, continuation, usually is not part of the cycle. Because it often is overlooked in project management, this step is added.

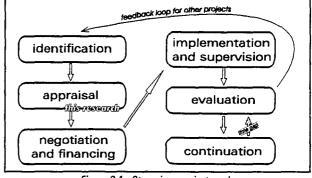


Figure 3.1 Steps in a project cycle

Projects, for example for electricity supply improvement, require scarce resources. These can be applied to other projects as schools or transport as well. Government mainly determine the allocation of scarce resources at sector and institute level¹⁾. Foreign donors make such policies as well. This allocation of resources is supposed to be rationally.

Project identification is a task for the institute and donors of individual projects²⁾. Depending on the performance and policy priorities, studies for different projects are carried out. The projects with the highest benefits and which are in line with the policy, are selected for implementation.

This especially applies to government institutes and parastatals.

²¹ This supposes that institutes operate independent from government at project level. In practise, however, this separation has not always been clear.

Starting with a problem definition and goals which should be met, the project definition is worked out in the appraisal phase. This concerns technical, organizational and eventually other aspects. Several defined steps are involved, including the definition of the present situation, load forecast, optimal grid design and benefit measurement. The net present value and benefit/cost ratio are main calculations that indicate the financial feasibility. If the government or others are involved, their benefits (amongst others economic feasibility and return on own investments) can be decisive as well. The most profitable project design should be assessed. A detailed analysis is presented in the appraisal report.

An appraisal with positive results can be used to attract financiers. This can be the electricity company itself or the government. Usually, the money is borrowed from a financier (bank, etc.) after adopting the project. In the Tanzanian context however, most financiers are foreign donors. When financed, the project execution is planned. Preferably, subcontracting is open for tendering. The subcontractors are selected after negotiations.

Supervision of the field work should be carried out through periodic inspections and progress reports. Evaluation is implemented when the project is delivered and functioning. The performance is measured and compared to the goals set at the appraisal start. Eventually, negative differences can be recovered from the subcontractors. Evaluation mainly serves as feedback management information for future projects.

Continuation concerns a proper functioning of the project during its whole life time. The functioning of the organization which manage the project is especially important. Main aspects of this are the relation with customers, a sufficient maintenance organization, development and proper modifications where necessary.

3.2 Theoretical aspects

The project description in the following paragraphs requires understanding of some basic principles of electricity distribution. An explanation is presented below for those who do not have an electrotechnical background. Besides electricity, maintenance appeared to be a fundamental aspect of the project. To understand the maintenance aspects dealt with, basics of maintenance sciences are discussed in paragraph 3.2.2.

3.2.1 Basic principles of electricity supply³⁾

Electricity as energy source is generated from primary sources like coal, gas and hydro power in a power station. From there the voltage is stepped up by transformers to transmit the electrical energy to consumer areas. There it is transformed to lower voltages and distributed to the consumers.

If we, for the sake of simplicity, abandon the transformation of voltages, the most simplified representation of an electrical circuit can be given by a consumer which gets its electrical energy via a connection from a generator.

³⁾ Part of this description is derived from Richard van den Broek [15]

By analogy with water in a pipe, electricity flows between two points in a circuit because there is a difference in pressure between them. The difference in pressure is called the voltage (symbol V), expressed in volts. Higher voltages are expressed in kilovolts (kV). The quantity of the flow is called the current (symbol I). The unit used is ampere (A). The quantity of energy which is transported through a conductor depends on both the voltage and the current. The energy flow per second is called the power (symbol P), expressed in watts (W).

In most electrical grids the voltage and current are alternating units with a sine curve of a certain frequency, mostly 50 hertz (Hz). Dependent on the sort of load, the voltage and the current can be out of phase. The difference in phase is presented by the angle ϕ . The cosine of this angle is called the power factor. In practise, the power is transported by means of a three phase system, which refers to the three wires through which current flows. In this

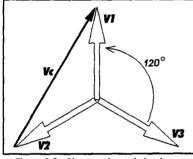


Figure 3.2 Phase and coupled voltages

respect, we can distinguish the phase voltage, which is defined as the voltage between one phase and the zero (a reference point) and the coupled voltage, defined as the voltage between two phases. In the generator at the power plant on each of the three phases a separate voltage is induced, with 120 degrees phase difference (figure 3.2). This causes a fixed ratio between phase and coupled voltage:

$$V_c = V_{pk} \times \sqrt{3} \tag{3.1}$$

V_c : coupled voltage [kV] V_{sh}: phase voltage [kV]

From now the term V will be used for the coupled voltage.

Now we can come to the expression for the power which is transported:

$$P_{tr3} = I \times V * \sqrt{3} * \cos \phi \tag{3.2}$$

 $\begin{array}{ll} P_{tr,3} & : transported \ power \ over \ 3 \ phases \ [kW] \\ V & : coupled \ voltage \ \ [kV] \end{array}$

 $\cos \phi$: power factor

When this power is constant over time, the electrical energy which is transported can be expressed as:

$$E_{tr,3} = P_{tr,3} \times T$$
 (3.3)
 $E_{tr,3}$: transported energy [kWh]
T : time period [h]

The power demand by consumers will not be constant. The current and power factor will vary over time. The expression of the power should be integrated over time to come to the expression for the energy:

$$E_{tr,3} = \int P_{tr,3}(t) dt = \int (I_{(t)} \times V_{(t)} * \sqrt{3} * \cos \phi_{(t)}) dt$$
 (3.4)

The ratio between the energy consumed in a certain period and the product of the maximum power demand in this period and the period length is defined as the load factor. The product

in the denominator represents the energy which would have been consumed if the power would have been at its maximum value during the whole period. Common periods used are one day and one year. Thus, the load factor can be represented as:

$$LF = \frac{E}{P_{\text{max}} \times T} \tag{3.5}$$

LF : load factor

E : energy consumption in period T [kWh]

P_{max} : maximum power demand in period T [kW]

T : time period [h] (mostly 24 or 8760)

This reactive power is used for creating an electromagnetic field in appliances like motors and tube lights. A characteristic of the reactive load is that the current and voltage are not in phase. Multiplying current and voltage gives an alternating power with negative moments. This can be presented as a part of the power that is fluctuating between producer and consumer side, see Q in figure 3.3. Every sine period the same amount of energy is given and received. So it does not lead to an extra consumption of energy. But, as we will see below, the extra current required to transport this reactive power causes extra losses in the conductors.

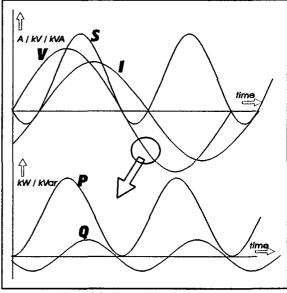


Figure 3.3 Phase shift and the powers

The active and reactive power can be joint in a total power, which is called the apparent

power. The current in the phases of an electricity system is basically determined by the size of the apparent power, according to:

$$I = \frac{S_{tr,3}}{V \times \sqrt{3}} \tag{3.6}$$

The relation between the apparent power and the active and reactive power can be given as:

$$S^2 = P^2 + Q^2 (3.7)$$

S : apparent power [kVA]
P : active power [kW]
Q : reactive power [kVar]

In this respect the power factor (cos ϕ) represents the ratio between the active power and the apparent power:

$$\cos \phi = \frac{P}{S} \tag{3.8}$$

The voltage drop over a connection (conductor, transformer) is directly proportional to the current which flows in the connection and to the size of the impedance of the conductor, which consists of the resistance and inductance. This resistance is directly proportional to the length of the conductor and inversely proportional to the surface area of the conductor. Therefore, the voltage drop can be limited by using short connections with large surface

areas. The negative aspect of a high voltage drop is that consumers obtain lower voltages than their appliances are designed for. For example, machinery connected to a motor require a certain amount of mechanical power. Assuming a constant ratio between electrical and mechanical power and a constant power factor, the motor can deliver this power with lower voltage only if the current increases. This raises the losses in the motor, transferred in heath. The life time of the motor (or other appliances) will decrease, eventually it will burn. Power losses in an electrical circuit occur both in connections and transformers. The power losses are quadratic proportional to the current in the system. The exact relation is:

$$P_{loss} = \sum 3 \times I_g^2 \times R_g + \sum (3 \times I_f^2 \times R_f + P_f(0))$$
 (3.9)

P_{loss} : power losses [kW] g, f : time period [h]

n, m : numbers of lines resp. transformers

R : resistance $[\Omega]$ I : current [A]

P_t(0) : transformer off load losses [kW]

To obtain the energy losses, the power losses have to be integrated over time according to formula 3.4.

In the same way as the load factor was defined with the maximum total power and the total energy consumed, a loss factor can be defined as the ratio between energy losses over a certain period and the product of the maximum power losses during the period and length of the period:

$$LS = \frac{E_{loss}}{P_{\text{max},loss} \times T}$$
(3.10)

LS : loss factor

E : energy losses in period T [kWh]

P_{max, loss}: maximum power losses in period T [kW]
T: time period [h] (mostly 24 or 8760)

3.2.2 Basic principles of maintenance

Once a system is obtained to fulfil a certain function, it has to be kept in a condition good enough to fulfil that function during its life time. This is the base of maintenance.

A system can be of many kinds: ecological (with environmental protection as a maintenance method), physical (health care), social (psychology) and technical (technical maintenance) are some examples. One similarity of these systems is that they have consumers. These consumers make use of the system, which durability is in their own interest. They maintain that part of the system they use, being conscious or unconscious they do. If these maintenance activities appear to be insufficient to keep the system functioning, organized maintenance can be supplemented. The institute examples between brackets (forementioned) are examples of such organized maintenance. It is not based on the individual consumer

approach, but on a structured approach considering a larger part of the system including many consumers. Eventually, also preventive maintenance will be institutionalized: not only 'extinguishing fire' but also trying to prevent fires, both undertaken within the frame of a policy. If the system is produced by men, the producer will take customer maintenance aspects into account in his design. So we come from the 'self-sufficient maintenance model' shown in figure 3.4, to an organization of maintenance with different parties involved.

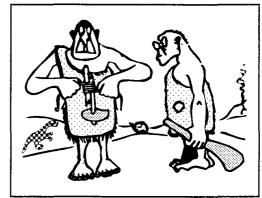


Figure 3.4 Maintenance in the stone age

From now on we will concentrate on maintenance of technical systems. A technical system refers to physical facilities: material things which are part of a production process. A common used definition for these facilities is: 'buildings, installations, apparatus and other process supporting goods'. For simplicity, we will call them objects. Several basic maintenance aspects are discussed below. First the object life, followed by its types of failures and the maintenance methods available to solve them. Thereafter, the organization of the maintenance is described. Finally, an introduction is made in the theory of maintenance models.

The objects life phases

To give an idea of the maintenance process, we first have a look on the life a single object goes through in a productive organization⁴⁾. The different life stages are presented in figure 3.5. The thin arrows in the figure are forward and feedback linkages. They concern information flows derived from results in a life stage, used for decisions related to another life stage. The producer side (object design) and buyers of discarded objects (disposal pro-

⁴⁾ This is an approach from the view of the consumer of the object. Another view is from the producer. Design, production and assembly are the main steps here. The classic product life cycle including research & development, production & construction, operation & support and retirement & disposal concerns an object type, produced in large quantities. Producer and consumer views and related management are fundamentally different, but do have relations. The feedback loop in the EUT Maintenance Model a main one. Other views can be on sectoral or national level, relating to the government.

cessing) complete the object oriented pattern. In this sense life cycles can be defined⁵⁾. The stages located in the organization (within the grey circle in the figure) are discussed below.

In the acquisition phase, the object requirements are identified first. Whether they meet the expectations is much related to quality. It is partly expressed by the fault sensitivity, which is difficult to measure in advance. This means that rules of experience play an important role in the acquisition phase. The kind of maintenance depends directly on the technology the object is made of. Main topics are the maintenance capacity and knowledge which the organization has 'in house' or can subcontract, to meet the maintenance

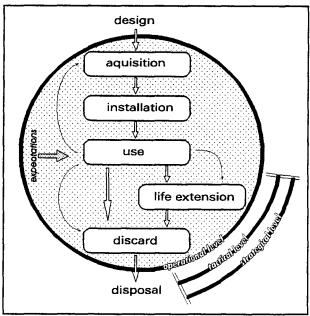


Figure 3.5 The object life stages

requirements. This includes the availability of spare parts. With complex objects, maintenance training provided by the supplier is a purchasing criteria. The maintenance costs during the whole life of the object can be estimated before purchasing. Figures depend on the sort of object.⁶⁾

Installation and testing is the next phase. Preferably, for more complex objects this is undertaken or supervised by the supplier, and is part of the guarantee terms. Instruction of handling to the operators of the object also belongs to this life phase.

The rest of the life the object is in *use*. Most of the maintenance management is directed to this life stage. Organization of operation and maintenance should be co-ordinated. Management has a central role in this process.

The needs of the user of the object may change over time. This may involve modification of the object. The function of an object might alter. To extend the life time, an object can be renovated. In fact, these three actions point to *life extension*.

Discard of the object may take place for technical or economical reasons. The shortest of the two life times will be decisive. The technical dead of an object is pointed in figure 3.6. The failure frequency raises so high, that maintenance and process breakdown costs grow larger than the cost which will be saved to delay investment for a new object. The economical dead of an object is reached if new objects have such better qualities that their investment costs are lower than the extra profit caused by their improved qualities (productivity, efficiency, reliability, manpower requirement, etcetera).

⁵⁾ In fact these are not real life cycles concerning physical systems, as presented in figure 3.5. The closing link of the cycle exist of information, fed back to the initial phase and used to design next generation systems.

⁶⁾ To give an impression: annual cost amounting three percent of the purchasing price is a common used budget figure.

failure types and failure chance

The object will fail to function at some moments. This can be caused by different reasons. For example, parts of the object are subject to wear, providing infrastructure may fail, persons may operate the object incorrectly, or the use and maintenance of the object is not well organized⁷⁾.

General patterns of failure exist. A very common one is the so called bathtub-curve, presented in figure 3.6. Three main phases can be distinguished in it, which are related to the life phases described above. In the first life phase the failure chance falls. Most failures are caused by teething troubles, as wrong tuning and unfamiliarity of technicians and operating personnel with the object. When these problems are solved the optimum period is arrived. Failures are caused by

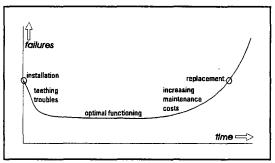


Figure 3.6 Bathtub-curve pattern of failures related to age

coincidental circumstances then. The mean failure frequency remains constant, till aging symptoms occur. Due to wear the failure chance raises, and so the resulting costs do.

The failure chance can be expressed in the mean time between failure (MTBF). Because mostly the different failure reasons are not related to each-other, it is more useful to know the MTBF for each failure reason. What the MTBF can be used for, is explained in the next subsection.

Three main types of failure consequences can be distinguished: personnel harm, financial damage and maintenance / organization consequences. Generally, their priorities are ranked in this sequence. In practise, the failure consequences are embedded in the object function. So, most objects can be categorized according to the importance of their maintenance.

maintenance types

The aim of maintenance was presented as 'keeping in good condition', to guarantee the function of the object. Different maintenance methods exist to reach this goal.

The most obvious method is repairing, the so called corrective maintenance (CR). When a failure occurs, it will be reported and action will be undertaken to solve the fault. Unpredictable failures complicate planning. Very short term planning involves the demand to solve faults versus the supply of maintenance capacity. The reaction time to faults can be planned according to their priority. Personnel can be planned depending their capacity, field and experience with object faults. The structure of the information flows and actions is explained in the subsection 'work order process'.

⁷¹ Van de Schaaf gives a description in his Eindhoven Classification model of system failure [62]. Four main failure reasons distinguished are technical factors, organizational factors, human behaviour and unclassifiable faults. He stresses on the human component of system failure. This component can be approved by registration and analysis of system failures, to lead to system improvements related to safety and reliability. This is supported by the use of computer maintenance information systems.

Another method is to try to prevent failures. Concerning technical ones, this is called preventive maintenance (PM). It concerns regular checks of the object condition and performance. This may include the measurement of certain critical parameters as pressure levels, liquid levels and electrical values. Prevention of personnel and organization faults are much related to communication and organization aspects.

The question related to PM is: which actions are included and how often? The maintenance protocol (action description) and frequency form the maintenance concept of an object.

Two kinds of PM exist, related to the points of time of maintenance. User based maintenance (UBM) is based on a certain maintenance frequency. For example, once a year an object gets large PM, six months later followed by small PM. The disadvantage of this method is that the frequency of PM is not related to the intensity of use, which can vary. Condition based maintenance (CBM) solves this problem. CBM only can be undertaken if the cumulative use of an object can be measured, for

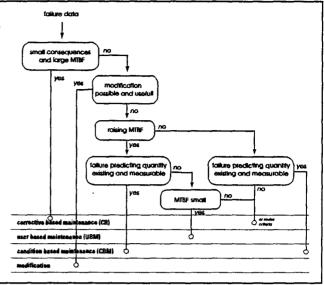


Figure 3.7 Decision-tree for the choice of maintenance type

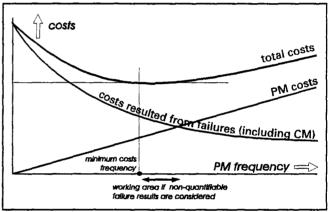


Figure 3.8 Costs optimum for PM

example the amount of active hours of an motor. CBM is more complex to plan than UBM and requires a frequent or on-line control of the object conditions.

The choice for one of the three maintenance types depends on a couple of aspects, as shown in figure 3.7. Relating to financial damage, the optimum relation between PM and CM can be obtained from figure 3.8.

the organization of maintenance

The organization of maintenance becomes complex for an organization of scale using maintenance sensitive equipment. The requirements for technical knowledge and skills result in the need for technicians and engineers. To keep communication with the organization direct and enhance the involvement, a technical team is included in the organization. Non-core-activities, such as specialisms, can eventually be sub-contracted. Main parties involved are the users of the objects, the management of the organization and suppliers of objects, spare parts, other materials and infrastructure.

The composition of a technical team depends on the technology used and related organization requirements. For most organizations of scale such as industries and larger institutes general patterns exist. The production process mostly has an electrical and mechanical component. This includes the related infrastructure as the supply of electricity, gas, oil, water, pressured air and gasses, eventually directly supplied from external sources. Furthermore, buildings and grounds require knowledge and skills of structural engineering. Eventually, specific technologies require special skills. Those

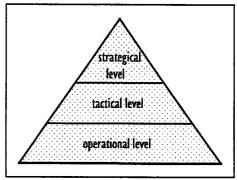


Figure 3.9 Organizational levels

four components — electrical, mechanical, structural and specialisms — form the operational level. This level requires co-operation and management. Most obviously this management is performed by a work preparator, mostly (but not necessarily) one step higher in the organizational hierarchy. Operating at both operational and tactical level, this person advises the management which operates at tactical / strategical level.

A method to describe the maintenance process is to construct a work-flow diagram with all important actions and information flows. An example is presented in figure 3.10. Such a diagram helps to understand the important information flows, and is used to define the weak and strong aspects and to identify the bottlenecks. With this knowledge the efficiency of the maintenance organization can be improved.

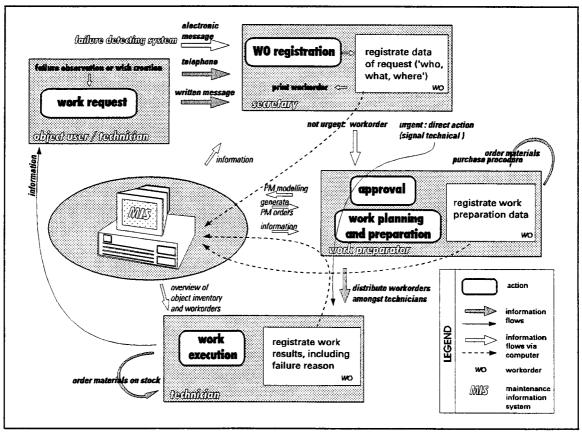


Figure 3.10 An example of maintenance organization: actions and information flows

The process in figure 3.10 is limited to the operational / tactical level. The object user, work preparator and technicians have part in the registration of workorders. The information gained after registration can be used for all three hierarchic levels, for short term and long term decisions. It goes beyond this introduction to treat this information in detail. Important examples of such evaluation questions are:

- object maintenance history for technicians ('which were the past failure reasons') and management (determining MTBF and the bathtub-curve)
- what did the team do for which money
 benefit / cost analyses, efficiency, competition with extern maintenance facilities
- planning of investments in the coming years
- planning of the maintenance capacity

For registration and evaluation written records may be used, as object logbooks. Registration of an inventory of all objects, including all relevant data, form indispensable basic information for good maintenance management. Computers⁸⁾ can help for inventory and workorder registration. On this base it can be used to answer evaluation questions. For complex processes and large amounts of data, computer evaluation becomes essential. Especially for cross sections of large information files, which mostly applies to information at strategical level. One side-mark has to be made: such computer evaluations are useful only if the basics of maintenance and well understood.

The description in this sub-section is based on an approach which departs from the maintenance team as initiator, which involves the rest of the companies organization. Another approach is the total productive maintenance approach (TPM), developed in Japan [Nakajima, introduction to TPM, 1988]. Maintenance is integrated in an organization-wide and continuous process of quality improvement, with high participation of the production employees. Because TPM is based on a combination of knowledge, skills and devotion of both management and employees, it can be implemented successfully only in organizations with a suitable stage of development and culture. Such organizations can be found in industrial high developed countries. In Tanzanian organizations, TPM is assumed to be not applicable.

⁸⁾ A functional computer application is a maintenance management information system (MIS), designed for maintenance registration and evaluation. Most MIS are used at operational level, using work orders as presented in figure 3.10. Others concern tactical / strategical level only, as many building maintenance packages do. Methodologies to choose and implement a MIS are briefly described by Kers [51] and more elaborated by Martin [Martin, on the determination of functional requirements in a maintenance environment, 1994]. Considering recent MIS implementations in Dutch organizations, I found them only partly successful. The introduction is mostly departed from management, overlooking the operational level. Without a strong involvement of the technicians, much of the management information becomes unreliable. An integral approach with a bottom-up implementation leads to better results.

from the maintenance concept to a model

determination of the maintenance concept

The maintenance concept is the central object-oriented issue related to PM. The question which actions are involved is a matter of experience and advice of the supplier of the object.

The question what the frequency of UBM should be, is answered mostly by taking standards which are used per object type. Standards advised by the object supplier are more appropriate, but mostly do not take into account the intensity of use and user-specific circumstances. Better is to determine the minimal costs frequency of PM, using the method illustrated in figure 3.8. But mostly it is difficult to determine the costs curves with sufficient accuracy. In such case, a practical method to determine the frequency of UBM is to use the failure frequency (MTBF-1) plus its standard deviation. This maintenance frequency should be adjusted for objects with large failure consequences.

This theoretical approach can be implemented successfully only if:

- the MTBF and its deviation can be determined with sufficient reliability this is only possible for large quantities of measurements: many objects of the same kind and intensity of use and / or long measurement periods
- the MTBF may only relate to those failures which could be avoided by undertaking PM

the maintenance process in a model

Because not all factors which affect the objects performance can be controlled, the MTBF varies. If on the longer term the MTBF increases or decreases, the UBM frequency for optimal costs changes. So, the frequency of UBM should be adjusted.

By doing this, the maintenance circle is closed. Starting at the formulation of the maintenance concept, PM is undertaken, varying the MTBF, with a feedback to the maintenance concept. This is the basic process of most maintenance models. A sophisticated one of them is the EUT Maintenance Model⁹⁾.

⁹⁾ This model focuses at an larger scale than micro-level: the designers of the objects are included as well. This results in a large feedback loop from failure evaluation to object design. The EUT Maintenance model is developed by the latest professor Geraerds. His research group Logistic Management Systems (LBS) is part of the faculty Technology Management of the EUT. The model can be found in [62] and many other publications.

3.3 Project appraisal - a methodology

The central issue in the appraisal approach is the electricity demand and supply. The demand projection for the project period determines the technical parameters the grid has to meet. On this basis a new grid design can be made. Its costs and benefits determine the project feasibility. Two approaches to determine the feasibility are used: the financial and economical approach.

The most unreliable elements used in the determination of the project feasibility are analyzed. The sensitivity of the feasibility is tested by varying these elements. Finally, the project features are described. This concerns emerging additional possibilities caused by the project, and the definition of bottlenecks which threats a successful project implementation.

All steps to pass are presented in figure 3.11 and explained below.

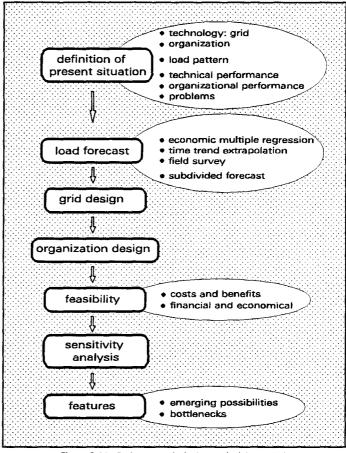


Figure 3.11 Project appraisal, the methodology used

other methodologies

Another methodology for electrification project appraisal is designed by van den Broek ^[16]. Principally, his methodology is comparable by the one applied for this research. Differences concern his socio-economic approach and the application to rural electrification instead of semi-urban grid improvement.

The methodology used by the World Bank (the Esmap study) and the Jica for grid improvement projects in Dar es Salaam differs significant from the one used in this research. This methodology is described in appendix L. Its results and the results from this research are compared in paragraph 3.4.11.

present situation

The condition of the grid and present supply capacity determine, together with the demand, the present performance of supply. At the supply side two aspects are distinguished: technology and the organization of it. Technology is embodied in the grid layout, divided into the different voltage levels. Organization mainly concerns maintenance and the relation with the consumers, both undertaken by Tanesco.

Interesting present load patterns are the daily and annual load curves of demand. Besides the power demand, the power factor is of importance. The geographical spread of the total load

over the area influence certain performance parameters as well: load at the end of a line counts more in the voltage drop than load at the beginning of the line does.

After describing the technology and organization, performance parameters of them are defined and, if possible, measured. Main technical parameters are the reliability of supply, the voltage drop and transitional switching voltages. Energy losses may be added to them as quality parameter. Because these losses do concern Tanesco and not the consumers, they are excluded here, but play a major role in the benefit / cost analysis. Organizational quality parameters are hard to define and quantify. Therefore they are described qualitative. Finally, the problems causing a shortcoming supply quality are described.

load forecast

To determine the load in the whole project period, a forecast of the future load has to be conducted. Three main load forecast methodologies are applicable:

- 1 econometric multiple regression
- 2 time trend extrapolation
- 3 field survey

These methodologies apply to all existing and potential electricity consumers, which can be divided into several groups according to their typical load features: households, industries, commercial activities, agricultural consumers, public services and other uses.

The econometric multiple regression is based on correlations between load determining variables such as incomes and prices and electricity demand in the past. Future demands are related to predicted growth of these variables. This method is only applicable if sufficient data are available.

Time trend extrapolation is principally based on data of past electricity use. It is applicable only if a history of demand exists, which allows reliable analysis.

Field survey is the methodology if the former two can not be applied. Existing and potential consumers are interviewed with a list of questions, in order to measure their present and future consumption. The future energy use form a main uncertainty in field surveys.

The choice which methodologies to use depends on the characteristics of the area. Mbagala has a history of electricity supply and records have been kept of individual consumer use. This enables the appliance of time trend analysis. Because factors brought about consumption in the past may change in the future, expectations of these factors are considered. Main factors are demographic and economic developments, the electricity price and consumer behaviour. To improve the forecast accuracy, a field survey is added for industrial consumers. This additional survey is required because the small number of industries and the instability of their electricity use do not allow time trend extrapolation.

An existing national econometric multiple regression which results have been applied at project level as well, is used for comparative purpose. Econometric regression can not be used because the econometric data required did not exist at all.

On the base of the load forecast and required technical parameters a grid is designed. All current technical shortcomings should be met. Within these conditions, aimed is at a grid at minimum costs and maximum benefits. The demographical growth in the area is taken into account. The urban development of Mbagala — with quantitative and qualitative aspects — form the starting-point for the grid design.

organizational aspects

The grid project requires adequate management. In the continuation phase, this is especially related to maintenance. Manpower and equipment requirements can be defined, additional to the current situation. Bottlenecks found in the description of the present situation have to be dealt with in the project appraisal, which may have organizational consequences.

cost / benefit and feasibility analysis

Once the project design is made, the costs and benefits can be calculated. The costs concern the execution of the project. The benefits are based on opportunity costs: what will be operational benefits and costs with and without the execution of the project. Costs and benefits can be determined from a financial as well as an economical point of view. Because costs and benefits mainly concern Tanesco, the feasibility for this company is decisive. Also some words will be attributed to the economical consequences¹⁰⁾.

An important element of the benefits are the marginal economic costs of the supply of electrical energy. The determination of these costs require a power market survey. If such survey has not been executed recently, it should be done as part of the project appraisal.

Long term projections in a rapid growing area as Mbagala can impossibly have a high accuracy. If the nature of the project does not allow detailed determination of costs and benefits, the projections are used to sketch the feasibility. This is a critical point in the appraisal phase: it gives the 'green light' to continue the project, or not.

So, the analysis is meant to indicate a direction concerning the project feasibility. Both costs and benefits are indicative, and not directly usable as tool for project implementation.

sensitivity analysis

The most uncertain factors to come to the final load estimation are varied in order to study the influence of the outcome. Resulting, a low and high growth scenario are made, based on different developments of Mbagala and different economic growths.

project features

The renewed grid opens possibilities to electrify surrounding areas. These possibilities and their impact on the project are sketched.

The economical feasibility is of relevance because the government is concerned as well. Tanesco acts under the authority of the Ministry of Water, Energy and Minerals.

3.4 Project appraisal - the elaboration

The elaboration follows the methodology described in paragraph 3.3. First, the area of research is defined. Next, the definition of the point of departure, the present situation, is described in paragraph 3.4.2. Thereafter, the electricity demand in the project period is estimated with the help of load forecasting techniques in paragraph 3.4.3.

Based on the most likely load scenario, an optimal grid design is presented in paragraph 3.4.4. This includes calculations of technical parameters to determine the performance of the grid with and without the project undertaken. On this base the project benefits are determined. Together with the project costs, we come to the project feasibility parameters in paragraph 3.4.5. The most uncertain factors used to determine the project feasibility are varied to know the sensitivity of the final outcome. At last, some features of the project design are discussed.

3.4.1 Definition of the research area

The area supplied by the two feeders in the south is larger than Mbagala. The suburbs Temeke and Mtoni are included as well. Initially, the whole area should be subject of study. After a first analysis of the load situation it appeared that the whole area, which is extremely large to be supplied by single feeders, should be split up. A division into Mbagala and, at the other side, Temeke and Mtoni, seems to be the best choice. This split up is done at the half of the load: both areas are expected to have about the same load in the project period. For this reason, Mbagala was selected as area of research. Temeke and Mtoni were excluded.

3.4.2 Description of the present situation

The definition of the starting point of the appraisal phase concerns two major aspects: the current state of technology and the organization of it. Started is with a description of the organization of the electricity supply. The maintenance aspect is elaborated. The rationale to stress maintenance is based on the results of the elaboration of the problem definition, presented further in this chapter.

Technology relates to the electricity grid. The layout and load of the new grid are discussed in paragraph 3.4.2.2 and 3.4.2.3. The performance of the grid is described in paragraph 3.4.2.4. This includes the quantification of the main quality parameters and identification of underlying bottlenecks. Finally, some words are attended to the actual phase of the project. This is related to the practical relevance of the study.

The descriptions are based on information obtained from data collection. Most figures come from different Tanesco departments. Lacked data were added by doing own measurements ¹¹⁾. For organizational descriptions interviews were held in a discussion form.

The information required was not easily to collect. This was caused by non-structured data management at the offices concerned and the different parties involved within Tanesco ('everybody has something, nobody has everything').

3.4.2.1 the organization

The planning of distribution grids is carried out by the department of Distribution and Commercial Services at the Tanesco Head Office in Dar es Salaam. This department investigates the performance of distribution grids all over the country and designs grid improvements where necessary.

The regional offices control the operation of the distribution grids. For the feeder in Mbagala this concerns the Temeke Regional Office (Temeke-RO) in the district Kurasini. This office controls the small substation Kurasini with its feeders and takes care of the electricity supply in the southern part of Dar es Salaam. This mainly concerns meter reading of customers, construction of new connections and solving of grid faults. Also the control for low voltages at supply level and measuring of the transformer loads are part of their responsibilities. Grid calculations are not made by this office. If new projects concerning the area are executed, the regional offices are involved mainly in the execution phase.

Donors mainly are involved at individual project level, in which they finance and advice. Mostly this concerns all project phases, except of the continuation. Many times the donor requires a role of subcontractors and the use of components from countrymen companies.

the organization of maintenance

A maintenance team of the Temeke-RO works in shifts. This concerns corrective maintenance: with a truck the team solves faults. At the Temeke RO an urgency post is manned continuously, to receive information and inform the maintenance team.

Recently, a programme for preventive maintenance for Dar es Salaam was set up: the Dar es Salaam Power Distribution System Maintenance Project (Damp). Damp is a program embodied by a maintenance team, located in an office at the Msasani substation area, north of the town centre. It was established at the end of 1995 as part of Tanesco, with support of the Jica, and is intended to last till 1999. Damp aims to improve the poor condition of the distribution feeders in Dar es Salaam, and to keep it in a good condition afterwards.

Damp has its place in the diagram of regional electricity organizations in Dar es Salaam, as presented in figure 3.12.

Communication between Damp and the regional offices exists mainly of failure recording to Damp and regional requests for technical assistance from Damp in case of main feeder problems. Distribution experts from the Zonal Office and regional staff members form the Power distribution sys-

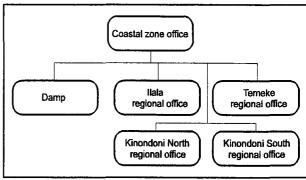


Figure 3.12 Organization diagram with Damp

tem maintenance committee. It is set to aim at co-ordinating various issues related to Damp, as proposal approvals, discussing and monitoring plans.

At Damp's start in 1995, curative maintenance was structured, but preventive maintenance was hardly ever undertaken. To establish a well working system, it had to be built from the fundaments. Therefore, a schedule was set up, including four phases:

1. Construction of an inventory of objects of all 56 feeders in Dar es Salaam One object type is invented: the poles

Variables per pole are:

- pole number
 - a plate with unique code is fixed at the pole
- type of insulator connection
- eventually added strength lines (edge poles)
- eventually added transformers with capacity
- eventually added load breakers
- distance to next pole
- 2. The first preventive maintenance round, including all objects

At the time a pole was listed in (1), the state of the poles and related components were inspected and recorded. Depending on these results and feeder load data, the feeders were ranked according to their condition. The feeders in worst condition were scheduled for repair first.

- Regular PM
- 4. Introduction of a MIS (maintenance information system)

Because of the huge amount of overdue maintenance accumulated before Damp's start, phase 2 required a mound of work. At the end of 1996, this was the actual project phase.

Damp contains an inspection and a maintenance team, 22 employees together. Including engineers, other staff, drivers, guards etcetera Damp has a workforce of 40. The organization diagram is presented in appendix N. The two maintenance activities, inspection and repair, are separated in an inspection team and maintenance team¹²⁾.

Engineers and technicians from Damp are 'borrowed' from the regional offices. In 1999 they will return. This construction is used to obtain a good transfer of knowledge. Training is a main aim of the project. For example, 14 linesmen of the maintenance teams are trained on-the job by two Japanese linesmen for a period of two years.

¹²⁾ In fact, the maintenance team on itself performs CM, with the inspection team as reporters of failures. But because of the close co-operation, the teams may be considered as one unit, performing PM.

The actions and information flows involved in Damp's work are presented in figure 3.13. This figure concerns the operational level. Construction of PM schedules and reports from data evaluation are examples of tactical actions. Design work and planning concern (i) the set up of a maintenance proposal, approval of it by the Zonal director, design and prepatory work and (ii) public notice of power interruption, co-ordination with regional office plans and the arrangement of equipment and materials.

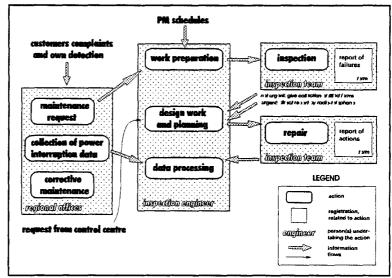


Figure 3.13 Maintenance by Damp: actions and information flows

The maintenance concept for regular PM of a feeder consists of a fixed frequency of three inspections per year. The defined actions consist of visual inspection and collection of feeder load data. Visual inspection concerns the pole quality (rotten, standing straight), arms and insulator quality, for which a binocular is used. For line edge poles it includes the strength of the support line, if a transformer is added a visual transformer check, load measurement and earthing resistance (with lower PM frequency), and a visual check of the circuit breakers if they are added. The load data of the feeders are obtained from the Zonal Office, which measure the 56 feeders for one day each. This is done by the placement of logging meters in a substation.

3.4.2.2 the grid layout

The grid can be divided into feeders, transformers and low voltage networks. These subdivisions are explained below.

medium voltage grid

Mbagala is supplied by a medium voltage line from the 33 kV / 11 kV substation Kurasini. The feeder with the distribution transformers is presented in figure 3.14¹³⁾. The line is designated as K3-feeder or Kr3-feeder. The K stands for Kurasini, 3 means the third feeder from this substation. This feeder is also denoted as Kilwa feeder. In the report the abbreviation K3 is used. Next to the K3 feeder a second line is added to supply the factory Tanzania Sheet Glass, which is the K5 feeder. Since Tanzania Sheet Glass is out of production this feeder is almost not in use. In 1992 and 1996 only three industrial transformers were connected.

The lengths of the line between the branches are presented in appendix P.

The total area supplied is 22 squared kilometres, which is the largest area fed by an 11 kV feeder in Dar es Salaam.

Both feeders are designed for a voltage of 33 kV, but the operational voltage is 11 kV. The conductors are constructed overhead, for which wooden poles are used.

Data of the conductors are:

- iron reinforced aluminium conductor with a surface of 100 mm²
- resistance of 0.34 Ω per kilometre
- inductive reactance of 0.385 Ω per kilometre¹⁴⁾
- a fixed voltage point of 11 kV at the beginning of the feeder (autotransformer)

The poles and conductors are made and delivered by Tanzanian companies.

transformers

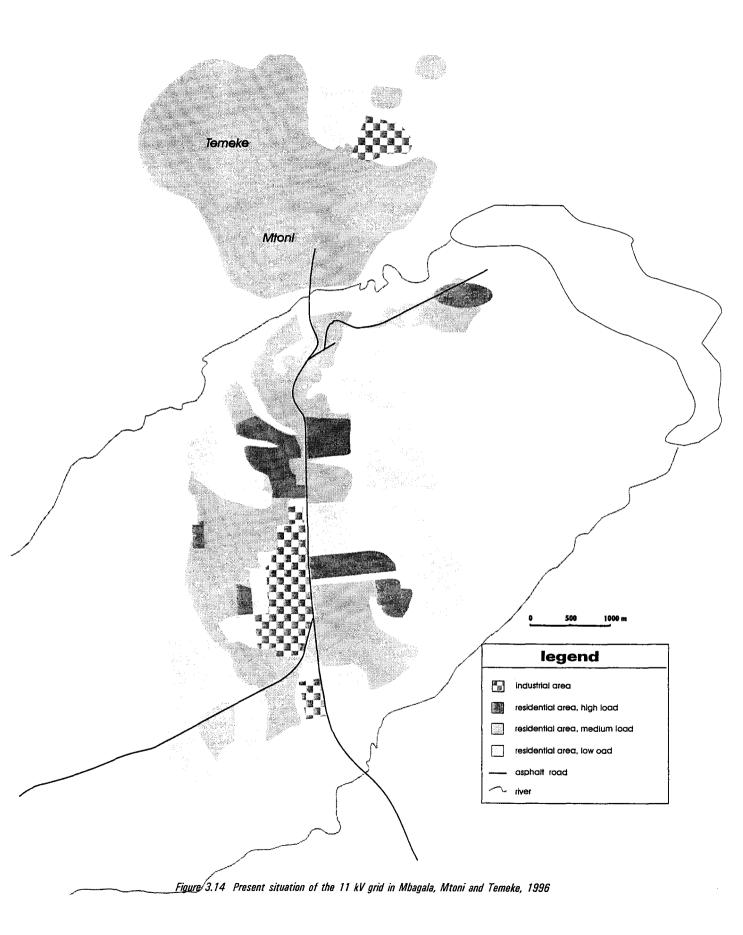
In Mbagala 30 distribution transformers are connected to the poles. In Mtoni and Temeke it concerns 29 transformers. Two transformers were recently added at the new southern extension. The capacities of all transformers range from 100 kVA to 500 kVA each, plus four 800 kVA transformers of Tanzania Sheet Glass. The primary and secondary windings are connected in star-star. The transformers are assembled and delivered by Tanelec, a Tanzanian company.

low voltage grid

The three phase part of the low voltage grid consists of 50 mm² aluminium reinforced steel conductors. Single phase customer lines are constructed of 25 mm² conductors. All lines are constructed overhead.

New consumers have been connected to existing single phase lines without adequate planning. If each connection is added without considering the total layout of the local low voltage network, the structure of the total shifts further away from an optimum situation. It results in irrational network structures, with many branches connected after each other. Also, transformers are asymmetric loaded, causing extra energy losses in transformer and conductors. This situation does not concern the industrial area, where transformers are placed close to the industries.

The impedance data obtained agree with standard values. With the formula $X = \frac{X}{2 \times \ln \left(\frac{d}{d} r + 0.25\right)}$ a control of the inductive reactance is made, resulting in a value of 0.33 Ω per kilometre. The distance d between the phases is about one metre, above each other.



3.4.2.3 the load of the grid

The load is of relatively low density. About 30 percent of the houses in Mbagala is supplied with electricity. All industries, restaurants and bars are connected.

The peak load of the K3 feeder in 1991 usually was around 3.6 MW. Only one complete daily load curve was available, added with incomplete measurements from 1993. That year I measured at the Kurasini substation to control for the peak load. ¹⁵⁾ In 1994 Tanesco relieved the worsening overload of the feeder by connecting the grid to another feeder as well, namely in Temeke. The amount of this additional energy supply is not known. Therefore all daily load measurements during this situation are not comparable to former measurements.

The daily load curves are presented in figure 3.15. The peak load occurs around eight o'clock in the evening. In 1993 the height of it correspondents with a load of 5.0 MW¹⁶⁾. The dotted curve is added for illustrative purposes, it does not have comparative significance. In July 1996 the peak load for the whole area would be around 7.6 MW, in which Mbagala had part for about 2.8 MW. These values include line losses, which contribute for about 9 percent. The power factor has been about 0.9. The load curve has a load factor of 0.56. The loss factor is 0.37.

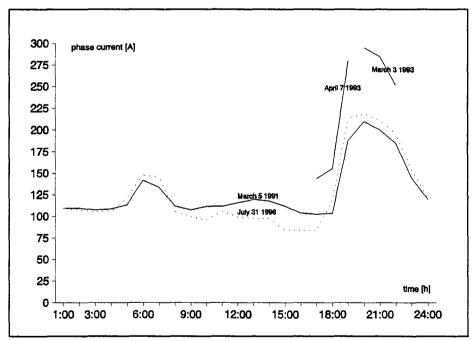


Figure 3.15 Daily load curves of the K3 feeder

The load of the K3 feeder is not measured at the main control centre at Ilala, which means that the curve has to be measured at the unmanned Kurasini substation. Usually, the Zonal Office undertakes the measurements and uses a logging meter it owns. Because I could not obtain such meter, the presence during the whole measurement was required. After permission to enter the substations, the values of the load were measured every half hour and every quarter during peak load.

The power factor is not measured. Besides the current of each phase only the power of all feeders together is measured in the substation. I estimate the power factor at 0.9. This is a common value for residential dominated load. The feeder load is not compensated by capacitors.

Households form a dominant part of the load. They determine the peak load, at a time that nearly all industries stopped production. People put on their lights when darkness starts, around half past six in the evening. Lighting is a main use for most small consumers. Other applications such as cooking and refrigerating are used by a few high load consumers. The small morning peak is also caused by residential load. Most people wake up early, just before six when the sun rises.

To know the amounts of energy used by individual consumers, data of the billing system were analyzed. The bills are ranked in sequence of the consumers account-number. Mbagala concerns account numbers from 06.55 to 06.79, forming 23 sub-groups. These were taken as strata, from which 20 were taken samples Noted was the account number, vear of connection and the average monthly energy use from February 1996 till and including July 1996¹⁷⁾. quantities of energy the consumers used in that period are

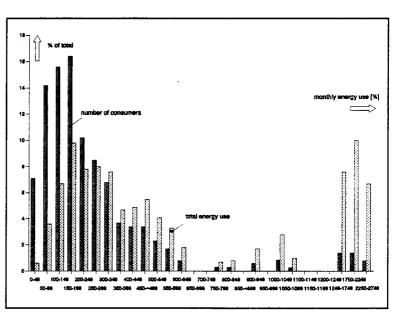


Figure 3.16 Consumers in Mbagala, categorized to energy use, Feb.-July 1996

given in figure 3.16. The average monthly use in that period was 283 kWhr a month¹⁸⁾.

The main industrial activities are small scale enterprises as grain mills and small workshops for car maintenance. The industrial area in Mbagala contains only four full operational industries. The two largest industries do not produce. Two industries start up, the most others are produce irregular. Together, the simultaneous load during production hours is estimated at 300 kW, or 30 percent of the total load at that moment.

The commercial load exists mainly of refrigerators and lighting in restaurants and bars. Their number is relatively small, by which they nearly do not influence the total load.

The residential domination and relative small industrial load of feeder K3 is shown by the large difference between the peak load in the evening and the load during working hours. This difference results in a load factor of 0.59. Over the year the load differences in Tanzania are marginal. In weekends and public holidays the load is somewhat lower.

⁹⁶ out of the 450 consumers included one ore more months with estimated values. 39 consumers were connected after February 1996, by which less than 6 energy values were available. All these consumers were excluded from the analyses. The sample was supplemented instead. The occurrence of estimated data and typing errors make automatic computer processing unreliable: all data have to be controlled visually.

The categories above 1250 kWhr all concern consumers from Mtoni Kijchi, strata number 06.57. In the early 1990's the National Bank of Commerce built middle income houses for their personnel there. Without them, the average use in Mbagala would be 245 kWhr per month.

bias by power cuts

The load in the period 1992-1995 had been affected by power scheduling. Certain industries got financial problems due to a decrease of production, caused by power cuts. Some of them stopped production. Others would utilize the periods with electricity supply optimally, by which their load in periods of supply increased. A clear influence on the household use did not take place. The load of refrigerators used in bars and restaurants probably increased, because at every power cut they have to start up. Thus, the daily curve has been affected and probably increased by the power rationing. However, the total energy delivered decreased (as shown in figure 1.13 at page 20).

The peak load measured during the load scheduling period in March 1993 is 295 amperes, while the peak load in 1991 was 210 amperes. In what extent this increase is caused by the power scheduling is unknown. The load in case of a continuous supply is estimated at 275 amperes for 1993. This value is used as a starting point for further calculations.

transformer loads

As shown in figure 3.14, the grid contains 56 distribution transformers, of which 28 in Mbagala and 28 in Temeke and Mtoni. 19 of the latter are part of two simple straight-form networks.

The most critical voltages concern the transformers at the end of the feeder in Mbagala, with residential loads. They have the highest voltage drop at peak load time.

The load of some transformers and some locations where low voltages occur are known at the Kurasini office, but an overall overview is not available. Data of the peak load of 24 transformers were obtained from the Tanesco office in Kurasini. They were measured in December 1990, for which maximum ampere meters were used. These transformer load data are not recent enough to use. Additionally, I measured part of the transformer loads in 1993¹⁹⁾.

For the calculations a symmetric load of the three phases is assumed. In fact, the transformers are not symmetric loaded, causing extra transformer losses. But the accumulation of all transformer loads results in nearly equally loaded feeder phases. Therefore the assumption is justified, as far as the calculations do not include the transformers and low voltage grids.

⁹⁾ A meter with ampere tongs from the Zonal Office could be used and an engineer with a car and ladder could be arranged after three weeks delay at the Head Office. Seven transformers were measured at April 24th, 1993, from 20:00 to 20:45. At this day the load scheduling was no longer used.

3.4.2.4 the performance of supply

The purpose of describing the present performance of supply is twofold. First, the important quality parameters have to be known, in order to determine whether the quality of supply meets the standard criteria. Preferably, the quality parameters are quantified. Secondly, the reasons for shortcoming supply quality are identified. These problems have to be considered when formulating the project proposal. Solutions should be found to tackle the problems, or they should be avoided. Otherwise, they may become bottlenecks for a successful project implementation.

As presented in paragraph 3.3, the main parameters determining the technical performance of a distribution grid are:

- reliability of supply
- voltage level
- transitional switching voltages

The major underlying organizational aspects were identified by research. These are:

- the communication with different parties involved
- the relation with consumers
- maintenance
- quality control of incoming materials

Both the technical and organizational aspects are discussed below.

reliability of supply

The unreliability of supply can be expressed in a percentage of the time that the electricity supply is cut off and the average amount of these cuts per month. The cuts can be categorized according to the voltage levels where the failure occurs: generation level, transmission level, medium voltage distribution level and low voltage distribution level. In Mbagala, by far the most cuts are caused at generation and distribution level.

generation level

Since 1992 periods of severe water shortage in the hydro power reservoirs have occurred. This concerns the dry periods, which intensities are variable from year to year. As soon as the water level in the dams decreases and minimum levels are expected to be exceeded, Tanesco is forced to launch power shedding schedules. It means that all over the country, areas are cut from supply for announced periods.

In 1992 load sheddings amounted for about 10 percent of the total electrical energy generated. In 1993 the situation even worsened, especially in the period from February till May. An example of the load shedding in Mbagala is presented in table 3.1. The periods without electricity supply are dark coloured in the table.

	Febr March 1993	April 1993		
day	5:00-17:00 17:00-5:00	5:00-17:00 17:00-5:00		
monday				
tuesday				
wednesday				
thursday				
friday				
saturday				
sunday				

Table 3.1 Load schedule for the K3 feeder, Feb - April 1993

The load scheduling was not executed accurately, especially in its first months. Often electricity was not supplied in times where it should be. Only at public holidays electricity was supplied uninterrupted all over the country.

The energy shortage is caused by a shortage of system capability. While the capacity is sufficient to supply peak demands, the total energy reserve can be exhausted. In Tanzania the risk of energy exhaustion is mainly determined by two factors: the draught and the spread of risk in generation. Draughts occur in all of East Africa. The intensity of individual droughts are unpredictable, but historical long term patterns can be taken into consideration for expectations for coming years. The spread of risk depends on the number of power plants and the different energy sources they use. Tanesco still depends on two hydro power stations, both fed by the same river sources (see chapter 1).

Additional factors are frequent maintenance of turbines and the simultaneous character of the droughts in surrounding countries, whereby spread of risks by imports and exports are not applicable.

To combat the dramatic situation, in 1994 Tanesco installed diesel generators in the north of Dar es Salaam, with a capacity of 100 MW. These generators are able to run full time. Although they relieve the situation, it is not sufficient to prevent energy shortages. In the second half of 1997 severe load sheddings were required again. The situation is expected to improve as soon as the next power station (Kihansi) is put into operation, which was planned for 1997.

distribution level

At distribution level the power is mainly cut due to faults and maintenance, of which the former is dominant. Records have been kept since Damp started to collect feeder fault data in 1996. But it is impossible yet to give reliable estimations of the number of faults per month and the duration and reason of them. For the K3 feeder this probably concerns about three faults per month, resulting in about five hours of power cut.

No records have been kept of faults at low voltage level such as short circuits, burnt transformers and burnt security devices.

the voltage level

No measurements of critical voltage levels were available. The regional offices are not used to control for voltages at customer side.

The lowest voltage levels were calculated. Basic data used are the total peak load and spread of it over the different transformers. Industrial production times and load were obtained from the industrial survey (chapter 2). Furthermore, the grid layout including impedance values could be collected.

For the calculations, the conductor data (§ 3.4.1.3) and grid layout data were used. These data are valid for proper built and maintained feeders. At several places it appeared that connections of two conductor ends at a pole were not clasped with a connection cable, but wired. After time these connections oxidize, resulting in increased contact resistance. This means that in practise the voltage level will be worse than the calculated one.

Calculations with a load flow programme²⁰⁾ resulted in a maximum voltage drop at the primary transformer side of 13.6 percent in 1996 if the feeders are supplied from the Kurasini substation. This exceeds the maximum value allowed of 6 percent by far.

transitional switching voltages

The power switches of the K1 and K3 feeders are not controlled for switching at the moment the sinus of the current is zero. High voltage swings occur. An example of the consequences of this phenomenon is the damage of computers.

The character of transitional switching voltages basically differs from other grid problems. Although they are worth to study, I did not collect data of these voltages²¹⁾. The assumption was made that in case of replacement of the switches, the next ones chosen should be automatically controlled for switching at the current zero.

relation with customers

Meter reading, billing and dealing with complaints, questions and requests for new connections are main aspects of the relation with consumers. If a periodical energy value is not known (by forgotten measurement, unreliable meters, errors in the data communication, etcetera), the value is estimated by Tanesco. About 20 percent of the bills show such estimated values in one or more months, for a total period of half a year. This is a high figure. Whether this depends on the meter reading, bill processing or communication in between, is unknown. Dealing with complaints, questions and requests deals with customer-kindness and the good name of Tanesco. Since Tanesco operates as a monopolist in the electricity market, this seems to be an unimportant issue. But customers can function as quality indicators. By reacting on their instructions not only abuses can be solved, but also grid faults, making them part of the maintenance organization. The communication with

For grid calculations the loadflow programme KBRAD was used. This program is chosen because it is designed for simple grid calculations, relatively easy to use and already available and used by Tanesco.

Such data is not available, they have to be measured. As far as I could retrieve, measurement equipment for switching phenomenons with extreme short measurement times is not available in Tanzania.

consumers seems not to be taken very seriously by the Tanesco emergency and maintenance employees: it is not part of the company culture.

maintenance

The regional offices, of which Temeke RO is one, are the providers of maintenance. An integrated combination of CM and PM belongs to their main tasks. However, PM has hardly been undertaken. This can be attributed to the quantity of CM work, related to the poor state of the grid. One can speak of a vicious circle. Lacking aspects to break out of this circle are a vision of maintenance management, maintenance culture at all job-levels and financial restrictions²²⁾. The situation did not improve last years. However, the start of Damp and the prospect of transfer of knowledge is promising.

Another problem indicated is stock management. There has not been a systematic exchange of information about stock keeping. Complete surveys of actual stocks were lacking. It often happened that useful stocks were kept at substation areas without central knowledge of their existence. Recently a store system project started, executed by a private consultant. The integration of stock keeping with maintenance management is the main feature of this project.

quality of incoming materials

The quality of materials for grid maintenance and expansion is not always good. Cables are easy to control with standard procedures, but cross-arms and insulators are not. To improve quality control, a quality testing programme was set up. Samples of the delivery are sent to Tanesco's department of Distribution and Commercial Services. Those are sent to the Tanzanian Bureau of Standards (TBS) and the university institute Bico. There the samples are tested. Still, complaints and doubts about the quality remained. This mostly concern locally produced materials.

communication with different parties involved

As presented in paragraph 3.4.1.2, the main parties involved are the Temeke Regional Office, the Zonal Office, the Head Office, control centres, Damp, the Jica and consumers.

Related to maintenance, two central communication centres exist: the Temeke Regional Office and Damp. Information needed for PM is collected at Damp, eventually via the Zonal Office. The latter concerns feeder disconnection initially reported at the Temeke office and maximum load data measured by the Zonal Office. Information for daily operation is collected at the Temeke Regional Office. Examples are consumers complaints and local grid faults.

The latter reason requires annual budget choices. In years with tight budgets, the items with long payback periods are usually the first to be dropped. PM can be such an item. This problem can be relieved in good financial years. If those years do not come, PM forms a structural problem.

In fact, the communication flows and actions concerning both CM and PM are much related to each other. The separation in two independent organization structures finds its justification in the need for a whole new approach and project establishment for PM. It includes that communication between Damp and the regional offices is important.

The situation that none of both organizations is responsible for the performance of the distribution lines, is undesirable. Principally, PM and CM of the same objects can not be separated.

A main shortcoming in the communication between different parties concern the availability of information. Not one of the parties involved owns all information related to certain feeders. Most rational, the centres of information concerning distribution feeders are the regional offices.

Concerning the grid project in Mbagala, the communication between Jica and the Temeke regional office is poor. The office is not informed about actual project steps and has hardly been involved with the project preparation.

summary of performance

The main quantifiable problems are the technical shortcomings of the grid, especially the voltage level. This is caused by the underdimension of the grid.

The main underlying problems concern the organization of maintenance. The development of structural maintenance is the major organizational issue, and should be included in the project proposal.

In this respect, the Damp project is promising. The co-operation between Tanesco and Jica resulted in well organized PM. Attention should be paid to communication and co-operation with the regional offices, to introduce the latter ones in their role as responsible party for maintenance. The integration of CM and PM is a point of attention.

Communication between different parties is not well structured. Especially the co-operation between the Jica and Temeke Regional Office has been poor.

When the local supply will improve after the project implementation, the periodical power rationing can worsen the results achieved. In-depth study of this national problem could, however, not be included in this research.

3.4.2.5 the current project stage

As part of the preparation of the project definition phase, the Esmap study had been executed together with Tanesco engineers in 1992 and 1993. All design and planning activities were undertaken by the Japanese organization. In 1994 the substation and rough feeder design were presented. The project stages up to implementation were executed by the Jica. The project recently started its implementation phase. Construction of a new feeder and substation will start in 1997 / 1998.

significance of this project elaboration

The actual passing of the appraisal phase is significant for the relevance of this study. The elaboration with its recommendation for grid design in Mbagala will be useless for Tanesco. On the other hand, the methodology of project appraisal is applicable for further projects. It shows significant differences with the method used by Jica. Also, aspects of the project elaboration results for the Mbagala case can be used for the continuation phase.

3.4.2.6 summary of results of present situation

grid layout	two 11 kV distribution feeders with too long length (10 km) see figure 3.14
load	peak load supplied feeder area, 1996: 7.6 MW
	peak load Mbagala, 1996: 2.8 MW
	peak load at 20:00, residential load
	$\cos \phi = 0.9$
	LF = 0.56
	LS = 0.37
performance	voltage drop = 13.6 %
	poor reliabilty, mainly a national problem
	transitional switching voltages need attention
performance	maintenance, especially PM
related problems	communication between parties

summary of the present situation and the performance of supply in Mbagala, 1996

3.4.3 Load forecast

As presented before, the basic three forecast methodologies applicable are:

- 1 econometric multiple regression
- 2 time trend extrapolation
- 3 field survey

The utility of these methodologies and their elaboration are discussed below.

3.4.3.1 economic multiple regression

macro economic approach

For different countries, the World Bank conducts forecasts of the GDP on macro-economic level. This was used by Acres to conduct a load forecast for the period 1993-2002 ^[2]. The growth in GDP was translated into growth of electricity demand, basically using the price elasticity. Several other factors were taken into account by estimating them: (i) demographic growth, (ii) electricity losses and (iii) history of sales, connections, consumption, tariffs and load shedding. For every of the eight consumer categories as used by Tanesco, a load forecast was conducted.

The World Bank estimated the economical growth for 1993-2002 at 7.4 percent per year, including 7 percent industrial growth²³⁾. For the period 2003-2014 this concerns a figure between 8.7 percent and 9.8 percent. This resulted in an annual sales increase of 9.0 percent for the period 1993-2002. As part of this figure, residential and light industrial annual growth was estimated at 9.3 and 10.7 percent respectively.

With this forecast technique an impression of the load growth can be obtained, to serve as indicative information for strategical decisions at national level. For example, to set up a preparatory framework, before projects are identified. An advantage of this technique is the rapid execution: two staff members did it in three weeks.

However, the resulted data do not apply to individual projects. Furthermore, the relation between GDP and electricity use may be causal, but there are other factors influencing the electricity use. For example, economic liberalization resulted in a sharp increase in the sell of new electrical appliances, which hardly could be predicted.

economic approach at project area level

The technique used for the macro economic forecast can be applied on project level as well. Instead of a country, the project area is the subject dealt with. Application to Mbagala results in the need for reliable data of incomes, income projections and price elasticity of electricity. Not any of these data were available. To obtain these data, a household survey would be required. The reliability of the results of such a survey are doubtful, especially related to income projections and the satisfaction of the price elasticity as sole factor. Also, it is difficult to produce time series with statistical significant results. For these reasons and the availability of other techniques, a household survey was not conducted.

²³⁾ In 1994 the World Bank updated her old projections which were presented in *Tanzania Economic Report, 1991*.

3.4.3.2 time trend extrapolation

For areas with a history in electrify use, load trends of the past can be analyzed. On the basis of these historical data combined with a demographic projection, the load forecast can be worked out. The analysis is executed at micro level: the individual consumer. The basic data source form consumer registration by the electricity company²⁴⁾.

First, consumers are ranked according to their specific nature of electricity use. For Mbagala these are:

- 1. households
- 2. industries
- 3. commercial activities

An estimation of the relative relevance of these three indicates the importance of the forecast analysis of each. In the industrial survey (chapter 2) the load of each industry was analyzed. Compiling these loads, taken into consideration aspects such as the individual and the co-operative load factor and the power factor, we come to an estimation of 10 percent of the total load. Commercial activities (bars, restaurants) concern less than 5 percent. Because this small influence does not allow much study effort and the load probably will develop similar as the household use will do, commercial activities are incorporated in the household analysis²⁵⁾. Residential load is dominant with a share in load of about 85 percent. It is analyzed below.

household analysis

For time comparative analysis, data were used from 1993 and 1996. The laboursome character of data collection required selective choices.

The basic data are formed by the information from the bills of all 1,271 consumers connected in June 1993 and of all 3,300 consumers connected in July 1996. The consumers are ranked in the billing system with account numbers starting with 06.55 up to 06.80.

Two patterns²⁶⁾ determine the load forecast. Those are used as determining forecast actions A and B, supplemented by a third action C:

To calculate the consumer bills, monthly data of the electrical energy use of every consumer are recorded.

In 1996 compared to 1992 / 1993, some new bars were established already, including some more urban-like ones which sell fresh milk. Continuously working refrigerators demand relatively high loads. However, this fits the urbanization trend, including significant residential load increase which is shown in this paragraph.

To obtain an overview of all variables of influence, an Ishakawa diagram was constructed, presented in appendix P. The final determinants in this complex model are used in my approach. At page 121, they are subdivided the groups A and B.

determine:

- A. increase in use of existing consumers
- B. change in number of consumers
 - new ones
- existing households still not connected including backlog connections of consumers
- new households in the area
- households in another area reached by future system expansion
- leaving ones
- disconnection of households
- move of households
- C. considerations and adjustments

approach to forecast the household load with time trend extrapolation: actions

The forecast actions A, B and C are elaborated below.

A. increase in use of existing consumers

A final sample of 122 consumers which were connected to the grid from 1993 to 1996 resulted in the consumption values included in table 3.2. Rows of energy data containing one or more estimated values or errors were excluded from this sample.

			annual increase
average monthly use [kWhr]	294	439	12 %

Table 3.2 Increase of individual use by Mbagala residents, Jan-Jun 1993 and Feb-July 1996

B. increase in number of consumers

The annual amount of new connected households is presented in figure 3.17²⁷⁾. The figure gives a striking increase of new connections since 1993. This has been about 20 percent of the total number annually.

Leaving households are excluded in the figure. They do have influence if their house will not be used by new people or if the new households use other amounts of energy. However, this influence is expected to be low.

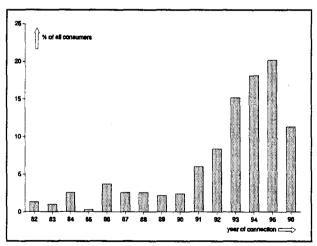


Figure 3.17 Years the consumers were connected

⁽¹⁾ This figure include the year of connection of consumers registered in July 1996. This means that consumers connected in one of the former years and disconnected afterwards, are not included in the figure.

⁽²⁾ The figure for 1996 concerns the first half of the year only.

Households in areas outside Mbagala which eventually can be connected by future grid expansion, are excluded for the time being, because estimations are too speculative. Possible new load of importance may concern the village Kongowe south of Mbagala, if it will become a growing centre.

In October 1996 the backlog list for Mbagala counted 313 applications²⁸⁾, which already paid the connection fee. Connection is expected to take place in two months.

C. considerations and adjustments

Considerations and adjustments concern a control of the projection results. Future demographic variables can be estimated roughly. By doing this, the time trend extrapolated for number of consumers can be controlled. The likelihood of the extrapolation made of the individual consumer growth can be considered as well. Main factors of influence which may change are the electricity price and consumer behaviour. Furthermore, striking differences between consumer groups may cause deviating load divisions and load growths.

use of existing consumers

The annual load increase of 12 percent can not be controlled. Income trends are not known. The assumption of an income elasticy of 0.8 for electricity results in an average annual income increase of 15 percent, which is unlikely high. Other factors than income elasticy might justify the 12 percent increase. Whatever these factors are, a 12 percent growth might be assumed in a transitional urbanization phase, it is unlikely high for a structural increase. A drop to a 6 percent growth after 3 years is more likely.

number of consumers

The percentage of households connected to the grid can be obtained by dividing the total number of consumers by the number of houses. This implies the assumption that one house, with two households living in it, has one connection. For 1996 this gives: 3,300 divided by 13,000 is 25 percent²⁹. 1990 figures for the three regions of Dar es Salaam give values of 37 percent (Kinondoni), 40 percent (Ilala) and 26 percent (Temeke), which would have been increased for 1997. Based on information from surveys, the World Bank estimated the connection rate for the whole city of Dar es Salaam at 50 percent for 1992. All these data show an arrear in connections for Mbagala of some 15 percent of the total population, compared to other suburbs.

One may discuss the relevance of taking the backlog data apart, because such a list always has existed. These backlogs are just part of the annual number of new connections. However, the backlog list does not necessarily remain a constant length, it is expected to decrease. The date the consumers of the 1996 backlog-list applied vary from 18-5-1993 to 15-10-1996.

²⁹⁾ This contradicts with the figure of 34 percent derived from a socio-economic survey held in 1996.

Mbagala is a rapid growing area, with migration from the town and rural areas. Main expanding living areas for the coming period (assume 10 years) are shaded in the map in appendix E. Growth figures are hard to give, because only one population sensus had been conducted in 1988, which reliability is doubtful. Comparing an estimation for 1996 with that sensus gives an indicative figure for the population growth of 10 percent annually (from 59,400 to 140,000 in nine years, for both Mbagala and Charambe).

For figurative purposes the following calculation and assumptions were made: Assume that Mbagala will become more urbanized in the next ten years. Urbanized suburbs have connection rates of around 40 percent now, which figure has increased and will continue to increase. An estimation of a connection rate of 50 percent for the year 2007 seems to be justified for Mbagala. At the supply side we may assume that grid improvement and extension will be carried out, enabling to supply the increasing demand. The number of households in the year 2007 will be around 34,000, based on a number of 13,000 in 1996 and an annual growth of 10 percent. So, the number of consumers in 2007 will be 17,000. This means an annual consumption increase of 18 percent. This supports the time trend result of 20 percent growth, presented before.

electricity price

The demand of electrical energy is related to the electricity price. The relation between price and demand, expressed in the electricity price elasticy, is not exactly known. As presented in paragraph 1.4.3, this price elasticy is low. A survey for Dar es Salaam gave a figure of -0.12.

In the period 1993-1995 the price was adjusted for the real marginal costs of generation and supply of electrical energy. Except of the tariffs for small use, households pay a market-conform price. Corrected for devaluation of the Shilling, this meant a price increase of about 200 percent in three years. A residential consumer pays about 3.7 dollarcents for monthly use below 500 kWhr and 11.7 dollarcents above. Price changes are not expected any more, within the project period.

But extrapolation of figures from before 1993 has to be adjusted. On average, the price for households, corrected for inflation, doubled since that time. So the use will probably de-crease by about 20 percent. For this purpose the annual demand growth by existing consumers is adjusted from 12 to 10 percent the first three years and from 6 to 4 percent in following years.

Another component of the electricity price is the connection fee. In the years before 1995 this fee amounted to Tsh. 35,000,-, which had significant influence on the connection rate in supplied areas ^[16]. Identified as a set-back for Tanesco's income generation, this connection fee was decreased to Tsh. 15,000. For the load forecast it means that more low income households will apply for an electricity connection. It will increase the total connection rate. So, the estimated 50 percent for the year 2007 may be too low. The extra consumers will have small impact because their load is the lowest of all consumers. The impact of the connection fee decrease on the number of new connections in 1996 is unknown (if this impact would be large due to an arrears-effect, the time trend extrapolation leads to an overestimation of load instead of an underestimation). For both reasons, the estimated connection rate is assumed to need no adjustments.

consumer behaviour

Consumer behaviour influences the amount of energy use. As discussed in paragraph 1.4.3, electricity use is a derived demand. The prime variable for electricity demand is the use of electrical appliances. The purchase and use of electrical appliances relies on a few factors. At first on the purchasing power, which depends on the income. We already expressed this in the income elasticy for electricity. A second factor is the appliances: their price and availability. Thirdly, common customs influence individual preferences and choices. Common purchasing behaviour exists and develops. Such cultural behaviour is dynamic: it will change over time, depending partly on the rational factors mentioned before (income, prices, availability). It is difficult to give quantitative figures, especially predictions. In general, the liberalization in the 1990s resulted in a significant increase of the availability of appliances. Because the economy did not increase proportional, it is not clear what the effect on purchasing behaviour was and will be.

striking deviations within the total consumer group

Striking load deviations were found for one consumer group. This concerns the households with the highest energy uses. In figure 3.16 they are the ones at the right side, showing a minor group in quantity but with a relevant share in the energy consumption. All of them live in Mtoni Kijchi (see paragraph 3.4.1.3). In the sample used to obtain table 3.2, these households are overpresented. Exclusion of the high energy consuming households of Mtoni Kijchi results in the figures of 212 kWhr and 310 kWhr per month for 1993 and 1996 respectively (instead of 294 and 439 kWhr). The annual increase remains the same. Extrapolation of aggregate consumption data should be undertaken with caution, because it is not sure whether the establishment of this sole company housing estate will be continued by other ones in the future.

3.4.3.3 field survey

industrial analysis

A field survey was conducted to project the load of the individual industries. Trends of the past were analyzed as well, but the projections rather rely on field survey than on time trend extrapolation.

The industrial load forecast consists of the forecast for existing industries and an estimation for new industries. The existing industries were asked for their production plans for the coming years and related expected load. The results of the individual load projections are presented in appendix R. The results of the study of institutes presented in chapter 2 were used to estimate the load of new industries.

In general, the industrial use in Mbagala grew slightly, with about .. percent annually. The load varies on a low level, compared to the total electrical capacity. Low capacity utilization an a few close downs are the causes. This makes a load forecast uncertain: the future load of existing industries rely much on the performance of affecting factors. Most of these factors will improve within a few years, as described in chapter 2. Thus, the load is expected to increase over about three years.

The two large industries are not expected to start up again. Besides Tanita this concerns TSG. Only a relative small production part of TSG will remain functioning.

Small industries and productive organizations not included in the individual load forecast are mainly producing for the local market in Mbagala. Therefore, their load is expected to grow proportional to the residential load, whether their size or number will increase. Grainmills form an exception, as discussed in chapter 2. Their load already decreased an will decrease further.

The industrial area in Mbagala is suitable to accommodate new industries. Together with an industrial area in the north of Dar es Salaam it is meant to be the main developing area for light industries. However, this process still is in a preliminary phase and needs time to start up. Although infrastructure will improve significant, setbacks which have occurred last years may be expected for the coming years as well, for example load shedding. Also, improved infrastructure does not imply industrial development, as we have seen in chapter 2.

The peak loads of the individual industries together in 1996 is 800 kW, with a power factor of 0.85. A maximum coincidence factor for the industries together of 0.5 is, results in a peak load of 400 kW during the daytime. The average industrial load factor is estimated at 0.35.

The load for existing industries will increase slightly till the year 2000, with approximately. From the year 2000³⁰⁾ this will increase to 7 percent per year. Spoken in general terms, this means that in the period 2000-2005 the capacity utilization will increase by 50 percent. Afterwards further growth results from capacity expansion.

Most infrastructural improvements will be realized in the period 1998-2002. Industrial growth of existing industries is expected to follow quite soon. New investments will follow a couple of years later. A sharp increase as soon as good infrastructure is provided belongs to the possibilities. However, for the simplicity a start at 2000 followed by a constant increase is used, to come to the same end-result.

New industries are expected to start from the year 2000. In 2007 they are estimated to have the same total load as the existing industries have, if these would produce with a high capacity utilization of 75 percent. This results in a total growth till 2007 of approximately 300 percent, compared to the present industrial load. Annually this means 17 percent, from 2000 to 2007, based on the 1996 figure.

3.4.3.4 summary of load forecast results

Summarized, the resulted growth figures resulted from the load forecast are:

	house	holds	indus	rtries
year	growth in individual use	growth of number of consumers	growth in individual use	growth of number of consumers
1996-1999	10 %	18 %	3 %	5 %
2000-2007	4 %	18 %	7 %	17 %

Table 3.3 Results from the load forecast for Mbagala

These results, mainly based on adjusted time trend analysis, results in the scenario presented in figure 3.18. The values at the left axis concern the peak load. A table with the forecasted values is included in appendix R.

There is no reason to assume a changing pattern in the daily load curves for industrial an residential use. Because both will grow with about the same speed, the total load curve will remain the same.

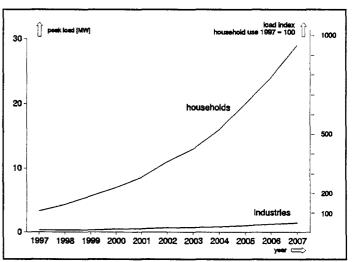


Figure 3.18 Load scenario for Mbagala, 1997-2007

The power factor will remain high for households. With increasing loads it will become more attractive to compensate certain industrial power factors with capacitors at low voltage. Thus, the power factor during daytime will improve somewhat.

The results of the adjusted time trend extrapolation give significant higher growth rates for both industries and households than the national economic multiple regression does. Considering the load growth in the past and expected urbanization of Mbagala, this deviation is justified. Therefore, the scenario made is used for the next step, the grid design.

3.4.4 Electricity parameters, resulted from calculations

The results from calculations of the voltege drop and losses are presented in table 3.4. This concern th current opration of the K3 feeder only and an optimal distribution of load over both the K3 and K5 feeder. For calculations, measured and estimated transformer load data are used. The load growths are obtained from the load forecast.

For the areas Mtoni and Temeke general annual growth figures were used of ten percent. Compared to Mbagala, these figures are rather conservative. This finds its justification in the fact that these areas are not expanding any more, the growth consist of growth of energy consumption of existing consumers and a slight increase of the connection rate. Because Mtoni and Temeke are situated at the beginning of the feeder, the sensitivity of grid performance parameters resulted from variation in load growth is relatively small.

The resulting values of the voltage drop at the end of the feeder and of the total feeder energy losses are excessive high. They make the operation of the feeder impossible within a few years. This situation can be relieved by sharing the load over both the K3 and K5 feeders and by additional supply by another feeder. Tanesco used the latter option.

The values in the table are lower than the values obtained by calculations assuming an equally distributed load over the feeder, as used in the Esmap study. For 1996 this differs by one fifth (the voltage drop is 13.6 percent instead of 16.8 percent). This finds its reason in the relative low load in Mbagala in the starting year 1996: the load is more concentrated at the beginning of the feeder in Mtoni and Temeke.

From the year 2000 (K3 feeder) or 2004 (both feeders) the values become so excessive high, that they are unrealistic. Assuming no grid extensions, only part of the demand can be supplied. For example, by not allowing new connections. For determining the annual energy losses in table 3.4, a loss factor of 0.4 is used.

	K3 feeder			K3 and K5 feeder		
year	max, voltage drop [%]	peak losses [%]	annual energy losses (MWhr)		peak losses [%]	annual energy losses (MWhr)
1996	13.6	8.5	700	6.3	3.7	300
1997	17.1	10.9	1,200	7.8	4.6	490
1998	22.1	14.7	2,300	0.7	5.9	910
1999	27.7	19.7	3,500	11.7	7.2	1,300
2000	37.2	28.7	6,300	14.3	9.0	2,000
2001	-	-	-	17.6	11.5	3,100
2002	-	-	-	22.1	15.1	5,200
2003	-	-	-	28.5	20.8	8,500
2004	-	-	-	39.2	32.1	16,200
2005- 2007	-	-	-	-	-	-

Table 3.4 Voltage drop and energy losses for the K3 feeder, supplied from the Kurasini substation

3.4.5 Grid design

After describing the conditions on which the grid size is designed, the layout of the grid is discussed. This starts with the need for a new substation, followed by a description of its feeder. At last, the layout of distribution feeders is described. These components together lead to the grid design.

conditions

The main design condition is that the supply has to meet the demand, over the whole project period. The package of technical requirements following from the past paragraphs are:

- 1. the voltage drop any primary transformer side may not exceed the 6 percent value in the year 2007
- 2. the reliability of supply has to be guaranteed, by sufficient durability and a design which is suitable for maintenance

Taking the technical conditions applied to the increasing demand as prerequisites, the grid design can be directed to minimum costs and maximum benefits. The reduce of energy losses form the main benefits component.

Aspects which should be considered are the reliability of supply and the maintenance aspect of the grid.

new substation

The main reason for the high voltage drop is the feeder length. With the increasing load density the total load area is too large to supply by feeders from a substation outside the area. Based on the load forecast, calculated parameters show a voltage drop in 1996 of 13.6 percent and annual energy losses amounting 8.8 percent of the total energy distributed. Although the additional supply at the Temeke branch relieves this situation somewhat, the parameters reach unacceptable values already in 1996.

The solution is the placement of a substation in the second part of the load area. This is in the middle of Mbagala. The substation transformer capacity should be sufficient to supply the demand till the year 2007. This capacity can be extended in phases. For strong increasing loads, as the Mbagala case, this can be financially attractive. Capacity extension has to be included in the substation design then.

Two possible options exist for the type of substation, depending on the voltage level. These are a 33/11 kV or a 132/33 kV substation. The choice for one of them depends on the load — do 11 kV a 33 kV substation feeder meet the requirements in 2007? — and the cost-benefit analysis. The substation transformer should be fed by one or more distribution lines from other substations. The Kurasini substation is the only obvious choice for a 33 kV feeder. This substation is of a 33/11 kV type. Ilala is the choice for a 132 kV feeder. As other projects will develop and the overall load will increase, there will be a need for other 132/33 kV substations. The build of them in the southern part of Dar es Salaam is assumed to take place before the year 2007. Other connections can be made by then ³¹⁾.

According to the plans for the Dar es Salaam power supply system expansion [43], Kurasini will be one of the new 132/33 kV substations in 2002. The supply of the Mbagala substation by more feeders will improve the reliability of supply in Mbagala. A second connection can be the proposed substation at Yombo, planned for the year 2000.

new feeder to Mbagala

To line feeding the Mbagala substation has to operate at 33 or 132 kV. The cable surface may be 100 or 180 mm². The current K3 or K5 feeders can better not be used to supply the substation at 33 kV (for which they are designed), because of reliability reasons and the need for distribution feeders near the Kilwa road anyway. So, a new substation feeder should be constructed. Two possibilities exist for this construction:

- 1 Building the main feeder along the Kilwa Road This is maintenance friendly (well accessible)
- 2 Building the main feeder away from the main road
 This gives a higher reliability, because damage by traffic occurs at the road side only
 But it gives rise to the problem of the eroded falls, which especially exist south of the
 Kizinga Creek (see map in appendix E). This multiplies the construction costs.

Further in this research, the first option will be used.

local distribution feeders

The existing K3 and K5 feeders can remain. Maintenance including replacement of cable parts, insulators, poles and transformer fuses is required. The transformers should be equally spread over both feeders, departing from their loads.

The load of supplied areas increases, which require larger or additional transformers connected to both feeders. The residential expansions at the east and west side of the Kilwa Road need extra branches with a length of three kilometres. If just the feeders at the Kilwa Road are used, the voltage drop and energy losses become too high in the year 2000. With an optimum share over both feeders, this will be 2001.

Two new feeders are the solution. One to the western and one to the eastern part. The structure of the network of feeders with branches and transformers is decisive for the local voltage drop and energy losses. If this network is not planned in advance, local grid expansions will be constructed ad hoc. These local extensions may be justified individually, but a view on the total network will show a development into irrational structures, raising the losses and voltage drop.

Departing from the end situation in 2007, the optimum network design can be made. The structure is set right at the project start, by the construction of the two feeders.

The feeders operate at 11 kV or 33 kV. Which of these voltages to choose, can be determined after calculations of the technical parameters for the project period.

planning of local distribution feeders - development areas as starting point

The extension of the population will take place principally in new development areas. Seen from the Kilwa Road, these areas are situated beyond the existing populated areas. This concerns both the east and west side. The areas are not supplied of electricity and sparsely populated now, but extension already started. When these areas are occupied, the development areas will move further: the second growth phase.

This mainly concern the eastern part, which has the most open land suitable for living. At the west side a main development axis will arise around the new outer ring road. Apart from the east and west developing area, the area around the village Kongowe, south of Mbagala, will develop as a peri-urban centre. From now, those three developing areas will be denoted as the east, west and south developing area. All together are called the development areas.

These development areas form the load areas for the new distribution feeders, one for each area. The first and second development phase are shown in figure 3.19 with grew respectively white filled arrows. Main new development plans are mentioned in the figure as well. They are part of an urban development process, of which both the quantity and quality are decisive for the load growth. The development of the new areas is used as starting point for the grid design.

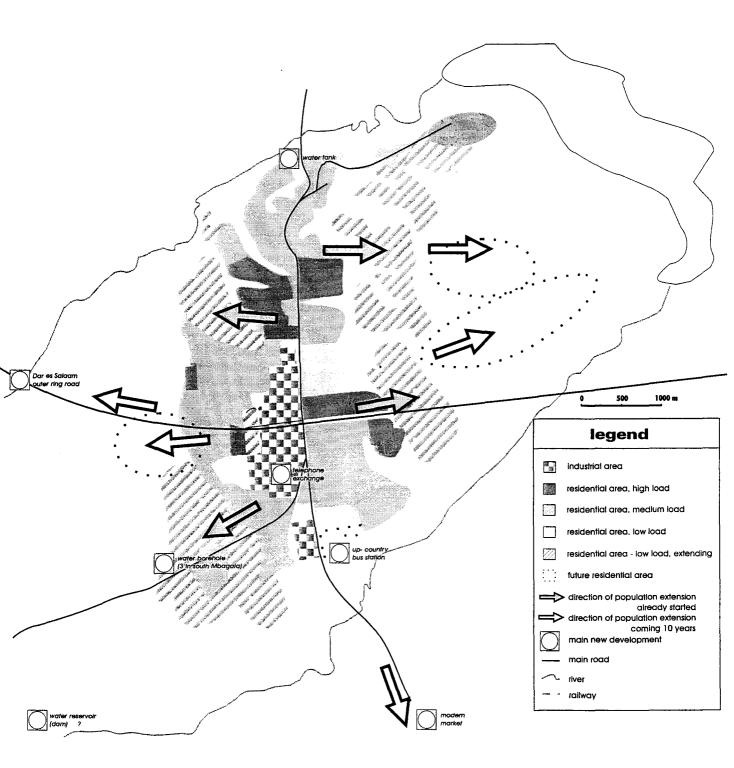


Figure 3.19 Design of the medium voltage electricity grid in Mbagala, for 1996-2007

3.4.6 Electricity parameters for grid design, resulted from calculations

The load forecast gave us the following growth figures for the whole area³²⁾:

	1996 - 2000	2001 - 2007
existing consumers	10 %	4 %
new consumers of which:	18 %	18 %
new consumers in existing areas	7 %	7 %
new consumers in development areas	10 %	10 %

As presented in figure 3.18 and appendix R, this results in a total load in the year 2007 of 29 MW.

to a layout of the load distribution

To be able to design the different feeders, the load in the areas concerned should be forecasted. An approach is used including the following actions:

A separate the total area in

- areas supplied of electricity: 'existing areas'
- developing areas which are not supplied now determine the load in 2007 for the total of existing areas and the total of development areas
- B existing areas

determine the spread of load in the area for 2007, together with the corresponding feeder lengths

point of departure is the load spread in 1996 and the load forecast figures, adjustments to the results are made where necessary: the load in certain areas will grow faster than in other areas

C development areas

estimate the spread of the total load in 2007 over the west, east and south area. subdivide the load of each development area in sub-loads, determine the corresponding feeder lengths

D total load layout

compose the results to a calculation model, including all feeders calculate the voltage drop and energy losses for each feeder, for the year 2007

approach to control the distribution feeders design: actions

These actions are elaborated on the next pages.

These growth figures concern the load of the whole area.

A separation in an existing and a development area

The existing area is the one currently supplied, as presented in figure 3.14. The load situation in 1996, with individual transformer loads, is taken as point of departure. The annual increase for existing users is used: 10 percent till and including 2000, 4 percent afterwards. The expected doubling connection rate in ten years results in an annual increase of 7 percent. Together, the annual growth comes to 17.9 percent till and including 2000 and 11.5 percent afterwards³³.

Calculations result in a load excluding losses of 16 MW for the existing area and 13 MW for the development areas in 2007. The resulted values for each year are presented in the second table of appendix R.

B spread of load in existing area

The calculations of voltage drops and energy losses, according to the load forecast, were made at individual transformer level. By doing this, the spread of load is known. An adjustment is made for the dense load area of Mtoni Kijchi, which already has a high connection rate³⁴⁾. Therefore the load growth of this area is adjusted to 12 percent up to and including 2000, 8 percent afterwards.

All transformer data are grouped in three parts³⁵⁾:

- one in the southern branch of the connection substation Kilwa Road feeder
- the area of Mtoni Kijchi this area finds its importance in the impact on voltage drop and energy losses: the load is relative and the area is furthest from the new substation
- the rest of the northern branch of the connection substation Kilwa Road feeder

Grouping results in the following figures for the year 2007: Mtoni Kijchi 3 MW, northern part 11.5 MW, southern part 1.5 MW.

The load in the southern part is assumed to be equally spread. The load for Mtoni Kijchi is at the end of the branch, 2.5 kilometres from the connection to the feeder at the Kilwa Road. The rest of the northern load is not equally spread: from the branch to the substation, the median of the load is situated at 35 percent of the feeder length, which is 1.5 kilometres.

C spread of load in development areas

The 13 MW load for the development areas is assumed to be spread as follows:

 east development area: 5 MW subdivided in four load components. The largest of those, 2 MW, supposes development along the new outer ring road.

³³⁾ These growth figures are derived from the whole area load and have to be calculated as such.

The socio-economic survey presented in appendix K gives a connection rate of 70 percent for Mtoni Kijchi.

The transformer loads are grouped for two reasons:

^{1.} Using similar growth figures for all areas 'belonging' to a transformer - adapted for local growth differences - allows predictions at general area scale rather than accurate predictions at transformer scale.

^{2.} Load figures for the development area concern area scale. Comparison with data at transformer scale is not logical.

- west development area: 6 MW subdivided in two load components of 2 and 4 MW. The latter value concerns a large geographical area including Mwanamtoti and Mbagala Kuu (these mtaa names are presented in appendix E).
- south development area: 2 MW
 this concerns the development of the village Kongowe
 the wood factory Pole Italy with a peak load of about 0.7 MW is assumed not to produce peak load time (20:00 pm)

D composition of a total load layout

The considerations presented above result in the load layout presented in figure 3.20. For illustrative purpose, the figure is not drawn at geographic scale. The feeders and substation correspondent with figure 3.19.

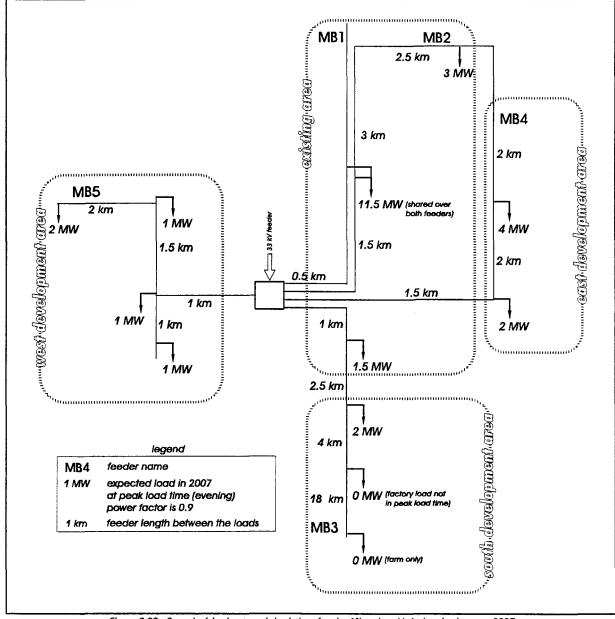


Figure 3.20 Spread of loads at peak load time for the Mbagala grid design, in the year 2007

the 132/33 kV or the 33/11 kV option

Calculation with the data from figure 3.20 gives the values for the voltage drop and energy losses presented in table 3.5. The loads of the MB1 and MB2 feeder are shared equally.

		existing area	west developing area	east developing area	south developin area
33 kV 180 mm ² substation feeder	maximum energy losses [%]		5.	6	
11 kV 100 mm² feeders	maximum energy losses [%]	6.3			
	maximum voltage drop [%]	10	6.3	10	4.6
132 kV 100 mm² substation feeder	maximum energy losses [%]		0.	6	
33 kV 100 mm² feeders	maximum energy losses [%]	0.6			
	maximum voltage drop [%]	1.1	0.7	1.1	0.5

Table 3.5 Maximum voltage drop and energy losses for grid design in the year 2007

The table shows too high voltages if the feeders operate at 11 kV. This concern the area in the north-east of Mbagala, far from the substation. These are the 3 MW load of Mtoni Kijchi and the 4 MW load in the east development area. The voltage drop maximum of 6 percent will be exceeded in this area in 2004 or 2005.

The energy peak losses come to 10.0 percent for the 33/11 kV option. This means that 8.5 percent of all projects energy input will be lost. This value is too high for Tanzanian standards.

A move of the substation planned at the industrial area to the load centre of Mbagala, near the military area, is no solution for these high voltage drop and energy losses. With the substation at this location, all feeders will get voltage drops just above the maximum value allowed in 2007. Besides, the industrial side is a rational choice for other reasons.

The result is that the 33/11 kV grid has to be replaced for one of 132/33 kV, in the year 2004. This includes the replacement of all distribution feeders designed for 11 kV, transformers and the substation.

The grid can be constructed at 132/33 kV level directly at the project start in 1997 as well. The disadvantage of this option is the large overkill of capacity in the first part of the project period.

Thus, the choice between the two options depends on the costs and benefits analysis.

3.4.7 Organizational aspects

The project team concerns all steps included in the negotiation and financing, and the implementation and supervision phases. The negotiation and financing phase concern management, especially related to subcontracting. The implementation and supervision phase includes ordering of materials, construction and supervising. This requires a construction team, which Tanesco can provide for. The construction of the feeders is the most labour-intensive part. Assuming a total work of 6500 man-hours for 25 kilometre feeder to be executed in three months, results in 16 construction labourers plus engineers.

After the project is installed, further extension of the grid at low voltage level require extra labour-force. The amount of new connections will raise, as well as all other consumer related aspects. An exception is the meter reading. For every new connected consumer a Luku meter will be installed, whereby meter readers become unnecessary. Furthermore, maintenance require an extension of labour force. How large the organization of the Temeke Regional Office has to grow is a subject which needs further attention. With an increase of ten times the existing load in ten years, a significant growth of the organization is justified. For example a growth of two times the existing organization size in the period 1997-2007 360

The total labour costs for both the set up and continuation of the project form a minority of the total costs.

³⁶⁾ Because most manpower tasks do not concern Mbagala only, but other areas in the Temeke region as well, the real organization growth will rely on the work load of all areas.

3.4.8 Costs and benefits

To obtain an impression of the importance of the project, it is recommendable to determine the related costs and benefits. A project only is justified if it is feasible, which means that the benefits have to exceed the costs.

The purpose of discussing the costs and benefits in this paragraph is to indicate a direction of the feasibility we can expect. This is done from an approach which is rather qualitative than quantitative: describing and understanding the determinants, without analyses to come to detailed cost and benefits breakdowns. Namely, the nature of the study is about presenting a methodology and ideas, not to present direct usable schedules as part of the operational work-preparation.

The costs are restricted to project costs. The benefits are determined by comparing the situation with and without the execution of the project. It includes running cost components.

The project costs and benefits can be considered from different party views. The most common used ones are the firm level and national level views. The former one points to the financial feasibility, the latter one to the economical feasibility. The firm level of Tanesco is the point of departure for cost and profit determination, leading to a financial analysis. The return of investments at firm level is what counts for the investor.

Tanesco operates under the authority of the Ministry of Minerals, Water, Energy and Minerals. This ministry looks after the consequences at the national economy as well. It means that, if a project is financially feasible, it will be supported only if economical feasibility is expected. Thus, the project costs and benefits should be considered beyond the firm level.³⁷⁾

Once determined, the costs and benefits are used to calculate two main feasibility expressions: the benefit / costs ratio and the net present value. The cost-benefits analysis is applied for both the 33/11 kV and the 132/33 kV option.

3.4.8.1 project costs

The project costs are determined by the purchase and construction costs of the substation, feeders and transformers. For the economic analysis border prices are used, for which national taxes levied on components are neglected. The prices for components were obtained at the department of Corporate Planning and Research at the Tanesco head office.

Most components are used for the construction in the first project year. The instalment of the 11/0.4 kV and 33/0.4 kV transformers for the new feeders is spread over the project period. They will be added as soon as this is required by the load. This also concerns the build of medium voltage branches.

Special attention should be paid to the economical issue if the market is dominated by one or a few suppliers. Tanesco has a monopoly. The assumption of maximum profit gaining for the company will be to the detriment of the consumers.

component	number / quantity	year of introduction	total costs in US dollar, 1996
33 / 11 kV	option		
transformer 33 / 11 kV , 15 MVA	1	1997	550,000
transformer 33 / 11 kV , 15 MVA	1	2003	550,000
circuit breaker 33 kV	2	1997	246,000
circuit breaker 11 kV	4	1997	200,000
other substation costs	1	1997	100,000
33 kV substation feeder 180 mm²	10 km	1997	250,000
branches 33 kV	3 km	1997 - 2004	71,000
11 kV feeders 100 mm²	10 km	1997	224,000
branches 11 kV	2.5 km	1997 - 2004	56,000
reconducting 11 kV	13 km	1997	130,000
reconducting branches 11 kV	5 km	2000 - 2005	50,000
transformers 11 / 0.4 kV, 200 kVA	70	1997 - 2007	630,000
transformers 11 / 0.4 kV, 500 kVA	60	1997 - 2007	816,000
replacement of old transformers 11 / 0.4 kV, 200 kVA	10	1997 - 2007	90,000
132 / 33 k\	√ option		
transformer 132 / 33 kV, 25 MVA	1	1997	750,000
transformer 132 / 33 kV, 25 MVA	1	2003	750,000
circuit breaker 132 kV	1	1997	≈ 200,000
circuit breaker 33 kV	5	1997	615,000
other substation costs	1	1997	150,000
132 kV substation feeder 100 mm²	10 km	1997	700,000
33 kV feeders 100 mm²	10 km	1997	230,000
branches 33 kV	5.5 km	1997-2004	127,000
reconducting 33 kV	13 km	1997	130,000
reconducting branches 33 kV	5 km	2000-2005	50,000
transformers 33 / 0.4 kV, 200 kVA	70	1997-2007	630,000
transformers 33 / 0.4 kV, 200 kVA	60	1997-2007	816,000
replacement of old transformers 11 / 0.4 kV, 200 kVA	28	1997	252,000

Table 3.7 Project costs of components, including taxes

The substation transformer needs a capacity of about 34 MVA in the year 2007. Because of a large overkill of capacity in the first project years and high initial investment costs, a 15 MVA transformer will be chosen, followed by another one in 2002. For the 132/33 kV option a 25 MVA transformer is chosen, because of the small price difference of 20 percent.

These prices include all material components and construction costs. Additional costs for preparatory engineering, overhead and additional labour costs are small compared to the total investment costs. Together with the item unforeseen, it is estimated at 5 percent of the project costs for 1997. This results in the investments cost schedule presented below. The annual discount rate used is 10 percent.

year		33 / 11 kV		132 /	33 kV
	total costs [US 5]	replacement costs for 132/33 kV in 2004 [US \$]	discounted costs for 1997 [US \$]	total costs [US \$]	discounted costs for 1997 [US \$]
1997	1,971,000	-	1,971,000	3,332,000	3,332,000
1998	156,000	-	142,000	148,000	134,000
1999	156,000	-	129,000	148,000	122,000
2000	164,000	-	123,000	156,000	112,000
2001	164,000	-	112,000	156,000	107,000
2002	164,000	-	102,000	156,000	97,000
2003	714,000	-	403,000	156,000	88,000
2004	164,000	4,712,000	2,418,000	156,000	80,000
2005	148,000	131,000	61,000	889,000	415,000
2006	140,000	131,000	56,000	131,000	56,000
2007	140,000	131,000	51,000	131,000	51,000
		total 33/11 kV	5,567,000	total 132/33 kV	4,594,000

Table 3.8 Total project costs 1997 - 2007

In case of a replacement of the 33/11 kV grid by 132/33 kV in 2004, the instalment of the 15 MVA substation transformer in 2003 will be abolished. Other 11 kV extension costs after 2003 are abolished as well. The second 132/33 kV transformer, required in the year 2005, is directly included in the new substation. 11 kV distribution feeders constructed in 2007 are designed for 33 kV and have not to be removed in 2004.

Except of the substation transformers and other substation equipment, all materials are purchased from Tanzanian companies. The rationale for the choice of local materials finds its reason in the lower purchasing costs and standardization. Standardization improves the materials maintainability and changeability. The foreign cost component of local materials is about 70 percent. The 11/0.4 kV and 33/0.4 kV transformers are assembled by Tanelec using parts imported from Norway. Also the costs for medium voltage cables have a large foreign component.

To obtain real economic costs of locally produced materials, the costs should be adjusted for shadow prices³⁸⁾. Direct government support for supplying firms by means of using favourable exchange rates (the firm can buy dollars for a low, artificial rate) is assumed to be non-existent, since free market exchange rates were introduced. Direct government support for construction material factories, by which the selling price of materials can be below the total production costs, is not known. For these reasons, shadow price adjustment is not used.

Tanzanian sales taxes on materials are not included in the economic costs. These taxes amount to 30 percent. So, the total discounted economic project costs are for the 33/11 kV grid 3.9 million US \$ and for the 132/33 kV grid 3.2 million US \$.

³⁸⁾ Shadow prices are used to express actual economic values. This becomes relevant if market prices do not reflect the real costs, due to market distortions.

3.4.8.2 project benefits

The benefits for Tanesco consist of

- the sales of electricity
- reliability benefits
- energy savings

These energy savings are the difference in energy losses between the situation with and without the project undertaken. Reliability improvement results in an increase of the amount of energy sold and a decrease of maintenance costs. Electricity sales benefits concern the profits from sales resulted from load increase which could not be supplied without project implementation.

The economical benefits are mainly confined to the consumers in Mbagala. They depend on the project execution and are, in principle, not equal to the income effect for Tanesco. Namely, the price differs from the initial value for the customers, expressed in the surplus value. Effects as temporary employment creation during the build of the grid are neglected.

energy benefits

The electrical energy is produced by power stations, and transmitted and distributed by grids. Part of the energy is conversed from diesel. This forms the variable part of the production costs. The fixed part is composed of investment costs for the power stations with dams, high voltage and medium voltage grids. Furthermore a relatively small part exist of organizational costs: labour costs, offices, vehicles, etcetera.

All these costs can be combined into one value: the costs to produce one kilowatthour of electricity. These costs do not concern the average, but the marginal costs. Namely, a new project requires energy which is additional to the existing production. The costs for an additional amount of energy are expressed in the marginal energy costs. Especially in periods of energy shortage the marginal energy costs are high: they are equal to the incremental value for consumers, plus the damage for them (due to production losses). Kennedy & Donkin Power Limited and Tanesco determined the long run marginal costs (LRMC) for electrical energy ^[90]. Based on border prices and a discount rate of 12 percent, the LRMC at distribution level is 7.7 dollarcents. This value is based on an analysis for the period 1993 - 2015. The costs include an economical component: real costs for expected power rationing for industries are estimated.

The energy benefits are determined by subtracting the calculated annual energy losses of the designed grid from the annual energy losses by the old grid. This value is multiplied by the LRMC of electrical energy. The results are presented in table 3.9.

The problem with these calculations is that continuation with the existing grid is technically impossible from the year 2004, and sooner if the load is not equally distributed over both feeders.

A second problem is that the old and new grid have different load areas, which can not simply be subdivided to obtain comparative figures: two loads together result in higher losses than the summation of both individual losses (squared relation). For figurative use, the losses for Mbagala for the old grid are obtained by dividing the total losses over the areas 'Mbagala' and 'the rest', proportional to their load. So, the resulted benefit figures can be seen as estimations. All values in the table are rounded off. The values of the 33/11 kV grid between brackets are not used because the grid is supposed to be replaced by 132/33 kV after 2004. Instead, the values for the 132/33 kV grid are used.

year	annual losses old grid, optimal	annual losses old grid,	Mbagala [MWhr]			ss savings Whr]	ecanami (US \$,	
	load distribution [MWhr]	Mbagala only [MWhr]	33/11 KV	132/33 kV	33/11 kV	132/33 kV	33/11 kV	132/33 kV
1997	490	230	95	10	135	220	10,000	17,000
1998	900	410	170	20	240	390	18,000	30,000
1999	1300	690	285	35	405	655	31,000	50,000
2000	2000	1100	430	50	670	1050	52,000	81,000
2001	3100	1800	650	80	1150	1720	89,000	132,000
2002	5200	3200	1060	120	2140	3080	165,000	237,000
2003	8500	5300	1480	170	3820	5130	294,000	395,000
2004	16200	10400	2250	260	8150	10140	628,000	781,000
2005	-	-	(3500)	410			> 781,000	> 781,000
2006			(5050)	590			per year	per year
2007	-	-	(7380)	860	•			

Table 3.9 Project benefits from energy savings

A situation which just enables operation occurs around the year 2004, with annual loss reduction for the 33/11 kV grid and 132/33 kV grid worth \$ 628,000 and \$ 781,000 repectively. Assuming a conservative loss estimation of the 2004 value for all later years, it results in a value for losses of \$ 3.5 and \$ 4.1 million dollars respectively. Discounted for 1997 values with a discount rate of 1.1, the resulted benefits are \$ 1.7 and \$ 2.0 million respectively.

The assumption that the load will not grow after the year 2004, requires disconnection of a part of the existing consumers and not allowing new ones. This economic costs of this scenario are discussed in the subsection 'economical benefits'.

reliability benefits

To determine the reliability benefits, the reliability of the old and new grid situation should be estimated. With the annual amount and length of power interrupts and a determination of the economic costs of interruption, the annual costs of interruptions can be determined. The difference between old and new grid situation form the project reliability benefits.

Two problems occur for the elaboration of this method for the Mbagala project. At first, only very recently records were started to be kept about local power interruptions. The summary data available do not allow for conclusions about reliability. Future estimations as well as estimations for the new project will be even more arbitrary.

The second problem is that in the past years the reliability of supply depended on the national energy problem, rather than the local performance. Therefore, resulted financial losses for the consumers are clouded by the changing consumers situation caused by severe 'national power cuts'.

In the Esmap study ^[97] the profits from reliability improvement are very roughly estimated³⁹⁾ and form the majority of the total project benefits. This results in unreliable project feasibility figures. Therefore, the reliability benefits are not quantified in this research.

benefits from electricity sales

Generally, the sales of electricity are the income source to pay all costs of electricity production in the country, including a margin for new investments. However, most countries in Sub-Saharan Africa have electricity tariffs below the LRMC. So, financially the electricity sectors are loss makers. In the 1990s, a few countries adjusted the electricity tariffs for the LRMC [48]. Tanzania toke a step in this direction in 1994 / 1995.

households

Small energy amounts for households and light industries are subsidized. Larger energy amounts exceed the LRMC. Most industries pay much more than the LRMC, which striking because it is cheaper for Tanesco to sell bulk amounts of higher voltage. The tariff system is explained in paragraph 1.4.3 (page 18) and appendix D.

A combination of the figures of the tariff system (figure 1.11) and the consumers categorized to energy use in Mbagala (figure 3.16) results in figure 3.21.

We see that most consumers with a majority of the energy consumption are subsidized. Only the high energy consumers generate profits. The figure results in an average household price of about Tsh. 38,-. So, financial losses amount 40 percent of the sales.

Esmap assumed the outages saved at 1.5 percent of the annual energy use.

As we saw in the load forecast, the average use per consumer will crease. This means that the bars in the figure will shift to the right side, and come partly in the profitmaking part. According to the load forecast, the average use of 283 kWhr will increase to 535 kWhr in the year 2007. Assuming that the tariff system does not change (in constant prices), this means that the total profit from household sales will be around zero for the whole project period.

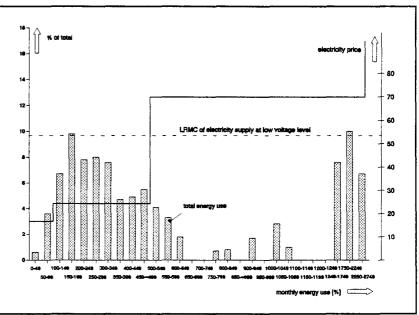


Figure 3.21 Determination of average household electricity price

industries

The industries in Mbagala concern two tariff groups: tariff 1 for households and light industries and tariff 2 for low voltage supply. The industries at the industrial area belong to tariff 2. Besides energy payment, tariff 2 includes maximal load payment. Thus, the electricity price depends on the continuity of the load. The average electricity price industries in Mbagala pay in tariff two is estimated at Tsh. 120,- 40). Most industrial consumers in tariff 1 are using around 2000 kWhr only. Their average price is about Tsh. 50,- per kWhr, which is close to the LMRC, and thus not interesting for benefit calculation.

The total industrial energy use in 1996 for tariff 2 is estimated at 150,000 kWhr per month. Using the industrial forecasted growth figures, we come to the use and benefit figures presented in table 3.10.

The benefits which can be contributed to the project, are those who would not be made without project implementation. This concerns the years that industries could not be supplied any more with the old grid. As determined in paragraph 3.4.4, supply of electricity would become impossible from the year 2004. Because industrial supply is more sensitive, electricity supply becomes unusable for industries around 2000 in peak load hours or 2002 in office hours. Aggregated discounted benefits for the project period 2001-2007 give project benefits of US \$ 2.0 million.

Two extreme examples are: a factory producing fourteen hours per day, six days per week with a 80 percent of their peak load and a power factor of 0.9 pays on average Tsh. 80,- per kWhr. An industry with an average production load of 40 percent of its peak load, with a power factor of 0.8, during 6 hours per day, 150 days per year pays on average Tsh. 320,- per kWhr.

Adat	annual industrial energy use for tariff 2 [GWhr]	benefits (sales - LRMC) (US \$)	discounted benefits
1997	1.8	201,000	201,000
1998	2.0	223,000	203,000
1999	2.1	235,000	194,000
2000	2.3	257,000	193,000
2001	2.5	279,000	191,000
2002	3.1	346,000	215,000
2003	3.9	436,000	246,000
2004	4.8	536,000	275,000
2005	6.0	670,000	313,000
2006	7.6	849,000	360,000
2007	9.5	1,061,000	409,000
			2,800,000

Table 3.10 Benefits from industrial energy sales

economical benefits

As discussed in the sub-section 'energy benefits', many consumers can not be supplied any more if the project will not be executed, both existing and potential new consumers. This scenario seems to be unlikely. But it is worth to sketch the opportunity costs in this way, to get an understanding of the projects importance.

Main question to answer is: what are the costs for all (potential) consumers in Mbagala, without the project being executed? To find an answer for this question, the reaction of the consumers has to be determined. The eventual use of substitution energy sources is a major issue for the related consumer costs.

Again, the consumers are divided into households and industries. For each group the considerations described above will be elaborated.

households

Residential electricity is a consumption good. It might enable reading at evening hours better than kerosene lamps do and listening radio and watching television with their possible educational aspects. Computers and world-wide networks certainly have a large impact in the western world and might get this in the future in Mbagala. But the relation between residential electricity use and economy was never proved to be causal. Operationalization and quantification of subdivided factors of residential household electricity use, related to economic growth, meet problems. Likely, those factors play a too minor role to find any correlation with economic growth. The proposed relations, used in different Tanzanian prefeasibility studies, are mainly based on feelings.

This does not mean, however, that household electricity use does not have any economic value. In a wider context, we can define economic profits as the surplus value for the consumers and supplier. In simple terms, it means that if consumers will maximally pay Tsh.15,- for a good and the price is Tsh.10,-, its surplus value is Tsh.5,-. If the selling price exceeds the economic costs of production, economic benefits are generated.

The theory of economical benefits of electricity supply is explained by R.van de Broek and L. Lemmens in [15] and [16]. With the use of demand curves, economical costs and consumer prices for electrical energy and its substitutes, the benefits of electricity supply can be determined.

Application of this methodology for the Mbagala project meet a very basic problem: the demand curves are unknown. 'What are the inhabitants of Mbagala willing and able to pay for their energy now and in the future' is a question I can not answer. Secondly, the extent of substitution is unknown. Electricity by lighting will be replaced by kerosene, electricity use for certain small appliances by batteries, but probably most electricity use will not be substituted. Only data of economic costs, consumer prices and energy conversion factors are available. Concluding, the economic benefits for the households can not be determined due to a lack of data.

Besides, it is uncertain whether the economic benefits are positive. Namely, household electricity use is subsidized. Not as heavy as before the price adjustments till 1996, but still with 50 percent for consumption below 500 kWhr per month. Only the price for consumption above 500 kWhr exceeds the LRMC of electricity supply.

To give any impression of the amount of economical benefits which are possible, is helpful to sketch the value of the total electrical energy sold in the project period. Based on the load forecast, a value equal to the LRMC at consumer level of 8.9 dollarcents per kWhr and 1996 prices, the value of energy consumption for 1997-2007 is US \$ 57 million (non-discounted).

industries

The substitute for industrial electricity supply is own electricity generation. In Mbagala, the most obvious method to do this is to use a diesel generator. The costs for diesel generation exist of investment costs and diesel costs.

The determination of benefits is explained in figure 3.22. The exact shape and position of the demand curves are not known. They are nearly vertical, because the demand elasticy for energy prices is small. The demand is determined by the production process and utilization of it, which hardly depends on energy prices ⁴¹⁾.

The demand curve of electricity is positioned just above the curve of diesel generation. The quality of both energy sources is nearly equal (but the reliability of own generation might be even higher), but own gener-

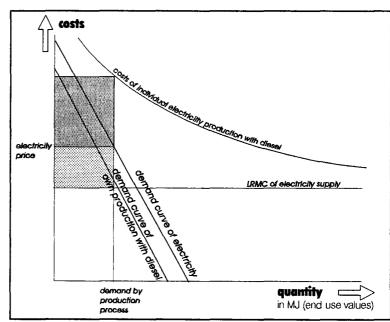


Figure 3.22 Benefits of electrical energy for industries

ation requires maintenance including the need for spare parts.

If we assume that all industries substitute their electricity supply for own generation, the economic loss can be calculated as the summation of the two grey blocks in the figure. The dark shaded block concerns benefits for the consumers. The light shaded block concerns sales benefits for Tanesco, already determined in this paragraph.

The data used for this calculation are presented at the next page.

The share of electricity costs in the total production costs has been about 10 percent. Only if electricity prices become excessive high the production quantity — and so the electricity demand — will decrease.

generator purchase costs	50 kVA	US \$ 15,000
	100 kVA	US \$ 20,000
	200 kVA	US \$ 32,000
	500 kVA	US \$ 41,000
diesel purchase costs		Tsh. 300 (US \$ 0.5) per litre
generator diesel consumption	i, average ⁴²⁾	0.3 litre per kWhr
LRMC of electricity supply (e	conomical costs)	US \$ 0.089 per kWhr
electricity price ⁴³⁾ (financial c	osts for consumer)	US \$ 0.20 per kWhr
summation of individual indu	strial peak loads in 2007	2,000 kW
summation of industrial energ	gy use 1997 - 2007	26,000 MWhr

Data used for cost the calculation of a replacement of grid electricity supply by diesel generators, for industries

A simple calculation with on average half of the diesel generator capacity of 100 kVA used during six days of eight hours per week, gives a diesel consumption of US \$ 18,700 per year. The generator purchase costs are about the same. Due to the excessive high interest rate of about 50 percent, the investment costs amount about 50 percent of the diesel costs for this example, and much more for irregular production processes.

The assumption that diesel generation costs (0.3 * 0.5) US\$ plus 65 percent investment costs per litre, leads to a total industrial loss for diesel generation of US \$ 1.3 million for the whole project period. Corrected with a discount rate of 1.1, this value becomes US \$ 0.8 million. The cost values used are given below. The prices include taxes.

This energy use can be around 0.13 litres per kWhr for a very stable load, which is equal to the capacity of the generator. Most industries, however, do not have continuously stable loads.

Determined in this paragraph before.

3.4.8.3 project feasibility

The cost and benefit analyses do not allow detailed feasibility determination, because not all benefit components are quantifiable. Using costs and quantifiable benefits only, results in the values presented in table 3.11. Because the purpose of this analysis is to give an indication of the feasibility, confined is to the benefit-costs ratio. Other methods to express the feasibility as net present value and pay back period are, for the reason of simplicity, not calculated.

The 'larger than' symbol (>) means that not all benefits are included, because of quantification problems. All values are calculated for 1996 prices. Annual inflation rates and an annual conversion factor are not used.

33	/ 11	kV	project
132	/ 33	kV	project

60	sts	benefits		
financial [min US \$]	economical [min US \$]	financial [mln US \$]	economical [min US \$]	
5.6	3.9	> 3.7	> 4.5	
4.6	3.2	> 4.0	> 4.8	

financial b/c ratio	economical b/c ratio
> 0.66	> 1.2
> 0.87	> 1.5

Table 3.11 Project costs and benefits summarized, discounted values for 1997

On the base of quantifiable data, the best project option is financially unfeasible. Non-quantifiable financial benefits concern reliability improvement. These benefits are not expected to very large compared to the quantified benefits, so the benefits / costs ratio will be not much larger than 0.87.

The economical benefits which can not be quantified concern the household surplus value of electricity, compared to alternative energy sources. Considering the total sales expected in the project period (\$ 57 million, non-discounted value), these surplus benefits might be significant high. So, the economically the project is feasible with a benefits / costs ratio of 1.5 at least, which may be larger.

3.4.9 Sensitivity analysis

The methodology on which the grid design is based contains the determination of different parameters. Not all of these determinations have the same accuracy. The aim of a sensitivity analysis is to qualify the parameters with low accuracy and study the results of varying them.

the residential load growth as part of the urbanization trend

The most uncertain factor in the Mbagala project appraisal is the load growth. With an extreme growing market, both quantitative (number of connections) and qualitative (individual load), the projected load exceeds the present load several times. This makes the project be based on a future-description, which has no clear relation with the present situation.

The load forecast shows a dominant role of the household use. A deviation of the residential load growth will have a higher impact than deviation of other variables will have. The main parameters related to residential load growth are:

population growth connection rate individual load growth infrastructure

The electricity price and power rationing do not belong to these 'sensitive parameters'. The electricity price is expected to remain stabilized in the coming ten years. The impact of power rationing is as large as the cut energy concerns, but not more than that.

All four 'sensitive parameters' are much related to the urbanization process of Mbagala. The population growth is a quantitative parameter, which mainly depends on the available arable land in Mbagala and the rest of Dar es Salaam and external factors stimulating migration. The connection rate and individual load growth are both related to economical growth and are qualitative. Infrastructure is related to both growth aspects ⁴⁴⁾.

We can consider two alternative forecasts: a low load and a high load scenario. With the low load, the proposed urban transition does not take place. The population will remain growing, but infrastructure will not be improved significantly. The outer ring road will not be constructed. No serious water supply improvement will be carried out and schools remain overcrowded. Real incomes will not grow. The development is quantitative, not qualitative.

With the high load scenario, Mbagala develops into an urban area, well accessible by an improved Kilwa Road and the Outer Ring Road. The amount of planned housing projects will increase. Infrastructure as telephone, water supply amd electricity supply will improve. To a lesser degree, this concerns health and education. Incomes in Mbagala will raise, eventually increased by an economic growth in Dar es Salaam.

The quality of infrastructure influences qualitative parameters: higher income households only start living in Mbagala as certain infrastructural aspects as water, electricity and telephone are provided. An extra access road to Mbagala will lead to trade, selling activities and other businesses, attracting people from different income groups.

Both scenarios are assumed to have the 'sensitive parameters' presented in table 3.11.

parameter	low growth	most probable scenario	high growth scenario
mean annual population growth, 1997-2007	5 %	9 %	13 %
mean annual individual load growth, 1997-2007	2 %	6 %	10 %
connection rate in 2007	35 %	50 %	65 %
mean total load growth	10.4 %	23.0 %	35.6 %

Table 3.11 Parameters for annual household load growth, for different scenario's

The resulted loads are presented in figure 3.23. The differences in load are extreme.

The 33/11 kV grid has sufficient capacity for the low growth scenario. The choice to start with a 15 MVA substation transformer lowers the 'overkill' of system capacity.

The high scenario requires capacity extension to 50 MW in the year 2007. For this scenario, 33/11 kV has to be replaced already in 2002 because of high voltage drops.

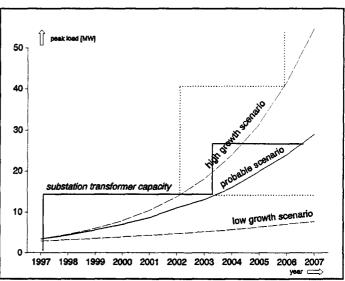


Figure 3.23 Low and high residential load scenario's for Mbagala, 1997-2007

Financial and economical conse-

quences concern mainly the amount of energy sold, which is not determined. The variation in energy loss reduction is assumed to be zero, because continuation or further increase of the load with the old grid is impossible after 2003. Surplus benefits for industries compared to diesel generation remains constant.

the industrial load growth

The influence of industrial load is relatively small. In 2007, the industrial peak load amounts to 8 percent of the residential peak load. Furthermore, the load of most industries does not apply to the grid peak load at eight o'clock in the evening. So, industries hardly do contribute to critical technical parameters and are not of importance for the required grid dimension. Varying the industrial load with, for example, a factor two, will have no serious impact on the grid performance. A result of extreme load deviation is that the project feasibility will change. This concerns financial benefits from industrial sales and economical surplus benefits.

For figurative purpose, the extreme cases of an industrial load growth of the half and the double of the forecasted values are determined. With a load increase half the forecasted one, the financial benefits will come to about US \$ 3 million instead of US \$ 4 million, resulting in a benefit / cost ratio of 0.65. With a load increase double the forecasted one, the benefit / cost ratio becomes 1.3. Including the industrial surplus value of electricity for the economical feasibility, we come to benefit / cost ratios of 1.1 and 2.4 for the half growth and double growth variants respectively.

Industrial load will become more important if heavy industries would be established in Mbagala. But the zoning plan for the industrial area of Mbagala includes light industries only.

3.4.10 Features for grid improvement

emerging possibilities

The main existing features concern the supply of new development areas, which are included in the project appraisal. Eventually, arising small load centres outside Mbagala can be supplied in the future, if such grid extensions are feasible.

Eventually, the industrial area in Mbagala can be supplied by a separate distribution feeder. This creates the possibility to switch the industrial area and the rest of the load independently. In case of required power scheduling the industries can be spared. This will decrease economic costs of power cuts. Thus, the impact of unreliability which can not be contributed to the project (national problem) can be relieved. Furthermore, the local reliability of industrial supply can be improved by separate feeding.

Around the years 2000 and 2002, the Mbagala substation can be connected to other 132/33 kV substations nearby. This will improve the reliability of supply determined by one transmission feeder. Furthermore, such connections will decrease energy losses, which can play a role after the project period.

bottlenecks

The identified present problems were discussed in paragraph 3.4.2.4. All of them need serious attention. One of these problems can form a bottleneck for the continuation phase of the project. This is the maintenance aspect, elaborated in paragraph 3.4.2.1. A continuation of the Damp project, followed by strengthening of local maintenance management at the regional office is required to guarantee the quality of electricity supply in the project period.

Considering the effort used to obtain a good electricity supply, expressed in the project costs, it should be a waste of sources to undertake no activity to maintain this quality. The costs of maintenance are not determined in this study, but are very low compared to the project costs. They are included in the ten percent project costs margin used in this study.

3.4.11 Results compared with the applied Esmap / Jica methodology

The methodology used in this research and the methodology applied by the World Bank in the Esmap study differ. These differences and the different results for the Mbagala project are summarized below. The work of the Jica is a continuation of this Esmap study, for which some results were adjusted. These adjustments are presented below as well.

subject	Esmap study	this study
methodology		
calculation of grid performance parameters	with feeder current and assumption of equally distributed load	with differentiation for local loads
area specific characteristics	for load analysis is the area considered as a 'black box'	load-related characteristics of the area are considered
calculation of project benefits, reliability improvement	a fixed ratio of the energy consumption is used to calculate the extra energy delivered by reliability improvement. its energy value is 8 times the LRMC.	recorded power interruption data are used. if these are not available, the reliability benefits are not calculated
load forecast	macro economic	area specific
accuracy of projected loads	low; very low for fast and unplanned grow- ing areas	reasonable; moderate for fast and unplanned growing areas
simplicity of methodology appliance	fast executable methodology data collection at concerned offices field work only for feeder load data, if those are incomplete at office	appliance needs more effort involvement of regional engineers is advisable to take 'knowledge from the field' into account
results		
annual load growth rate	9 percent	on average 23 percent (varies)
grid composition	grid 33/11 kV transformer 5 MVA K5 feeder becomes substation feeder 3 feeders of 11 kV (of which 2 new)	grid 132/33 kV transformer 25 MVA plus 25 MVA later new substation feeder 5 feeders of 33 kV (of which 3 new)
project costs	US \$ 493,000 (1992)	US \$ 4.6 million (1996)
benefit / costs ratio	14 without reliability benefits: 1.2 (financial and economical mixed)	financial 0.9 economical 1.5
	adjusted results by Jica	
annual load growth rate	5.5 percent	
grid composition	transformer 15 MVA new substation feeder	
project costs	?	

3.5 Conclusions

The methodology designed for the project appraisal differs significantly from the methodology for grid improvement projects in Dar es Salaam, used by the World Bank. The basic difference is that the methodology presented in this report gives a better understanding of the demand side of the project. This results in a higher accuracy of the defined grid requirements. The differences between the designed methodology and the used one mainly concern the following items:

- making an analysis of load patterns within the area of research, instead of considering the area as one unity without further differentiation
- making an analysis of the load growth on the base of structured load forecasts methods.
 This led to the analysis of historical data at individual consumer level and a field survey, instead of using projected national growth figures
- integrating urban development projections (mainly infrastructure) with the load forecast and geographical spread of the load growth
- identifying the reasons for the present problems of supply. These reasons might become bottlenecks for a successful project implementation

The elaboration of the methodology results in serious shortcomings of the electricity supply in 1996, which will further worsen in the coming years. This is mainly related to low consumer voltages and high energy losses for Tanesco. Technically, significant grid extensions are required.

The conducted load forecast prescribes the technical requirements for the end of the project period, on which the new grid is designed. This design was made. This concerns a new substation, a feeder for it, and 5 distribution feeders. Two options were eleborated, depending on the voltage level used. One concerns 33 kV transmission and 11 kV distribution voltage, which is common in Tanzanian urban areas. The other option concerns 132 respectively 33 kV. The 33/11 kV is the cheapest, but does not meet the technical requirements in the year 2007. The 132/33 kV does, but means an overkill of capacity almost during the entire project period .

The cost-benefit analysis show maximal benefits for the 132/33 kV grid design. Furthermore, it indicates that the project is unfeasible for Tanesco, if non-quantifiable benefits are excluded. For the national economy, the project is just feasible.

The reason for the doubtfull feasibility of the project is the subsidy for residential consumers, whereby no benefits are obtained from sales for the largest consumer group. Significant profits only can be made if policy-makers at ministry level abolish this heavy subsidy.

The most sensitive factor for the project feasibility is the residential load growth, which is strongly related to an expected urbanization trend. Deviation from expected growth figures can only be responded by a phased implementation of the 132/33 kV transformer capacity.

Underlying problems related to the electricity supply in Mbagala, which may appear as bottlenecks for successful project implementation, are:

maintenance

There has been no structural organization of maintenance, especially related to PM Recently a project for PM for distribution feeders in DSM was introduced, which is a promising start.

relation with consumers

In general, most consumers are treated without serious attention. Good supply goes in line with good custom services. Also, communication with consumers about failures is an important item in the work-flow of the maintenance team.

communication between different parties involved
 Especially the communication and co-operation between the project donor and initiator and the responsible party for the continuation phase (Jica respectively Temeke regional office) of the project has been poor

information sources

literature sources: an explanation

Step by step I obtained an overview of the literature which is relevant for this research. It might be useful for colleague students - as well as others interested in the subjects dealt with in this report - to mention the information sources I used.

These mainly concern:

internet_catalogues

This is a 'must' to find your way in the cobwebs of available book titles and article abstracts. I specially used the 'Nederlandse centrale catalogus' and 'ABI/inform', which are available on the Eindhoven university central computer menu.

sources in Dar es Salaam

The following sources I used, ranked to importancy:

- 1 different institutes, to obtain the recent reports. for my research this concerns the institutes mentioned in the list 'oral sources'
- 2 Tanzania Publishing House (Samora Avenue)
- 3 Bureau de Statistics (Kivukoni Street)
- 4 University Press (University)

sources in the Netherlands

The libraries where I found the most interesting literature are:

- * Africa Study Centre (ASC) in Leiden (phone 071-5273354 / 5273372)

 This library owns the largest collection of African research material in Europe. I'll advise students doing their research in or about Africa to visit this library.
- * Eindhoven University of Technology

Besides in Tanzania and a few northern West-European countries, interesting researches are conducted in the USA and, especially, Canada. Many publications are not available in Dutch libraries. A well stocked Canadian library is the Koerner library of the University of British Colombia in Vancouver.

Most of the literature in the following list I own or copied partly. If you want to go through these works, just phone me (040-2128848) or mail (Balsemienplein 15; 5644 LE Eindhoven; the Netherlands / daank@stack.nl).

note: [..] stands for Journal article

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[b2] [b3]		Viswanathan, A Jayson	chief technician	06-01-93 16-10-96
[c]	Ally	Ally, S.	entrepreneur	13-01-96
(d)	Chanuahela Salt Ltd.	?	employee	11-10-96
[e1]	DAF - Leyland	Mbise, M.N.	assembly manager	12-03-93 11-10-96
[e2]		Suto	sales manager	15-10-96
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[g1]	Galinoma	?	employee	13-01-93
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[h]	Global Sea Products	Abri, A.M.	director	11-03-93
[i1] [i2] [i3] [i4]	CG. Jensen → Skanska Jensen	Uppgren, K. Miselya Voitek Reynolds, M.	civil engineer electrical engineer mechanical and electrical engineer company manager	26-01-93 26-01-93 12-10-96 15-10-96
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[k1] [k2]	Marshalls Ceramics	Mpokonja Kasubi	manager technician	93 06·11-96
[1]	Mbalinga	Lukosi	manager	93 07-11-96
[m]	Mbagara industries	?	entrepreneur	23-03-93
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[o]	Mduluguja	?	entrepreneur	23-03-93
[p]	Mohammed	Mohammed	entrepreneur	13-01-93
[q1] [q2] [q3] [q4] [q5] [q6]	Tamelt	Aerdts, T. Komba, S.J. Komba, V. Abdul Mwabala, J. Mwele	mechanical engineer factory manager mechanical engineer stores & sales officer production supervisor	15-01-93 09-10-96 23-10-96 23-10-96 23-10-96
[r1] [r2]	Tanita Co. Ltd	Lila, H.M. Farijala	chief engineer acting chief engineer	22-01-96 15-10-96
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[C2]		Rajabu Abdallah	commissioner for Education city academic officer (education)	29-10-96 30-10-96
[C3] [C4]		Wolf	town planner	11-01-93
[C5]		Komba	town planner	31-10-96
(C6)		Saïdi	land officer for Temeke · Temeke branch	29-10-96
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[F2]	Urban Development	Hayuma	director of Urban Development	06-04-93
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(F3)		Mushi	town planner	29-10-96
[F4]		Mabugo	land officer	24-10-96
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[G]	Ministry of Water, Energy and Minerals	Sechu	design engineer	24-10-96
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[01] [02] [03] [04] [05] [06] [07]	Tanesco, Head Office	Kiyeyeu Sofia Masawe Chanji, I. Semela Tweve, A.M. Lawuo, J.	engineer distribution & commercial services engineer distribution & commercial services manager rural electrification engineer rural electrification economist rural electrification senior pl.&design engineer rural electrification computer operation manager	92/93 (several *) 92/93+96 (,,) 92/93 (,,) 92/93+96 (,,) 92/93 (,,)
[P1] [P2] [P3] [P4]	Tanesco, coastal zone office	Gura Massasa Safishu Fumbuka, E.G.	zonal engineer trainings centre (protection) zonal distribution engineer technician zonal distribution engineer	10-03-93 21-04-93 19-04-93 06-11-96
[01] [02] [03] [04] [05] [06] [07] [08]	Tanesco, Temeke regional office (Kurasini)	Kiyeyeu Kyando Mtega, C.F. Munisi Tobias Harumna Ally Lujatu	2 nd regional manager mains distribution engineer mains engineer design & planning mains distribution engineer distribution engineer technician technician / meter reader engineer (Tanesco workshop)	Oct 96 (several *) 92/93+96 (,,) 19+25-10-96 92/93 (,,) 92/93 (,,) 05-03-93 14-12-92 10-03-93

APPENDICES

Α	Tanzanian industries classified
В	Definitions
С	Exchange rates
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E	Map of Mbagala
F	Factors related to industrial development; an institutional approach
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1	Questionnaire for industries
J	Answers of questionnaire
K	Mbagala socio-economic survey
L	Esmap methodology
M1	Proposed electricity network in Dar es Salaam in 2007
M	Damp and maintenance registration
N	Daily curve measurements
0	Transformer load data, K3 feeder
Р	Factors influencing the electricity demand: a morphological approach
٥	Industrial load forecast
R	Results of total load forecast
S	Research background

ISIC	division / major			government industries		co-operatives		total
code	group name	10-49	50 and more	10-49	50 and more	10-49	50 and more	
21	coal mining	0	0	0	1	0	0	1
23	metal ore mining	46	11	.0	0	0	0	57
29	other mining	33	5	10	9	1	2	60
31	food, beverages and tobacco	52	37	13	46	15	6	169
321- 322	textiles and wearing apparal	43	34	6	14	39	16	152
323- 324	leather and footwear	15	4	1	6	1	0	27
33	wood and furniture	165	26	31	12	53	2	289
34	paper and printing	45	12	6	5	0	0	67
35	chemicals and related products	33	20	3	8	1	0	65
36	non metallic mineral products	15	6	7	9	4	0	41
37	basic metal	0	0	0	6	0	0	6
381	metal products	67	20	12	5	10	1	115
382- 383	machinery	18	10	7	6	0	0	41
384	transport equipment	21	19	8	3	2	1	54
385- 39	other manufactu- ring industries	12	6	3	2	3	0	26
total		565	210	106	132	129	28	1170

Tanzanian industries classified to sector, scale and ownership^(23,24)

location	ownership	no of employees					total
		10 - 19	20 - 49	50 - 99	100-499	over 500	
Dar es Salaam	private	127	94	67	42	6	336
Saldalli	public	3	11	16	20	13	63
	co-operative	21	10	1	0	0	32
interior	private	214	130	48	36	11	439
	public	45	47	23	32	28	1.75
	co-operative	69	29	14	13	0	125
total		478	321	169	142	58	1170

Tanzanian industries classified according to scale, ownership and location[23,24]

Description of industrial sectors

2 Mining and quarrying

The coal reserves are not exploited in Tanzania, only one coal mine is registered. All 57 gold mines are private owned and most of them are established in the regions Rukwa and Mwanza. Most of the other mining activities concern salt mines and aggregate mines (aggregate is a cement additive).

31 Manufacture of food, beverages and tobacco

The products of this sector are diverse. Main ones are cooking oil, milled grain, beer, soft drinks, black tea and cashew nut kernels and liquors.

The sector comprises relatively many large scale companies, most of them situated in the regions Tanga (black tea), Iringa (black tea), Mtwara (cashew nuts) and Morogoro (mainly refined sugar). Among the largest industries in Tanzania belong two breweries and three tobacco processing industries.

321 Manufacture of textiles and 322 Manufacture of wearing apparel except footwear

The textile industries are of a relatively large scale. Main products are cotton lint, produced by ginneries situated chiefly in the regions Morogoro and Shinyanga, and cotton yarn. Almost all ginneries are co-operatives. The production fell dramatically in the 1980's.

323 Manufacture of leather, leather products and substitutes and

324 manufacture of footwear

The leather industries are of a relatively small scale. Seven out of twenty-seven industries have more than 99 employees, of which three are tanneries. The main activity at smaller scale is the production of shoes.

33 Manufacture of wood and wood products, including furniture

This sector is dominated by private small scale industries, with a few large government industries in the interior. The main activities in this sector are timber sawing and furniture manufacturing. A third one is carving of ebony sculptures, which mainly concerns enterprises with less than 20 employees.

34 Manufacture of paper and paper products, printing and publishing

Most of the paper and printing enterprises are situated in Dar es Salaam. A relative large number of industries is of medium scale, with 20 to 49 employees. Only three industries produce paper. The sector consists mainly of printing industries and stationeries.

35 Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products

Most chemical industries are located in Dar es Salaam and have between 20 and 100 employees. Their gross output is relatively high. The types of products are diverse. 12 of the 55 chemical industries produce soap, 7 cosmetics, 6 medicines and 6 paints.

36 Manufacture of non-metallic mineral products, except products of petroleum and coal

Non metallic mineral products concern the raw material cement and products of cement, clay and glass. The cement industry consists of three portland cement industries, established in Dar es Salaam, Tanga and Mbeya. They are government owned and belong to the largest industries in the country. The processing industries are mainly factories producing bricks, tiles and clay pots.

37 Basic metal industries

The six basic metal industries are government owned, four of them with 100 to 500 employees. Five are situated in the main industrial area in Dar es Salaam, with Aluminium Africa Ltd. as largest producer. These industries produce metals to supply the metal processing industries of division 38.

381 Manufacture of fabricated metal products, except machinery

The 115 industries in the sector make a range of different metal products. There are industries producing nails, knives, buckets, spares and tools. Welding activities are practised on a small scale.

382 Manufacture of machinery except electrical and

383 Manufacture of electrical machinery, apparatus, appliances and supplies

Thirty-one industries produce non-electrical machinery. Twenty-five of them are established in the interior, producing grain milling machines, charcoal stoves, machine spare parts and saw milling machines. The electric motors to drive this machinery are produced by sector 383 or are imported. Sector 383 contains 10 industries. Pemmaco produces electrical motors for industrial purposes. Suppliers of the electricity sector are TANELEC, producing mainly transformers and switchgear, two other switchgear producers and Tanzania Cables, producing electric conductors. Other products are batteries for cars, lamps and radios.

384 Manufacture of transport equipment

The transport equipment industries are of medium scale. The main activity is the production of bodies for busses and trucks, concerning 16 industries. Other activities are the building of motor bodies, the assembly of trucks, production of machinery parts, production of boats, ox-carts and bicycles. The latter three concern industries of relatively small scale. Garages are not included in this sector. Car repair is not a manufacturing activity and belongs to ISIC division number 9, services.

385 and 39 Other manufacturing industries

The remaining manufactured products are measuring and controlling equipment not classified elsewhere, watches and clocks, jewellery and industries not classifies elsewhere. This group concerns a mere 19 industries with diverse activities.

Definitions

automation

Automation is use of self-controlled operating machinery. Men supervise the process, but do not operate it by hand.

electricity grid in Mbagala

The electricity grid in Mbagala comprises of the distribution feeder and local distribution networks. The distribution feeder presently consists of an 11 kilovolt feeder from the substation at Kurasini, including the connected low voltage transformers. The local distribution network operate at 400 volts. Physically the feeder and grids consists of wooden poles, cross arms, pole strengthen stays and supporting poles, overhead conductors, conductor connecting insulators, transformers, fuses and switches.

electricity quality standards

The quality standards for medium voltage distribution grids are set by Tanesco. For urban areas this concerns:

- 1. The voltage drop may not exceed the value of 5 percent of the nominal voltage.
- 2. The annual energy losses may not exceed the value of 4 percent of the energy distributed annually.

Other quality parameters as frequency, reliability, phase balance and switching phenomenons are not expressed in quality standards.

factors

Factor is an other word for variable. Applied to this research, 'factors influencing industrial development' are prime variables which will move the variable industrial development to a certain extent. By making a variable operational, it can be expressed in a quantitative value and eventually be measured.

human capital

Skills and knowledge of people, used for economic activities.

industry

An industry is a productive organization meeting all of the following criteria:

- 1. using machinery to make or process products
- 2. selling products for a market
- 3. producing a certain number of products, intended to do this constantly
- 4. producing products with a certain degree of standardization, thus not at customer specification only

industrial development

Industrial development concerns the long term pattern of changes of the three components of industry: inputs, transformation process and output. Long term means a period of more than one year.

industrialization1)

Industrialization is the improvement of efficiency of industrial production. Efficiency is the ratio of total output to all inputs used²⁾. For the purpose of comparison the inputs and outputs are expressed in monetary values, adapted to inflation. Industrialization may take place by changing technology, human capabilities, economic infrastructure, etcetera.

institute

An institute is an organization which embodies a part of an institution. For example, a ministry is an institute which is part of the political institution.

institution

An institution is a formalized, standardized and collective function of the society. Distinguished are the economical, political, kinship, educational, health and religious institution.

maintenance

Maintenance of a technical system is defined as all activities which are aimed to maintain or restore the technical condition of that system, necessary to fulfil its function.

maintenance concept

Mbagala

Mbagala is part of the district Temeke, which is part of the region of Dar es Salaam. It is defined as the two wards³⁾ Mbagala and Charambe. These two wards are physically bordered by the Kizinga Creek, Mzinga Creek and sources of these rivers and roads. This is illustrated in figure B1 [D]

The administrative codes concerned are:

region	07	Dar es Salaar
district	073	Temeke
ward	073	Mbagala
ward	103	Charambe

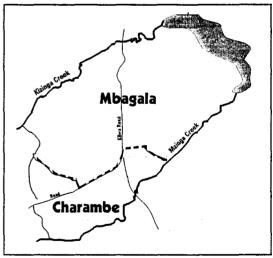


Figure B1 Mbagala, definition

The definition used is applicable at micro level and efficiency related. This differs significantly from definitions used by economist describing industrial performance at macro or meso level. Tanzanian economists mostly describe the contribution of industry to the GDP and detail as far as the performance at industrial sector level is concerned. This performance mostly concerns characteristics as output, value added or capacity utilization.

²⁾ Industrial efficiency is also named productivity.

³¹ Tanzania is divided in regions, which are divided in districts. These districts consist of wards, the smallest administrative area definition used.

mechanization

Mechanization is the use of machinery, which is manually operated.

production process

The transformation process used to make the finished products out of the inputs. The process includes all equipment and human activities directly related. A framework used to structure the components of the transformation process distinguishes human-ware, orgaware, techno-ware and info-ware^[x].

social capital

The attitude to take economic decisions on the base of trust rather than on rational economic behaviour. Trust relates to all other people, but may be restricted to a certain social institution. For this research entrepreneurship is the most interesting part of economic decisions.

squatter area:

A residential area which is build without government permission and planning. Mostly the inhabitants build their houses themselves and with the support of constructors of the informal sector. Infrastructure performs bad and is not well planned. The entity of a squatter area is not defined, it may be a mtaa or geographical bordered area.

Real exchange rate of Tanzanian Shilling; value of one US American dollar

year ¹¹	value of Tsh	depreciation [%]
1985	16,50	
1986	51,41	211
1987	83,72	63
1988	124	48
1989	190	53
1990	197	4
1991	234	19
1992	335	43
1993	486	45
1994	530	9
1995		
1996	605	

¹⁾ In December

lending rate, June 1995 33.8 % discount rate medium and long term, June 1995 49.2 %

Tanesco electricity tariffs

sources: [x], [x] and [x]

old tariff 1 residentials

Applicable to premises used exclusively for domestic and private residential purposes.

0 - 100	0 - 100	5	10	see new tariff 1
101 - 7500	0 - 1000	7	15	
	1001 - 2500	15	38	
	2501 - 7500	28	60	
over 7500	0 - 1000	15	38	
	1001 - 7500	28	60	
	over 7500	55	100	
		service cha	rge per meter reading	period [Tsh]
0 - 1000		150	200	
over 1000		500	1000	

old tariff 2 light commercial

Applicable to shops, restaurants, theaters, hotel clubs, harboers, schools, hospitals, airports, lodging houses, group of residential premises with one meter and on premises where similar business or trade is conducted and where consumption is less than 7,500 kWhr per meter reading period.

0 - 200	0 - 200	7	23.50	shifted to
over 200	0 - 1000	20	42	new tariff 1
	1001 - 2500	40	75.50	
	2501 - 7500	65	90	
	over 7500	75	120	
		service chi	arge per meter readin	g period [Tsh]
0	- 20	250	500	
ove	er 200	1,000	2,000	

consumption range			
		charge rate [Ts	
[kWhr / month]			
		93 from 7 1	
	from Jan 19:		994 from Nov 1995
 Residence de la consequencia della consequencia de la consequencia de la consequencia de la consequencia della con			

old tariff 3 light industrial

Applicable to premises engaged in production of any article / commodity or in industrial process where the main use of electricity is for the motive power, or an electrochemical or electrothermal process and where the consumption is less than 7,500 kWhr per meter reading period. Connection is performed low voltage with three phases.

0'- 1000	0 - 1000	6	21.50	shifted to	
over 1000	0 - 1000	16	40	new tariff 1	
	1001 - 2500	37.50	75		
	2501 - 7500	55	90		
	over 7500	75	120		
service charge per meter reading period [Tsh]					
all		1,000	2,000		

new tariff 1 residentials, small commercial and light industrial

Applicable for general use of electricity; including residential, small commercial and industrial use, where the average consumption is less than 7,500 kWhr per meter reading period.

0 - 100		17.20
101 - 500		27
501 - 2500		70
over 2500		130
	service charge per mater reading period	[Tsh]
0 - 100		200
101 - 500		750
501 - 2500		1500
over 2500		3000

charge type and unit ch		charge rate [Tsh]
	from .ian 1993	from ? 1994 from Nov 1995

old tariff 4 and new tariff 2 low voltage supply

Applicable for general use where power is metered at 400 volts and the average consumption in more than 7,500 kilowatt hours per meter reading period. Connection is performed low voltage with three phases. Both the energy and maximum kVA use are measured.

demand charge [Tsh / kVA]		1,600	2,900	6,250		
unit charge [Tsh / kWhr]	first 150 * BD	25	55	59		
	next 150 * BD	20	50			
	remainder	17.50	45			
		service charge per meter reading period [Tsh]				
all		20,000	40,000	4,000		

old tariff 4a agricultural consumers

Applicable to agricultural consumers whose consumption is more than 5,000 units per meter reading period engaged in direct raw farm produce production and / or processing.

demand charge [Tsh / kVA]		1,000	2,300	shifted to	
unit charge [Tsh / kWhr]	first 150 * BD		47,50	new tariff 2	
	remainder	15	43		
		service cha	rge per meter reading	period [Tsh]	
all		20,000	40,000		

old tariff 5 and new tariff 3 high voltage supply

Applicable for general use where power is metered at 11 kV and above.

demand charge [Tsh / kVA]		1,400	2,600	4,600
unit charge [Tsh / kWhr]	first 150 * BD	24	50	53
	next 150 * BD	20	41	
	next 150 * BD	16	37.50	
	remainder	14	30	
		service cha	rge per meter reading (period [Tsh]
all		30,000	40,000	4,000

						ang					cha					
		an														
								om			rom			fror		

old tariff 5A high voltage supply energy intensive consumers

Applicable to high tension consumers whose demand is above 5,000 kVA and consumption above 800,000 kWhr per meter reading period.

demand charge [Tsh / kVA]		1,300	2,900	shifted to
unit charge [Tsh / kWhr]	first 150 * BD	20	45	new tariff 3
	next 150 * BD	18.50	41	
	next 150 * BD	16	37.50	
	remainder	14	30	
		service char	ge per meter reading p	eriod [Tsh]
all		50,000	80,000	4,000

old tariff 6 and new tariff 4 public lighting

Applicable to public lighting and places of worship.

unit charge [Tsh / kWhr]	<u> </u>	5	15	21.30

old tariff 8 water supply accounts

Applicable to all public water supply pumping installations with consumption above 10,000 kWhr per meter reading period.

demand charge [Tsh / kVA]	1,000	2,200	
unit charge [Tsh / kWhr]	14	43	
	service cl	harge per meter reading	period [Tsh]
all	20,000	40,000	

old tariff 9 and new tariff 5 Zanzibar supply

demand charge [Tsh / kVA]	1,083.57	1,083.57	1,500
unit charge [Tsh / kWhr]	5.70	5.70	10.00
	service ch	arge per meter reading	period [Tsh]
	0	0	4,000

Notes

1. BD = Billing Demand

The billing demand is the higher of the kVA maximum demand during the month and 75 % of the highest kVA maximum demand for the preceding 11 months.

Provided that during the first year of operation the BD shall be the higher of the kVA maximum demand during the month, and 75 % of the highest kVA maximum demand recorded commencing from the month the consumer is connected.

- 2. Meter reading period is the period of time elapsing between any consecutive readings of the meter and / or maximum demand indicator installed by the company but with exception of their first and last period. Each such period shall be as near to thirty days as possible.
- 3. These tariffs are applicable only to supply of electricity to consumers with power factor not lower than 0.95 in case of lighting loads or 0.9 in case of other loads. Otherwise power factor surcharge shall be applied on the normal charges.

industrial organizations in residential areas

1	S. Ally	grain mill	16	A. Mohammed	grain mill
2	Seifu Baker	grain mill	17	S. Njopeka	grain mill
3	Basnen	grain mill	18	Saphy	grain mill
4	M. Bawizir	grain mill	19	J. Tulshi	grain mill
5	H. Chikane	grain mill	20	Joachim Vaz	grain mill
6	Diso Enterprise	grain mill & saw	21	Nia Welders	metal work,
7	Kipati	grain mill			car repair
8	K. Lukosi	grain mill	22	Omary F. Yamba	grain mill
9	Mahimbo	grain mill	23	A. Zame	metal work
10	R. Mamasse	grain mill	24	?	grain mill
11	Marshalls	grain mill	25	Ndangwa	grain mill
12	Mbagala Industries	grain mill	26	?	grain mill
13	Mbelwa	grain mill	27	Salt Iodation	salt processing
14	Mduluguija	grain mill			
15	Mhina	bricks			

industrial organizations in the industrial area

28	Afro Leather	leather processing
29	Furniture World	furniture
30	Global Sea Products	fish processing
31	Jensen	construction
32	Leyland - DAF	car assembly
33	Leyland - Landrover	car repair
34	Int. Consultant Eng.	construction
35	Tamelt	rooftiles and carpentry
36	Tanita	cashew nuts
37	Tanzania Sheet Glass	glass sheets
38	Marshalls Ceramics	ceramics
39	unknown	build started in 1996

non-industrial productive organizations, concentrations

all concern informal activities and are established in and around residential areas

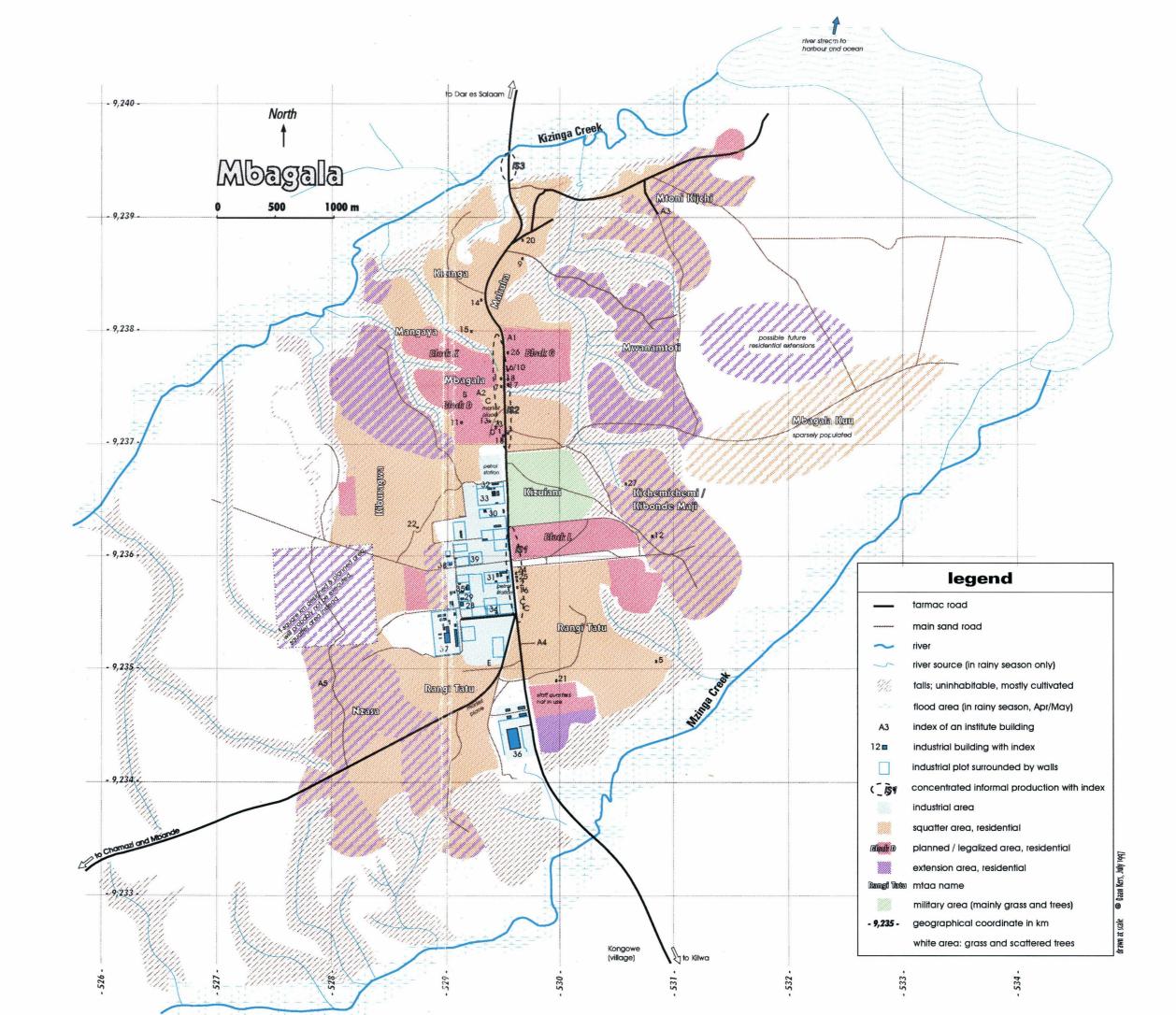
IS1 12 wood/furniture workshops, 5 metal workshops

IS2 6 wood/furniture workshops, 2 metal workshops

IS3 about 5 wood/furniture workshops

institutes

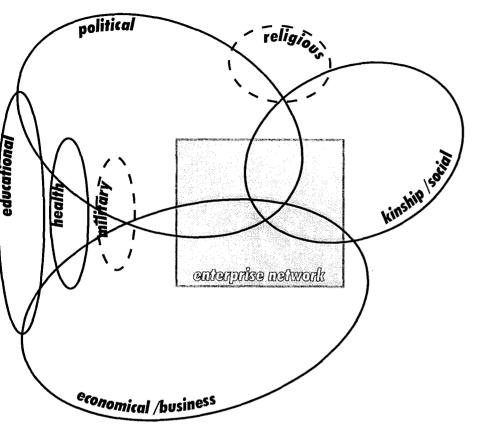
Α1	St Anthonys secondary school	not included:
Α2	Mbagala primary school	mosques and churches
А3	Mtoni Kijchi primary school	electricity network; see chapter 3
Α4	Rangi Tatu primary school	telephone network
Α5	Nsaza primary school	water pipeline and boreholes
В	clinic	public transport stops
С	dispensary	
D	court	not existing:
Ε	police station	post offices



Appendix F	Factors related to industrial development	, from an institutional approach

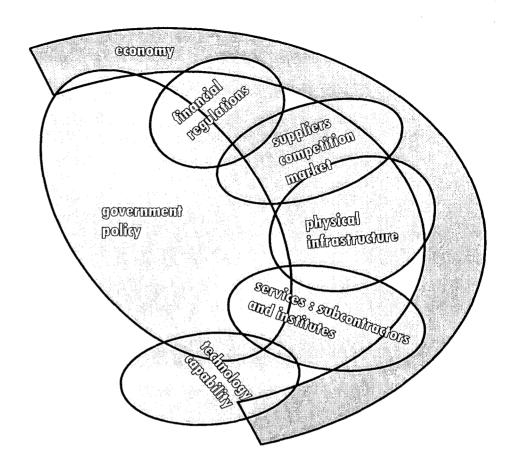
INSTITUTION	GROUP OF VARIABLES	VARIABLE	INDICATOR
economic	land	available land for industrial development	area of available land (acres) not occupied
		price of land	Tsh per acre
	labour	availability of labour	number of unemployed in a specific category
	and entrepreneur	skill level (including entrepreneur)	- (average no. of) years of apprenticeship - type of craft
		knowledge level (including entrepreneur)	(average) no. of years education level of education
		wage policy	types of government regulations employer's custom
		individual wage level	Tsh per month per employee
		family income level	- Tsh. per month - payment in kind
		saving possibilities	percentage of income
		conditions of employment	by industry: provision of transport, housing, payment of health care government regulations employer's custom
		family employees	number of employees which are family of the entrepreneur
	finance	sources of financing	types of financing and their share in total financing
		private capital of entrepreneur	amount of entrepreneur's capital
		loans	- conditions to obtain loans - obtainable amounts
		interest rates of loans	annual percentage
		financial support by development organizations	- amount of financial support - conditions
		supply of foreign currency	- conditions to obtain forex - obtainable amounts
		insurance	- price level (%) of different types of insurance - conditions to be insured
	equipment	reliability of machinery	percentage of time that production is ham- pered due to maintenance of machinery age of machines
	inputs	supply of raw materials and semi-manufactured products	delivery times price fluctuations frequency of periods of shortage
		supply of spare parts and tools	- delivery time - frequency of periods of shortage
		water supply	provision by government y/n continuity of supply quality of water price per 1000 litre shortage
		quality of electricity supply	- voltage level - reliability of supply
		frequency of power cuts	number of power cuts per week number of unexpected power cuts per week duration of power cuts
		electricity price	- expences on electricity as percentage of production costs
	outputs	quality requirements	
	(market)	geographical distribution	the area of the market

INSTITUTION	GROUP OF	VARIABLE	INDICATOR
1110111011011	VARIABLES	FAIRTOLL	indication.
		competing industries	share in the market no. of competing industries their establishments, geographical
	transport	state of roads	- asphalted or sand roads - quality
		density of roads	number of roads to customers
		railways	density of railway grid related to industry transport costs compared with road transport transport time compared with road transport
		sea transport	- no. of shipping companies and harbours of destination
	others	telecommunication	- access to different types of telecommunication - reliability of grid - density of grid (f.e. customers connected)
		sewage system	- provided by government y/n - density of grid
		repair and maintenance facilities	distance to nearest repair and maintenance facilities
politics	tax regulation	import and export tax	height of import and export taxes for goods concerned
		production taxes	heights
		taxes on capital	heights
	industrial law	licences for establishment	conditions for establishment
		prohibition of products due to parastatal monopolies	licences refused by government due to competitive reasons
		laws with regard to operation	number of warnings and fines
		import licence regulation	problems occured w.r.t import licencing
		export licence regulation	problems occured w.r.t export licencing
	government support	subsidizing	amount of government subsidizes obtained government policy w.r.t. the industrial sector concerned
		industrial advising institutes	- number of government institutes which support with technological and general
		industrial insurance boards	- membership of industrial insurance boards - support of industrial insurance boards
	others	bureaucracy	time delays in case of request for licences complaints about bureaucracy by entrepreneur
		security	number of burglaries annually
		participation of employees in decision making	existing of a work council within the enter- prise
health care		health of employees	percentage of absence by employees, caused by illness
religion		preference for specific labour	- preference according to entrepreneur - percentage of religions amongst employees
		reluctance against products produced	occurance of complaints by employees and conflicts resulted
		profession of faith	hours weekly used for the profession of faith during production time
militairy		requisition of materials	number of occurances, kind of requisided goods



dotted line: no part of the research

factors influencing industrialization; a network model to the institutional approach



factors influencing industrialization; a division in groups and their interdependence

morphologic analysis of industrialization at micro level: the Ishikawa diagram

Appendix G Relations between factors: a morphological approach

										_													
			1	2	3	4	5	6	7	8		9	10	11	12	13	14	15	16		17	18	1
	micro level	_																					
1	technology capability			х		X	XX	ХХ	ХХ	XX			М									М	
2	motivation labourers		x				x																
3	wage level			Х		Х												М	М			М	
4	profit		х		х				Х	Х												Х	
5	capacity utilization					XX																х	
6	maintenance						Х						М										
7	prod.process innovation					х	x	x								х							
8	product innovation			<u> </u>	<u> </u>	Х		<u> </u>	Х			[x		M						l
	macro level			···								p. 4.70		4						_			
9	government policy		XX		хх	x		<u> </u>				XX	хх	XX	Х	х		Х	X			XX	Х
10	physical infrastructure						ХХ					,		Х	х	х	Х					XX	
11	services & institutions		Х													Х						х	
12	raw materials					x	ХХ																
13	spare parts ¹¹					х		XX									************						
14	competition ¹⁾			<u></u>		XX		<u> </u>		x													_
15	bribery, corruption				<u> </u>	Х		<u> </u>		<u> </u>						х						Х	_
16	theft					Х	<u> </u>	<u> </u>		<u> </u>]		<u> </u>	<u> </u>								х	
	international level										-								,	, ,			
17	internat. market prices					XX				x				ļ		x						Х	
18	foreign investments						х		}			x					х						
19	foreign aid						x		x			XX	XX	x			x						

factors influencing industrialization: a cross-impact analysis

- x minor relation
- X relation
- XX strong relation
- M no relation for primer variable at micro level, but at macro level

Appendix G Relations between factors: a morphological approa

definitions used in the cross-impact matrix

1	technology capability	knowledge and skills of lat	pourers and management					
2	motivation	satisfaction about work	satisfaction about work					
3	wage level	of labourers and management: gross and nett income						
4	profit	value added minus total costs for means of production and labour						
5	capacity utilization	ratio of quantity of output	produced and nominal production output					
6	maintenance	quantity and quality of cur	rative and preventive maintenance activities					
7	prod. process innovation	modifications at or the pur	rchase of means of production, to improve / maintain the companies rationale of existence					
8	product innovation	design of modifications an	d new products intended to improve / maintain the companies rationale of existence					
9	government policies	collection of regulations:	policy wrt. foreign exchange rate: rate and availability					
			monetary policy wrt. supply of money (obtainability of credits) and inflation					
			industrial strategy → sector support					
			export restrictions					
			import restrictions					
10	physical infrastructure	collection of:	roads					
			communication: telephone, internet					
			water supply					
			sewage system					
			electricity for all: qqc (quality, quantity / availability and costs)					
11	service & institutions	service related subcontrac	etors (wrt. maintenance) and research institutions (qqc)					
12	raw materials	inputs of primary and inter	rmediary goods (qqc)					
13	spare parts	spare parts locally availab	le and directly imported (qqc)					
14	competitors	industries producing the s	ame kind of products or substitutes					
		items:	market position: share, geographical distribution					
			strengths and weaknesses compared to competing industries					
15	bribery, corruption	degree of occurrence of b	ribery and other market disturbing actions (which are considered to be illegally)					
16	theft	theft of means of product	ion .					
17	internat, market prices	value of produced goods a	at the international market.					
		expressed in foreign curre	ncy or local currency with the use of the real exchange rate					
18	foreign investments	foreign investments in ind	foreign investments in industries in Tanzania					
		at macro, meso and micro	level (Tanzania - industrial sector - concerning industry)					
19	foreign aid	gifts and loans of money	under better conditions than at market prices					
		obtained from foreign gov						

registered name	Isic	industry type	remarks	registered namelsic	Isic	industry type	remarks
Global Sea Products	3111	fish processing	out of production	Jensen	511	construction	not industrial
Tamita	3113	cashew nuts	out of production	Intern. Consult. Engineering	511	construction	not industrial
Mahimbo	3116	grain mill	1 mill				
M. Bawizir	3116	grain mill	3 mills	Leyland-Landrover	9	car repair	Isic 9:
Mbagala Industries	3116	grain mill	2 mills	Ruibi Garage	9	car maintenance	not industrial
Seifu Baker	3116	grain mill	4 mills	Classic Motors	9	car maintenance	
A.H. Mohammed	3116	grain mill	3 mills	Mchaki Works	9	car maintenance	
H. Chikane	3116	grain mill	2 mills	Majis Hassan	9	car maintenance	
Mduluguija	3116	grain mill	1 mill	<unknown name=""></unknown>	9	car maintenance	
Kipati	3116	grain mill	8 mills,				
6 in production				3 Way Investments			not found
S. Ally	3116	grain mill	2 mills (1)	Mbosala			not found
Mbelwa	3116	grain mill	4 mills	H. Ally			not found
Saphy	3116	grain mill	2 mills	Sudi			not found
Omary F. Yamba	3116	grain mill	3 mills	Caritas Tanzania	out o	f production, not	industrial
R. Mamasse	3116	grain mill	2 mills			, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
Diso Enterprises	3116	grain mill	2 mills				
	331	saw mill	3 machines				
K. Lukosi	3116	grain mill	disconnected				
S. Njopeka	3116	grain mill	disconnected, closed				
Basnen	3116	grain mill	disconnected				
J. Tulshi	3116	grain mill	disconnected, closed				
Joachim Vaz	3116	grain mill					
Ndangwa	3116	grain mill					
Salt Iodation Plant	311	salt treatment					
Afro leather	3231	leather processing	3				
Furniture World	3320	furniture					
Marshalls	362	ceramics	not industrial				
Tanzania Sheet Glass	3620	glass sheets	out of production				
Mhina	369	bricks					
Tamelt	369	rooftiles					
	3320	carpentry					
A. Zame	3812	metal works	out of production				
Nia Welders	3813	steel manufacturi	ng,				
		car maintenance					
Leyland-DAF	3843	car assembly					

date of visit:

name of company:

name of interviewed person:

function of interviewed person:

1. To which industrial sector the company belongs:

ISIC category	name of sector
311-312	food
	fish processing
	grinding of grain
	processing of vegetables and fruit (canning)
	backeries
	coffee-roasting
	tea processing
313	beverages
314	tobacco
321-322	textile and wearing apparel
323	leather
331	wood and wood products
	sawmills
	joinery works
	boxes, chests, pallets
	rush, plaiting
332	furniture industry
341	paper and paper products
342	printing
35	chemicals, petroleum rubber and plastic products
	coal (a.o. charcoal producers)

ISIC category	name of sector
36	building materials, earthenware, glass
	bricks and rooftiles
	pottery and ceramics
	cement and calc
	concrete, asbestos-cement
	glass
37	basic metal industry
381	metal producers, except machinery
382	machinery production, except electrical
383	electrical machinery, appliances and supplies
384	transport equipment
	motorized vehicles (a.o. cars)
	non-motorized vehicles (a.o. carts and bikes)
385	measuring and controlling equipment, photographic and optical goods, clocks
39	ornaments, music instruments
4	electricity, gas , water
5	construction
	housebuilding
	road construction

other (please specify):

- 2. In which year was the company established?
- 3. The type of organisation of the company is:

private, owned by one person / family	
a Limited company	
a branch factory of a larger national organisation	
a branch factory of a larger international organisation	
a state enterprise (100 %)	
a cooperative	
a joint venture between (please specify):	
	ī

4. How do you finance your enterprise?

own capital		
capital from investors		
loans		
others (please specify)		

- 3. How much personnel does the company have at this location:
 - a. wage labour
- under contract
- temporary labour
- b. family labour
- 4. The type of outputs products is:

P	
standard products	
standard products with standard modification	
standard products with modifications to customer specification	
products to customer specification	
other (pleace specify):	

5. What is the average number of production of finished products per week?

< 5	
6 50	
51 500	
501 5000	
> 5000	

- 6. What is the selling price per product?
- 7. Does the company make use of machinery for the production?

yes	
no	

8. Does the company make use of tools for the production?

few	
many	

9. The company sells the finished products to:

trade companies	
certain individual customers, by appointment	
individual customers who come to see the products and buy	
parastatals	
others (please specify)	

10. Which factors are important for the performance of the company:

factor	unimportant	some unimportant	some important	important
quality of roads				
quality of water supply				
quality of telephone system				
quality of electricity supply				
availability of capital (loans)				
availability of foreign capital				
obtainability of licences				
availability of repair and maintenance facilities				
availability of spare parts and tools				
security				
others (please specify):				

11.	What are	the	expenditures	for t	the ener	gy sources	used	(1991)	?
		****				3,		, ,	

- electricity from TANESCO

Sh./month

- diesel

Sh./month

- others (please specify)

if annual data are not available, monthly data can be used.

- 12. Does the company have standby power sources?

 If yes, of what capacity (kW)?
- 13. How frequently do electricity cuts occur?

What is the average time of an electricity cut?

Do you get prior notice of electricity cuts?

- 14. In which aspects did the company change since establishment, with relation to the production process, capacity utilization, manpower and ownership?
- 15. Has the company extension plans for the coming five years?

Which electricity demand is expected with relations to these extensions?

year	capacity in case of normal production in kW	monthly electricity use in kWhr
1993		
1994		
1995		
1996		
1997		

Inventory list

The main energy using parts in the company are :

		number	energy use	
motors	electrical	••	kW	
	diesel other (please specify):		litre / w	eek
furnaces	electrical	••	kW	
	wood	**	kg / wee	эk
	charcoal other fuel (please specify):		kg / wee	∍k
lighting	electrical other (pleace specify):		· kW	
others	(pleace specify):			

Social-economic survey

The University College of Land and Architecture Studies co-operated with the Sustainable Dar es Salaam Project (SDP) in a research for town planning purposes. In October 1996 the students in Urban & Town planning Magege and Cehpa conducted a study of Mbagala.

The purpose was to investigate the living and related economical situation and needs of the population in Mbagala. These data help the SDP to understand the needs in the different areas of Dar es Salaam for different infrastructural and related services. The need for such information evolved out the lack of data: even basic demographic characteristics are not known, except of an unreliable and outdated population census.

why using this survey

The survey I found interesting for two reasons:

- In the application of the project appraisal I lacked data of the households. This especially
 concerns incomes, spendings, energy use and urbanization patterns. I marked out the
 research for industrialization and could make an electricity load forecast for industries. But
 the household use appeared to be the most sensitive determinant for the total load
 forecast.
- 2. Many factors related to industrialization concern households as well. Although households are excluded from the research, it is wise to get some understanding of their situation and needs. Advised measurements to stimulate industrialization better go in line with residential needs than contradicting them.

Besides, the survey results were most actual. Serious attention had been paid to them because I got convinced of the serious character of the work undertaken by the researchers. However, the results were not mixed up with my own findings and were used for indication purpose only.

methodology

The students, their supervisor 1) and the SDP conducted a questionnaire for households,

based on the components: A basic characteristics

B problems phasing the area, environmentally / physically

C social facilities

D expenditures

All questions were formulated in the Swahili language and asked oral. If an answer could not be restricted to a small number of possibilities, open questions were used. This minimalized the influence on interviewees. Furthermore, low reliability questions were avoided. For example, many people would be reluctant to tell their total household income. Instead, the main categories of household spendings including the category 'others' were used.

Uclas has conducted such studies including questionnaires of other areas than Mbagala before.

The area of research was defined as the ward Mbagala. Before holding the interview, the whole area was visited by the students. They found a geographical division in ten districts, the so called 'mtaa's'. They were taken as strata. To obtain statistically reliable results, ten samples of 20 households each were selected. Since no files of households existed, an adjustment was made to the sample method. Land-survey maps of 1994 (derived from 1992-photo's) were used, containing every single building.

After defining the mtaa borders, 20 buildings were selected in each mtaa, spread over the area. When the building appeared to be not a house where

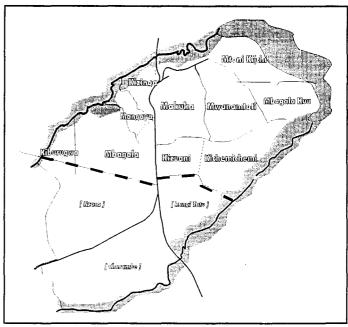


Figure K1 The ten mtaa strata used in the survey

people used to live in, the first house next to that building was selected. The interviewee was one of the representatives of (one of) the household(s) in the house, arbitrary male or female. The total interview was labour extensive: it toke three weeks. Besides the households survey, each mtaa leader²⁾ was interviewed. This was aimed at obtaining qualitative information and control of the results of certain questions in the household survey.

results

The questions and results were translated into English by the students. We went through all questions to control for unequivocalness. For the answers of the individual interviewees separated row numbers were used, to be able to calculate correlations between variables. As far as the measured results concern values with a continuous scale, I calculated the mean and deviation. Only correlations which give useful indications for my research I calculated.

striking differences between strata

A few mtaa's deviate from the average pattern. Households in Mbagala Kuu and Kichemichemi in the remote east part have low incomes (Tsh 73,000 resp 51,000 per month) and a low electricity connection rate (20 % and 15 %). Kizuiani and Kizinga, closer to the centre, have the highest incomes (Tsh 111,000 and 118,000). Other characteristics for these mtaa's do not deviate.

For the rest no clear geographic patterns exist. The highest electricity penetration concern Mtoni Kijchi and Mwanamtoti in the north (70 % and 55 %). Household sizes are small in Mangana (3.6 persons) and Kiburugwa (4.1) in the west. Highest migration patterns concern Mtoni Kijchi, Mangana and Mbagala (all 65 %). Water shortage and malaria are the main problems everywhere (50 % - 85 % mentioned first).

In each mtaa meetings are organized where local problems and actions are discussed. These meetings are chaired by the choosen mtaa leader, mostly an elderly man. The organization of the meetings and mtaa-council is based on local initiatives, without direct government- or other extern influences.

0000000000		
ĦŒ	questi on	änswer
1	what is the education level of household members	50 % primary 4 % higher education
		15 % secondary ordinary level 3 % university
		8 % secondary advanced level 20 % none
2	a what is your origin (born)	52 % Mbagala 48 % from else
	b if from outside Mbagala, where do you come from	40 % town
	}	17 % suburb around town
		43 % inland (of which 8 % Kongowe) 44 % resettlement 5 % employment
	c ,, , what was the reason to come	44 % resettlement 5 % employment 25 % business 3 % availability of land
		18 % better life
	d ,, , year of arrival	average year: 1973
3		quarana 2
J	a what is the number of households in your house b what is the number of members of your household	average: 2 average: 6
4	a what is your employment	63 % private
		22 % parastatal
		9 % government
5	what are the main problems of the area	first priority second priority
		68 % water 11 % water
		13 % health 12 % schools 33 % health 35 % schools
6	a can you contribute to solve these problems	63 % yes 27 % no
	b if yes, how	65 % with money
		35 % with work
7	a has anything undertaken yet to solve these problems or	19 % yes 81 % no
	do plans exist	20.00
	b if yes, how	68 % money contribution 32 % road construction
8	a is it possible for a car to reach your place	60 % yes 40 % no
	b if no, how far is the nearest place to reach	on average: meters
	c is there any transport problem in this area d if yes, which ones	40 % yes 60 % no accessibility
		·
9	a where do you throw your solid waste	51 % burning 7 % along the road
		28 % in a pit 0 % others
	b if your waste is being collected, how is it processed	13 % in a municipal area 78 % burning
	To your waste is being conected, now is it processed	16 % by municipal
		7 % just left
10	a what are the main disease in your household	66 % malaria
10	a while the main disease in your nousehold	23 % diarrhoea
		12 % aids
	b where do you get your health facilities	77 % Mbagala 6 % Muhimbili hospital
		13 % Ilala 5 % Temeke
11	a what are your total monthly expenditures on:	on average average total
		70 % food Tsh. 61.200 Tsh. 86.900
		10 % energy 8,600
		5 % transport 4,600 <u>average total per capita</u>
		1 % water 1,200 Tsh. 14,500
		2 % house rent 1,500 (US \$ 290,- per year)
		1 % school fees 1,100 10 % others 8,500
	b which energy sources do you use:	74 % charcoal 70 % kerosine
	a termin unorgy sources as you use.	34 % electricity 0 % gas
		50 % firewood 0 % others
	1	0 '4 (ucaanna 0 '4 Afficia

the household income distribution

mean, monthly	86,900 Tsh
standard deviation	63,900 Tsh
Gini coefficient	32.7 %

The household income is relatively equally distributed in Mbagala, as showed in figure K3. It shows a pattern even more like west-European countries than that of Tanzania.

This is explained by the low incomes in Mbagala, compared to the rest of Dar es Salaam. Higher income households do not go to live in Mbagala. You will find them especially the areas north of the city centre.

In this light it might seem striking that the annual per capita income (US \$ 290,-) is about threefold that of Tanzania. This is caused by low incomes in the dominating agricultural rural areas in Tanzania. Largely self-subsistence farmers generate relatively low sold surpluses.

correlations

For this research the relation between income and electricity connection is useful. Both variables are positive correlated as expected, but not very strongly: +0.37.

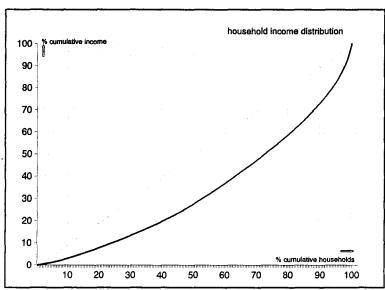


Figure K2 Household income distribution of Mbagala, 1996

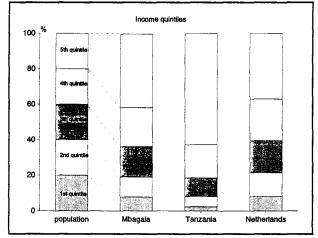


Figure K3 Income quintiles of Mbagala, Tanzania and the Netherlands

Probably the relation is causal, but other factors cloud it. For example, difficult access to the nearest grid point to be connected can cause long connection delays.

Proposed relations as 'origin from Mbagala → income', 'income → kind of main problem' and 'education → income' are not existing³⁾. The latter one might seem striking, but is explainable because formal employment needing higher education, as larger industries and institutes, does not exist in Mbagala. Because other relations were not found interesting for the research, a cross-impact matrix was not made.

The correlation coefficient of 'native from Mbagala' → 'income' is -0.02. The income of those who mentioned water, health or school as the main problem, as well as malaria, hardly did deviate from the overall average. Relating income to education gave a deviation for university degree only: 15 % above average income.

Methodology used by Esmap

The Esmap methodology is presented in figure L1. At first the energy losses and voltage drop are calculated for the recent situation. Then the load forecast is made, by which the energy losses and voltage drop for the whole project time are calculated. If the voltage drop or energy losses exceed the maximum values, grid improvements are designed. For the grid design the voltage drop and energy losses are calculated, using the same formulas as used for the existing grid. A cost benefit analysis of the grid rehabilitation project is executed, in which the benefits are the energy saved and reliability improvement by the new grid. For this purpose the economic values of the energy losses and power cuts are determined.

Both formulas for energy losses and voltage drop are constructed with the assumption that the load at the branches are equal and the distances between the branches at the feeder are equal too. In case of irregular intervals and large differences between loads the formulas may not be used.

energy losses

The energy losses are calculated by the formula[x]

$$P_{losses} = \mathbf{3} \times I_{\text{max}}^2 \times r \times I \times LLF \times \frac{(1+2^2+...+n^2)}{n^3}$$

$$I_{\text{max}} = \text{the maximum value of the current, averaged for the three phases}$$

$$r = \text{the resistance of the conductor per kilometre for one phase, in ohms}$$

$$I = \text{the length of the feeder in kilometres}$$

$$LLF = \text{the loss load factor, which is the proportion of the average losses and the maximum losses}$$

$$n = \text{number of branches of the feeder}$$

Both the maximum current and the loss load factor are determined by measuring the daily curve of the current of the feeder. To obtain the loss load factor the load factor (LF) is determined at first, by calculating the proportion between the average current and peak current. Then the loss load factor is calculated by the formula^[x]

$$LLF = 0.9 \times LF^2 + 0.1 \times LF$$

Measuring takes place in the substation where every half hour or hour the load of the feeder is noted. It is desirable to measure both the power factor and the current, but mostly only the current in the phases is measured in the substations.

The length of the line is estimated by using maps and drawings. Data of resistance values of standard type conductors are available.

The formula part $(1 + 2^2 + ... + n^2) / n^3$ presents the multiplying factor for distributed load. An uniformly distributed load with n is infinite large results in a minimum multiplying factor of 0.3.

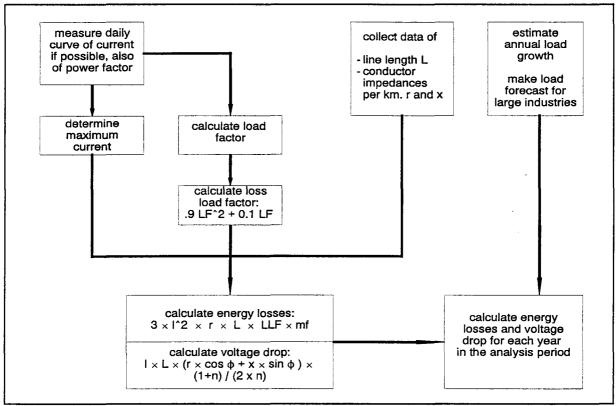


Figure L1 Methodology for medium voltage improvement by ESMAP, technical part

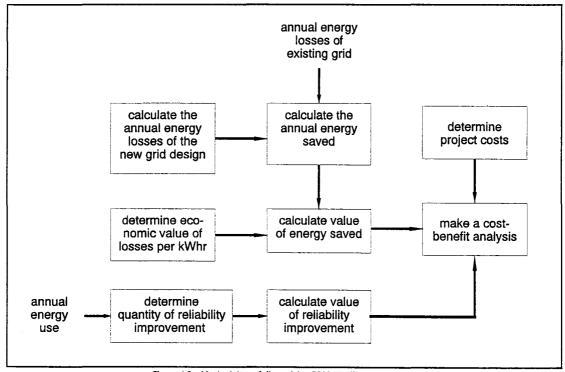


Figure L2 Methodology followed by ESMAP, financial analysis

maximum voltage drop

The maximum voltage drop is calculated by the formula[x]

$$V_{\text{max}} = I_{\text{max}} \times I \times (r \times \cos \varphi + x \times \sin \varphi) \times \frac{1+n}{2 \times n}$$

 I_{max} , I, r = as described above, under 'energy losses'.

= the reactive impedance of the conductor for one phase per kilometre, in ohms

 ρ = the power factor angle

n = number of branches of the feeder

Data of the reactive impedance of standard type conductors are available. The power factor angle is measured at the peak load. If measurement is not possible, the value is estimated. The number of branches is presented at drawings of the feeder. $(1 + n) / (2 \times n)$ presents the multiplying factor for the line end voltage. For uniformly distributed load with n is infinite large the factor is equal to 0.5.

load forecast

In general for load forecasting a growth percentage of 6 percent is used. This forecast is based on a model of average economic growth. Depending on typical characteristics of the load area the load growth will deviate. In urban areas with low building activity and in which most houses already are supplied of electricity the annual growth will be smaller. The area supplied by the K3 feeder is an area in development and the load growth will probably higher than 6 percent. The overall estimation made in the Esmap study is plus 9 percent per year.

cost benefit analysis

The economic value of the energy savings and reliability improvements form the benefits of the project. The costs of the designed project are calculated and a cost benefit analysis is made.

For the maximum voltage drop and energy losses allowed standard values of 6 percent and 4 percent respectively are used. If these values are exceeded, a new grid design is made. The voltage drop and energy losses for this grid are calculated with the same methodology as used for the existing grid. If these values meet, the economic values of energy saved and reliability improvement by the grid design is determined.

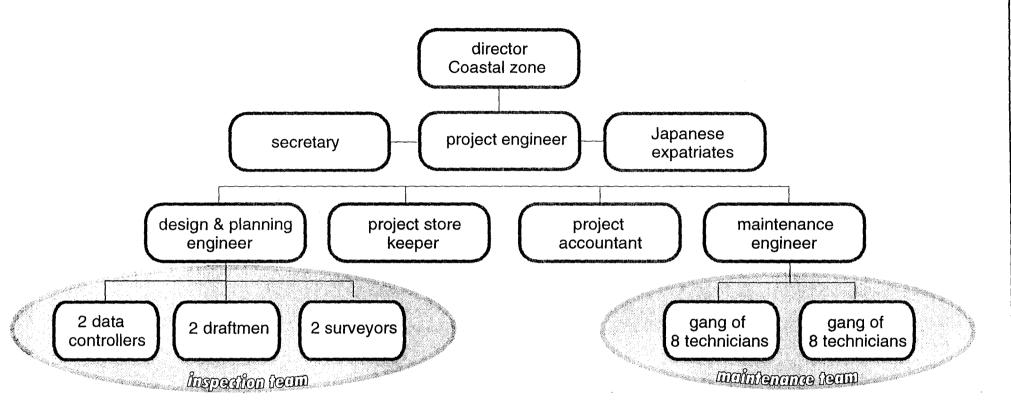
For the energy losses the economic value per kilowatthour has to be determined. The total electricity production costs consist of the costs for the capacity installed and the operational costs. Both are determined at a national level. The energy price is obtained by dividing the sum of both costs by the annual energy generation. In Tanzania the operational costs are relatively low, because the main raw material used is streaming water from the rivers (hydro power).

For saved losses the marginal costs of electricity are a better criterion than the average production costs of electricity. In years before extension of generation capacity the marginal costs are high. In case of overcapacity (new power station build) the marginal costs are low.

The economic costs of electricity concern the consumers as well. In case of energy short-ages power rationing is required. This results in high losses for industries, for which the economic value is difficult to determine. A rough estimation of economic costs of outages made is one US dollar per not delivered kilowatthour.

The marginal costs of electricity for the years 1992 to 2010 are calculated by the Canadian energy bureau Acres, in which a situation of energy losses is predicted from 1994 to 1996. The average marginal costs of electricity at distribution level is determined at 10.4 US dollar cents per kWhr and 7.9 US dollar cents at transmission level. An annual discount rate of 12 percent is used in the calculations.

For the value of reliability improvements the costs for outages of one dollar per not delivered kWhr is used. This is an average value for all customers. The annual amount of reliability improvements is estimated at 1 percent of the total annual energy use, with a variation from 0.5 to 1.5 percent. In most cost-benefit analyses the value of reliability improvement exceeds the energy savings by far.



organization chart of Damp

WEEKLY WORKS SCHEDULE (DAMP) From 4/11/96 MONTH NOVEMBER to 10/11/96 DATE TUESDAY WEDNESDAY MONDAY THURSDAY FRIDAY . SATURDAY SUNDAY REMARKS ORK-DESCRIPTION Date: 8/11/96 Date: 9/11/96 Date: 16/11/96 Date: 4/11/96 Date: 5 1196 Date: 6/11/96 Date: 7/11/96 DB feeder LV Lines. INE INSPECTION DATA COLLECTION & SORTING Con Three transformer Compiling data in Proposed 11KV double circuit for INE MAP DRAWING Survey Sheets for UPDATING MG4 & MG5 MG4 and MG5 MEASUREMENT OF EARTH RESISTANCE OF T/F Compilation of Data up to Data collection Summarizing the COMPILATION OF POWER from Itala & ybundo Data October 31st, 1996 Centrals NTERRUPTION STATISTICS POLE NUMBER PLATE Suspended IXING OLE NUMBER PLATE Suspended **JANUFACTURING** DESIGN MATERIAL

PRE CUREMENT & PREPERATION extension of liky

DF MAINTENANCE WORK

BESTIMITE PREPARATION

For the proposed

For the propo Material Pre-arrent for Tandale works weekely works Schedule preparation for next week. 1) Switching 1) Switching 11) Transformer Installation i) Surtching i ii) Stay fixing at Pole 12 11 \$13 i) Suntaking ii) LT lines ii) Stringing 4 spans 6 wires, (Asse 100mil) i) Switching Shifting in) Fixing LT stay Veltage improvement ii) Flying Stay fixing iii) old poles at Jangwani between pole NO 2 Beach including at pole No 4 iii) LT fole hole! uprosting iv) Transformer Carrier Construction (iv) Dressing LV iii) old poles upnoti excavation and execution MR Sato's house and others lives on new v) Farthing arrange iv) Section formation HIT pole. (ii) - Tree cutting at pole Nº 4 & Nº 6 - Disc replacement and compressions MAINTENANCE WORKS at Kunduchi forder

Appendix M Damp and maintenance registration

					DATE:07.0	CTORFR 94.
POLE No	MBL-54	MBL- 55	MBL-56	MBL-57	MBL-58	MBL-59
SPAN LENGTH (M)	6	0 5	50 5	1 5	7 4	9
ABS OR TRANS CAPA						
ALIGNMENT & CONDITION			——————————————————————————————————————	——————————————————————————————————————		## 0 %
REMARKS.		Pin Insulators Cross error Wood Pols L.V. Pols.	Pn Insulators Cross orm Wood Poli LV. Line	Disc Insulators Cross own Wood pole L.V. Line	Pin Insulaturs Cross cym Wood Pole L.V. Line	An Insulations Cross arm. Wood belo L.V. Line
POLE No	NBL- 59	MBL-60	WBT- 21	WST-65	WRT-63	WET- 24
SPAN LENGTH (M)	5	a 3	3	9 5	51 6:	12
ABS OR TRANS CAPA			TRANSTERAGE 200 KVA P/M. MICKI MITCHGANI			
ALIGNMENT & CONDITION			-11-0-1100-1111-1-1-1-1-1-1-1-1-1-1-1-1		Spik Arion F	# ***
REMARKS	·	Pin Insulatera Cross arm Wood Pala LV Lina	Pin Insulator Cros: arm vocad Pols Lv. Line.	Pin Insulations Cress arm Wood File L.V. Line	Pin Insulaters DISC Insulaturs CRES CAM WEED, Pelle L.V. Line	Disc Insulations Cress crim Wood Polk Livi Lina
MEMO						

JULY :99611 KV SERVICE INTERRUPTION IN DAR ES SALAAM MBEZI 5/5 MIKOCHENI S/5 OYSTERBAY S/5 UBUNGU S/5 CITY CENTER S/5 1.29T 2.33 1.55 E3 | 2-58 0.63 B1 1.1 10.6d 2.83 18163 11 12 13 0.01 B1 B43 1:25 1:25 1.73 15 B1 53 B37 B3 B143 1.35 16 18 19 B1 1.33 Appendix M 20 21 134 1.2 <u>22</u> 83 18:31 *2*3 Damp and maintenance registration 1.76 <u>24</u> 186 <u>25</u> 1313 26 6.97 <u>27</u> 0.01 181 1.35 28 053 BA 29 JC. m m mo

B= Over Current-C = Forth Kamit

1= Red place 2= Yellow Where

Appendix M. Damp and maintenance registrati

INSPECTION REPORT FOR DISTRIBUTION LINES

Date of inspection:	Name of Feeder:	Voltage:kV
·	CABLE RECORDS:	
Connected between:	<u> </u>	
Length: metres.		
DETAILS OF INSPECTION	INSPECTION REMARKS	REMEDIAL MEASURES TAKEN
Termination condition		
Lightning Arresters:		,
i). Installed?		
ii).Earthed?	,	-
Physical condition of the cable:		·

inspected by.....

i). Outer sheath

iii).Any other observations

ii). Armour

. r

•	INSP	ECTIO	N REPO	ORT FO	R DIS	TRIBU'	rion i	INES	
Date of ins	spection:./	./ <i>4./94</i>							
Name of Fee	eder: .C.	-12	. POLE NUM	MBER	C7-12 MLK			:	e sa
Voltage:	kV				15				
,	•							•	
	<u>P 0 1</u>	LE RECORI	<u>) s</u> :						
Type of cor	nstruction:	WISH B	TRN	: • • • •	Number of	stays:/	Type of p	ole: Stul	ple
Transformer	r installed	50 kva G/	м; р/М '	• :					
ABS/LBS Ins	stalled?	Any Rem	ark		· • • • • • • • • • • • • • • • • • • •		• •		
Physical al	lignment:								
1)Intermed	iate 2)Pin a	ingle 3)Stra	ight line s	ection 4)Te	erminal 5)Li	ne section	angle 6)H p	ole 7)TEE O	FF- Nos
8)Double ci	ircuit.								
DETAILS OF INSPECTION	preceding span length	pole condition	surroundings	Anti climbing devices	Cross arms	Stays	Conductors for pre-span	Insulators	Terminations/ sections/ Jumpers
INSPECTION REMARKS	/	(100c)	r. Pro	- jucal	Cred	Putton Congrap	Crod	Cross	Crowd
REMEDIAL MEASURES						· Gan			

TAKEN

time	imean [A]
20:00	295
20:45	290
21:15	278
22:00	252

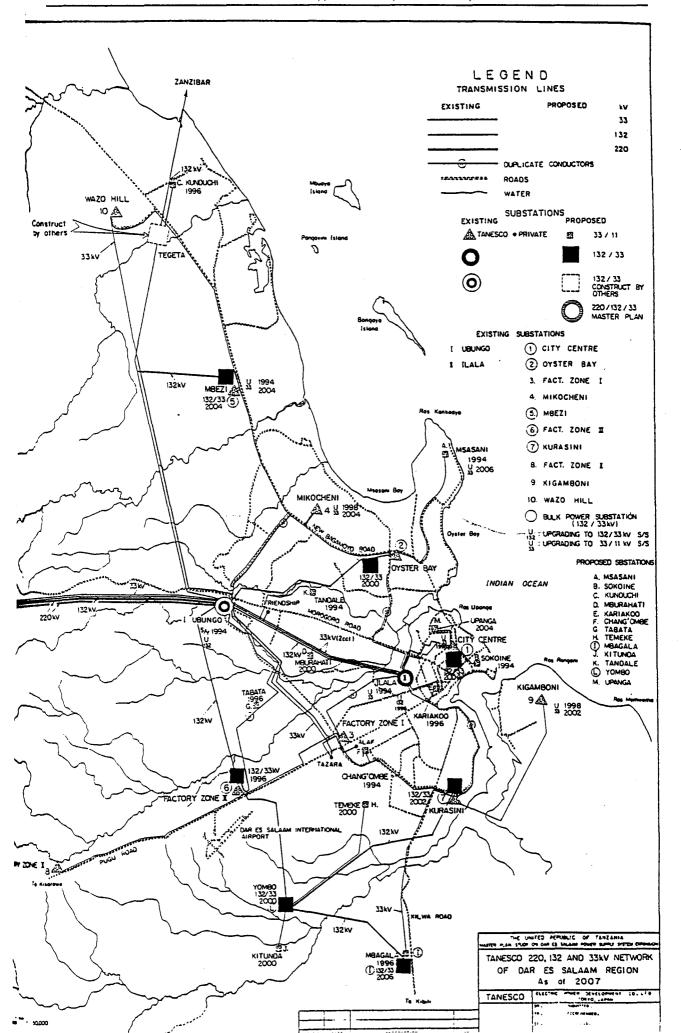
Load data of K3 feeder, 3-3-1993, measured by Kurasini Office

time	[1 [A]	12 (A)	13 [A]	lmean (A)
17:00	72	72	71	72
17:30	71	71	70	71
18:00	79	79	77	78
18:15	85	84	84	84
18:30	102	100	100	101
18:45	130	124	124	126
19:00	143	138	138	140
19:15	0	113	115	
19:30	0	115	117	
19:45	0	115	118	
20:00	0	113	115	

Measurement of load of K3 feeder, 7-4-1993

notes:

The values of 7-4-1993 are noted as they were indicated by the meter, which scale is doubled. These values have to be multiplied by 2. The values after 19:00 are caused by a failure and are neglected.

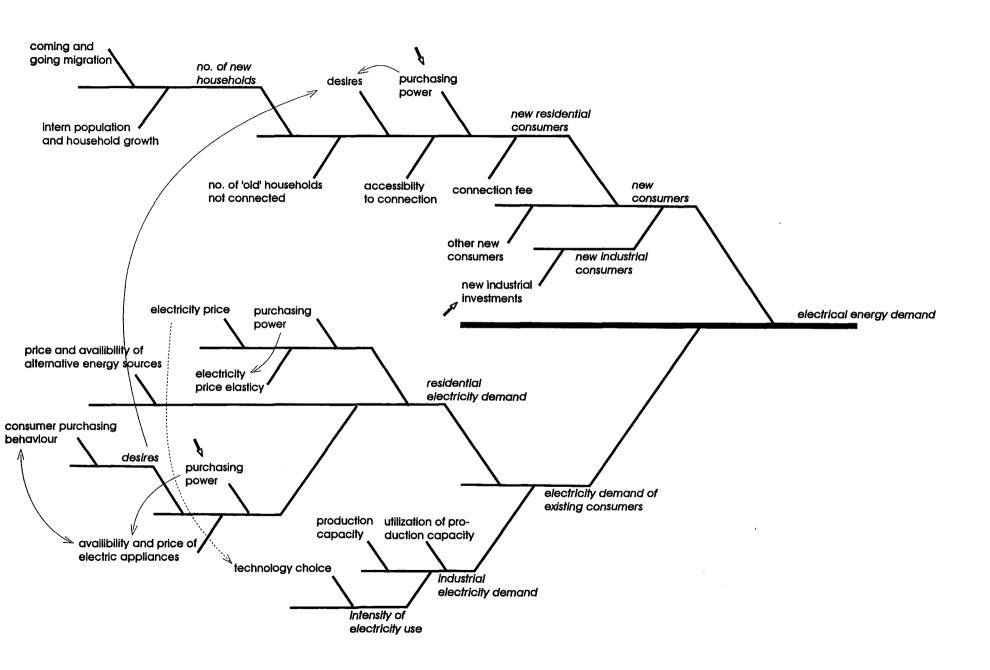


trafo	data m	easured at	April 24 th	at peak	co	llected per	ak load da	ta,	peak load	capacity
no.	Ired	lyellow [A]	İbiye	lblack 1)	lred	lyellow	Iblue	iblack 11	1993 ²⁾ [kVA]	[kVA]
1					210	60	110	130	87	100
2			****		40	10	50	40	29	100
3									195	300
4									130	200
5									130	200
6				·					130	200
7-18								}	1690	2600
19									130	200
20			-		250	340	200	150	228	315
21									65	100
22-28									715	1100
29									33	50
30-32									500	1500
33	70	65	65	9	55	30	55	30	46	200
34	180	17	140	120	125	32	30	105	77	200
35	180	155	145		44	170	170	70	111	200
36									260	400
37									130	200
38					40	130	90	165	75	100
39									0	200
40					70	60	50	20	0	200
41					45	55	50	20	43	100
42									130	200
43	2	4	0		150	100	50	100	87	100
44									65	100
45	2	4	1	3					65	100
46									0	200
47									0	200
48-51									0	3200
52	55	65	85	55					47	100
53									65	100
54					20	25	20	0	0	100
55	0	3.5	0	3.5	50	50	65	20	48	100
56					55	50	65	20	0	500

Transformer load data, Feeder K3

¹⁾ The black conductor is the neutral connection

The data from 1990 are multiplied by 1.25. The power factor is assumed to be 0.9 for each transformer. For the load of the remaining transformers their capacity is used as distributive code. The total load of the line is 5400 kVA.



Tanzania Sheet Glass

account no 11.06.42.001

Not producing since 1983

designed peak load: 1200 * 0.6 kW (source TANESCO, own statement 4000 kVA)

Producing conineously, in 3 shifts

Load factor 0.7 Power factor 0.8

Transformers: 2 * 1250 kVA, 2 * 800 kVA

Diesel standby generator 800 kVA

expectation:

restart of sand benigication and crushing plant

5 hours per day, 4 days per week

load factor 0.1 full load 200 kW

power factor 0.9 (corrected)

Afro Leather

account no 06-76-20001-0 / 11.06.45.001

Machinery:

Rotating drums driven by motors.

together 60 kW, PF. 0.8

Flashing machine

50 kW

Sanding machine

40 kW

- Splitting machine

Will be delivered

One shift, 8 hours

Own statement: peak load 133 kW, PF. 0.8

Load factor 0.2.

Furniture World

Machinery:

Stripping machine

2.2 kW

New machine with larger capacity will be purchassed

Double end tenderer

6 * 4.5 kW, PF. 0.86 1.9 kW, PF. 0.9 2.5 kW, PF. 0.76

Edge band machine

2.2 kW, PF. 0.84 6 * 0.6 kW, PF. 0.7

Circular saw

2 kW

- Drilling machine

2 * 1.5 kW, PF. 0.82

Extraction fan

11 kW

Compressor

4 kW

Production is starting up One shift, 8 hours peak load 65 kW Load factor 0.1

Levland-DAF

account no 06-75-01001-3

The only machinery used are a drilling machine, two welding machines and electric hand drills.

Transport bridge is build.

One shift, 8 hours

Peak load expected 15 kW, PF. 0.7

Load factor 0.2

load will probably decrease in the future

Leyland-Landrover

account no 06-75-01101-x / 11.06.40.701

Machinery:

circular saw about 3 kW turning lathe 2.2 kW drilling machine 1 kW machine to align wheels about 5 kW engine-block cleaning machine 4 kW, PF. 0.8 electric welding machine 20 kVA electroplate and spraying machine 4 kW, PF. 0.7 drier 7.5 kW, PF. 0.75 18.5 kW, PF, 0.78 compressor 3 kW, PF. 0.75 water pump

One shift, 8 hours

Peak load on max.kVA meter 62 kVA

Diesel generator: 36.6 KVA

Power factor 0.75-0.80

Load factor 0.1

No load increase expected

Global Sea Products

account no 06-75-01701-8

Not producing since 1992

Machinery:

Container cooling 37 kVA
 Ice machine 1.9 kW
 Cooling of working room about 30 kW
 Freezer 19 kVA

One shift of 8 hours

Peak load about 90 kW, PF. 0.9

Load factor 0.7

will not produce anymore

Jensen

account no 11.06.41.001

Machinery used in carpentry workshop and metal workshop.

Peak load 140 kVA, PF. 0.85-0.9

(including brick factory with peak load of 70 kW built in 1994)

One shift of 8 hours

Load factor 0.2, will increase to 0.3. load will not increase coming years

Tamelt

account no 06-75-30001-5 / 06-75-30021-x

Machinery: 30 kW, about 35 kW, 3 * 15 kW

One shift of 8 hours Total peak load 120 kW

Load factor 0.1

Tanita

account no 06-75-30001-5 / 11.06.44.001

Not producing, will probably start up again in 1994

Full production at 8:00-21:00, during night lower production

Peak load 350 kW, PF. 0.9

Load factor 0.4-0.5

Annual energy use 1989-1991 of Pugu Road factory 450-776 MWhr

Marshalls

crushing machines 1.5 kW

1 kW

boremill

4 kW 2.2 kW

clay mixers

0.5 kW

oven

110 kW

power factor 0.8 load factor 0.2 peak load 115 kW

expection: constant load

grainmills

average peak load 35 kW

power factor 0.7

load factor 0.3, will become 0.2

average monthly production 2000 kWhr

about 15 grainmills (formerly 23)

number and individual load decreases

one larger grainmill:

Kipati account number 06-69-23001

with 8 mills, sum peak load 165 kW, actual peak load around 70 kW

Mbagala

	resid	residential forecast				
year	growth; new consumers	growth; existing consumers	peak load (MW)			
1996	18 %	10 %	2.6			
1997	18 %	10 %	3.4			
1998	18 %	10 %	4.4			
1999	18 %	10 %	5.7			
2000	18 %	4 %	7.0			
2001	18 %	4 %	8.6			
2002	18 %	4 %	11			
2003	18 %	4 %	13			
2004	18 %	4 %	16			
2005	18 %	4 %	20			
2006	18 %	4 %	24			
2007	18 %	4 %	29			

industrial forecast					
growth, new consumers	growth, existing				
	consumers				
5 %	3 %	0.4			
5 %	3 %	0.4			
5 %	3 %	0.5			
5 %	3 %	0.5			
17 %	7 %	0.6			
17 %	7 %	0.8			
17 %	7 %	1.0			
17 %	7 %	1.2			
17 %	7 %	1.6			
17 %	7 %	1.9			
17 %	7 %	1.3			
17 %	7 %	2.4			

Temeke amd Mtoni

general growth	peak load (MW)
10 %	4
10 %	4
10 %	5
10 %	5
10 %	6
10 %	6
10 %	7
10 %	8
10 %	9
10 %	9
10 %	10
10 %	11

results of the load forecast, whole area supplied by K3 and K5 feeders

	existing areas	development areas
year	load (MW)	load (MW)
1996	2.6	0
1997	3.1	0.3
1998	3.7	0.6
1999	4.5	1.1
2000	5.5	1.6
2001	6.3	2.3
2002	7.3	3.4
2003	8.5	4.5
2004	9.8	6.3
2005	11.9	8.4
2006	13.8	10.2
2007	16.2	12.8

the load forecast divided into area supplied in 1996 (existing areas) and not supplied in 1996 (development areas), Mbagala

Research background

The reader should be informed with the background of a research. What was the occasion to undertake it, which preparations had been made, which problems occurred in the field and what will happen with the report ?¹⁾

the research occasion

In the spring of 1992 I started to think about a subject for my final research. The research group ITDS, seeing an increasing number of students coming, decided to focus its activities on industrial development in Tanzania, especially in Dar es Salaam. Many relations between Dutch and local students and other researchers, as well as local institutes and companies, would provide a research network. With the results of the students researches a framework could be set up, with the Tanzanian industrial development as central theme.

Besides observing, the Dutch research group has participated in a number of industrial activities in Dar es Salaam, by means of its Centre for International Cooperative Activities (Cica). Local management was advised and trained, Dutch students undertook studies and industrial investments had been funded. The main local relation for Cica (so for ITDS) has his residence and influence in Mbagala, in the very south of Dar es Salaam. This suburb is where the Cica started two industrial projects. Also a Dutch student house was built.

The subject of research chosen by my supervisor and me supported ITDS' interest: industrial development in Mbagala. Because of the electricity component in my study, we took electrification in Mbagala as a related subject. Supposed was that a few factories and households in Mbagala were supplied of electricity of poor quality. In the scope of a suburb rehabilitation program, an electricity project would be implemented by Tanesco, funded by the World Bank. The relevance of this electrification would be the substitution of the use of charcoal for cooking by the use of electricity. Charcoal decreases the national forest reserve, while electricity is generated by renewable hydro power. Besides electricity, many other factors would relate to industrial development, which I could describe as well.

preparation

In the preparation phase in the Netherlands I went into available literature about electrification in developing countries, mostly concerning rural areas.

The WSO in the Hague, an organization for scientific study tours, was contacted. I wrote my research proposal, thought it was quite a good one, defended it successfully and was funded by the WSO for the air ticket costs. Afterthought, I amaze the WSO's approval.

Surprisingly, students and other scientists rarely include such information in their reports. Too many times they describe aims of research and their relevance just as compulsory items, without mentioning who these aims invented and why.

in the field

Once arrived in Tanzania, the situation turned out to be different than expected. Mbagala was supplied of electricity for more than ten years and Tanesco did not have any plan for a rehabilitation or extension project in this area.

Soon was found out that the supposed substitution of the use of charcoal by electricity is not existing in Tanzania, and probably does not exist anywhere. Namely, electricity is not used instead of but additionally to charcoal. I could throw away my research proposal.

Three options remained:

- 1 maintain the subject electrification choose another area, which will be electrified
- 2 maintain the subject industrialization in Mbagala instead of the electrification subject, make an own study about the quality of electricity supply as one of the factors related to industrialization
- 3 go back to the Netherlands and reconsider the whole research eventually choose another one

All of these options meant a significant switch of the research. The first option was applicable for rural areas only. There was need for feasibility studies in this field. But industries could hardly be expected in the rural projects, while I saw industrialization as a central issue in my research. I choose the second option. This one had the disadvantage that nobody in Tanzania was interested in the research.

Fortunately (for me) the electricity quality appeared to be fairly bad in Mbagala, hampering the industrial development significantly. I was able to describe this process and could place it in a broader frame of industrialization. Attempting to make an electricity load forecast, the grid adaptions required to meet a reasonable quality of electricity supply were determined. Back in the Netherlands the write of the report started.

back home

I didn't know where to write the report for. In fact this had been the case with the whole research: in Tanzania nobody needed it so I didn't get serious criticism. People at Tanesco and other institutes had been helpful to supply data, but a one-way communication without discussion and dialogue is not what you need for serious research. I was not satisfied with the quality of my research.

I decided not to finish my study and fulfilled my civil service for one year, followed by a contract. The experience I gained is in the field of maintenance sciences in a hospital: I worked with the technical services and implemented a maintenance management computer programme. The activities of the research group in maintenance sciences at the faculty of Technology Management at the TUE were used to develop a theoretical basis.

follow op research

In 1995 a follow up study for the 1992/1993 research was prepared. I went through huge files of literature and selected what was useful. I pointed the weak points in my research and formulated which information needed to be obtained. A return to Tanzania proved to be necessary for two purposes:

- 1 To describe a process of development. In 1992 industrial performance had been measured as a random indication. By measuring a second time with an interval of four years I expected to be able to describe a development. Besides, the 1992 information became outdated.
- 2 To improve the quality of my research. The aim was to obtain a well founded framework of factors influencing the industrial development. Namely, I found my old research results too 'free floating'.

I saved money, bought a ticket to Dar es Salaam and took with me my old report and an action schedule for 6 weeks. This time I worked more motivated and purposive, visiting 19 industries and 24 branches of 16 institutions. The results achieved stem not only from serious work, but good fortune as well:

- Mbagala had been changed, its industrial activity changed as well. I measured not the same results as I did four years before.
- The grid rehabilitation in Mbagala I recommended in 1993, was funded and planned to start in 1997. Finally there was need for the research.
- My relations at Tanesco were re-established very quickly. Moreover, one of the persons I worked with in the head office in 1992 /1993 became acting regional manager of the Temeke district and as such responsible for the coming Mbagala grid project. A dialogue developed, instead of just asking and receiving data.
- Tanesco felt a major need for maintenance engineering: exactly the field I gained experience in last three years. In 1995 Tanesco started to set up a maintenance programme, with Japanese assistance. Four years ago I considered the construction of the project and not the continuation of it: a classic error in the history of development aid.

The follow up research had to be marked out, but the wanted information could be collected. Coming home I wrote my report and sent six copies to concerned people in Dar es Salaam: four to Tanesco: to the acting regional manager of the Temeke region mr. Kiyiyeu, to the director of Corporate Planning & Research mr. Sumari, and to two engineers from the department of Corporate Planning mr. Tweve and mr. Chanji. Furthermore one to the coordinator for city expansion at the Sustainable Dar es Salaam Project mr. Kanza and one to the town planning students Cehpa and Magege.

I hope to defend my research successfully at the end of this year.